Lesson 1: The Energy Connection

Overview

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.

Teacher Background

In this initial activity, students consider how familiar items in an "Energy Discovery Box" relate to energy. Some of the items have more obvious connections to energy than others. The exercise is used for engaging students' thinking and surfacing their current understandings about energy. Students dig deeper into the items' energy connections in the culminating lesson (Lesson 8). For this reason, use an explorative approach with this exercise as opposed to expecting students to generate definitive and exhaustive answers.

Detailed descriptions of energy connections related to each item are included in Teacher Resource 1.1. The purpose of this resource is to provide background information and insight for the teacher. It is not expected that students identify or understand these connections to this depth. This initial activity sets the stage for upcoming lessons that more closely examine the interactions between objects and energy.

Key Ideas

- 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.

Lesson Goals

Students will:

- explore their current ideas about energy.
- begin to examine people's interactions with energy.

Vocabulary

energy: the ability to change an object in some way

Preparation

- Become familiar with the energy connections for the suggested Energy Discovery Box items by reviewing the descriptions included in Teacher Resource 1.1. Use the information in the Teacher Resource to determine which items are appropriate to include for your students. Some of the suggested items have highly complex energy connections.
- Gather representative items for the Energy Discovery Box. Select enough items to provide variety and to have a few extra items that could be used to model an annotated drawing for students. It is recommended students work in pairs (one item per pair) but some teachers may prefer to have students work individually (one item per person).
- Consider decorating the outside of the Energy Discovery Box with question mark cutouts or in some other mystery-related way to enhance anticipation and excitement.
- Review the Teacher Reference 1.2. Consider adding personalized examples and transferring the material onto a piece of chart paper, overhead transparency, or slide to make it easier to share with students.
- If using the extension activity, preview the vetted media in the "Energy in the News" on the PowerSleuth website of the Energy for Maine section. Consider substituting or supplementing these stories with more recent energy related ones as they become available in the news and include print material. While previewing the media, create a list of some of the energy related words and phrases that students are likely to identify in the selected media. See extension activity description for suggestions.

Safety

Instruct students to handle items from the "Energy Discovery Box" with care. Some are fragile and several would be harmful if ingested. Review the safe handling of compact florescent light bulbs (CFLs) if using an actual CFL and not the packaging or picture. In the event of accidental breakage, follow the U.S. Environmental Protection Agency's recommendations for clean up and safe disposal outlined at: http://www.epa.gov/mercury/spills/

Materials

Item	Quantity
For *"Energy Discovery Box"* – a cardboard box or plastic tub large enough to hold a variety of props such as: • Small sample of coal (in plastic bag) • Energy bar or drink • Ear of corn • Subway ticket or map or some item representative of public transportation • Wind up or other "human-powered" mechanical toy or device • Mitten • Reusable foil-lined insulated shopping bag • Solar powered calculator • Instant cold pack • Battery (D-cell) or battery operated flashlight • Cell phone or other representative consumer electronics item • Bottle of water • Pinwheel • Clothespin • Energy-efficient light bulb picture or package • Power strip • Picture of Speed Limit 55 road sign • TV remote control	1 per class (Select a variety of items and enough items so that each pair of students has an item.)
Chart paper	1 sheet per pair
Markers	enough for each pair
Masking tape	1 roll per class
Scientist's Notebook	1 per student
Student Handout 1.1: Energy Snapshots Recording Sheet	1 per student
Teacher Resource 1.1: Descriptions of Energy Connections for Suggested Items in Energy Discovery Box	1 as reference for teacher
Teacher Resource 1.2: Sample Energy Snapshots	1 as reference for teacher
Computers with Internet access (optional: for extension)	1 per student or 1 per student pair
Digital camera (optional: for capturing images of students' annotated drawings)	1

Time Required: 2 sessions

Session 1: "Quick write," demonstration of annotated drawing, selection and drawing of discovery box item.

Session 2: Debrief of discovery box item, introduction of energy snapshots, "Energy in the News" extension activity.

Connection to *Maine Learning Results: Parameters for Essential Instruction (MLR)*, and *Benchmarks for Science Literacy Standards (BSL)*

- Energy is required for technological processes such as taking apart, putting together, moving around, and communicating. BSL 8C/M7** (6-8)
- Describe several different types of energy forms including heat energy, chemical energy, and mechanical energy. MLR D3(6-8)h*

Teaching The Lesson

Engage

1 **Introduce "Energy Discovery Box" and "Quick Write."**

Place the "Energy Discovery Box" in a place that is visible to all students. Without showing students any of the items that are in the box, explain that they are about to examine items that relate to energy in some way. Note that some of the items have more obvious connections to energy than others and that it will be their job to figure out the connections.

