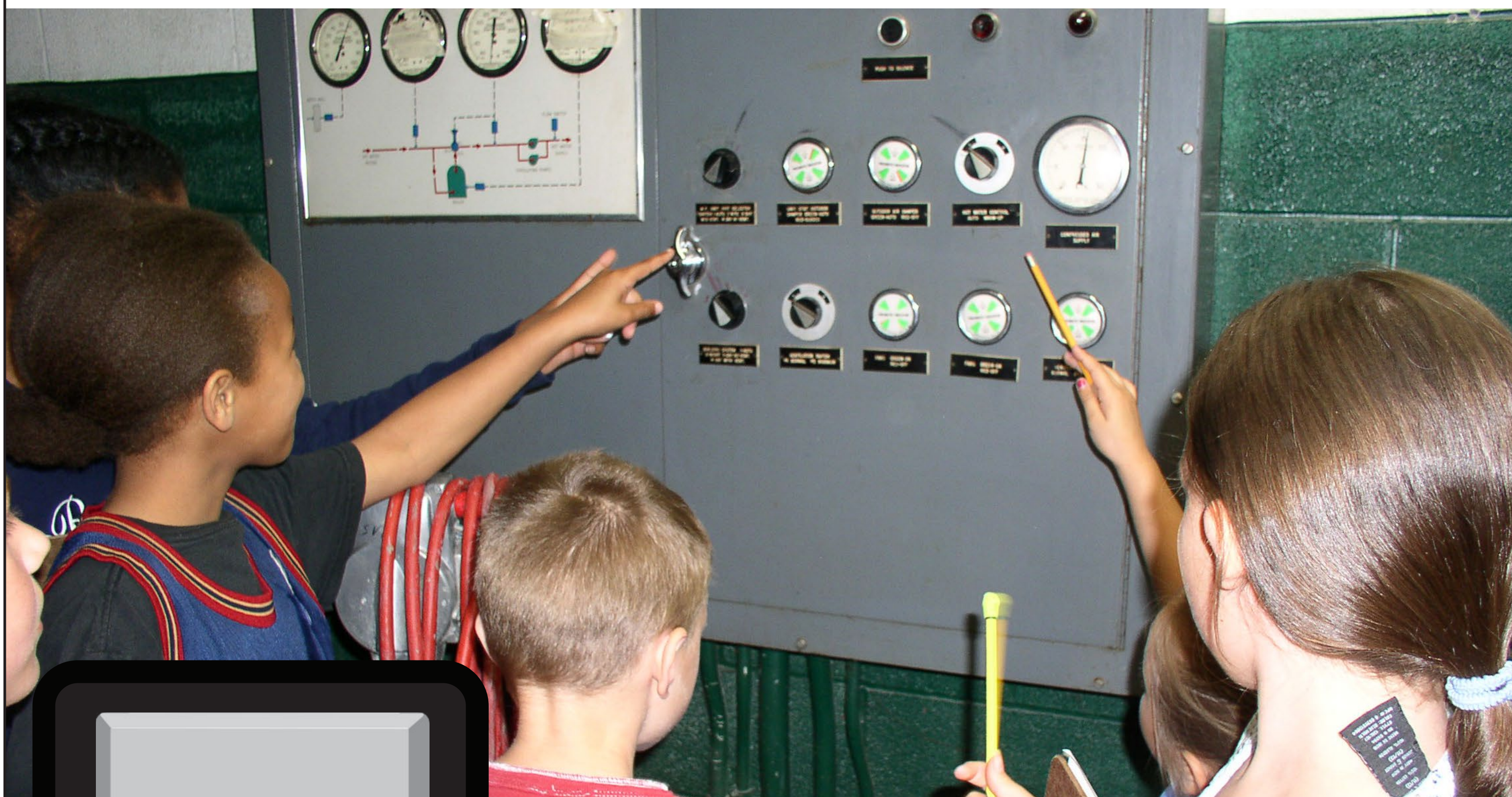
2014-2015

Monitoring and Mentoring

Teacher Guide

These hands-on activities introduce students to energy consumption and conservation using the school as a learning laboratory. Upper elementary and intermediate students can mentor younger students to teach and learn about measuring energy consumption, determining costs of energy use, quantifying environmental effects of energy use, and devising a plan to reduce energy use.



Grade Level:

- Ele Elementary
- Int Intermediate

Subject Areas:

- Science
- Social Studies
- Math
- Language Arts
- Technology

NEED
National Energy Education Development Project

Teacher Advisory Board

NEED Mission Statement

The mission of The NEED Project is to promote an energy conscious and educated society by creating effective networks of students, educators, business, government and community leaders to design and deliver objective, multi-sided energy education programs.

Teacher Advisory Board Statement

In support of NEED, the national Teacher Advisory Board (TAB) is dedicated to developing and promoting standards-based energy curriculum and training.

Permission to Copy

NEED materials may be reproduced for non-commercial educational purposes.

Energy Data Used in NEED Materials

NEED believes in providing the most recently reported energy data available to our teachers and students. Most statistics and data are derived from the U.S. Energy Information Administration's Annual Energy Review that is published yearly. Working in partnership with EIA, NEED includes easy to understand data in our curriculum materials. To do further research, visit the EIA web site at www.eia.gov. EIA's Energy Kids site has great lessons and activities for students at www.eia.gov/kids.

NEED
National Energy Education Development

1.800.875.5029
www.NEED.org

Printed on Recycled Paper

Monitoring and Mentoring

Teacher Guide

Monitoring and Mentoring Kit

- 1 Incandescent bulb
- 1 Compact fluorescent bulb
- 1 Kill A Watt™ monitor
- 5 Sets of radiation cans (2 per set)
- 10 Lab thermometers
- 5 Sets of insulation materials (3 ft per set)
- 2 Student thermometers
- 1 Indoor/outdoor thermometer
- 1 Light meter
- 1 Flicker Checker
- 1 Waterproof digital thermometer
- 1 Digital humidity/temperature pen
- 30 Student Guides
- 1 Building Buddies Teacher Guide
- 1 Building Buddies Student Guide

Table of Contents

Standards Correlation Information

www.NEED.org/curriculumcorrelations

Next Generation Science Standards

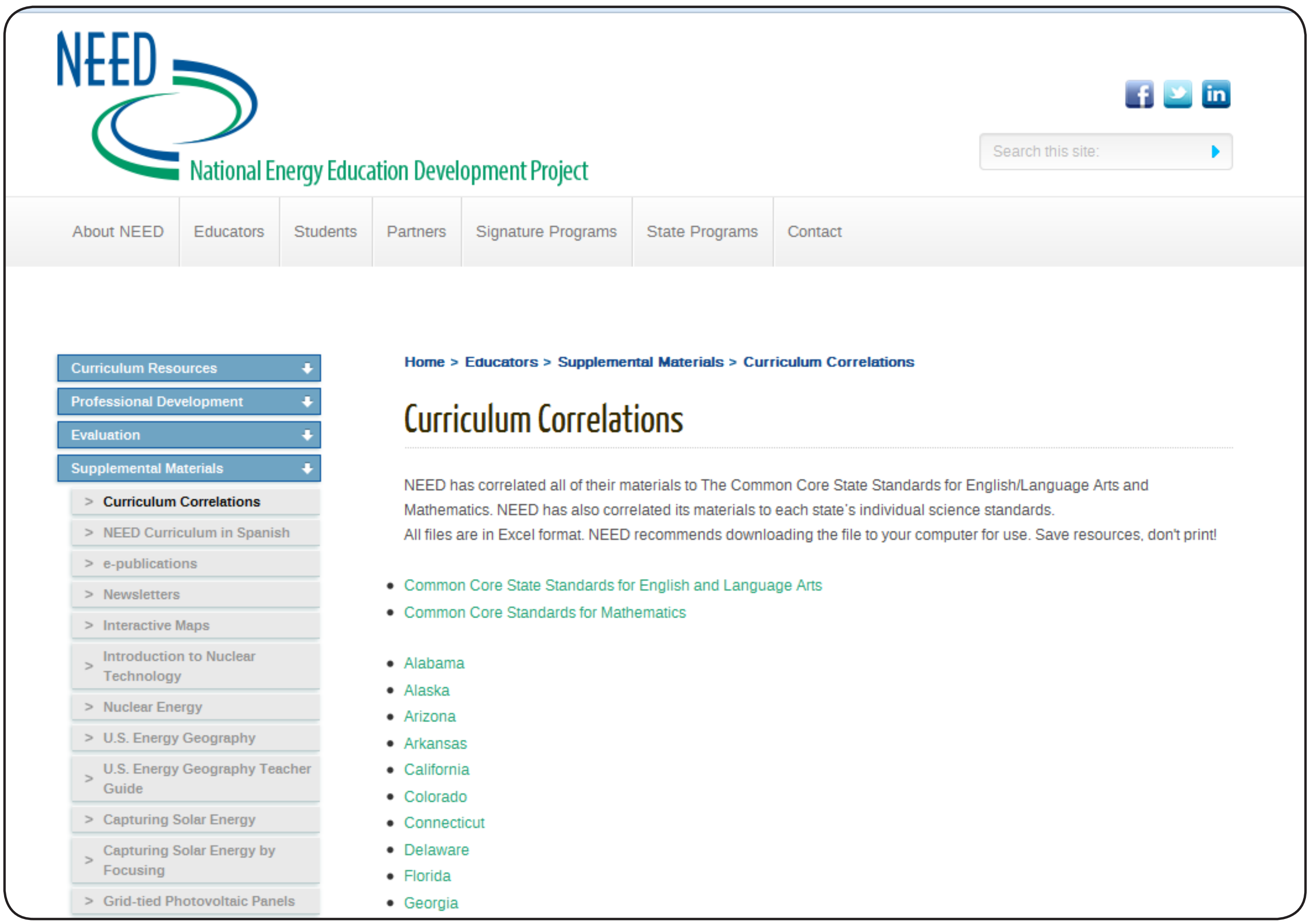
- This guide effectively supports many Next Generation Science Standards. This material can satisfy performance expectations, science and engineering practices, disciplinary core ideas, and cross cutting concepts within your required curriculum. For more details on these correlations, please visit NEED's curriculum correlations web site.

Common Core State Standards

- This guide has been correlated to the Common Core State Standards in both language arts and mathematics. These correlations are broken down by grade level and guide title, and can be downloaded as a spreadsheet from the NEED curriculum correlations web site.

Individual State Science Standards

- This guide has been correlated to each state's individual science standards. These correlations are broken down by grade level and guide title, and can be downloaded as a spreadsheet from the NEED web site.



Monitoring and Mentoring Materials

ACTIVITY	MATERIALS INCLUDED	ADDITIONAL MATERIALS NEEDED
Insulation Investigation	▪10 Radiation cans (5 sets of 2) ▪10 Lab thermometers ▪Insulating materials	▪Tape ▪Hot water ▪Rubber bands ▪Timer or stopwatch
Facts of Light	▪2 Student thermometers ▪CFL ▪Light meter ▪Incandescent light bulb ▪Kill A Watt™ monitor	▪2 Lamps ▪Tape
Flicker Checker	▪Flicker Checker	
Kill A Watt™ Investigations	▪Kill A Watt™ monitor	▪Pluggable electrical devices
School Energy Consumption Survey	▪Light meter ▪Digital waterproof thermometer ▪Digital humidity/temperature pen	
Building Buddies	▪Indoor/outdoor thermometer ▪*Building Buddies* guides (Teacher and Student) ▪Digital humidity/temperature pen ▪Light meter	

Teacher Guide

Introduction

Monitoring and Mentoring is designed to be the classroom education component of a total energy management plan for elementary and intermediate schools. A companion unit, *Building Buddies*, is available for primary and lower elementary students, with activities that upper elementary and intermediate students can use to teach the basic concepts of energy and conservation to younger students. An energy management plan could also include training of the building manager, administrators, and maintenance staff, and retrofitting the building.

The activities in this unit have been designed so that they can be used as separate activities, although they do build on one another to provide all of the information students need to conduct the school surveys and conduct on-going monitoring and data analysis, as well as outreach activities with primary students.

Grade Level

- Upper elementary and middle school students (5th grade reading level)

Time

- Approximately 10 class periods, plus out-of-class research and on-going monitoring, depending upon the extent of cooperative learning activities with primary students.

Overview

Monitoring and Mentoring introduces students to the concepts of energy, energy consumption, its economic and environmental effects, and conservation and efficiency through a series of activities that involve hands-on learning, teaching others, monitoring energy use, and changing behaviors.

Background/Skills

Monitoring and Mentoring is a hands-on unit that explores consumption and conservation using the school as a real–world laboratory to inform their energy conservation at home. The activities encourage the development of cooperative learning, math, science, comparison and contrast, public speaking, and critical thinking skills.

