

School Energy Survey

Teacher Guide

Students investigate all aspects of the school's energy consumption by conducting a comprehensive energy audit and developing an energy conservation plan to implement.



Grade Level:

Sec Secondary

Subject Areas:



Science



Social Studies



Math



Language Arts



Technology



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.

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

Energy Data Used in NEED Materials

NEED believes in providing teachers and students with the most recently reported, available, and accurate energy data. Most statistics and data contained within this guide are derived from the U.S. Energy Information Administration. Data is compiled and updated annually where available. Where annual updates are not available, the most current, complete data year available at the time of updates is accessed and printed in NEED materials. To further research energy data, visit the EIA website at www.eia.gov.



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School Energy Survey Teacher Guide

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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 website.

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 website.

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 website.

The screenshot shows the NEED website interface. At the top left is the NEED logo (National Energy Education Development Project). To the right are social media icons for Facebook, Twitter, Instagram, Pinterest, a calendar, and Blogger. Below these is a search bar with the text "Search this site:". A navigation menu contains links for "About NEED", "Educators", "Students", "Partners", "Youth Awards", "Contact", and "Shop". On the left side, there is a vertical menu with dropdown arrows for "Curriculum Resources", "Professional Development", "Evaluation", "Supplemental Materials", "Curriculum Correlations", and "Distinguished Service and Bob Thompson Awards". The main content area is titled "> Educators > Curriculum Correlations" and "Curriculum Correlations". The text below the title states: "NEED has correlated their materials to the Disciplinary Core Ideas of the Next Generation Science Standards. NEED has also correlated all of their materials to The Common Core State Standards for English/Language Arts and Mathematics. All materials are also correlated to each state's individual science standards. Most files are in Excel format. NEED recommends downloading the file to your computer for use. Save resources, don't print!". Below this text is a list of links: "Navigating the NGSS? We have What You NEED!", "NEED alignment to the Next Generation Science Standards", "Common Core State Standards for English and Language Arts", and "Common Core Standards for Mathematics". At the bottom of the list are state names: "Alabama", "Alaska", "Arizona", "Arkansas", and "California". On the left side of the screenshot, there is a green calendar icon with a blue square on one of the dates. Below the icon is the text: "NEED is adding new energy workshops all the time. Want to".



Teacher Guide

Background

The *School Energy Survey* is designed to give students the necessary background and framework to conduct an energy survey of their school building. The step-by-step approach guides students through the process of analyzing energy consuming appliances and systems. After gathering data, students identify energy-related issues and brainstorm solutions. Students then rate the costs and benefits associated with their proposed solutions and put together an action plan. Finally, as an extension, students can monitor the impacts of their plan over time. At each step, graphic organizers and charts are provided to help students structure their plan.

The *School Energy Survey* also introduces students to careers available in the energy management industry. Energy analysts perform energy studies on commercial, residential, and industrial buildings to determine cost-effective ways to save energy. The activities in the *School Energy Survey* closely parallel the tasks performed by engineers and other technicians in this growing field.

Materials *FROM LEARNING AND CONSERVING KIT*

- Waterproof digital thermometer
- Digital humidity/temperature pen
- Flicker Checker
- 2 Kill A Watt® monitors
- Light meter
- 9-volt Battery (for light meter)
- Indoor/outdoor thermometer
- Incandescent light bulb
- Compact fluorescent light bulb (CFL)
- Light emitting diode (LED)

Preparation

- Familiarize yourself with information and activities in the Teacher Guide and Student Guide.
- Familiarize yourself with the equipment included in NEED's *Learning and Conserving Kit*. Make sure that you have a working knowledge of the information, definitions, and conversions, and how to operate the equipment. See page 21 for more information on this kit, if necessary.
- Make copies of the pages from the Student Guide that you want the students to complete. It is suggested that students keep journals or science notebooks during the unit to record their thoughts, observations, and data.

Evaluation

- Evaluate students based on their data collection and proposed plan.
- Evaluate the unit with students using the *Evaluation Form* on page 23 and return it to NEED.

Grade Level

- Secondary, grades 9-12

Time

- Approximately seven 45-minute class periods, plus out-of-class research and monitoring

NEED Resources

- The *School Energy Survey* is designed to supplement NEED's secondary Energy Management curriculum: *Learning and Conserving*. It also works well in combination with *Plug Loads*, an activity designed specifically for analyzing the consumption of electrical devices. These units guide students and teachers through a comprehensive study of how energy is used at school and home.
- NEED's *Saving Energy Expo* and *Energy Conservation Contract* activities are excellent additional, or substitute, culminating activities.

These activities and more are available on NEED's website at www.NEED.org.