Before students investigate the items in the box, invite students to consider what they already know about energy by saying something like: *Energy is all around us – it is everywhere! People use energy in countless ways every single day. We are pretty familiar with energy in this sense. How would you describe it?* Direct students to do a "quick write" in their scientists' notebooks, using the following prompt:

- *Use words and pictures to describe energy. Include specific examples.*

Encourage students to write as much as they can in a 3-5 minute time period given because they will be using their descriptions of energy in the next part of the lesson.

> **Note:** *Some students lacking prior knowledge and experiences with energy topics may struggle with generating ideas to include in their Quick Write. Consider following up the Quick Write with a class generated concept map using words and phrases generated by students. This will help pull out additional student initial ideas. Keep the map available for students to refer to as they segue into the next activity.*

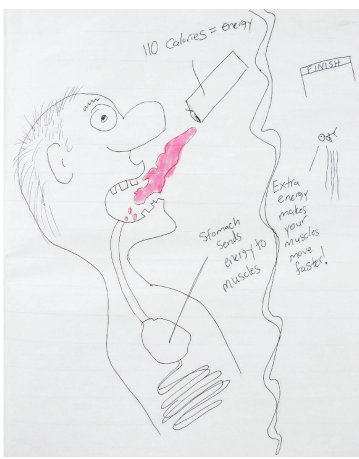
2 **Practice analysis of Discovery Box items.**

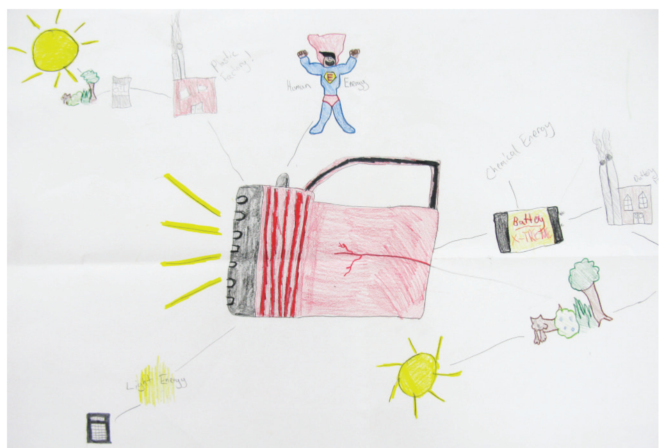
Explain to students that they will develop an annotated drawing. Describe the nature of annotated drawings. This type of drawing includes explanatory notes or brief comments to make ideas clear. Share with students that "annotate" means to add notes to a text or diagram which give explanation or comment.

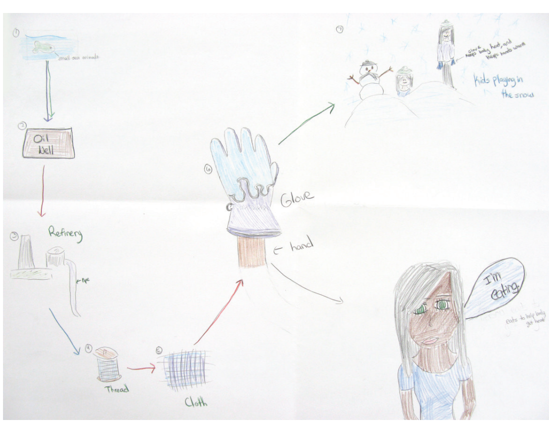
Model for students how to analyze a Discovery Box item by modeling the creation of an annotated drawing. Begin by "randomly" selecting an item from the box. Described here are suggestions on how to create an annotated drawing of a D-cell battery: Make a simple sketch of the battery on a piece of chart paper or blackboard. Begin to add a few words that illustrate the connections the battery has to energy. Draw a line from the battery's center and ask students for a suggestion as to connections that they could make – perhaps write "stored" or "source of" energy here. Continue to model ways of thinking about the connections by talking through the thought process out loud. Students may suggest that devices could be connected to a battery to receive energy - add this notation. Model referencing the concept map generated earlier to make more connections. Also, encourage students to refer to their Quick Write notes as they make more connections. Push for students to include as many connections as they can and acknowledge that some may be more obscure than others. For instance, the battery's plastic cover is a petroleum product. Petroleum is made from plants powered by energy from the sun and by animals that had ultimately been powered by energy from plants.

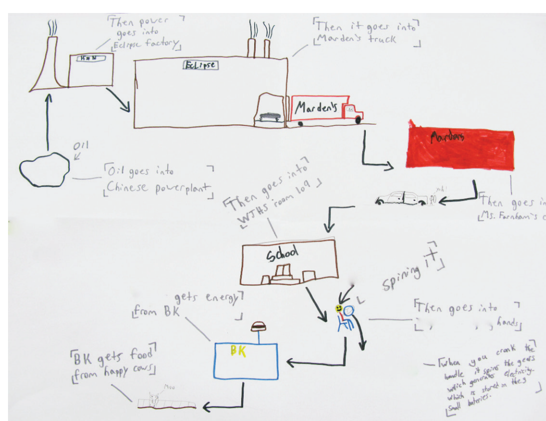
Consider showing students additional examples of annotated drawings of familiar topics. Point out how annotations are useful to briefly explain or label important ideas and words depicted in the drawing.