Preparation

- Familiarize yourself with the Teacher Guide, the Student Guide, and the information for each activity. Make sure that you have a working knowledge of the information, definitions, and conversions.
- If you are using the *Monitoring and Mentoring Kit*, familiarize yourself with the equipment. Procure materials needed that are not included within the kit (see chart on page 5).
- Make copies or digital masters of the following pages in the Teacher Guide for projection:

MASTER	TEACHER GUIDE PAGE
United States Energy Consumption by Source, 2012	13
Sample Kitchen Diagram	14
Light Bulb Comparison	21
Comparing Light Bulbs Answer Key	22
The Light Meter	23
EnergyGuide Label	30
Comparing EnergyGuide Labels	31
Kill A Watt™ Monitor Instructions	33
Digital Thermometer	38
Humidity/Temperature Pen	39

Additional Resources

The data in this curriculum comes mostly from the U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy (EERE) Energy Savers web site at http://energy.gov/energysaver/energy-saver. This web site has additional information, maps, and statistics that the students can use. Copies of the Energy Savers guide may be ordered in bulk or downloaded from the Energy Savers web site.

Answer Keys

Reading an Electric Meter | *STUDENT GUIDE PAGE 21*

1,050 kWh x $0.10/ kWh = $105.00

Electric Meters | *STUDENT GUIDE PAGE 22*

January 31 reading: 26,510 kWh

January 1 reading: 26,010 kWh

Electricity used: 500 kWh

Electricity Cost: 500 kWh x $0.12/kWh = $60.00

Practice Reading Electric Meters | *STUDENT GUIDE PAGE 23*

February 1 electric meter: 71,565 kWh

February 28 electric meter: 78,265 kWh

Electricity Used and Cost = 78,265 kWh - 71,565 kWh = 6,700 kWh x $0.10/kWh = $670.00

March 1 electric meter: 36,210 kWh

March 31 electric meter: 37,825 kWh

Electricity Used and Cost = 37,825 kWh - 36,210 kWh = 1,615 kWh x $0.12/kWh = $193.80

Reading a Natural Gas Meter | *STUDENT GUIDE PAGE 24*

Usage Charge = 1,337 Ccf x $0.81 = $1,082.97

Natural Gas Meters | *STUDENT GUIDE PAGE 25*

January 1 natural gas meter: 3,528 Ccf

January 31 natural gas meter: 3,652 Ccf

Natural gas used: 3,652 Ccf - 3,528 Ccf = 124 Ccf

Usage Charge: 124 Ccf x $1.07/Ccf = $132.68

Practice Reading Gas Meters | *STUDENT GUIDE PAGE 26*

February 1 natural gas meter: 3,077 Ccf

February 28 natural gas meter: 3,877 Ccf

Natural gas used: 3,877 Ccf - 3,077 Ccf = 800 Ccf x $0.81/Ccf = $648.00

March 1 natural gas meter: 1,750 Ccf

March 31 natural gas meter: 2,340 Ccf

Natural gas used: 2,340 Ccf - 1,750 Ccf = 590 Ccf x $0.81/Ccf = $477.90

Comparing Appliances | *STUDENT GUIDE PAGE 46*

How many years will it take before you begin to save money? **Four Years**

How much money will you have saved after seven years? **$99**

Water Heater 1: Purchase Price: $375.00

Water Heater 2: Purchase Price: $250.00

WATER HEATER 1	EXPENSES	COST TO DATE	WATER HEATER 2	EXPENSES	COST TO DATE
Purchase Price	$375	$375	**Purchase Price**	$250	$250
Year One	$273	$648	**Year One**	$305	$555
Year Two	$273	$921	**Year Two**	$305	$860
Year Three	$273	$1,194	**Year Three**	$305	$1,165
Year Four	$273	$1,467	**Year Four**	$305	$1, 470
Year Five	$273	$1,740	**Year Five**	$305	$1,775
Year Six	$273	$2,013	**Year Six**	$305	$2,080
Year Seven	$273	$2,286	**Year Seven**	$305	$2,385

Energy Efficiency BINGO Instructions

***Energy Efficiency Bingo* is a great icebreaker for a NEED workshop or conference. As a classroom activity, it also makes a great introduction to an energy unit.**

Preparation

- 5 minutes

Time

- 45 minutes

Bingos are available on several different topics. Check out these resources for more bingo options!

- Biomass Bingo—*Energy Stories and More*
- Change a Light Bingo—*Energy Conservation Contract*
- Energy Bingo—*Energy Games and Icebreakers*
- Forms of Energy Bingo—*Science of Energy*
- Hydropower Bingo—Hydropower guides
- Hydrogen Bingo—*H_2 Educate*
- Marine Renewable Energy Bingo—*Ocean Energy*
- Nuclear Energy Bingo—Nuclear guides
- Offshore Oil and Gas Bingo—*Ocean Energy*
- Oil and Gas Bingo—Oil and Gas guides
- Solar Bingo—Solar guides
- Transportation Bingo—*Transportation Fuels Infobooks*
- Wind Energy Bingo—Wind guides

Get Ready

Duplicate as many *Energy Efficiency Bingo* sheets (found on page 45) as needed for each person in your group. In addition, decide now if you want to give the winner of your game a prize and what the prize will be.

Get Set

Pass out one *Energy Efficiency Bingo* sheet to each member of the group.

Go

PART ONE: FILLING IN THE BINGO SHEETS

Give the group the following instructions to create bingo cards:

- This bingo activity is very similar to regular bingo. However, there are a few things you'll need to know to play this game. First, please take a minute to look at your bingo sheet and read the 16 statements at the top of the page. Shortly, you'll be going around the room trying to find 16 people about whom the statements are true so you can write their names in one of the 16 boxes.
- When I give you the signal, you'll get up and ask a person if a statement at the top of your bingo sheet is true for them. If the person gives what you believe is a correct response, write the person's name in the corresponding box on the lower part of the page. For example, if you ask a person question "D" and he or she gives you what you think is a correct response, then go ahead and write the person's name in box D. A correct response is important because later on, if you get bingo, that person will be asked to answer the question correctly in front of the group. If he or she can't answer the question correctly, then you lose bingo. So, if someone gives you an incorrect answer, ask someone else! Don't use your name for one of the boxes or use the same person's name twice.
- Try to fill all 16 boxes in the next 20 minutes. This will increase your chances of winning. After the 20 minutes are up, please sit down and I will begin asking players to stand up and give their names. Are there any questions? You'll now have 20 minutes. Go!
- During the next 20 minutes, move around the room to assist the players. Every five minutes or so tell the players how many minutes are remaining in the game. Give the players a warning when just a minute or two remains. When the 20 minutes are up, stop the players and ask them to be seated.

PART TWO: PLAYING BINGO

Give the class the following instructions to play the game:

- When I point to you, please stand up and in a LOUD and CLEAR voice give us your name. Now, if anyone has the name of the person I call on, put a big "X" in the box with that person's name. When you get four names in a row—across, down, or diagonally—shout "Bingo!" Then I'll ask you to come up front to verify your results.
- Let's start off with you (point to a player in the group). Please stand and give us your name. (Player gives name. Let's say the player's name was "Joe.") Okay, players, if any of you have Joe's name in one of your boxes, go ahead and put an "X" through that box.
- When the first player shouts "Bingo," ask him (or her) to come to the front of the room. Ask him to give his name. Then ask him to tell the group how his bingo run was made, e.g., down from A to M, across from E to H, and so on.

- Now you need to verify the bingo winner's results. Ask the bingo winner to call out the first person's name on his bingo run. That player then stands and the bingo winner asks him the question which he previously answered during the 20-minute session. For example, if the statement was "can name two renewable sources of energy," the player must now name two sources. If he can answer the question correctly, the bingo winner calls out the next person's name on his bingo run. However, if he does not answer the question correctly, the bingo winner does not have bingo after all and must sit down with the rest of the players. You should continue to point to players until another person yells "Bingo."

ENERGY EFFICIENCY BINGO

ANSWERS

A. Can name two ways to increase a car's MPG
B. Can name three ways to save energy at home
C. Can name three ways to save energy at school
D. Has at least one ENERGY STAR® appliance at home
E. Knows the definition of *energy efficiency*
F. Knows the definition of *energy conservation*
G. Knows what an ENERGY STAR® label means
H. Knows what SEER is
I. Knows the type of bulb that uses one quarter of the energy of incandescents
J. Knows where to find an EnergyGuide label
K. Can name two appliances that should be run only when fully loaded
L. Uses day lighting in the classroom instead of overhead lights
M. Sets this item differently at day and night and for the season
N. Knows the number one use of energy in the home
O. Has an energy conservation team at school
P. Knows whether energy is the first, second, or third highest expenditure in a school district (choose one)

A proper tire inflation, drive the speed limit, slow acceleration	**B** Switch to CFLs, use a programmable thermostat, wash clothes in cold water, etc.	**C** Turn off computers/lights/appliances when not in use, close doors and windows, etc.	**D** ask for location/description
E Using technologies to continue activities at the same level while using less energy	**F** Choosing to use less energy through alternative behaviors or actions	**G** The product meets energy efficiency requirements	**H** seasonal energy efficiency ratio of cooling output by power consumption
I CFL	**J** On appliances and products for homes and business	**K** dishwasher and clothes washer	**L** ask for details
M programmable thermostat	**N** heating/cooling	**O** ask for description/details	**P** second, the first is personnel

Conservation in the Round

***Conservation in the Round* is a quick, entertaining game to reinforce information about energy sources, forms of energy, and general energy information from the *Intermediate Energy Infobook*.**

Grades

- 5–8

Preparation

- 5 minutes

Time

- 20–30 minutes

"In the Rounds" are available on several different topics. Check out these guides for more, fun "In the Round" examples!

- Hydrogen in the Round—*H_2 Educate*
- Oil and Gas Industry in the Round—*Fossil Fuels to Products*, *Exploring Oil and Gas*
- Energy in the Round—*Energy Games and Icebreakers*
- Forms of Energy in the Round—*Science of Energy* guides
- Uranium in the Round—Nuclear guides
- Solar Energy in the Round—*Energy From the Sun*
- Transportation Fuels in the Round—*Transportation Fuels Infobooks*

Get Ready

- Copy the *Conservation in the Round* cards on pages 46-48 onto card stock and cut into individual cards.
- Make an additional copy to use as your answer key. This page does not need to be cut into cards.
- Have a class set of the *Intermediate Energy Infobooks* available for quick reference.

Get Set

- Distribute one card to each student. If you have cards left over, give some students two cards so that all of the cards are distributed.
- Have the students look at their bolded words at the top of the cards. Give them five minutes to review the information about their words using the *Intermediate Energy Infobooks*.

Go

- Choose a student to begin and give the following instructions:
    - Read the question on your card. The student with the correct answer will stand up and read the bolded answer, "I have _____."
    - That student will then read the question on his/her card, and the round will continue until the first student stands up and answers a question, signaling the end of the round.
- If there is a disagreement about the correct answer, have the students listen to the question carefully looking for key words (forms versus sources, for example) and discuss until a consensus is reached about the correct answer.

Alternative Instructions

- Give each student or pair a set of cards.
- Students will put the cards in order, taping or arranging each card so that the answer is directly under the question.
- Have students connect the cards to fit in a circle or have them arrange them in a column.

Background Reading

Overview

The informational text in the Student Guide provides background information on energy consumption, conservation, and efficiency to give students a foundation for exploring and understanding the activities. Graphic organizers are included in the Student Guide to help students recognize and categorize the important information in the text.

Objectives

- Students will be able to identify and describe energy use in their lives.
- Students will be able to define energy.
- Students will be able to identify and organize important information from nonfiction text.

Time

- One 45-minute class period.

Introduction

- Introduce the unit by asking the class to brainstorm a list of all of the ways energy is being used in the classroom. Write the list on the board. Make sure that heating/cooling, lighting, and running appliances and electronics are listed.
- Ask students to explain how they think energy efficiency might be different from energy conservation. Project or show the *Efficiency vs. Conservation* chart on page 10 of the Student Guide and record student ideas as they have a preliminary discussion.
- Discuss why everyone should be concerned about saving energy—natural resources, economics, environmental impacts.
- Ask students to point out ways they waste energy and ways that energy is wasted in the school.
- Explain the objectives of the *Monitoring and Mentoring* unit and their first assignment to gain information.
- Review *Energy Definitions and Conversions* on page 9 of the Student Guide.

Procedure

1. Direct the students to the graphic organizers on pages 10-15 of the Student Guide. Review each organizer and explain that they will write important facts in the organizers as they read the informational text.
2. Preview the headings of the informational text on pages 2-8 of the Student Guide with the students. Point out that they will need to decide what the important information is in each section and in which graphic organizer it should be placed.
3. Assign the students to read the informational text, completing the graphic organizers as they read.
4. Revisit the *Effiiciency vs. Conservation* chart with students after reading. Correct any misconceptions, provide more examples of each, and ask students to discuss how efficiency and conservation are related and must work together to be effective.
5. Review each organizer as a class, directing students to fill in facts they might have omitted. Remind students that the organizers will be helpful references as they proceed through the unit.