Introduction

✓Procedure

1. Explain to students that they will be conducting an energy survey of their school building. Explain that the building is a system made up of many components designed to create a healthy environment conducive to learning. Have students brainstorm the ways that energy is used in the building. Discuss the equipment and devices that make up the following energy system components: Building Envelope, HVAC, Lighting, and Electrical Devices.
2. How do these systems interact and affect one another? Lead a discussion where these connections are described. Discuss how steps taken to save energy could negatively impact the learning environment. How could these impacts be mitigated? For example, decreasing the level of ventilation can produce a build-up of moisture and other contaminants that can lead to health problems. Another example is replacing lights with lights that use less energy but don't provide as much light. This could cause problems related to eyestrain. When making changes to save energy, adequate lighting, ventilation, and other services must be maintained.
3. Direct the students to read the *Introduction* and *The School Building is a System* sections in the Student Guide. Afterwards, lead a discussion about what the largest energy consumers will be in the school building, based on the EPA Climate Zone information provided. Ask students to share examples they have observed of how the school building is wasting energy and how the building is using energy efficiently. Record student responses. Finally, discuss the financial and environmental costs of energy waste and the opportunities provided by using these resources efficiently.
4. Explain that the students will learn about the tools they will be using and will conduct several activities before completing the survey to give them more information.
5. Have the students review pages 12–16 in the Student Guide to learn about the tools they will be using.



The Cost of Using Electrical Devices

🕒 Overview

This activity teaches students how to quantify the annual consumption and cost of using electrical devices. They will be using the energy information gathered from electrical devices by using the Kill A Watt® monitor. Students will also determine the amount of carbon dioxide produced by the energy use of each electrical device. Students develop an awareness of school electricity consumption and its impact on the environment.

📖 Background

Carbon dioxide (CO₂) is a greenhouse gas. Human activities have dramatically increased its concentration in the atmosphere. Since 1850, the level of CO₂ in the atmosphere has increased by almost 44 percent. Generating electricity accounts for a large portion of CO₂ emissions in the U.S. Some electricity generation, such as hydropower, solar, wind, geothermal, and nuclear, doesn't produce carbon dioxide because no fuel is burned. About 38.64% of the nation's electricity, however, comes from burning coal. Another 30.12 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 CO₂ emitted into the atmosphere. On average, generating a kilowatt-hour (kWh) of electricity produces 1.23 pounds of CO₂, which is emitted into the atmosphere.

🎯 Objectives

- Students will be able to determine the energy requirements and cost of using electrical devices.
- Students will be able to describe the relationship between electricity consumption and the environment.

📄 Materials

- Kill A Watt® monitors
- Electrical devices

✓ Procedure

1. Students will be determining the annual cost of electrical devices throughout their school building. To determine the amount of time the device is used, it will often be necessary to talk with those who routinely use the device. Explain that this information can be gathered as part of the interviews they will conduct. Introduce the formulas students will use to determine the annual cost of using electrical devices, found on page 17 of the Student Guide. Work through the example provided with students and then have students perform the calculations on their own data.
2. For this activity, students are directed to calculate the cost of using devices based on the national average cost per kilowatt-hour for commercial customers. For a more authentic assessment of cost, have students research the cost in your area or obtain a copy of your school's utility bill.
3. Discuss the environmental impacts of using electrical devices. Instruct students to read page 18 of the Student Guide where the connection between electrical devices and climate change is discussed. Discuss this connection with students after they have read the section.
4. Explain that they should transfer their data to the table on the *Environmental Impacts* activity worksheet. Discuss the formula for calculating CO₂ emissions and ensure student understanding of instructions. Instruct students to complete the table, performing the calculations based on the data they collected.
5. Review the results with the class.



The Facts of Light

Overview

This classroom activity teaches 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 schools, about 17 percent of the total electricity bill is for lighting and in homes, about 11 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 there was widespread adoption of efficient lighting technologies, the electricity demand for lighting would be reduced by 33 percent. This would avoid the construction of 40 new power plants.

Compact fluorescent lights (CFLs) use 75 percent less energy than incandescent bulbs and last up to 10 times longer. Using CFLs can help cut lighting costs up to 75 percent. In addition, CFLs produce very little heat, reducing the need for air conditioning in warm weather.

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 (LEDs) are also efficient lighting options. LEDs use about the same amount of energy as a CFL bulb, but they have an average lifespan of 25,000 hours—much longer than CFLs. LEDs work particularly well in outdoor environments because of their durability and performance in cold weather. Currently, LEDs are more expensive, but costs are continually decreasing due to improved technology and increased demand.