Included here are a few samples:









3 Facilitate the "adoption" of Discovery Box items.

One at a time invite student pairs to, without looking, randomly select one item out of the "Energy Discovery Box." As student pairs make selections, make sure that all students in the class get to see each of the items. At this point, encourage a few comments but limit class discussion about the possible connections since this is the students' next task.

Explore

4 Initiate and monitor creation of annotated drawings.

First, encourage student pairs to brainstorm how their item is connected to energy through a brief discussion (3 minutes). Second, distribute a piece of chart paper to each student pair. Direct students to create an annotated drawing. Encourage students to work collaboratively, discussing their ideas and how to make them clear to others. Emphasize that it is more important to "make their thinking visible," capturing their ideas about the relationship(s) between their adopted item and energy than to get the "right" answer or to have the most artistic drawing. Suggest that students use words or phrases from the concept map generated earlier if they are stuck. Letting students know ahead of time that they will have a limited amount of time to develop their drawings helps shift the emphasis of the exercise to students' ideas rather than spending too much time drawing.

As student pairs work, circulate among groups, examining drawings and listening to conversations. Ask probing questions to promote deeper thinking. As students work, also begin to make note of some of the patterns and ways students' ideas can be grouped. This will aid in the facilitation of the discussion that follows in the next step.

Reflect And Discuss

5 Facilitate discussion of students' drawings.

Have students post their annotated drawings along the classroom walls. Invite students to take a few moments to review their peers' drawings.

Facilitate a class discussion about what they noticed about ideas represented in drawings. Specifically, ask students to comment on what they noticed about the energy connections "made visible" in the drawings. Refer to and point out specific ideas evident in the students' drawings as the connections are discussed. Ask probing follow-up questions to engage students in deeper thinking, but avoid the temptation to "correct" student thinking at this point.

One of the purposes of this initial activity is to surface students' current ideas about energy and its connection(s) to an item. Rather than correcting students' ideas, stimulate deeper thinking about their ideas by replying in an exploratory manner such as: *"I wonder about….."* or *"This is an interesting connection. Could you tell us more about…."* or *"How could someone find out more about this connection?"*

Consider the following discussion prompts:

- *What are some of the connections that items seem to have with energy?*
- *Which connections are most prevalent?*
- *Which connections seem to be unique to particular items?*
- *Which connections did you find surprising?*
- *Which connections would you like to find out more about?*
- *Which connections are new to you; perhaps ones that you hadn't thought about before?*
- *Are there any connections that you disagree with or are not sure about?*

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Assist students in organizing their collective thoughts and preserving them for reflection. Chart and organize students' energy ideas into categories. For instance, students may identify some of the items as energy sources or stored energy or as capable of "producing" energy. Most likely the idea of energy conservation or using energy efficiently will be part of students' conversations. Students may recognize that Earth's energy can be traced back to the sun. They may also talk about ways people use energy, be familiar with different forms of energy, and/or describe energy changing forms. Create a list of "energy" words that surface during the discussion. These words can be displayed on a word wall to help students remember and use these words. Bring the activity to a close by reviewing and summarizing the common connections surfaced in the discussion.

Alternatively, student's drawings can be rearranged and grouped to show various themes or categories that emerge. For an upper level extension, have students include the sun's connections to categories.

Consider taking digital photographs of students' annotated drawings. Photographs can be printed and pasted into students' scientists' notebooks.

6 Introduce "Energy Snapshots."

Say something like: *We certainly have many ideas about energy and we described a number of connections between different items in the Energy Discovery Box and energy. Over the next few weeks we will be examining energy connections and learning how scientists describe interactions between objects in terms of energy.*

Distribute a copy of Student Handout 1.2: Energy Snapshots to each student or have students develop a strategy for recording the snapshot information in their scientists' notebooks. Introduce the idea of snapshots by asking students to think about a situation in which they used or interacted with energy today. Stimulate their thinking by asking: *What are some of the connections you have with energy? For example, how many of you woke up to the sound of your alarm clock going off or the radio playing this morning? How is this connected to energy? How many of you took the school bus to get to class? How is this connected to energy?*

Explain that over the next few days students will monitor their individual connections to energy by selecting up to three different 15-20 minute time periods during which they have a variety of connections to energy. For each time period, students will create an "Energy Snapshot" documenting the sequence of interactions between objects and consider the energy connections. Use the example outlined on Teacher Resource 1.2 to show students how to create a snapshot that tracks the activity sequence and show them how they might describe the energy they think is involved. Emphasize that students should enter descriptions for **"How does this activity or event involve energy?"** to the best of their ability. It is more important for students to enter events and connections they know than to try and identify different energy forms at this point. Determine a due date for students to complete the snapshots before Lesson 6, when these snapshots will be examined.