OPTIONAL: This activity can also be completed as a jigsaw. In this method students should be assigned topics to become experts on. They will read the entire informational text looking for information on their topic. Then, they will instruct others on their topic and highlight the important information they learned and recorded on their graphic organizer.

Home and Classroom Energy Use

Overview

The students will complete *Energy Systems and Sources* and *Home Energy Use Surveys* with their families to begin to understand the energy sources they use at home, how they use energy at home, as well as how they waste and save energy at home. The students will also draw diagrams of their kitchens and classrooms, using symbols to indicate energy–related structures and devices.

Objective

- Students will be able to list and identify the sources of energy used at home and school to heat, cool, cook, and power machines.

Time

- One 45-minute class period, plus homework.

Preparation

- Make copies or project the *United States Energy Consumption by Source, 2012* and the *Sample Kitchen Diagram* on pages 13-14 of the Teacher Guide.

Procedure

1. Use the *United States Energy Consumption by Source, 2012* master to review the sources of energy and how they are used.
2. Review the *Energy Systems and Sources* and the *Home Energy Use Survey* on pages 16-17 of the Student Guide and assign as homework.
3. Have the students compare their answers to a buddy's. Have the class compile the data from their *Energy Systems and Sources* and *Home Energy Use Surveys*, then determine the most and the least common answers. Discuss the variety of the class results and what they indicate about energy use in your area. Discuss ways energy is wasted and conserved by households, as indicated by the results.
4. Have the students go to page 18 of the Student Guide. Use the *Sample Kitchen Diagram* to explain the diagram and the symbols in the legend.
5. Have the students go to page 19 of the Student Guide. Instruct the students to examine the classroom and draw sketches of the room on notebook paper, then transfer their drawings to the grid in their Student Guides, using the symbols on the legend. If you like, draw a master diagram of the classroom on large paper or an interactive board for display.
6. Instruct the students to draw kitchen diagrams on page 20 of the Student Guide as homework.
7. Discuss and review.

Extension

Have the class create graphical representations of their survey data and incorporate statistical terms such as mean, median, mode, and range.

United States Energy Consumption by Source, 2012

NONRENEWABLE

PETROLEUM **34.6%**
Uses: transportation, manufacturing

NATURAL GAS **27.4%**
Uses: heating, manufacturing, electricity

COAL **18.2%**
Uses: electricity, manufacturing

URANIUM **8.7%**
Uses: electricity

PROPANE **1.7%**
Uses: heating, manufacturing

RENEWABLE

BIOMASS **4.6%**
Uses: heating, electricity, transportation

HYDROPOWER **2.8%**
Uses: electricity

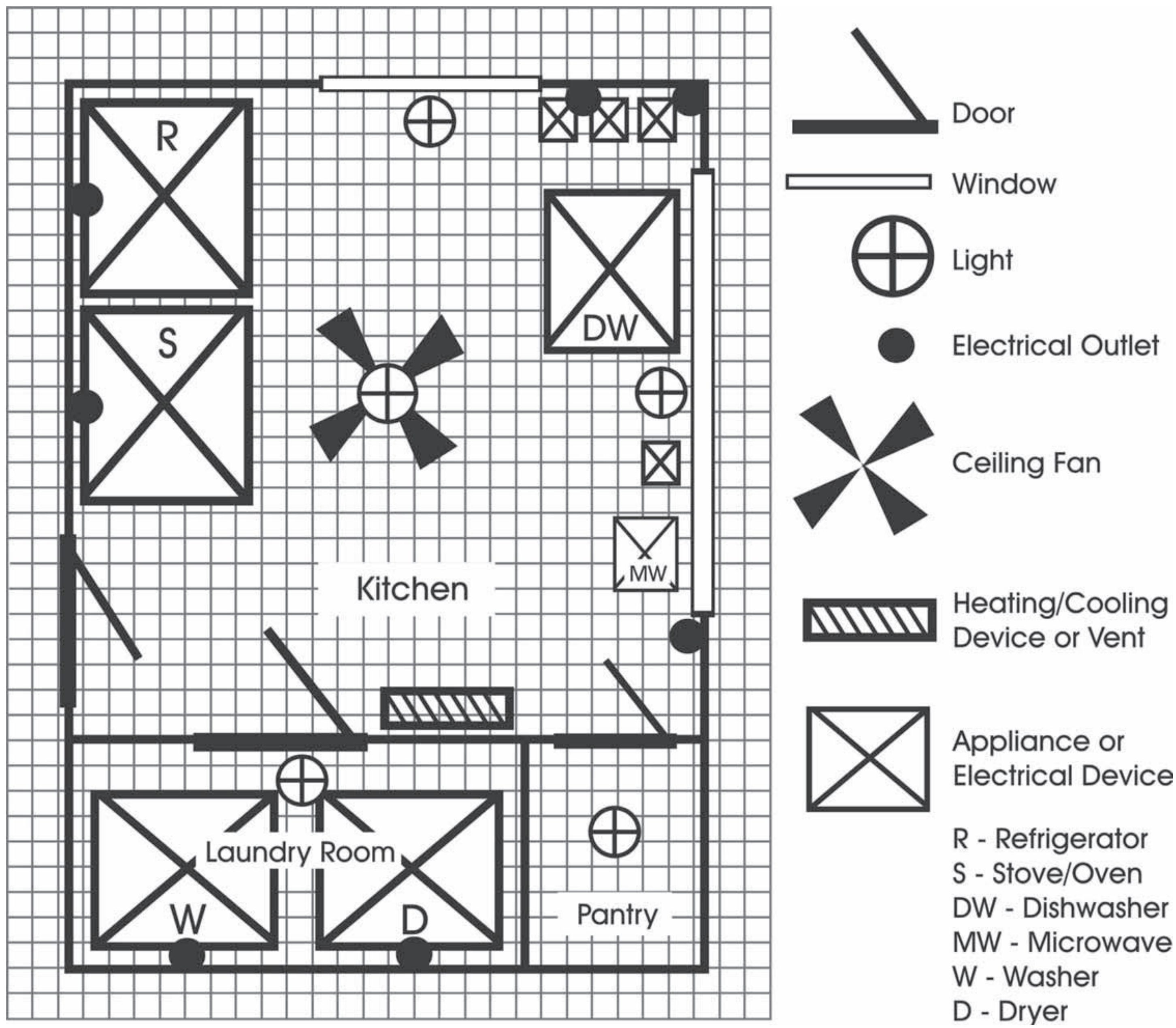
WIND **1.4%**
Uses: electricity

GEOTHERMAL **0.2%**
Uses: heating, electricity

SOLAR **0.2%**
Uses: heating, electricity

Data: Energy Information Administration Total does not equal 100% due to independent rounding.

Sample Kitchen Diagram



Reading Meters

Overview

This activity teaches students how to read electric and natural gas meters, how electricity and natural gas are measured, and how to determine the cost of electricity and natural gas. Students monitor their school electric meter to develop an awareness of the amount of electricity consumed. *This activity can also be conducted using students' home electric or natural gas meters.*

Background

Schools use a lot of energy to provide students with a comfortable and usable building in which to learn. Educational machines—such as televisions, copiers, DVD players, and computers—use energy as well.

The two major types of energy used by schools are electricity and natural gas. Many different energy sources are used to generate electricity—both renewables and nonrenewables. Today, 37.4 percent of the electricity in the U.S. is generated by coal-fired plants.

In schools, electricity is used to provide light, to operate the machines and appliances, to cool the building and, perhaps, for heating, cooking, and hot water heating. Natural gas is used principally to heat buildings, heat water, and for cooking. It can also be used to generate the electricity the school uses. Other fuels that schools might use are heating oil, propane, solar energy, and geothermal energy.

Electricity enters the school through a distribution line that passes through a meter. The meter measures the amount of electricity consumed in kilowatt-hours.

Natural gas enters the school through a pipeline with a meter that measures the volume of natural gas consumed in hundreds of cubic feet, or Ccf. The school is billed for the amount of thermal energy in the natural gas—the number of therms that are used—and a conversion factor is recorded on the bill. In 2012, the U.S. average heat content of one Ccf of natural gas was 102,400 Btu or 1.024 therms of heat energy. This figure varies depending on where the natural gas originates. Utility bills list the actual energy content conversion factor.

Concepts

- We can measure and monitor the energy we use for lighting, heating, cooling, heating water, and operating appliances.
- Understanding how we use energy and how much energy we use can help us conserve.

Objectives

- Students will be able to read electric and natural gas meters.
- Students will be able to monitor school energy use by reading a school electric meter for a five–day period.
- Students will be able to calculate the cost of energy used based on meter readings.

Time

- One 45-minute class period, plus on-going monitoring.

Preparation

1. Obtain permission to have students examine and monitor the school electric meter.
2. Obtain the electricity and/or natural gas rate schedule for the school from the business office or utility company. Students may also complete the activities using the national averages provided within each activity.

✔Procedure

1. Introduce the activity to the class, discussing the tasks that use electricity and natural gas at home and at school.
2. Go to page 21 of the Student Guide—*Reading an Electric Meter*—and review the information with the students.
3. Have the students complete the *Electric Meters* activity on page 22 of the Student Guide. Review with the class. Note that this activity represents a residential reading, and uses a different rate/kWh.
4. Assign page 23 of the Student Guide—*Practice Reading Electric Meters*—as homework. Review the answers with the class.
5. Conduct the natural gas meter activities on pages 24-26 of the Student Guide as you did the electric meter activities. Make sure you point out the differences in the meter face, if any, and how natural gas is metered and billed.
6. Have students monitor school energy use for one week by reading the school's electric meter at the beginning and end of each school day, recording the readings in a chart such as the one below, and calculating the cost. Make sure to explain to students that their electric meter could be digital rather than analog. Some parts of the country and some types of buildings will have access to digital meters, while others may still have analog meters. Discuss that no matter what type of meter they look at, the process for calculating use and cost is the same.

School Electricity Use Over a One Week Period

DAY	AM READING	PM READING	Δ	PRICE	COST/DAY
Monday					
Tuesday					
Wednesday					
Thursday					
Friday					
				WEEKLY COST	

Extension Activity: Turn Off The Power For Just One Hour

Get the entire school involved! Conduct a "Turn Off The Power For Just One Hour" activity. Monitor electricity use for one hour during a normal school day, then turn off as many electrical devices as practicable in the school for the same hour the next day and record the electricity use. Report the results to all participants in the school.

Insulation Investigation

Overview

In this hands-on investigation, students work in groups to explore concepts of insulation and conduction. Each group will insulate one metal radiation can of a set of two with one of several insulating materials. Students then measure and record the heat loss from hot water in the cans to determine the insulating properties of the material over time. Student groups then compare the insulating properties of the different materials.

Background

Buildings need insulation to provide resistance to heat flow. The more heat flow resistance the insulation provides, the lower the heating and cooling costs. Heat flows naturally from a warmer to a cooler space. In the winter, this heat flow moves directly from all heated spaces to adjacent unheated spaces, and even to the outdoors. Heat flow can also move indirectly through interior ceilings, walls, and floors—wherever there is a difference in temperature. During the cooling season, heat flows from the outdoors to the interior of a building.

To maintain comfort, the heat lost in the winter must be replaced by the heating system, and the heat gained in the summer must be removed by the cooling system. Properly insulating a building will decrease this heat flow by providing an effective resistance to the flow of heat.

An insulation's resistance to heat flow is measured or rated in terms of its thermal resistance or R-value. An R-value indicates an insulation's resistance to heat flow. The higher the R-value, the greater the insulating effectiveness. The R-value depends on the type of insulation and includes its material, thickness, and density. When calculating the R-value of multilayered insulation, add the R-values of the individual layers. Installing more insulation in a building increases the R-value and the resistance to heat flow.

The effectiveness of an insulation's resistance to heat flow also depends on how and where the insulation is installed. For example, insulation that is compressed will not provide its full rated R-value. The overall R-value of a wall or ceiling will be somewhat different from the R-value of the insulation itself because some heat flows around the insulation through the studs and joints. Therefore, it's important to properly install insulation to achieve the maximum R-value.

The amount of insulation or R-value that is needed depends on the climate, type of heating and cooling system, and the section of the building that is to be insulated. There are minimum R-values needed for different fixtures in the home. In very cold climates, a higher R-value is recommended.

For a color version of the map of recommended R-values on page 4 of the Student Guide, visit the Department of Energy's Energy Savers guide at http://energy.gov/energysaver/articles/tips-insulation.

Concepts

- Heat naturally flows from warmer areas to cooler areas.
- You can help prevent heat flow by using insulation.
- Some materials are better insulators than others.