Objectives

- Students will be able to quantitatively describe the differences in the energy consumption of incandescent, halogen, compact fluorescent, and LED bulbs.
- Students will be able to describe a life cycle cost analysis.

Procedure

1. Have the students read *Lighting Options* on page 19 of the Student Guide.
2. Have the students complete the *Comparing Light Bulbs* activity on page 20 of the Student Guide. Review with the class, emphasizing the difference between purchase price and life cycle cost. If students wish, they may research the cost per kilowatt-hour paid by your school to complete the activity.

Comparing Light Bulbs Answer Key *Student Guide Page 20*

	INCANDESCENT BULB	HALOGEN	COMPACT FLUORESCENT (CFL)	LIGHT EMITTING DIODE (LED)
Number of bulbs to get 25,000 hours	25	8.3	2.5	1
Cost of bulbs for 25,000 hours of light	\$12.50	\$24.90	\$7.50	\$8.00
Total kWh consumption	1,500 kWh	1,075 kWh	325 kWh	300 kWh
Cost of electricity	\$150.00	\$107.50	\$32.50	\$30.00
Life cycle cost	\$162.50	\$132.40	\$40.00	\$38.00
Pounds of carbon dioxide produced	1,845.0 lbs carbon dioxide	1,332.3 lbs carbon dioxide	399.8 lbs carbon dioxide	369.0 lbs carbon dioxide



Reading Meters and Utility Bills

🕒 Overview

This activity teaches students how to read electric and natural gas meters in order to calculate the cost of the energy consumed.

📖 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, interactive boards, DVD players, copiers, 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—but 38.64 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 buildings, 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 attached. The meter 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. One Ccf of natural gas contains about 103,000 Btu or 1.030 therms of heat energy. This figure can vary by up to 25 percent depending on the supply. Utility bills list the actual energy content conversion factor.

Heating oil is delivered by truck and pumped into a storage tank. The tank could be located underground or inside the building. The amount of heating oil purchased is measured when it is delivered and the school district is billed by the delivery company.

🎯 Objective

▪Students will be able to describe how electricity and natural gas are measured and how their costs are calculated.

✓ Procedure

1. Introduce the activity, discussing the tasks that use electricity and natural gas at home and school.
2. Have the students complete pages 21-22 of the Student Guide. Review with the class.
3. Explain that many utility meters are now digital rather than analog, and that many new meters automatically transmit energy usage to the utility company. Have the students monitor one or all of the school's electric meters for a week and determine how much electricity is used on average each day using the same basic math in the meters activity. Find out the electricity rate for the school and have the students determine the average cost per day for electricity.
4. For longer-term monitoring, instruct students to design a spreadsheet to record meter readings monthly. Students can graph the data and determine trends related to weather and changes in behavior.
5. Explain that another way to monitor energy use is by reading utility bills. Review the following terms with the class: therm, Ccf, kilowatt-hour, and baseload. Refer students to the glossary for definitions of terms unfamiliar to them.
6. Have the students review the *Sample Bill Explanation Key* and sample school utility bills on pages 23-25 in the Student Guide.



How Your School Uses Energy

🕒 Introductory Procedure

1. Explain to students that they will work in teams to complete a series of data organizers and conduct interviews to determine how the school is using energy. They will then develop recommendations on how energy could be used more efficiently.
2. Define key terms for students, including building envelope, boiler, hygrometer, watt, and foot-candles. Refer the students to the glossary for definitions of unfamiliar terms.
3. Have students read pages 2-11 of the Student Guide. Explain that these pages give them important background information.
4. Lead a discussion on what students might expect to find during their survey. For each energy system component (Building Envelope, HVAC, Lighting, Electrical Devices), ask students to discuss what they should be looking for during the survey.

Building Staff Interviews

📖 Background

Students will develop a battery of interview questions and then interview staff members on energy-related equipment and behaviors in their areas of the building. Students should be familiar with a variety of interview strategies and formats.

School staff energy interviews can become a purposeful writing activity designed to collect data from a variety of school building staff. Students may choose to design different questions for different types of staff or design one set of questions that will work well with them all. Students should decide whether to interview all staff in one department or to choose one representative staff person.

Types of staff to be interviewed:

- Teachers constitute the largest body of employees occupying the greatest building area.
- Office staff members have different needs, hours, types of devices, and experiences.
- Maintenance and operations personnel have knowledge, understanding, and access to information on the operation of the building and energy-related issues.
- Other staff may include cafeteria personnel, athletic department personnel, and after school program leaders.