> **Note:** *The majority of examples given in the "Energy Snapshot" highlight energy interactions in "manufactured" contexts. It would be perfectly acceptable for students to record sequences of interactions that involve living things, but keep in mind that these types of interactions are often more challenging for students to discern.*

Alternatively, have students take 3-5 digital photographs to document their 15-20 minutes of energy use. Students can use the digital cameras built into their Maine Learning Technology Initiative (MLTI) laptops. Students should email photos to the teacher prior to Lesson 6. The teacher will assemble the photos in a slideshow for students to review and analyze in Lesson 6.

Extension

"Energy in the News"

> **Note:** *This activity could be done as an out-of-class or in-class assignment or be available to students that finish their annotated drawings early. Students should review one clip at a time rather than 2-3 in a row at one time. Preview each of the video clips and read each of the articles before assigning them to student groups. Consider substituting these stories with more recent energy-related ones as they become available. Stories on energy-related topics from the local area could be substituted; however, sometimes it is easier for students to discuss topics that are a little more removed from their immediate area especially if they are controversial. This activity could also be used to launch an ongoing "current energy events" assignment, where students bring in articles or locate video clips they find in the media. Students could contribute to an ongoing "bank" or bulletin board of media to reviewed and shared periodically. When using additional media or substituting media, consider selecting stories that are representative of energy topics related to transportation, heating/cooling, and electrical generation so that all energy sectors are represented.*

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1. Review "Energy in the News" video clips and articles.

Ask students about some of the top news stories they have seen or heard about in the news or in magazines. Explain to students that they will be closely examining news stories related to energy.

Direct students to the "Energy in the News" section of the PowerSleuth website under Energy for Maine. Ask students to work individually or in pairs to examine 2-3 of the stories found in the bank. Post the following for students to consider as they review media:

- In what way(s) are the events highlighted in this story connected to energy?

Ask students to make note of the energy connections they see in their scientists' notebooks.

> **Note:** *Magazines specifically geared toward middle school students such as Current Science, Science World, Time for Kids (Grades 4-6), and such also frequently contain articles on a variety of current energy topics.*

2. Discuss energy connections.

After students have reviewed selected media, facilitate a class discussion about the energy connections they identified. Use the same approach as with the discussion of the Energy Discovery Box items. Like before, as students offer their ideas, ask probing follow-up questions to engage them in thinking more deeply and to guide them in seeing connections and patterns. Add any new energy words that surface to the class chart or word wall.

Remember there is no preferred or "correct" way to organize the words and phrases but the activity serves as an exercise in focusing students' attention on the different ways people interact with and use energy and the dependence people have on energy. Students should notice that energy plays a large role in and is connected to every aspect of (modern) life including transportation, electrical generation, heating and cooling, manufacturing, food production, sports, entertainment, etc.

If time allows, consider discussing with students the idea that energy is taken for granted; our dependence on energy often goes unnoticed until it is unavailable or becomes expensive. For example, energy is very much in everyone's mind when a storm causes widespread power outages or when gasoline prices rise at alarming rates. Remind students that people are concerned meeting the energy demands of the 21st century and are actively seeking ways to meet those demands. Explain to students that during the next few weeks, their lessons about energy will include how people use energy and what responsibilities this brings.

Connection to Maine Agencies

A Maine Energy Education Program (MEEP) representative will come to interested schools, free of charge, to guide and support the concepts in this lesson. For more information go to the MEEP website: http://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 References and Resources

Anneberg Media. (1997-2009). Science in Focus: Energy. http://www.learner.org/workshops/energy/workshop1/meanings.html

How Stuff Works
http://electronics.howstuffworks.com/remote-control1.htm

National Academy of Sciences. (2008). What You Need to Know About Energy. Washington, D.C.: National Academy Press. http://www.nap.edu/catalog.php?record_id=12204

National Science Foundation. Climate Change. http://www.nsf.gov/news/special_reports/climate/index.jsp

The Energy Connection

Energy Snapshots Recording Sheet

Date	Activity / Sequence of Energy Events	Approximate Duration	How does this activity or event involve energy?

Descriptions of Energy Connections for Suggested Items in Energy Discovery Box

Note: *The descriptions included here are for the purpose of providing background information for the teacher. It is not expected that students be familiar with the extensive connections outlined below. The descriptions aim to help teachers recognize various facets of information that students may be trying to piece together and aim to provide insight as to students' commonly held ideas or current perceptions of energy. Students will have an opportunity to revisit Energy Box items in Lesson 8 and should be able to articulate more sophisticated and networked connections.*

Coal: Coal is a combustible black or brownish-black sedimentary rock composed mostly of carbon and hydrocarbons. It is the most abundant fossil fuel produced in the United States. Nearly half of the electricity generated in America comes from burning coal. When coal is burned, energy is released. This energy, stored in the sugars assembled by plants that lived hundreds of millions of years ago when the earth was partly covered with swampy forests, is chemical energy. For millions of years, layers of dead plants accumulated at the bottom of the swamps and were covered by layers of water and dirt, halting decomposition, and trapping the energy of the dead plants. Heat and pressure from the upper layers compressed the plant remains into coal. The energy stored in these ancient plants is released when the coal is burned. Coal is a nonrenewable energy source (a fossil fuel) because it takes millions of years to form.