Objectives

- Students will be able to compare and contrast the insulating properties of several materials.
- Students will be able to explain the purpose of insulation and its bearing on energy savings.

Time

- One 45-minute class period.

Materials

- 10 Radiation cans (5 sets of 2)
- 10 Lab thermometers
- Insulating materials for five centers
- 5 Rolls of tape
- Hot water
- Timer or stopwatch
- Rubber bands

Preparation

1. Set up five centers, each with 2 radiation cans of the same color, 2 lab thermometers, 1 type of insulating material, 1 roll of tape, and a few rubber bands.
2. Divide the class into five groups.

✔Procedure

1. Review the *Insulation Investigation* on pages 27-28 of the Student Guide with the students. Have them write a hypothesis after reviewing the procedure.
2. Assign the groups to their centers.
3. Explain that the groups must insulate only the sides of one of their cans.
4. Provide the groups with hot water when all of the groups have completed insulating their cans.
5. Begin timing when all of the groups are ready and have recorded the beginning temperatures. Direct the groups to record the temperatures of the water in the cans at two-minute intervals.
6. After 20 minutes, have the students calculate the differences (Δ) in temperatures for both cans from the beginning temperatures to the final temperatures.
7. Have the students complete the Data and Conclusion sections of the lab sheet.
8. Compare the insulating properties of the different insulating materials as a class, using the results of all of the groups.
9. Direct students to read *Heat Loss* on page 29 of the Student Guide to complete their conclusions.

Synthesis

- Discuss or have students write about the role and value of insulation in homes and schools.

Extension: Energy House

- Conduct NEED's *Energy House* activity, available online at www.NEED.org, in which students buy materials and insulate a cardboard house.

Facts of Light

Overview

These activities teach students how to compare the energy-related properties of different types of light bulbs. Students develop an awareness and understanding of life cycle cost analysis.

Background

Lighting accounts for a significant portion of the electricity used in the United States. In commercial buildings, such as schools, about 30 percent of the total electricity bill is used for lighting and, in homes, about 13 percent. Most of the light in residences is produced by incandescent light bulbs. These bulbs are surprisingly inefficient, converting up to 90 percent of the electricity into heat instead of light. If we converted to efficient lighting technologies, we would typically use about 25-80 percent less energy, saving money.

Technological improvements have resulted in compact fluorescent lights (CFLs) that use 75 percent less energy than traditional incandescent bulbs and last up to 10 times longer. Over the life of the bulbs, CFLs save the average consumer $40 or more in electricity costs. Most schools and commercial buildings use fluorescent lighting. There are different fluorescent systems available. New fluorescent lighting systems are much more efficient than earlier lights and provide more natural light.

Light emitting diodes, or LEDs, offer better light quality than incandescent bulbs, last 25 times as long, and use even less energy than CFLs. LEDs work particularly well in outdoor environments because of their durability and performance in cold weather. More LED options are also becoming available for indoor use.

Why doesn't everyone use energy efficient lighting? There are three reasons: lack of education about energy efficient lighting, the high initial cost—between $2 and $30 per bulb—and consumer buying habits. Many people do not recognize CFLs or LEDs, and few know that using energy efficient lighting can save so much money and electricity. Many people see the price tag and think they are getting a great bargain when they buy 5 incandescents for the same amount of money as one CFL.

Concepts

- Lighting consumes a significant amount of energy.
- New technologies in lighting can reduce energy consumption.
- Life cycle costs should be considered in lighting decisions, not just purchase price.
- Light bulbs produce heat as well as light.
- We can use technologies to measure the energy consumed and light output of light bulbs.

Objectives

- Students will be able to compare and describe the heat and light output of incandescent and compact fluorescent bulbs.
- Students will be able to describe the difference in the energy consumption of incandescent and compact fluorescent bulbs.

Time

- Two 45-minute class periods.

Materials

- 2 Lamps
- 2 Student thermometers
- 1 Compact fluorescent bulb
- Light meter
- Incandescent light bulb
- 1 Kill A Watt™ monitor
- Tape

Preparation

1. Make copies or project the *Light Bulb Comparison, Comparing Light Bulbs Answer Key,* and *The Light Meter* explanation on pages 21-23.
2. Set up the equipment needed to complete the investigations in the room at a place where all of the students can see them.
3. Divide the students into four groups. Assign one group to participate in each of the investigations and report the results to the class.

✔Procedure

1. Introduce the activity to the class, discussing the importance of lighting to our way of life. Use the *Energy Definitions and Conversions* on page 9 of the Student Guide to review the information the students need to understand to complete the activities, if necessary.
2. Review with the students the *Facts of Light* on page 30 of the Student Guide.
3. Review the *Comparing Light Bulbs* activity on page 31 of the Student Guide with the students. Have them complete the activity. Review as a class. Use the *Light Bulb Comparison* master if necessary. Substitute the cost per kWh for your area. Discuss the difference between the commercial and residential rates and decide which one to use.
4. Discuss the meaning of life cycle costs compared to purchase price, using the *Comparing Light Bulbs Answer Key* to assist the discussion.
5. Review *The Light Meter* explanation on page 32 of the Student Guide. Use *The Light Meter* master to explain its operation and the different ways that light is measured. Discuss *Recommended Light Levels* on page 33 of the Student Guide.
6. Have the assigned group of students complete the *Light Level Investigation* on page 34 and report the results to the class.
7. Review the investigation. If you have time, allow different groups of students to use the light meter to measure different areas, so that all of the students become familiar with its operation. Have the students report their results to the class.
8. Have the students compare their results to the *Recommended Light Levels* on page 33 of the Student Guide. Have the students individually complete the Conclusion section.
9. Review the *Light Bulb Investigation 1* on page 35 of the Student Guide with the students. Have all students write their hypotheses in their Student Guides.
10. Have the assigned group of students complete the investigation and report the results to the class. If you have time, allow another group of students to conduct the same activity and compare the results. Have each student individually complete the Conclusion section.
11. Review the *Light Bulb Investigation 2* on page 36 of the Student Guide with the students. Have all students write their hypotheses in their Student Guides.
12. Have the assigned group of students complete the investigation and report the results to the class. If you have time, allow another group of students to conduct the same activity and compare the results. Have each student individually complete the Conclusion section.
13. Review the *Light Bulb Investigation 3* on page 37 of the Student Guide with the students. Have all students write their hypotheses in their Student Guides.
14. Have the assigned group of students complete the investigations and report the results to the class. If you have time, allow another group of students to conduct the same activity and compare the results. Have each student individually complete the Conclusion section.

Extensions

- Have the students develop a marketing plan to convince people to use CFLs. Students can make posters, flyers, radio announcements, and television infomercials to explain the benefits of using CFLs.
- Have students combine their results from *Light Bulb Investigation 1* with their findings from *Comparing Light Bulbs*. Ask students to explain why these findings are related. If time allows, ask students to extend *Light Bulb Investigation 1* further to include more types of lighting.

Light Bulb Comparison

	INCANDESCENT BULB	HALOGEN	COMPACT FLUORESCENT (CFL)	LIGHT EMITTING DIODE (LED)
Brightness	850 lumens	850 lumens	850 lumens	850 lumens
Life of Bulb	1,000 hours	3,000 hours	10,000 hours	25,000 hours
Energy Used	60 watts = 0.06 kW	43 watts = 0.043 kW	13 watts = 0.013 kW	12 watts = 0.012 kW
Price per Bulb	$0.50	$3.00	$3.00	$20.00

Comparing Light Bulbs Answer Key




All bulbs provide about 850 lumens of light.

	COST OF BULB	INCANDESCENT BULB	HALOGEN	COMPACT FLUORESCENT (CFL)	LIGHT EMITTING DIODE (LED)
	Life of bulb (how long it will light)	1,000 hours	3,000 hours	10,000 hours	25,000 hours
	Number of bulbs to get 25,000 hours	25 bulbs	8.3 bulbs	2.5 bulbs	1 bulb
x	Price per bulb	$0.50	$3.00	$3.00	$20.00
=	**Cost of bulbs for 25,000 hours of light**	**$12.50**	**$24.90**	**$7.50**	**$20.00**
	COST OF ELECTRICITY	**INCANDESCENT BULB**	**HALOGEN**	**COMPACT FLUORESCENT (CFL)**	**LIGHT EMITTING DIODE (LED)**
	Total Hours	25,000 hours	25,000 hours	25,000 hours	25,000 hours
x	Wattage	60 watts = 0.060 kW	43 watts = 0.043 kW	13 watts = 0.013 kW	12 watts = 0.012 kW
=	Total kWh consumption	1,500 kWh	1,075 kWh	325 kWh	300 kWh
x	Price of electricity per kWh	$0.12	$0.12	$0.12	$0.12
=	**Cost of Electricity**	**$180.00**	**$129.00**	**$39.00**	**$36.00**
	LIFE CYCLE COST	**INCANDESCENT BULB**	**HALOGEN**	**COMPACT FLUORESCENT (CFL)**	**LIGHT EMITTING DIODE (LED)**
	Cost of bulbs	$12.50	$24.90	$6.30	$20.00
+	Cost of electricity	$180.00	$129.00	$39.00	$36.00
=	**Life cycle cost**	**$192.50**	**$153.90**	**$46.50**	**$56.00**
	ENVIRONMENTAL IMPACT	**INCANDESCENT BULB**	**HALOGEN**	**COMPACT FLUORESCENT (CFL)**	**LIGHT EMITTING DIODE (LED)**
	Total kWh consumption	1,500 kWh	1,075 kWh	325 kWh	300 kWh
x	Pounds (lbs) of carbon dioxide per kWh	1.33 lb/kWh	1.33 lb/kWh	1.33 lb/kWh	1.33 lb/kWh
=	**Pounds of carbon dioxide produced**	**1,995 lbs carbon dioxide**	**1,430 lbs carbon dioxide**	**432 lbs carbon dioxide**	**399 lbs carbon dioxide**

The Light Meter

Operating Instructions

1. Insert the battery into the battery compartment in the back of the meter.
2. Slide the ON/OFF Switch to the ON position.
3. Slide the Range Switch to the B position.
4. On the back of the meter, pull out the meter's tilt stand and place the meter on a flat surface in the area you plan to measure.
5. Hold the Light Sensor so that the white lens faces the light source to be measured or place the Light Sensor on a flat surface facing the direction of the light source.
6. Read the measurement on the LCD Display.
7. If the reading is less than 200 fc, slide the Range Switch to the A position and measure again.

Light Output or Luminous Flux

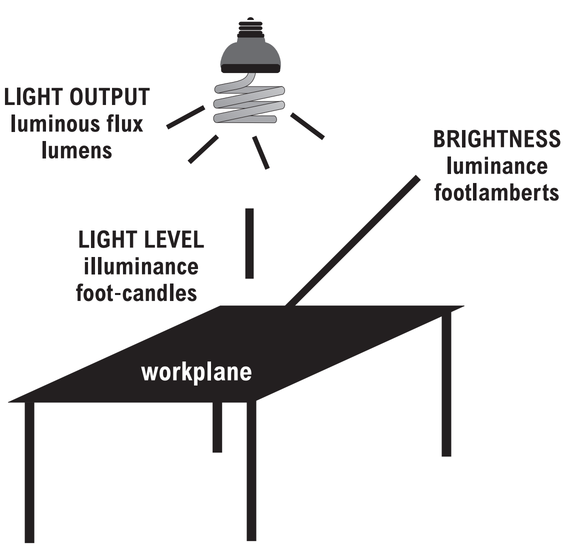
A lumen (lm) is a measure of the light output (or luminous flux) of a light source (bulb or tube). Light sources are labeled with output ratings in lumens. A T12 40-watt fluorescent tube light, for example, may have a rating of 3050 lumens.

Light Level or Illuminance

A foot-candle (fc) is a measure of the quantity of light (illuminance) that actually reaches the workplane on which the light meter is placed. Foot-candles are workplane lumens per square foot. The light meter can measure the quantity of light from 0 to 1000 fc.

Brightness or Luminance

Another measure of light is its brightness or luminance. Brightness is a measure of the light that is reflected from a surface in a particular direction. Brightness is measured in footlamberts (fL).



Flicker Checker

Overview

Most commercial buildings use fluorescent tube lighting. This activity teaches students to determine if a building is using the most energy efficient lighting. The Flicker Checker differentiates between fluorescent lights with magnetic and electronic ballasts.

Background

The most important difference between incandescent and fluorescent light bulbs is the process by which they produce light. Incandescent bulbs produce light by passing current through a wire. The wire, often made of tungsten, is a resistor. A resistor is a device that turns electric energy into heat and light energy.

The wire inside an incandescent light bulb is a special type of resistor called a filament. Many incandescent bulbs have clear glass so you can see the filament. In addition to the wire, the bulb contains a gas called argon. The argon gas helps the bulb last longer. If the wire were exposed to air, it would oxidize and the wire would burn out faster. The argon does not react with the metal like air does. The argon also helps the filament become a better resistor—it actually helps it produce more light than air would. Resistors emit more heat than light. In an incandescent light bulb, 90 percent of the energy from the electricity is turned into heat and only 10 percent of the energy is turned into light.