Areas of interest in the design of staff interviews:

- Staff awareness of the energy devices and systems that use energy in their spaces
- Familiarity with controls such as thermostats and energy-saving settings for equipment
- Patterns of use regarding these devices and systems
- Staff feelings and opinions about energy use and energy efficiency
- Staff awareness of energy waste in their work environment (What examples can they list?)
- Staff awareness of energy conservation practices (What examples can they list?)

Types of energy consuming systems and devices:

- Building Envelope: windows, doors, insulation levels, drafts
- HVAC: Climate controls; heating, air conditioning, ventilation
- Lighting: natural lighting, overhead lighting, task lighting
- Electrical Devices: copiers, projectors, printers, vending machines, interactive boards, pencil sharpeners, chargers, adapters
- Computers: desktops, laptops, peripherals (also electrical devices)
- Anything specific to the staff person: cafeteria appliances, gym exercise machines

Types of data to collect during interviews:

- Quantitative, numerical data: what time staff arrive and leave work, how often different electrical devices are used daily or weekly, etc.
- Qualitative or anecdotal data: the staff's understanding of their equipment, the ways the staff practice energy conservation, any ideas they have about energy waste or potential savings in their work environment, etc.

Types of questions (an interview may combine more than one type of question and response):

- Open-ended questions with oral responses
- Multiple choice questions
- Yes or no questions
- Quantitative questions (*i.e.*, “how many”)
- Likert scale questions (*i.e.*, “on a scale of one to five”, or “agree strongly; agree”, etc.)

📋 Preparation

- Help to identify key staff members for interviews. If you have assigned your teams to specific areas of the building for data gathering, then make sure that they will be interviewing staff members who work in those areas. Where more than one student is conducting the interviews, students should agree in advance on the questions, format, and any strategies to be used to conduct the interviews and assemble the data.
- Become familiar with the data gathering and analysis activities that follow as a way to understand the purpose of conducting these interviews.

🎯 Objectives

- Students will be able to:
 - Write interview questions pertaining to energy-related equipment and behaviors.
 - Conduct a staff interview and record responses.
 - Analyze data.
 - Present findings.

✓ Procedure

1. Divide students into teams. Explain that the first step of their survey will be the staff interviews. Teams will design and conduct these interviews. Explain that while they can determine a lot about the building’s energy consumption through observation, there are some things that they will only be able to learn by talking with those who work in the building. Have students brainstorm a list of important staff to interview and how their work impacts the energy consumed in the building.
2. Review with students the types of staff, areas of interest, types of systems and devices, types of data to collect, and explain the different types of questions they may use.
3. Have the teams compose a list of questions. Evaluate the questions using the rubric on the next page, before allowing the students to use them for interviews. If needed, have students refine their questions to be more effective data gathering tools. Help students organize scheduling of interviews if needed.
4. This assignment should conclude with student teams sharing collected data, determining areas of interest with regard to energy use patterns found, and preparing a report analyzing their findings. The results of the interviews can be used to prepare an Energy Action Plan outlining energy conservation practices observed and conservation practices that can be implemented.

Assessment

▪The rubric below can be used throughout the interview process and after.

Interview Rubric

Stage	Component	Needs Improvement	Adequate	Excellent
Pre-Interview	Understanding Objectives			
	Preparing for Interview			
	Identifying Key Staff			
Energy Consuming Systems and Devices Addressed in Interview	HVAC			
	Building Envelope			
	Lighting			
	Electrical Appliances and Devices			
	Special Case Loads			
Staff Attributes Addressed in Interview	Energy Consumption Awareness			
	Energy Related Behaviors			
	Knowledge of Systems and Devices			
	Current Conservation Practices			
	Willingness to Conserve			
Data Collection	Consistent Format Used			
	Qualitative Data Collected			
	Quantitative Data Collected			
	Multiple Interview Questions Employed			
	Report Format-Data Presentation			
Analysis of Data Findings and Recommendations	Correct Identification of Behaviors			
	Quality of Data Analysis			
	Contextual Usefulness			
	Quality of Final Presentation			



Gathering Data

🕒 Overview

This activity requires students to use observational skills and measurement tools to gather information about energy use. Students will then analyze their data, make suggestions, and complete a cost-benefit analysis of their solutions.

📖 Background

The foundation of the survey is the collection of data. Students use equipment and observation skills to gather energy-related data about the building. They also record examples of efficient use of energy and opportunities for savings they observe.

Become familiar with the data gathering and observation forms. Anticipate and prepare for any access issues with gathering the data in the parts of the building where students will be assigned. Be aware that each section of the data gathering form is designed to be used independently. If student groups are gathering data for HVAC and the Building Envelope, for example, they will be asked to ascertain some of the same information for more than one form. In this case, students only need to record the data once.