Students may connect coal as a substance that is burned, for example, to fuel trains. Maine has no coal burning power plants or coal mines so students may have limited familiarity with coal.

Energy bar or drink: Food contains chemical energy. The chemical make up (the arrangement of atoms or molecules) of foods determine how much energy they store. The amount of energy available in different foods is measured using a calorimeter.

Scientifically, foods are organic substances containing carbohydrates, proteins, and/or fats and serve as both fuel (an energy source) and building material for an organism. Foods labeled as energy bars typically contain a high concentration of carbohydrates, along with proteins and fats, to give the body fuel it needs to function. During digestion, chemical reactions occur that release the energy stored in the food. Most energy drinks make people feel intensely energized because they offer a quick source of easily and quickly metabolized food and/or often contain other chemicals such as caffeine, that stimulate the central nervous system. This period of high energy is often followed by a sudden period of lethargy. Students often think of energy as a substance and foods labeled using the words "energy" or "power" may reinforce this notion. Because of their labeling, students may believe that "energy bars" or "energy drinks" are somehow their labeling, students may believe that "energy bars" or "energy drinks" are somehow enriched with or possess a special "energy" quality, but in fact, all food (as defined scientifically) is an energy source. Water, vitamins, minerals, caffeine, and spices are non caloric and while some of these may be substances needed by living things and are ingested by organisms, they do not provide living things with energy.

Corn: Corn or maize is the most widely grown crop in the Americas. In fact, as revealed in *The Omnivore's Dilemma: A Natural History of Four Meals* by Michael Pollan, corn is an inextricable part of the American diet. A myriad of foods are made from or contain corn and corn is prevalent in livestock feeds. In recent years corn has been used to make fuels such as ethanol for vehicles and as an ingredient in some plastics. Corn is a plant (a grass) and like most plants, corn is photosynthetic. It is through the process of photosynthesis that carbon dioxide is converted into sugar using energy directly from the sun.

Students will likely identify corn as a food for people and livestock. They may also be somewhat familiar with fuels derived from corn.

Subway ticket or map or some item representative of public transportation: All forms of transportation require an energy source. Currently, the most prevalent modes of transportation, public or otherwise, rely on fossil fuels as their energy source. Gasoline, diesel, natural gas, and propane are all fossil fuels that are commonly used as fuels for public buses. These fossil fuels are formed similarly to coal, one key difference being that coal comes primarily from land vegetation – trees and large ferns that lived millions of years ago while petroleum products (those derived from crude oil, such as gasoline, diesel and jet fuel, and heating oil) generally come from the fossil remains of microscopic animal and plant-like marine organisms (zooplankton and phytoplankton). Crude oil formed as layers of decaying remains build up and become compacted by intense heat and pressure. After crude oil is removed from the ground, it is sent to a refinery. The oil is separated into petroleum products, including gasoline and diesel. Most modern trains are powered by diesel locomotives or by electricity supplied by overhead wires or additional rails. Over millions of years, as crude oil forms, pockets of "natural" gas get trapped. Natural gas and propane are similar but not the same substance. Propane is derived from natural gas as it is being processed. Natural gas is a mix of many gases and propane is chemically pure. Subway systems that Maine students are likely to be familiar with (Boston and New York) run on electricity. As noted above with coal, nearly half of the United States' electricity is generated by burning coal.

In addition to identifying some of the energy sources used to fuel public transportation, students may also make connections to some of the benefits of using public transportation, such as reducing the number of automobiles on the roads, which reduces emissions and helps conserve energy sources.

Wind up or other "human-powered" mechanical toy or device: A number of simple toys and devices- slingshots, bows and arrows, wind-up toys, watches, balloons, music boxes, and bungee cords use the energy of deformed (compressed or stretched) materials. Elastic energy is the energy stored when elastic materials are stretched or compressed. Materials that have elastic properties (such as rubber bands or springs) can be "reshaped" but naturally revert to their original shape when the force causing the deformation is removed. Many wind-up toys contain a spring that becomes compressed or tightened as it is turned by a key. After release, the spring reverts back to its original, decompressed position often turning a series of gears that make the toy "go" and/or produce other interesting effects such as sound or light.

Students readily associate energy with things that are in motion and mechanical devices. They may also make the connection that "human power" is the source of energy for the wind up toy. Some may connect a person's energy back to the food the person ate and ultimately the sun.