A fluorescent bulb produces light differently. It produces light by passing an electric current through a gas. The electrons in the molecules of gas become excited because of the electrical energy and some escape from the gas molecules. They bounce around and crash into the walls of the tube. The walls of the tubes are painted with a material that gives off light (it fluoresces) when electrons hit it. If you have ever seen the inside of a fluorescent tube, the glass is coated with white powdery material. This powder is what fluoresces (gives off light).

The part of a fluorescent light bulb that sends the current through the gas is called a ballast. There is a part of the ballast at each end of the tube. The ballast is an electromagnet that can produce a large voltage between the two parts. It is this voltage that gives the electrons of the gas molecules the energy inside the tube.

A magnetic ballast has an iron ring wrapped with hundreds of turns of wire. The current from the electrical outlet runs through the wire in the ballast. The wire also is a resistor to some degree, so there is some heat produced. There is also a little heat given off by the gas. A fluorescent bulb with a magnetic ballast converts about 40 percent of the electricity into light and 60 percent into heat.

An electronic ballast has a microchip, like that found in a computer, instead of the coils of wire. This ballast is about 30 percent more efficient in turning electrical energy into light than a magnetic ballast. Some heat is produced in the gas, but not in the ballast itself.

The reason that the Flicker Checker can tell the difference between the magnetic and electronic ballasts is because of the way the current is delivered to the gas. In any outlet in the United States that is powered by an electric company, the electricity is sent as alternating current—it turns on and off 60 times each second. Because the light with the magnetic ballast has wires attached to the outlet, it also turns on and off 60 times per second. The microchip in the electronic ballast can change that frequency. Light bulbs with electronic ballasts are made to turn on and off between 10,000 and 20,000 times each second.

FLICKER CHECKER SHOWING A MAGNETIC BALLAST

★Concepts

- Lighting consumes a significant amount of electricity in commercial buildings—about 20 percent in 2012.
- Most commercial buildings, including schools, use fluorescent tube lighting.
- New fluorescent lighting technologies can reduce energy consumption.
- Simple tools can help students determine the kind of lighting used in a building.

✪Objectives

- Students will be able to determine the type of ballast used in fluorescent lighting in buildings.
- Students will use persuasive writing/speaking to encourage others to install the most efficient lighting.

Materials

- Flicker Checker

Time

- One 45-minute class period.

✔Procedure

1. Review the *Flicker Checker Investigation* on page 38 of the Student Guide, explaining the difference between incandescent and fluorescent lighting and between magnetic and electronic ballasts.
2. Have the students as a class examine the lighting in several areas of the school, using the Flicker Checker to determine if the fluorescent lights have magnetic or electronic ballasts.
3. Have the students write letters to the principal, energy manager, building manager, or district administration if there are areas that do not have the most efficient lighting installed.

Electrical Devices and Their Impacts

Overview

These activities teach students how to read and interpret the energy information on the nameplates of electrical appliances and machines, to determine the amount of electricity consumed by those appliances over time, to calculate the cost of the electricity used, and to determine the amount of carbon dioxide produced by the energy use. Students develop an awareness of school and personal electricity consumption and its effect on the environment.

Background

Electric Nameplates

Every appliance and machine in the United States that uses electricity has a nameplate with the voltage required and the wattage. Sometimes, the current is listed instead of the voltage. If any two of the three measurements are listed, the third can be determined using the following formula: **wattage = current x voltage**.

Often, you will see the letters UL on the nameplate. The UL mark means that samples of the product have been tested to recognized safety standards and found to be reasonably free from fire, electric shock, and related safety hazards.

Using the data on the nameplate, the amount of time the appliance is used, and the cost of electricity, you can determine the cost of operating the appliance. To determine the cost to operate an appliance for one hour, use this formula:

cost per hour = wattage (kW) x cost/kWh.

Environmental Effects

Carbon dioxide (CO_2) is a greenhouse gas. Human activities have dramatically increased its concentration in the atmosphere. Since the Industrial Revolution, the level of CO_2 in the atmosphere has increased over 40 percent. Generating electricity accounts for a large portion of CO_2 emissions in the U.S. Some electricity generation—such as hydropower, solar, wind, geothermal, and nuclear—does not produce carbon dioxide because no fuel is burned.

A large amount of the nation's electricity (37.4 percent), however, comes from burning coal. Another 32.6 percent comes from burning natural gas, petroleum, and biomass. There is a direct correlation between the amount of electricity we use and the amount of CO_2 emitted into the atmosphere. On average, generating a kilowatt-hour (kWh) of electricity from fossil fuels produces 1.33 pounds of CO_2, which is emitted into the atmosphere.

Concepts

- The electrical appliances and machines we use consume a lot of energy and affect the environment.
- We can determine the amount of electricity that appliances use, the cost, and the amount of CO_2 emitted.

Objectives

- Students will be able to determine and list the energy requirements of electrical appliances.
- Students will be able to calculate the cost of using electrical devices.
- Students will be able to determine the environmental impact of using electrical devices.

Time

- Three 45-minute class periods, plus homework.

✔Procedure

1. Introduce the activity to the class, using the *Energy Definitions and Conversions* on page 9 of the Student Guide to review the information the students will need to complete the activity.
2. Have the students examine the machines in the classroom to find the nameplates.
3. Complete *Electric Nameplates Investigation 1* on page 39 of the Student Guide with the class.
4. Assign *Electric Nameplates Investigation 2* on page 40 of the Student Guide as homework. This activity allows students to measure devices in their homes.
5. Complete *The Cost of Using Electrical Devices Investigation 1* on page 41 of the Student Guide with the class.
6. Assign *The Cost of Using Electrical Devices Investigation 2* on page 42 of the Student Guide as homework. They will calculate the cost of the devices they measured at home. Remind students to use the correct rate for kWh consumption. Look up the local rate on the school's utility bill or with the utility company if desired.
7. Complete *Environmental Impacts 1* on page 43 of the Student Guide with the class.
8. Assign students to determine the environmental impacts of their devices at home by completeing *Environmental Impacts 2* on page 44 of the Student Guide as homework.
9. Review student homework results as a class.

Extension: Exploring the Greenhouse Effect and Climate Change

Have the students explore carbon dioxide levels and the greenhouse effect by building a greenhouse. See instructions for experimenting with the greenhouse effect in NEED's *Exploring Climate Change* guide, available online at www.NEED.org.

EnergyGuide Labels

Overview

This activity teaches students to read and compare the EnergyGuide labels required on most large appliances—such as refrigerators, furnaces, water heaters, and air conditioners. Students develop an awareness of life cycle cost analysis, payback period, and efficient technologies.

Background

The Federal Government requires that appliance manufacturers provide information about the energy efficiency of their products to consumers so that they can compare the life cycle cost of the appliances, as well as the purchase price. The life cycle cost of an appliance includes the purchase price plus the operating cost over the expected life of the appliance.

The law requires that manufacturers place EnergyGuide labels on all new refrigerators, freezers, water heaters, dishwashers, clothes washers, room air conditioners, central air conditioners, heat pumps, furnaces, and boilers. The EnergyGuide labels list the manufacturer, the model, the capacity, the features, the average amount of energy the appliance will use a year, its comparison with similar models, and the estimated yearly energy cost.

For refrigerators, freezers, water heaters, dishwashers, and clothes washers, the labels compare energy consumption in kWh/year or therms/year. For room air conditioners, central air conditioners, heat pumps, furnaces, and boilers, the rating is not in terms of energy consumption, but in energy efficiency ratings, as follows:

- EER–Energy Efficiency Rating (room air conditioners)
- SEER–Seasonal Energy Efficiency Rating (central air conditioners)
- HSPF–Heating Season Performance Factor (with SEER heat pumps)
- AFUE–Annual Fuel Utilization Efficiency (furnaces and boilers)

The estimated annual operating cost is based on recent national average prices of electricity and/or natural gas and assumes typical operating behavior. For example, the cost for clothes washers assumes a typical washer would be used to wash eight loads of laundry per week.

Concepts

- Some appliances are more energy efficient than others.
- The energy efficiency of major appliances can be quantified.
- The Federal Government requires that most major appliances carry labels to inform consumers of their energy efficiency ratings.
- Efficient appliances are usually more expensive to buy than less efficient models, but the life cycle cost of efficient appliances is usually much less than the less expensive appliances.
- Payback period is the operating time for an energy efficient appliance before the higher up-front (purchase) cost is recouped by lower energy costs.

Objectives

- Students will be able to read and interpret the information on EnergyGuide labels.
- Students will be able to compare the life cycle costs and payback periods for appliances using the information on their EnergyGuide labels.

Time

- One 45-minute class period.

Preparation

- Make copies or project the *EnergyGuide Label* and *Comparing EnergyGuide Labels* masters on pages 30-31.

✔Procedure

1. Introduce the activity to the class, using the *EnergyGuide Label* master and/or page 45 of the Student Guide—*Reading EnergyGuide Labels*. Discuss why the Federal Government would be involved in labeling the efficiency of appliances. Note the differences betweeen the labels on both pages.
2. Review *Comparing EnergyGuide Labels*, using the master on page 31. Review the concept of life cycle cost and explain the concept of payback period. Discuss with the class how the chart shows that even though Model 2 is more expensive to buy, it is a better bargain because of the lower energy costs. Explain that the payback period for this refrigerator is six years, because at that time, you will start spending less.
3. Have the students individually complete the *Comparing Appliances* activity on page 46 of the Student Guide. They will be using the principles discussed before, but now with a water heater. Review. Answers can be found on page 7.

Extension Activity

Take the students on a field trip or photo field trip or encourage them to visit a big box or appliance store. They should examine and compare the EnergyGuide labels on large appliances and the energy nameplates on small appliances and machines. Have them take notes or pictures to compare when they return to class.

U.S. Government

Federal law prohibits removal of this label before consumer purchase.

ENERGYGUIDE

Refrigerator-Freezer

- **Automatic Defrost**
- **Top-mounted**
- **No Through- the Door Ice Service**

BRAND B
Model 1
Capacity: 21.1 Cubic Feet

Compare ONLY to other labels with yellow numbers.
Labels with yellow numbers are based on the same test procedures.

Estimated Yearly Energy Cost

$49

$10 — $65

Cost range not available

410 kWh

Estimated Yearly Electricity Use

- **Your cost will depend on your utility rates and use.**
- Cost range based only on models of similar capacity with Automatic Defrost, Top-mounted, and No Through- the Door Ice Service.
- Estimated energy cost based on a national average electricity cost of 12 cents per kWh.

ENERGY STAR

ftc.gov/energy

Comparing EnergyGuide Labels

AN EXAMPLE

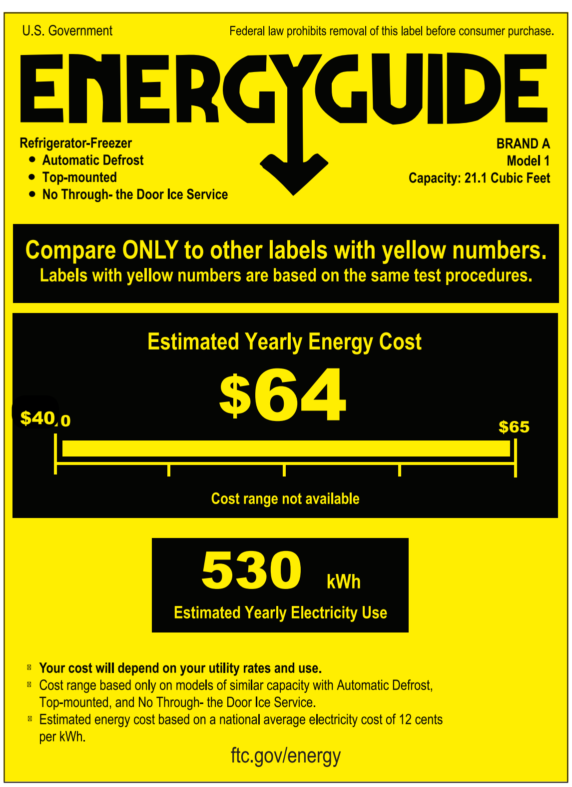
MODEL 1: $720

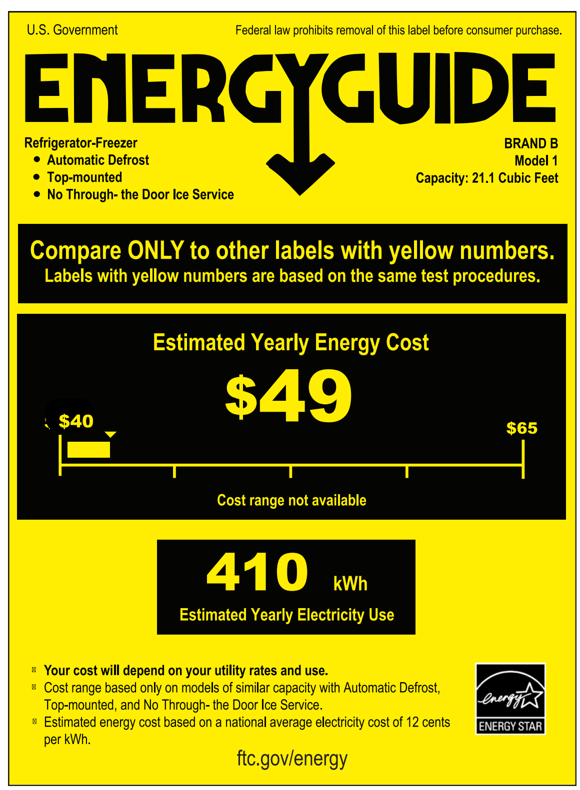
MODEL 2: $799

Let's go shopping for a new refrigerator! We want to buy a refrigerator that will save us money and energy over the life of the appliance, not just with the purchase price. The EnergyGuide labels for the refrigerators are shown at the bottom of the page. We can calculate how much it will cost each year for five years.