📋 Preparation

- Make copies of the data gathering, *Brainstorming Solutions*, and *Costs and Benefits* forms, as necessary.
- Obtain permission for students to access the spaces to gather data. Provide supervision as necessary.
- Determine how and where you want the teams to work. Two options are listed below:
 - Assign each team to an area of the building. It could be as specific as one room, or it could be as broad as a wing of the building. In this scenario, each team will gather all the data on the assigned space. Within groups, individual students can specialize in gathering specific data. For example, one student can gather data on lighting, another on electrical devices, etc.
 - Assign each team to a particular energy system component. For example, one team might do a lighting survey for a whole wing or the whole building, while another team surveys the electrical devices.
- Take into consideration your students' abilities to work independently and conduct the survey in one room if desired. Be prepared to provide safety guidelines and guidelines for accessing their assigned spaces.

🎯 Objective

- Students will be able to use tools and observations in order to determine whether or not energy is being utilized efficiently.

📄 Materials

- Digital waterproof thermometer
- Digital humidity/temperature pen
- Flicker Checker
- 2 Kill A Watt® monitors
- Light meter
- Indoor/outdoor thermometer

✓ Procedure

1. After the interviews, give the teams instructions on the data gathering procedure.
2. Review instructions for the tools they will be using. Demonstrate the proper use of each tool.
3. When gathering data, students should use the data gathering forms on pages 28-32 of the Student Guide to record information about energy use in the spaces they survey. The forms are broken into different sections for *Observation Data*, *Building Envelope*, *HVAC*, *Lighting*, and *Electrical Devices*. Before sending students out to gather data, go over the forms and ensure that students understand how to use them.
4. While gathering data on the other forms, students should also use the *Observation Data Form* on page 28 of the Student Guide to record their observations about energy usage in the school. In each location, students should note every incidence where they observe energy being used and list it on the form as either positive or negative.
 - If they believe that energy is being used efficiently, the observation should be listed in the right hand section (+) of the form.
 - If they believe that energy is being used inefficiently, they should list it on the left hand section (-) of the form. An example might be students entering an unoccupied classroom. If the lights in the room are on even though no one is in the room, it should be listed on the left hand section (-) of the form.

Brainstorming Solutions Form

Background

After the students have completed their tour of the building, they will brainstorm possible solutions to the energy issues they noted on the left hand section of the *Observation Data Form*.