Mitten: Maine students are undoubtedly familiar with mittens and know something about why one wears mittens outside in the colder months. The mitten is included in the Energy Discovery Box because many students believe that insulating objects produce their own heat. Children often think of heat as an intrinsic property of a material or object. In other words, students often think of materials as being inherently hot or cold or as containing a certain amount of "hotness" or "coldness." Heat is a form of energy - not a substance - yet it is often described as one. The mitten is not in and of itself "warm." The mitten does not give off heat. The mitten is not a heat source and it does not have a higher starting temperature than its surroundings. The person wearing the mitten gives off heat. The fiber that the mitten is made from has insulating properties that are effective in slowing the transfer of heat energy so the mitten "holds in" the body's warmth thus making the person feel warmer. (See Lesson 1: The Mitten Problem, Energy Heats Maine)

Reusable foil-lined insulated shopping bag: Many products designed to keep things hot or cold (thermoses, travel mugs, home insulation, space or emergency blankets) utilize reflective materials. A key piece to remember as students discuss heat is that "heat" moves – "cold" does not. Materials and substances warm up or cool down because of heat transfers. Foil insulation slows the movement of heat by reflecting infrared radiation. In the case of a silver-lined thermos bottle, the silver lining inside reflects keeps the food hot by reflecting the hot food's infrared radiation back to itself. For the same reason, the most effective way to use an emergency or space blanket is to keep the silver side towards the body.

Students may connect energy to reusable bags by describing the insulating properties of them. They also may realize that reusable bags, unlike plastic bags, are not petroleum based. Students may further know that energy is used to produce and distribute both types, and the reusable feature saves energy.

Solar powered calculator: Calculators are one example of a growing number of solar powered devices available to consumers. Solar powered calculators use solar or photovoltaic (PV) cells which convert sunlight directly into electricity. When light strikes a cell, a certain portion of that light is absorbed by a specially treated material (semiconductor). This material allows the free flow of electrons (electricity). This free flow of electrons, an electric current, can be drawn off and used to power a calculator. For more detailed information, consider reviewing "How Do Photovoltaics Work" by Gil Knier at http://science.nasa.gov/headlines/y2002/solarcells.htm. This resource contains more information about how solar cells work and the history of the development of solar cells.

Students have undoubtedly owned or used a solar powered calculator or some other solar powered device. Students may think that it is the sun or the heat from the indoor lighting rather than its light itself that is being absorbed by the cells. While students do not need to develop an understanding of the complex workings of solar panels, they should recognize that it is light and not heat that is absorbed by a PV cell. Students will probably also be familiar with the use of solar modules on homes and businesses.

Instant cold pack: Typically first aid kits are stocked with "instant" cold packs for quick and convenient treatment of an injury. The packs are made of chemicals (ammonium nitrate and water) that, when mixed together, become "cold." The two chemicals are initially in separate compartments in the pack. When the cold pack is needed, the inner compartment in the pack is broken allowing the chemicals to mix. The chemical reaction that takes place is endothermic (absorbs heat).

It may be counterintuitive for students to associate things that are "cold" with energy. All matter has thermal energy.

Additional information about thermal energy can be found in the teacher background sections of Lessons 1-3 in Energy Heats Maine and/or by visiting NSTA's Learning Center Energy: Thermal Energy, Heat, and Temperature http://learningcenter.nsta.org/product_detail.aspx?id=10.2505/7/SCB-EN.3.1

Battery (D-cell) and/or battery operated flashlight: As in many other electrical devices, flashlights house the components of simple circuits. A circuit is an unbroken path or closed loop which allows electrical energy to flow. The flashlight's components include a pathway for electric current. In a flashlight, the electric current goes through the metal wire (attached to a switch), through the metal spring, through the batteries, through the base of the light bulb, across the filament of the light bulb (if the bulb is an incandescent type), and through the side of the bulb. Without this complete pathway the flashlight will not light.

Students are likely to be familiar with flashlights and will most likely connect the components of the flashlight with energy. Students may recognize that batteries are an energy source and may know that there are chemicals inside the battery that react, acting like a "pump" to move electrical charges through the circuit. The electrical charges are already present in the wires and bulb. The battery, when connected properly, gets the charges moving. Many people think that batteries (and generators) send out a substance that gets "used up" but this is not true. When batteries "die" they do not "run out of electricity" but rather the battery's chemical reaction fails to fuel the movement of the electrical charge.

Students may be aware of other types of flashlights such as mechanically powered flashlights, those that have LED (light emitting diodes) rather than incandescent bulbs and/or those that use rechargeable batteries. (See Lesson 2: Circuits and Electric Light, Energy Lights Maine)

Cell phone: In recent years, there has been a dramatic rise in the number of consumer electronics in households. Today's teens are intimately familiar with cell phones and other small consumer electronics items such as portable music players, hand-held video games, TVs, DVD players, and laptops. These gadgets and the accessories that support them account for one of the most rapidly growing areas of energy use. Consumer electronic products consume about 15% of the electricity we use in our homes today. (Source: ENERGY STAR www.energystar.gov).