MODEL 1	EXPENSES	COST TO DATE	MODEL 2	EXPENSES	COST TO DATE
Purchase Price	$720	$720	Purchase Price	$799	$799
Year One	$64	$720 + $64 = $784	Year One	$49	$799 + $49 = $848
Year Two	$64	$784 + $64 = $848	Year Two	$49	$848 + $49 = $897
Year Three	$64	$848 + $64 = $912	Year Three	$49	$897 + $49 = $946
Year Four	$64	$912 + $64 = $976	Year Four	$49	$946 + $49 = $995
Year Five	$64	$976 + $64 = $1,040	Year Five	$49	$995 +$49 = $1,044
Year Six	$64	$1,040 + $64 = $1,104	Year Six	$49	$1,044 + $49 = $1,093

Compare the Cost to Date figures in Year Four. The life cycle costs favored Model One before the end of Year Four. At year five they were almost the same with Model Two much closer in cost to Model One. After year 5, Model Two becomes a better bargain. Since most refrigerators last about 20 years, which one would you buy?





Kill A Watt™ Investigations

Overview

These activities teach students how to use a Kill A Watt™ monitor to measure and monitor the electric power consumption of electrical machines and devices. These activities are very similar to those in the nameplates investigation, but expand on the skills used by incorporating a measurement tool and examining devices in various modes of operation.

Concepts

- The electrical devices and machines we use consume energy.
- We can monitor the amount of electricity that machines use and calculate the cost.
- Some machines use more electricity in active mode than in idle mode.
- We can monitor the difference in electricity usage between active and idle modes and calculate the cost.
- Some machines use electricity even when they are turned off.
- We can monitor the electricity usage of machines that are turned off and calculate the cost.

Objectives

- Students will be able to use a Kill A Watt™ monitor to gather electric consumption data from a variety of electrical devices in the school in active and idle modes, as well as when they are turned off.
- Students will be able to calculate the cost of using electrical devices.

Time

- Three 45-minute class periods.

Materials

- Kill A Watt™ monitor
- Pluggable electrical devices

Preparation

- Practice using the Kill A Watt™ monitor until you are confident with its functions.
- Make copies or project the *Kill A Watt™ Monitor Instructions* on page 33.

Procedure

1. Have the students go to page 47 of the Student Guide—*Kill A Watt™ Monitor.*
2. Explain what a Kill A Watt™ monitor does and review the operating instructions, using the master to show the parts of the monitor. Demonstrate the operation of the monitor to the students.
3. Review *Kill A Watt™ Investigation 1* on page 48 of the Student Guide with the students. With the students' help, select several electrical devices to monitor.
4. Divide the class into groups and assign each group to monitor one of the selected devices for a six-minute period. Have each group share its results with the rest of the class.
5. Have the students complete the computations and answer the conclusion questions.
6. Review with the class.
7. Repeat the process for *Kill A Watt™ Investigation 2* and *Kill A Watt™ Investigation 3* on pages 49–50 of the Student Guide.
8. Discuss how to save energy when using electrical devices, incorporating the data that has been gathered.

Kill A Watt™ Monitor Instructions

Kill A Watt™ Monitor

The Kill A Watt™ monitor allows users to measure and monitor the power consumption of any standard electrical device. You can obtain instantaneous readings of voltage (volts), current (amps), line frequency (Hz), and electrical power being used (watts). You can also obtain the actual amount of power consumed in kilowatt-hours (kWh) by any electrical device over a period of time from 1 minute to 9,999 hours. One kilowatt equals 1,000 watts.

Operating Instructions

1. Plug the Kill A Watt™ monitor into any standard grounded outlet or extension cord.
2. Plug the electrical device or appliance to be tested into the AC Power Outlet Receptacle of the Kill A Watt™ monitor.
3. The LCD displays all monitor readings. The unit will begin to accumulate data and powered duration time as soon as the power is applied.
4. Press the Volt button to display the voltage (volts) reading.
5. Press the Amp button to display the current (amps) reading.
6. The Watt and VA button is a toggle function key. Press the button once to display the Watt reading; press the button again to display the VA (volts x amps) reading. The Watt reading, not the VA reading, is the value used to calculate kWh consumption.
7. The Hz and PF button is a toggle function key. Press the button once to display the Frequency (Hz) reading; press the button again to display the power factor (PF) reading.
8. The KWH and Hour button is a toggle function key. Press the button once to display the cumulative energy consumption; press the button again to display the cumulative time elapsed since power was applied.

What is Power Factor (PF)?

We often use the formula **Volts x Amps = Watts** to find the energy consumption of a device. Many AC devices, however, such as motors and magnetic ballasts, do not use all of the power provided to them. The power factor (PF) has a value equal to or less than one, and is used to account for this phenomenon. To determine the actual power consumed by a device, the following formula is used:

Volts x Amps x PF = Watts Consumed

School Building Survey

Overview

In this activity, students investigate the construction of their school, the fuels the school uses to meet its energy needs, the amount of energy the school uses, and the ways that the school's energy consumption is managed and controlled. The students brainstorm and recommend ways that the school can save energy.

Background

Schools use a lot of energy to create a safe, comfortable, and productive environment for students to learn. Schools use energy to maintain comfortable temperatures, produce light, heat water, cook food, operate vehicles, and run hundreds of electrical machines and appliances–televisions, public address systems, scoreboards, computers, copiers, alarm systems, exit signs, etc. Most of the energy consumed by schools is supplied by electricity (45%) and natural gas (33%).

When an energy survey of a building is conducted, four main areas are included:

Building Envelope: The building envelope is the physical structure—the walls, windows, roof, doors, floor, stairwells, ceiling, and insulation. The design and construction of the structure is a major factor in heating, cooling, and lighting costs.

Heating/Cooling Systems: Heating and cooling the building is the largest single expense of the school. Most schools are heated with natural gas, some with electricity or heating oil. Electricity is usually used for cooling. Maintenance and temperature control of these systems makes a significant impact on energy costs. These systems are often referred to as HVAC systems.

Water Heating: Water heaters provide hot water for classrooms, lavatories, showers, laboratories, snack bars, and kitchens. They are usually fueled by natural gas or electricity. Insulation, maintenance, and control of temperature and water flow can reduce energy costs for the school.

Lighting: Electricity is used to provide artificial lighting to classrooms, gyms, auditoriums, corridors, offices, sports fields, and parking areas. Maximizing the use of natural light and installing efficient fluorescent lighting systems can significantly reduce energy costs. Controlling light intensity, turning off unnecessary lights, and proper system maintenance can also make an impact on lighting costs for the school.

★Concepts

- Schools use a lot of energy to produce a safe, comfortable learning environment.
- Many factors determine the amount of energy a school uses.
- Schools can reduce energy consumption by converting older systems using energy efficient technologies, instituting energy conservation measures, and educating students, administrators, and staff.
- Reducing energy use saves schools money that can be used for other programs and helps protect the environment.

✪Objective

- Students will conduct an energy survey of the school building and develop recommendations to save energy in the school building, based on their observations.

Time

- Two–three 45-minute class periods.

Preparation

- Obtain permission to conduct the survey, if necessary, from staff members, administrators, and facilities staff.
- Arrange for the building supervisor or principal to visit the class to provide the information in the General Information section of the survey.
- Arrange for a member of the maintenance or facilities staff to take the class on a tour of the building to explain the heating/cooling systems and to answer questions on the survey.

✔Procedure

1. Preview the *School Building Survey* on pages 51-52 of the Student Guide with the students. As you go over the questions on the survey, decide as a class who might best answer each question.
2. Have the building supervisor or principal visit the class to discuss the questions in the General Information section of the survey.
3. Take a tour of the building and grounds with a maintenance or facilities staff member answering the questions in the Building Envelope section. Have the staff person return to the class to discuss any remaining questions on the survey.
4. Discuss the findings with the class and brainstorm a list of ways the school could conserve energy.
5. Have the students draw diagrams of the school on the blank grid on page 53 of the Student Guide, indicating the energy information they discovered on their tour, and using any symbols used in earlier activities.
6. Place the students in groups of four and have each group develop a presentation to explain their findings and recommendations using the organizer on page 57 of the Student Guide. Presentations can be done in many mediums or formats including digital presentations, videos, display boards, or even skits.

School Energy Consumption Survey

Overview

In this activity, students investigate the management of the energy consumed in their school. They measure and monitor the temperature and light intensity levels in various different areas; the temperature of the hot water in different areas of the school; and other controls, management, and behaviors that affect energy consumption.

Background

Even if school buildings are well insulated and have the most modern, efficient energy systems, a significant amount of energy can be wasted if these systems are not controlled and managed wisely.

The best heating system in the world cannot operate efficiently if outside doors or windows are left open, or if the temperature is not controlled. The same is true for cooling systems. Temperature control systems should be set at 68°F (20°C) during the heating season and 78°F (25°C) during the cooling season during the day, and at 55°F (13°C) (heating season) and 85°F (29°C) (cooling season) during the night for optimum efficiency. Programmable thermostats—with access limited to authorized personnel—are recommended. There should also be policies regarding the opening of windows and doors during heating and cooling seasons.

If the temperature of rooms can be individually controlled, there should be policies on permissible temperature ranges. These ranges can vary for different rooms—gyms, for example, need not be heated to the same temperature as classrooms, when physical activity is scheduled. Auditoriums, hallways, storage rooms, and other little used rooms need not be heated and cooled to the same temperature as occupied rooms.

Even the most efficient lighting system is not efficient if it is used indiscriminately. In most schools, more light is used than is necessary. Maximum use of natural lighting should be encouraged and dimmer switches should be used where available. All lights not necessary for safety should be turned off when rooms are not in use. The same is true for outside lights.

Water heaters should be equipped with timers and temperature settings regulated according to task. Washing hands does not require water as hot as washing dishes. Most water heaters are set much higher than necessary for the task.

Concept

Schools can significantly reduce energy costs by using energy efficient technologies and monitoring and managing energy consumption through behavioral changes.

Objective

- Students will conduct a survey of the school's energy consumption and use their observations to develop a plan to reduce the school's energy consumption, and their classroom consumption.

Time

- Four 45-minute class periods, plus on-going monitoring as desired.

Materials

- Diagram of school
- Light meter
- Digital waterproof thermometer
- Digital humidity/temperature pen

Preparation

1. Arrange for the school district's energy manager or other expert to speak to the class about what is being done in the district to conserve energy.
2. Obtain permission for the students to survey and monitor classrooms and non-class areas of the school building.
3. Draw master diagrams of the school on the blank grid (pages 43-44 of the Teacher Guide), numbering the common areas and non-class rooms, then make copies of the diagrams, or project as needed.
4. Divide the class into six groups, assigning each group two classrooms, one common area, and one non-class area or office to monitor, using the diagram of the school. Choose areas from each side of the building, upstairs and downstairs, to get a wide sampling.

   NOTE: If the entire school is participating, have students monitor only their own classroom and their primary buddies' classroom, along with the common areas and non-class rooms.
5. Decide the time frame in which the students will be monitoring their areas. You can choose to have the students monitor the areas only once, every day for a week, or once a week or month. Make copies of the *Recording Form 1* and *Recording Form 2* on pages 55-56 of the Student Guide for each group of students, depending on the amount of monitoring the students will be doing.