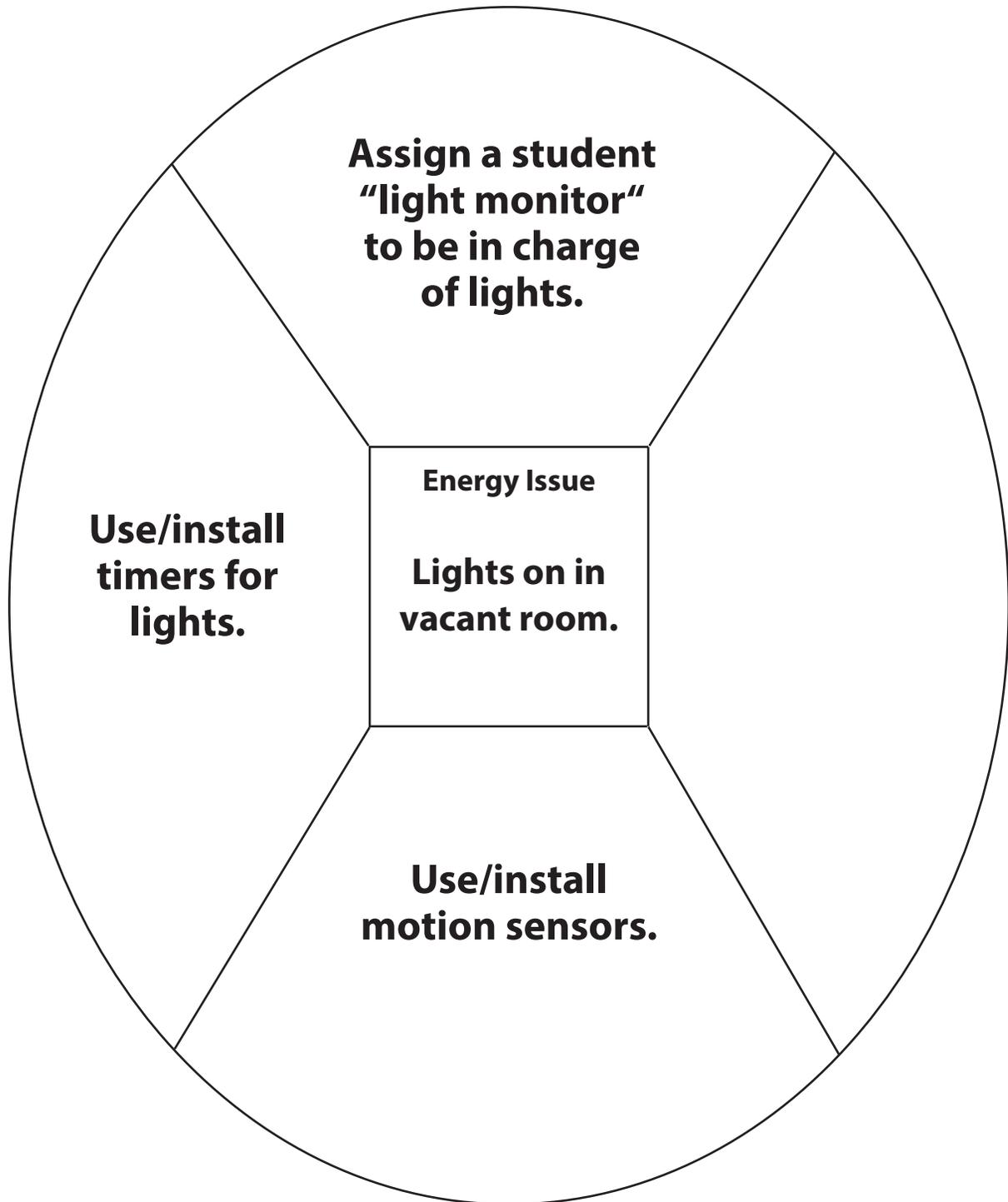
✓ Procedure

1. Explain to students that for each energy concern their team identified on their *Observation Data Form*, they will complete a *Brainstorming Solutions* graphic organizer on page 33 of the Student Guide. The concern should be written in the center and possible solutions should be brainstormed and listed in the outer sections of the organizer.
2. Establish guidelines for brainstorming. Explain that in a brainstorm, all ideas are acceptable. The teams should encourage the generation of ideas and no ideas should be discounted. Explain that they will have an opportunity later in the process to determine which solutions will be most effective.
3. Display or project the *Brainstorming Solutions* master on page 15. Using the example of lights left on in the vacant room, "lights left on" would be written in the middle section of the form. Possible solutions would be written in the outside sections of the form. Ask students to complete these in their teams.
4. Ask teams to share one or more of their concerns and brainstormed solutions. Lead a classroom discussion on the opportunities and potential challenges of the solutions that were brainstormed.



Brainstorming Solutions

During your energy survey, you observed conditions where energy was being used inefficiently. For each of these concerns, make a wheel organizer like the one below and brainstorm possible solutions. In the center of the wheel, write the name of the concern you are trying to address. In the outer sections, write the possible solutions.



Costs and Benefits Form

Background

The *Costs and Benefits* worksheet is used to analyze each of the potential solutions to the concerns students identified. It will help students select the most promising solution based on their analysis. Determining costs and benefits can be a challenging task.

In many cases the costs and benefits will be difficult to quantify. In these cases students should be directed to develop hypotheses on the relative costs and benefits as well as they can determine them. It is more important that students weigh the options and work through the problem solving process than to come up with concrete costs/benefits.

Procedure

1. Explain to students that the cost-effectiveness of an action is often the most important factor in deciding if the action should be taken. There may also be barriers, in addition to cost, to consider. These costs, financial and otherwise, need to be weighed against the savings and other benefits to be gained from taking the action.
2. Explain that in this step, students will try to determine which of their brainstormed solutions are the most cost effective, financially and otherwise.
3. Instruct the students to transfer the information from the *Brainstorming Solutions* graphic organizer to the top row of the *Costs and Benefits* worksheet on page 34 of the Student Guide. For each solution, students should identify the financial costs and other barriers related to time and effort, as well as the potential energy savings benefits. Project the master on page 17 as an example.
4. Ask students to share examples of their solutions and demonstrate how you would determine a cost-benefit rating. For example, if you wanted to investigate the savings available from choosing energy efficient computers and using the energy saving features on computers, a good resource is the EPA's (Environmental Protection Agency) ENERGY STAR® website. There, students can access free software to calculate the savings potential of computer-related energy saving behaviors. Go to www.energystar.gov and type in 'power management savings calculator' at the search prompt.

Students can research the savings available by replacing older refrigerators and freezers with new, more energy efficient models. On average, new refrigerators use 40 percent less energy than 10-30 year old models do. Many schools—and homes, for that matter—have refrigerators and freezers that are nearly empty much of the time. Consolidating to a few, newer refrigerators would add up to significant savings. Students can also look at the savings from replacing incandescent bulbs with compact fluorescent bulbs or LED bulbs (a 75 percent savings).