Students will most likely make the connection that cells phones require an energy source and in the case of the cell phone this energy source is a rechargeable battery. They may not be aware of the increasing percentage of energy use attributed to consumer electronics. Cell batteries must be periodically connected to an electrical source to recharge. Cell phone and other chargers that are plugged into an electrical source continue to draw electricity even when the device is fully charged. (More about phantom or vampire energy is included in the power strip description.) This idea is investigated in Lesson 7 of Energy for Maine as students use the Kill A Watt meters to monitor energy use.

Bottle of water: Numerous connections can be made with a bottle of water and energy. The most basic connection that students are not likely to be aware of is that the water has potential energy.

Students may make energy connections to water by associating the generation of electricity to hydroelectric dams (See Lesson 6: People Have the Power! Electrical Generation, Energy Lights Maine). They may also describe the movement of water through the water cycle or energy's role in water's change of state including in the context of weather. Students may be of connections similar to those described under the reusable insulated shopping bag or in the energy expended to manufacture and deliver convenience items.

An additional connection students may make is water's connection to living things. Students recognize that living things need water. However they may believe that living things use water in the same way that they use food. Living things need water, not as an energy source, but as the medium in which numerous simple chemicals dissolve, making water a key factor in the myriad of chemical processes necessary for sustaining life. (Refer to the energy bar/drink description for more information.)

Another connection students may make is the use of water for hydrogen powered cars. Visit the sustainable energy section of Chewonki's website to learn more about hydrogen's connection to energy. http://www.chewonki.org/pathways/interactive_poster/default.shtml

Pinwheel: Wind is caused by air flowing from high pressure area to low pressure area. As the sun heats up a certain area of land, the air around that land absorbs some of that heat. The hotter air above the land begins to rise very quickly. This happens because a given volume of hotter air is lighter than an equal volume of cooler air. When that lighter hot air suddenly rises, cooler air flows in. That air rushing in is wind. If an object such as a pinwheel or a wind turbine blade is put in the path of that wind, the wind will push on it, transferring some of its own energy of motion to the blade. This is in essence how a wind turbine, pinwheel, or boat sail "captures" energy from the wind.

Students are most likely familiar with the idea of harnessing wind to generate electricity but probably have not given much thought to the energy transformations and transfers that occur during this process. Students may also be aware of the pros and cons of wind power. (Connect to Lesson 7: Around and Around They Go – Turbines, Energy Lights Maine)

Clothespin: Using a "solar" clothes dryer utilizes the radiant energy of the Sun. The clothes on the line are wet. They have water left in them from being washed. The clothes become dry as the water leaves them. This happens from the effects of the Sun evaporating the water off the clothes. Evaporation is the process by which water is converted from its liquid form to its vapor form and thus transferred from land and water masses to the atmosphere. The rate of evaporation depends upon:

- Wind speed: the higher the wind speed, the more evaporation
- Temperature: the higher the temperature, the more evaporation
- Humidity: the lower the humidity, the more evaporation

It is not uncommon for Maine families to dry their clothes on a clothesline. They may connect using a clothesline as opposed to using an electric or gas dryer to dry clothes as an energy-saving measure. While the practice of using a clothesline is common in Maine, students may not connect this idea to evaporation and the energy associated with this process. Students may have a number of misconceptions about where the water goes when it evaporates. Some students believe that the water simply "disappears" or goes directly to the clouds.

Students may be interested to learn that a bill has been introduced to the United States Senate by North Carolina State Representative Pricey Harrison that would allow people to hang clothes outside to dry nationwide. In some communities this practice is banned. According to the United States Department of Energy's Energy Information Administration statistics from 2001, about 5.8% percent of residential electricity use goes towards the clothes dryer.

Energy-efficient light bulb: Several connections can be made between energy and energy-efficient light bulbs. Energy "efficient" bulbs, for example compact fluorescent light bulbs (CFLs), use less energy to do the same "job." A 25-watt CFL gives off the same light output (lumens) as the 100-watt incandescent bulb using less energy. The 100-watt incandescent bulb produces much more heat and has a shorter bulb life.