✔Procedure

1. Have the students read *School Energy Consumption Survey* on page 54 of the Student Guide. Discuss each of the four areas highlighted. Have the students brainstorm a list of questions for the energy manager.
2. Have the energy manager or another expert make a presentation to the students, and answer their questions.
3. Explain to the students they will be monitoring areas of the school in groups, then review the *Recording Form 1* and *Recording Form 2* on pages 55-56 of the Student Guide to inform them of the information they will be gathering and the tools they will be using.
4. Demonstrate how to operate the digital waterproof thermometer and the digital humidity/temperature pen, using the masters if necessary (pages 38-39). Review use of the light meter, if necessary.

   Note: Only the digital waterproof thermometer can be used for measuring the temperature of water. The digital humidity/temperature pen can only be used to measure air temperature and should not be allowed to get wet.
5. Allow each group 5-10 minutes to collect the data on the *Recording Forms*.
6. Analyze the results, looking for explanations of variations. Is it hotter on the south side of the building, in upstairs rooms? Discuss the findings and brainstorm ways to conserve energy. Draw up a list of recommendations to present to the school administration and the energy manager.
7. Have each student individually design a Plan to Save Energy for the spaces they studied using the *Findings and Recommendations* form on page 57 of the Student Guide. Using the students' answers, brainstorm with the class to develop a master plan to save energy in the school.

Digital Thermometer

A digital thermometer measures the temperature of a substance and displays the temperature reading on its face. It has a battery for power. Sometimes they are waterproof for measuring the temperature of a liquid.

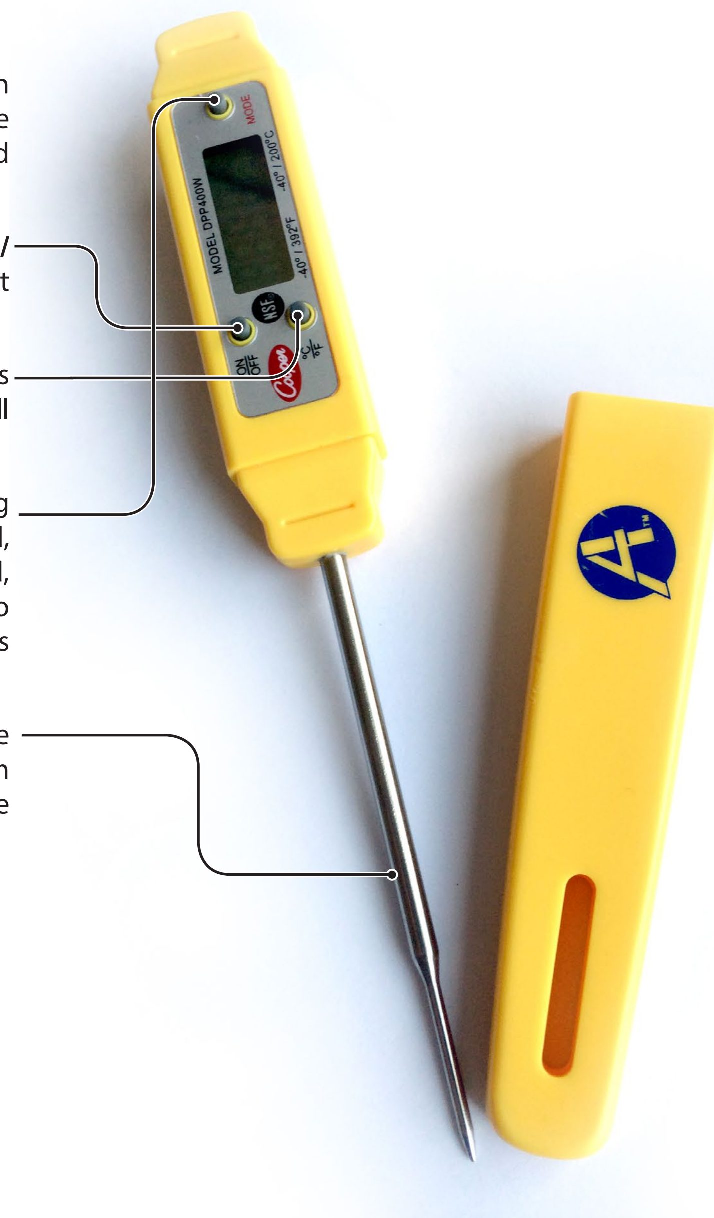
This digital thermometer can measure the temperature in Fahrenheit or Celsius. It shows the temperature range of the thermometer. It can read temperatures from -40° to 392°F and -40° to 200°C.

It has three buttons. The button on the bottom left is the **ON/OFF** switch. If the thermometer is not used for a few minutes, it turns itself off.

The **C/F** button on the bottom right switches from the Celsius scale to the Fahrenheit scale. The face of the thermometer will show a C or an F to indicate which scale is being used.

The **mode** button on the top holds the temperature reading when it is pushed. If you need the exact temperature of a liquid, you push the hold button while the thermometer is in the liquid, then remove the thermometer to read it. This button will also allow you to view the maximum and minimum temperatures measured when pushed two or three times.

The **metal stem** of the thermometer can measure the temperature of the air or the temperature of a liquid. The stem should be placed about halfway into a liquid to measure the temperature.



Humidity/Temperature Pen

Scientists measure the amount of water vapor in the air in terms of relative humidity—the amount of water vapor in the air relative to (compared to) the maximum amount it can hold at that temperature. Relative humidity changes as air temperature changes. The warmer the air is, the more water vapor it can hold.

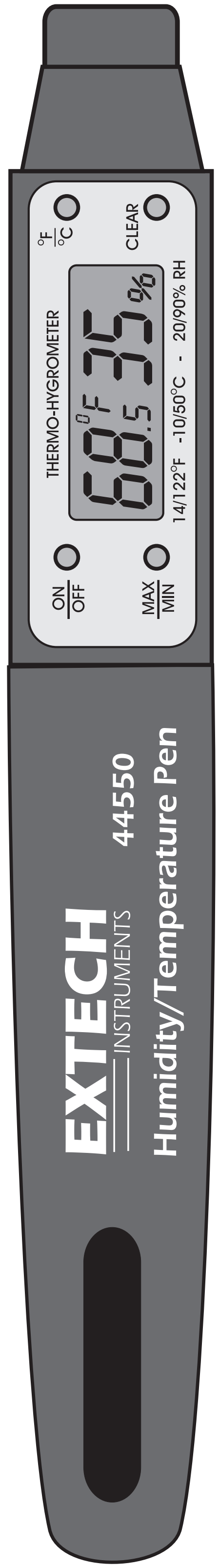
Air acts like a sponge and absorbs water through the process of evaporation. Warm air is less dense and the molecules are further apart, allowing more moisture between them. Cooler air causes the air molecules to draw closer together, limiting the amount of water the air can hold.

It is important to control humidity in occupied spaces. Humidity levels that are too high can contribute to the growth and spread of unhealthy biological pollutants. This can lead to a variety of health effects, from common allergic reactions to asthma attacks and other health problems. Humidity levels that are too low can contribute to irritated mucous membranes, dry eyes, and sinus discomfort.

This digital humidity/temperature pen measures relative humidity and temperature and displays the readings on its face. It has a battery for power. It can display the temperature in Fahrenheit or Celsius. The reading shown on the right is 68.5°F.

The hygrometer displays relative humidity in terms of percentage. The hygrometer shown reads 35%. This means that the air contains 35 percent of the water vapor it can hold at the given air temperature. When the air contains a lot of water vapor, the weather is described as humid. If the air cannot carry any more water vapor, the humidity is 100 percent. At this point, the water vapor condenses into liquid water.

Maintaining relative humidity between 40 and 60 percent helps control mold. Maintaining relative humidity levels within recommended ranges is a way of ensuring that a building's occupants are both comfortable and healthy. High humidity is uncomfortable for many people. It is difficult for the body to cool down in high humidity because sweat cannot evaporate into the air.



Directions

ON/OFF KEY

Press the ON/OFF key to turn the power on or off.

°F/°C

Press the °F/°C key to select the temperature unit you want to use, Fahrenheit or Celsius.

MAX/MIN

Press the MAX/MIN key once to display the stored maximum readings for temperature and humidity.

An up arrow will appear on the left side of the display to indicate the unit is in the maximum recording mode.

Press the MAX/MIN key a second time to display the stored minimum readings for temperature and humidity. A down arrow will appear on the left side of the display to indicate the unit is in the minimum recording mode.

Press the MAX/MIN key a third time to return to normal operation.

CLEAR

If an up or down arrow is displayed, press the CLEAR key until - - - appears on the display. The memory is cleared. New maximum or minimum values will be recorded within 3 seconds.

Building Buddies

Overview

The *Building Buddies* activities in the *Monitoring and Mentoring* program include daily monitoring of energy use by students in the classroom, as well as working with buddies in younger grades so that older students can learn through teaching, using the *Building Buddies* curriculum.

Background

The *Building Buddies* program is designed to be an on-going activity that promotes awareness of the ways schools use energy and the behaviors that can conserve energy in the school. The program is designed so that every student can participate in learning about energy, monitoring classroom temperatures and energy usage, and taking positive actions to conserve energy.

The monitoring component of the program—the *Monitoring and Mentoring Calendar*—incorporates weather conditions, temperature readings in both Fahrenheit and Celsius scales, relative humidity, and light output, as well as self-evaluation of behaviors.

For Single Classroom Use

Hang a copy of the *Monitoring and Mentoring Calendar* in the classroom each week. Assign two students each day to complete the calendar and be responsible for managing energy usage during the day—turning off lights, turning off machines when not in use, checking faucets, etc.

For Use With a Primary Class

Conduct the *Building Buddies* monitoring activities in the classroom and coordinate with a primary teacher to organize mentoring activities.

For a Total School Program

Conducting a total school program requires the coordination of activities with all teachers, as well as administration and maintenance. It is suggested that a group of primary and upper level teachers develop a plan to incorporate the activities into a program that will meet the needs of your school. Many of the activities are math intensive. You may find that third or fourth graders will be more comfortable with the primary program, depending on their ability levels.

Concepts

- Schools use a lot of energy to provide a safe, comfortable learning environment and to provide broad educational experiences.
- Students can incorporate simple behavioral techniques to save energy at school.

Objectives

- Students will be able to list and describe the ways we can save energy at school.
- Students will work with and teach other students to save energy based on their observations.

Time

- Five minutes a day to monitor energy use in the classroom, plus time to work with primary buddies.
- One 45-minute class period per month to analyze data.

Materials

- Copies of *Monitoring and Mentoring Calendar*
- Indoor/outdoor thermometer
- *Building Buddies* Teacher and Student Guides
- Humidity/temperature pen
- Light meter

Preparation

1. Make one copy of the *Monitoring and Mentoring Calendar* on page 42 for the classroom for each week.
2. Arrange for your students to work with a younger age classroom, coordinating times, procedures, activities, and copies of primary materials from the *Building Buddies* curriculum.

✔Procedure

1. Introduce the daily monitoring activity using the *Monitoring and Mentoring Calendar*.
2. Assign two students to complete the calendar and monitor energy use each day.
3. Introduce the mentoring component of the program, explaining that the students will work with primary buddies to complete the activities in the *Building Buddies* program.
4. Distribute the materials that have been copied from the *Building Buddies* guide to familiarize students with the activities they will be completing with their buddies. Review the materials with the students until you are confident they understand the activities and procedures.
5. Have your students work with their primary buddies to complete the activities, as you have coordinated them with the primary teacher. As an extension, have the students use other NEED primary activities to teach primary students about the energy sources and energy trade-offs.
6. Have the students analyze the data from the *Monitoring and Mentoring Calendar* once a month throughout the year, evaluating the effects of weather, outside temperature, and relative humidity.

Extension

- Have students catalog and graph the data from their *Monitoring and Mentoring Calendar* using spreadsheet software.

Monitoring and Mentoring Calendar

For the week of: ______________________

Classroom: ______________________

Monday

Time | **Weather**

___:___ a.m. ____________

___:___ p.m. ____________

Outside Temperature

___:___ a.m. _____°F _____°C

___:___ p.m. _____°F _____°C

Inside Temperature

___:___ a.m. _____°F _____°C

___:___ p.m. _____°F _____°C

Relative Humidity

a.m.: _____% p.m.: _____%

Light Level

a.m.: _____fc p.m.: _____fc

- ☐ We used lighting wisely.
- ☐ We used classroom electrical devices wisely.
- ☐ We used hot water wisely.
- ☐ We managed heating and cooling systems wisely.

Tuesday

Time | **Weather**

___:___ a.m. ____________

___:___ p.m. ____________

Outside Temperature

___:___ a.m. _____°F _____°C

___:___ p.m. _____°F _____°C

Inside Temperature

___:___ a.m. _____°F _____°C

___:___ p.m. _____°F _____°C

Relative Humidity

a.m.: _____% p.m.: _____%

Light Level

a.m.: _____fc p.m.: _____fc

- ☐ We used lighting wisely.
- ☐ We used classroom electrical devices wisely.
- ☐ We used hot water wisely.
- ☐ We managed heating and cooling systems wisely.