5. After listing the costs and benefits, students should assign a positive integer from +1 to +3 to rate the potential energy savings of the solution (+3 representing the most savings and +1 representing the least savings). The same should be done to rate the costs and barriers of each solution using negative integers from -1 to -3 (-3 representing the greatest costs and -1 representing the least cost). To determine the Benefits-Costs score for each solution, students should add together the benefits rating and the costs rating. The solution with the highest Benefits-Costs score might be considered the most promising solution to the energy concern being analyzed.



Costs and Benefits

Make a chart like the one below for each energy concern so that you can analyze the possible solutions. When considering costs and benefits, keep in mind financial and time considerations, as well as the effort involved to make the solution a success.

You may need to do some research to establish costs and benefits. The building staff can help you determine these costs and benefits. In some cases, you may be able to quantify the costs and benefits as you did in the *Cost of Using Electrical Devices* worksheet. In other cases, you may need to describe the costs and benefits.

ISSUE/SOLUTION ORGANIZER				
ISSUE:	SOLUTION 1:	SOLUTION 2:	SOLUTION 3:	SOLUTION 4:
Lights on in a vacant room.	Assign a student "light monitor."	Use/install timers for lights.	Use/install motion sensors.	
Costs/Barriers	Students are forgetful or do not want to appear bossy.	Could be expensive to purchase or install in entire building.	Could be expensive to purchase or install in entire building.	
Benefits	Cheap/no cost	No staff/personnel needed after programming.	No staff/personnel needed after programming.	
Benefits Rating (+1, +2, or +3)				
Costs Rating (-1, -2, or -3)				
Score (Benefits-Costs)				
Conclusion				



Developing an Action Plan

Background

It is important to understand that the people in your school can impact the success of an action plan. Gaining the support and cooperation of staff and students is a key step for successful action plan implementation. In addition, meeting your energy management goals frequently depends upon the awareness and commitment of the people who will be asked to change their behavior and/or implement the steps in your plan. Because of this, students may need to include motivational components in their plans.

The potential to raise awareness of energy use and ways to conserve energy can be enormous, as lack of awareness is often widespread. When the school community is energy aware, the power of each individual can be harnessed to reduce energy waste in the school. This step involves making everyone aware of energy issues and energy saving practices in their day-to-day activities in order to achieve sustained improvement.

Motivating Staff and Students

Influencing staff and student behavior is arguably the most challenging aspect of energy management, but it also can be the most productive. Experience has shown that significant energy savings, as much as 25 percent, can be achieved through simple, energy-saving activities alone. Student and staff “buy-in” is therefore a key factor in achieving these savings, and without awareness and training, few people will take energy efficiency in the school seriously.

It is one thing to get the administration to buy-in, but influencing behavior change, especially from those who may not be directly responsible for meeting energy goals, is much more challenging. Generally, the most effective strategies that help move people through the change process involve those that simultaneously increase buy-in and lower resistance to change.

Several important steps are involved in these strategies:

1. Create a compelling reason for making the change.
2. Tap into staff and student ideas to help them “own” the plan and benefit from it.
3. Support people in the change process.

Create A Compelling Reason For Making the Change

Different people will respond to different reasons for saving energy. However, people will probably not respond positively to simply being told to follow the plan and practice energy efficient behaviors. You need to give them reasons for saving by using different motivational themes.

The most effective themes incorporate the facts that a healthy learning environment enables students to gain knowledge, an energy management plan provides for financial gains, and energy conservation promotes environmental benefits. One or more of these themes should appeal to most students and staff and help provide the motivation to become more energy conscious and support the energy management plan.

High Quality Learning Environment

Every school day, over 58 million K-12 students across the nation go to class to learn. The quality of their education is dependent upon many factors, not just the teacher in the classroom. A high-quality learning environment has been recognized as a crucial element to the educational process. Buildings and rooms where classes are held are part of the learning environment.

Studies have found our nation’s school buildings to be lacking in many areas, including heating, ventilation, and air conditioning (HVAC), lighting, and energy efficiency. This means that millions of students are attending classes in buildings with unsatisfactory environmental conditions every day. Additionally, studies suggest that conditions not repaired can negatively impact students and their learning. The goal of every school is to provide a learning environment in which students can perform well. A quality energy management plan offers a healthy environment for students to gain knowledge and develop skills.