Students may discuss "energy efficiency" and wrestle with what is meant by this term. One of the ideas that will be developed through Energy for Maine is the idea that not all of the energy in a particular device gets used the way it was intended to be used (to achieve the "desired" effects). As energy is transformed, heat is given off. In this situation, heat is not a "desired" effect. It may be tempting to refer to the energy that gets transformed to heat or other undesired forms as energy that is "lost" but this may confuse students as they work toward developing an understanding of the Law of Conservation of Energy (First Law of Thermodynamics). (See Lesson 8: Light Bulbs and Energy Efficiency, Energy Lights Maine)

Power strip: The digital displays, illuminated on/off switches, and other glowing "stand by" lights found on many electrical devices are examples of "phantom loads" or "vampire" energy. These devices receive signals or are ready to operate at any time and because of this, they act like vampires quietly drawing energy even when they are "off." This "lost" energy represents a small but growing percentage of an individual home's electricity use (about five percent), but taken across all U.S. households, adds up to an estimated 65 billion kilowatt-hours of electricity each year. This extra electricity costs consumers more than $5.8 billion annually and sends more than 87 billion pounds of heat-trapping carbon dioxide into the atmosphere each year. (Source: Union of Concerned Scientists). Adapters for rechargeable battery-powered cordless phones, cell phones, digital cameras and music players, and power tools are examples of devices that draw power whenever they're plugged into an outlet, regardless of whether their battery is fully charged—or even connected. Other sources of constant draw include appliances or electronic equipment with standby capability (such as televisions and computer monitors), a remote control, and/or a digital clock display (such as microwaves, DVD players, and stereo systems).

To combat these silent energy stealers, completely disconnect items when not in use. Plugging frequently used items into a power strip makes it easier to completely switch devices "on" and "off" with the click of one button.

Students may recognize power strips as being useful in protecting against electrical surges or as a receptacle for plugging in multiple electronic devices. They may also discuss electrical safety including knowledge of how to safely use extension cords as to not overload circuits. (See Lesson 5: Signs of Safety, Energy Lights Maine)

Speed Limit 55 road sign: In 1974 a 55 mile per hour speed limit was put into law as a provision of the Emergency Highway Conservation Energy Act. The law, called the National Maximum Speed Law prohibited speed limits higher than 55 mph part of a nationwide effort to reduce oil consumption. The law was amended in 1987 to allow 65 mph speed limits on certain roadways and in the 1990's the law was repealed putting the decision at the state level. 55 mph was designated top speed because it was thought to be the most fuel efficient speed saving fuel. As it turned out, the energy saved was minimal (about 1%) or about the same amount a driver could achieve by maintaining proper air pressure in their tires. The 55 mph speed limit did save lives the first year the law was in effect. While there is some discrepancy in most efficient speed limit, many sources indicate it is between 55-65 mph.

Many students associate movement with energy. They may also make the connection that vehicles that travel on roadways are fueled by an energy source (gasoline, diesel, electricity, etc.)

TV remote control: Students will suggest connections between a television remote control and energy in a couple of different ways. Most will recognize the remote contains batteries and make connections similar to those described earlier in the section about battery/battery operated flashlight. Students will likely mention that the remote, when directed at the TV, makes the set turn "on" or "off," allows one to turn up or down the volume, and change channels and other settings. Students may make energy connections to the sound and light energy that results from the TV.

Some may have noticed that an infrared sensor is at work in a remote control. Infrared energy is light that humans cannot see, is part of the electromagnetic spectrum, and is similar to visible light. An infrared remote control sends out pulses of infrared light that represent specific binary codes (series of ones and zeros). These binary code sequences correspond to commands, such as "on" and "off" and volume up or down. The TV has an infrared receiver that decodes the pulses of light into the binary data (the ones and zeroes) that the TV's microprocessor can understand. The microprocessor then carries out the corresponding command.

Replacement or Challenge Items:

Something magnetic	Small motor	Speaker
Satellite image	Rubber band	Cheeseburger
Gyroscope	Tuning fork	Blue jeans

Sample Energy Snapshots

Date	Activity / Sequence of Energy Events	Approximate Duration	How does this activity or event involve energy?
	Alarm clock	Few seconds but clock on 24/7	Electricity produced sound and light (displaying time)
	Battery-powered toothbrush	2 minutes	Power from the battery made the tooth-brush rotate. Also heard a buzzing sound.
	Showered	7 minutes	Water was pumped (electricity) to hot water tank where it was heated by oil furnace. (furnace burned oil to warm up water)
	Hairdryer	4 minutes	Electric coils warm up air that the motor draws into the barrel and a fan directs the warm air onto your hair. Dryer makes a noise.
	Refrigerator	opened for 15 seconds but on 24/7	Get juice, milk, butter, and jam from refrigerator. An electric motor runs the refrigerator – keeping food cold. The motor makes a noise.
	Coffee maker	4 minutes	Water is warmed up by electric coils and drips into a pot which is kept warm by a heated burner. The coffee maker also has an illuminated time display.
	Toaster	2 minutes	Hot electric coils toast my bread. I noticed the coils glow bright red! The toast pops out of the top when the toast is ready.
	Checked email on computer	10 minutes	Electricity powered my laptop. Sound and light produced. I also noticed that the laptop gets hot after it is used for a while and sometimes I hear a fan come on.
	Watched morning TV news	20 minutes	Electricity powered TV. Sound and light and like the computer, the TV gets warm after it is on for a while (heat?).
	Went in car to school	15 minutes	Gasoline powered car. Car moves forward (mechanical), has lights, sound, and gets warm after running for a while.