Wednesday

Time | **Weather**

___:___ a.m. ____________

___:___ p.m. ____________

Outside Temperature

___:___ a.m. _____°F _____°C

___:___ p.m. _____°F _____°C

Inside Temperature

___:___ a.m. _____°F _____°C

___:___ p.m. _____°F _____°C

Relative Humidity

a.m.: _____% p.m.: _____%

Light Level

a.m.: _____fc p.m.: _____fc

- ☐ We used lighting wisely.
- ☐ We used classroom electrical devices wisely.
- ☐ We used hot water wisely.
- ☐ We managed heating and cooling systems wisely.

Thursday

Time | **Weather**

___:___ a.m. ____________

___:___ p.m. ____________

Outside Temperature

___:___ a.m. _____°F _____°C

___:___ p.m. _____°F _____°C

Inside Temperature

___:___ a.m. _____°F _____°C

___:___ p.m. _____°F _____°C

Relative Humidity

a.m.: _____% p.m.: _____%

Light Level

a.m.: _____fc p.m.: _____fc

- ☐ We used lighting wisely.
- ☐ We used classroom electrical devices wisely.
- ☐ We used hot water wisely.
- ☐ We managed heating and cooling systems wisely.

Friday

Time | **Weather**

___:___ a.m. ____________

___:___ p.m. ____________

Outside Temperature

___:___ a.m. _____°F _____°C

___:___ p.m. _____°F _____°C

Inside Temperature

___:___ a.m. _____°F _____°C

___:___ p.m. _____°F _____°C

Relative Humidity

a.m.: _____% p.m.: _____%

Light Level

a.m.: _____fc p.m.: _____fc

- ☐ We used lighting wisely.
- ☐ We used classroom electrical devices wisely.
- ☐ We used hot water wisely.
- ☐ We managed heating and cooling systems wisely.

ENERGY EFFICIENCY BINGO

- A. Can name two ways to increase a car's MPG
- B. Can name three ways to save energy at home
- C. Can name three ways to save energy at school
- D. Has at least one ENERGY STAR® appliance at home
- E. Knows the definition of *energy efficiency*
- F. Knows the definition of *energy conservation*
- G. Knows what an ENERGY STAR® label means
- H. Knows what SEER is
- I. Knows the type of bulb that uses one quarter of the energy of incandescents
- J. Knows where to find an EnergyGuide label
- K. Can name two appliances that should be run only when fully loaded
- L. Uses day lighting in the classroom instead of overhead lights
- M. Sets this item differently at day and night and for the season
- N. Knows the number one use of energy in the home
- O. Has an energy conservation team at school
- P. Knows whether energy is the first, second, or third highest expenditure in a school district (choose one)

A NAME	**B** NAME	**C** NAME	**D** NAME
E NAME	**F** NAME	**G** NAME	**H** NAME
I NAME	**J** NAME	**K** NAME	**L** NAME
M NAME	**N** NAME	**O** NAME	**P** NAME

I have kilowatt-hour. Who has a light bulb that produces more heat than light?	**I have landscaping.** Who has the most effective way for consumers to reduce the amount of energy used by industry?
I have an incandescent. Who has energy is neither created nor destroyed?	**I have reduce, reuse, recycle.** Who has any behavior that results in using less energy?
I have the Law of Conservation of Energy. Who has the number one use of energy in the home?	**I have conservation.** Who has the length of time you use an energy efficient appliance before you begin to save money?
I have heating and cooling. Who has the label designating energy efficient home appliances?	**I have payback period.** Who has the nation's leading recycled product?
I have ENERGY STAR®. Who has a way to reduce energy use by planting trees to block wind and provide shade?	**I have steel.** Who has a material that resists the flow of heat?

I have insulation. Who has a way to use gasoline more efficiently?	**I have energy efficiency.** Who has a digital meter installed in your home that communicates with your utility company to monitor and control energy usage?
I have keep tires properly inflated. Who has solar, hydropower, geothermal, biomass, and wind?	**I have Smart Meter.** Who has a way to learn how a building can use energy more efficiently?
I have renewables. Who has a light bulb that uses one-fourth the energy of an incandescent bulb?	**I have energy audit.** Who has the label that shows an appliance's annual energy use and operating cost?
I have a compact fluorescent. Who has the leading source of air pollution?	**I have EnergyGuide.** Who has the flow of electrons?
I have vehicle emissions. Who has using technology that needs less energy to perform the same function?	**I have electricity.** Who has caulking, sealing, and weather-stripping cracks around doors and windows?

I have ways to reduce air infiltration. Who has an alternative mode of transportation?	**I have take short showers.** Who has an energy intensive industry?
I have riding a bicycle. Who has the concept that a society should meet its energy needs without compromising the needs of future generations?	**I have petroleum refining.** Who has a device that allows you to control the temperature in your home?
I have energy sustainability. Who has the sector of the economy that uses the most petroleum?	**I have programmable thermostat.** Who has a renewable transportation fuel?
I have transportation. Who has the kitchen appliance that uses the most energy?	**I have ethanol.** Who has the nonrenewable energy source that is used to generate most of the nation's electricity?
I have refrigerator. Who has a way to reduce the cost of heating water?	**I have coal.** Who has a measure of electricity consumption?

NEED's Online Resources

NEED'S SMUGMUG GALLERY

http://need-media.smugmug.com/

On NEED's SmugMug page, you'll find pictures of NEED students learning and teaching about energy. You can also find pictures from NEED workshops, and photos of energy from around the country that were submitted for the Great American Energy Scavenger Hunt. Would you like to submit images or videos to NEED's gallery? E-mail info@NEED.org for more information.
Also use SmugMug to find these visual resources:

Videos

Need a refresher on how to use Science of Energy with your students? Watch the Science of Energy videos. Also check out our Energy Chants videos! Find videos produced by NEED students teaching their peers and community members about energy.

Online Graphics Library

Would you like to use NEED's graphics in your own classroom presentations, or allow students to use them in their presentations? Download graphics for easy use in your classroom.

SOCIAL MEDIA

Stay up-to-date with NEED. "Like" us on Facebook! Search for The NEED Project, and check out all we've got going on!

Follow us on Twitter. We share the latest energy news from around the country, @NEED_Project.

Follow us on Instagram and check out the photos taken at NEED events, instagram.com/theneedproject.

NEED ANNUAL REPORT

NEED's Annual Report gives summaries of the best state and national Youth Awards projects for 2013–2014, as well as information about The NEED Project and our state programs. Download the report online at www.NEED.org.

E-PUBLICATIONS

The NEED Project offers e-publication versions of various guides for in-classroom use. Guides that are currently available as an e-publication will have a link next to the relevant guide title on NEED's curriculum resources page, www.NEED.org/curriculum.

Don't see what you're looking for?

Check back often, as new e-pubs will be added throughout the year.

NEED Outstanding Energy Educators, Class of 2015

Calling all teachers…

NEED teachers are creative, intelligent, busy, fun, and loved by their students. NEED loves to recognize teachers for their dedication to their students and energy education!

Are you a teacher who fits that description AND teaches energy using NEED materials? Tell us about it! Nominate a fellow educator!

How to apply to be a member of the Class of 2015:

Submit a one-page, written description of the following:

- What energy topics were covered
- What activities were conducted
- What NEED resources were used
- How success was measured

Submit a lesson plan for an example activity (optional)

NEED will review submissions and all members of the Class of 2015 will be notified and recognized for their efforts in the classroom and in energy education!

http://www.need.org/outstandingenergyeducator

Monitoring and Mentoring Evaluation Form

State: ____________ **Grade Level:** ____________ **Number of Students:** ___________

1. Did you conduct the entire unit?	❑ Yes	❑ No
2. Were the instructions clear and easy to follow?	❑ Yes	❑ No
3. Did the activities meet your academic objectives?	❑ Yes	❑ No
4. Were the activities age appropriate?	❑ Yes	❑ No
5. Were the allotted times sufficient to conduct the activities?	❑ Yes	❑ No
6. Were the activities easy to use?	❑ Yes	❑ No
7. Was the preparation required acceptable for the activities?	❑ Yes	❑ No
8. Were the students interested and motivated?	❑ Yes	❑ No
9. Was the energy knowledge content age appropriate?	❑ Yes	❑ No
10. Would you teach this unit again?	❑ Yes	❑ No

Please explain any 'no' statement below.

How would you rate the unit overall?	❑ excellent	❑ good	❑ fair	❑ poor
How would your students rate the unit overall?	❑ excellent	❑ good	❑ fair	❑ poor

What would make the unit more useful to you?

Other Comments:

Please fax or mail to **The NEED Project**
P.O. Box 10101
Manassas, VA 20108
FAX: 1-800-847-1820

National Sponsors and Partners

American Electric Power
American Wind Energy Association
Arizona Public Service
Arizona Science Center
Arkansas Energy Office
Armstrong Energy Corporation
Association of Desk & Derrick Clubs
Audubon Society of Western Pennsylvania
Barnstable County, Massachusetts
Robert L. Bayless, Producer, LLC
BP
Blue Grass Energy
Boulder Valley School District
Brady Trane
Cape Light Compact–Massachusetts
L.J. and Wilma Carr
Chevron
Chevron Energy Solutions
Columbia Gas of Massachusetts
ComEd
ConEdison Solutions
ConocoPhillips
Constellation
Daniel Math and Science Center
David Petroleum Corporation
Denver Public Schools
Desk and Derrick of Roswell, NM
Dominion
DonorsChoose
Duke Energy
East Kentucky Power
Eastern Kentucky University
Elba Liquifaction Company
El Paso Corporation
E.M.G. Oil Properties
Encana
Encana Cares Foundation
Energy Education for Michigan
Energy Training Solutions
First Roswell Company
FJ Management. Inc.
Foundation for Environmental Education
FPL
The Franklin Institute
Frontier Associates
Government of Thailand–Energy Ministry
Green Power EMC
Guam Energy Office
Guilford County Schools – North Carolina
Gulf Power
Gerald Harrington, Geologist
Harvard Petroleum
Hawaii Energy
Houston Museum of Natural Science
Idaho National Laboratory
Illinois Clean Energy Community Foundation
Independent Petroleum Association of America
Independent Petroleum Association of New Mexico
Indiana Michigan Power – An AEP Company
Interstate Renewable Energy Council
Kentucky Clean Fuels Coalition
Kentucky Department of Education
Kentucky Department of Energy Development and Independence
Kentucky Power – An AEP Company
Kentucky River Properties LLC
Kentucky Utilities Company
Kinder Morgan
Leidos
Linn County Rural Electric Cooperative
Llano Land and Exploration
Louisiana State University Cooperative Extension
Louisville Gas and Electric Company
Maine Energy Education Project
Maine Public Service Company
Marianas Islands Energy Office
Massachusetts Division of Energy Resources
Michigan Oil and Gas Producers Education Foundation
Miller Energy
Mississippi Development Authority–Energy Division
Mojave Environmental Education Consortium
Mojave Unified School District
Montana Energy Education Council
NASA
National Association of State Energy Officials
National Fuel
National Grid
National Hydropower Association
National Ocean Industries Association
National Renewable Energy Laboratory
Nebraska Public Power District
New Mexico Oil Corporation
New Mexico Landman's Association
NRG Energy, Inc.
NSTAR
OCI Enterprises
Offshore Energy Center
Offshore Technology Conference
Ohio Energy Project
Oxnard School District
Pacific Gas and Electric Company
Paxton Resources
PECO
Pecos Valley Energy Committee
Petroleum Equipment Suppliers Association
Phillips 66
PNM
Read & Stevens, Inc.
Rhode Island Office of Energy Resources
River Parishes Community College
RiverQuest
Robert Armstrong
Roswell Geological Society
Sandia National Laboratory
Saudi Aramco
Science Museum of Virginia
C.T. Seaver Trust
Shell
Shell Chemicals
Society of Petroleum Engineers
Society of Petroleum Engineers – Middle East, North Africa and South Asia
David Sorenson
Southern Company
Southern LNG
Space Sciences University–Laboratory of the University of California Berkeley
Tennessee Department of Economic and Community Development–Energy Division
Tioga Energy
Toyota
Tri-State Generation and Transmission
TXU Energy
United States Energy Association
United Way of Greater Philadelphia and Southern New Jersey
University of Nevada–Las Vegas, NV
University of Tennessee
University of Texas - Austin
University of Texas - Tyler
U.S. Department of Energy
U.S. Department of Energy–Hydrogen Program
U.S. Department of Energy–Office of Energy Efficiency and Renewable Energy
U.S. Department of Energy–Office of Fossil Energy
U.S. Department of Energy–Wind for Schools
U.S. Department of the Interior–Bureau of Land Management
U.S. Energy Information Administration
West Bay Exploration
Western Massachusetts Electric Company
W. Plack Carr Company
Yates Petroleum Corporation