Financial Gains

Tightening budgets impact public schools, forcing many of them to eliminate academic and extracurricular activities. American K-12 schools currently spend over \$8 billion annually on energy costs. The U.S. Department of Energy (DOE) estimates that schools could save 25 percent of that money by improving energy efficiency. An effective energy management plan can help school districts direct more money into academics and extra-curriculars instead of energy costs. An effective energy management plan can also help districts remain within their budgets when costs rise unexpectedly.

Energy and the Environment

Protection of the environment is a strong motivator. Energy management plans can help preserve our planet's natural resources and promote a healthy environment.

Tap Into Student and Staff Ideas

Involving the building occupants in the development of your plan is an excellent way to ensure success. Present the plan to staff and student groups and ask for their thoughts and ideas. People who have been involved in the creation of a plan are more likely to believe in the plan and make a commitment to it.

Support People in Their Efforts to Save Energy

It is difficult to sustain voluntary behavior change without an on-going effort. Maintaining awareness and focus must be an on-going part of your energy management plan. One way to do this is to develop an agreement with your school district administration to return a percentage of the savings that result from your plan to the school to be used as determined by staff and students. Other incentive programs may also be proposed.

Maintaining high visibility for the program will also promote on-going participation. An effective strategy is to communicate plans and achievements with key stakeholders in the school community. Many communication methods exist, including leaflets, posters, newsletters, stickers, e-mails, presentations, competitions, and many more. Communication is not a one-way process. Feedback from the school community is essential to any successful energy awareness program. It lets you know how the program is performing and it also lets others know the effectiveness of their efforts. Promoting energy efficiency and conservation practices among staff and students is an ongoing process, not a one-time activity.

🔄 Objective

- Students will be able to develop and write an action plan for implementing at least one of their solutions to an energy-related problem they identified.

✓ Procedure

1. Explain to students that by implementing awareness campaigns, they can significantly decrease energy use in their schools. Guide them through an interactive process of drafting an implementation plan for reducing the energy use of the school, or even the entire school district. The plan should be built upon easily accomplishable steps to success.
2. Using the *Developing An Action Plan* worksheet, discuss the necessity for motivating students and staff. Ask students to identify the reasons why saving energy is important. Record their responses and ask them what would motivate their classmates and teachers to take the actions that they recommend. The discussion should include:
 - improving the learning environment;
 - saving money or avoiding costs for the district and taxpayers; and
 - improving the environment.
3. Assist the students in assimilating the knowledge they've gained during the survey process and extending it throughout the school and community with energy awareness campaigns or other energy-saving actions. Choosing energy-saving opportunities that apply to both school and home will create rich opportunities for classroom and home discussion, and increase the level of personal involvement.
4. Introduce students to the *Action Plan Worksheet*. Explain that they will use this worksheet to outline the steps for implementing each energy solution selected.
5. Students should brainstorm each task that must be completed in order to implement the solution. The tasks should then be placed in the order in which they should be completed.
6. After determining the order in which the tasks need to be completed, list them on the worksheet. The first task that needs to be completed is written under the ACTION TO BE TAKEN column next to 1., the second task written under the ACTION TO BE TAKEN column next to 2., etc.
7. For each task it is necessary to determine who is responsible for completing the task and the date by which it needs to be done. The person responsible for the task is written under the BY WHOM column and the date the task needs to be completed is written under the DUE DATE column.
8. Have students present the plans to the class.



Monitoring and Evaluating Your Plan

Background

On-going monitoring is an integral part of successful energy management plans. It provides the opportunity to see improvements in energy use. Evaluation determines the effectiveness of an action plan and allows for modification to continue energy performance improvement. Finally, evaluation of progress allows for and encourages the opportunity to recognize accomplishments. The basis of successful evaluation is an effective monitoring approach. There are several ways to monitor that will be explored in this section.

When designing a monitoring approach it's important to first understand the nuts and bolts of how energy is delivered to your school and how the district is charged for it. See the lesson *Reading Meters and Utility Bills* on page 9 for more information.

Preparation

- Decide whether you will gather data directly from meters, use billing data compiled by the district, or use utility bills directly. Using any one of these methods will be sufficient.
- If reading meters, be sure to take readings prior to implementing the plans to establish baseline consumption. It may be more effective to take these in advance yourself, but it can be part of the student project, as well. Determine the location of the meters and accessibility. Make arrangements with custodial staff to gain access to meters, if possible.
- If using utility data, ask your business office if this data is tabulated anywhere. Districts sometimes enter utility data into a spreadsheet or an application designed to monitor these expenses. If the tables or reports are well organized, this may be the easiest way for your students to work with the data. Otherwise, the actual utility bills can be acquired from the business office.
- If students will be monitoring energy-saving actions in the building, be sure to have guidelines in mind for student monitoring activities.

Objectives

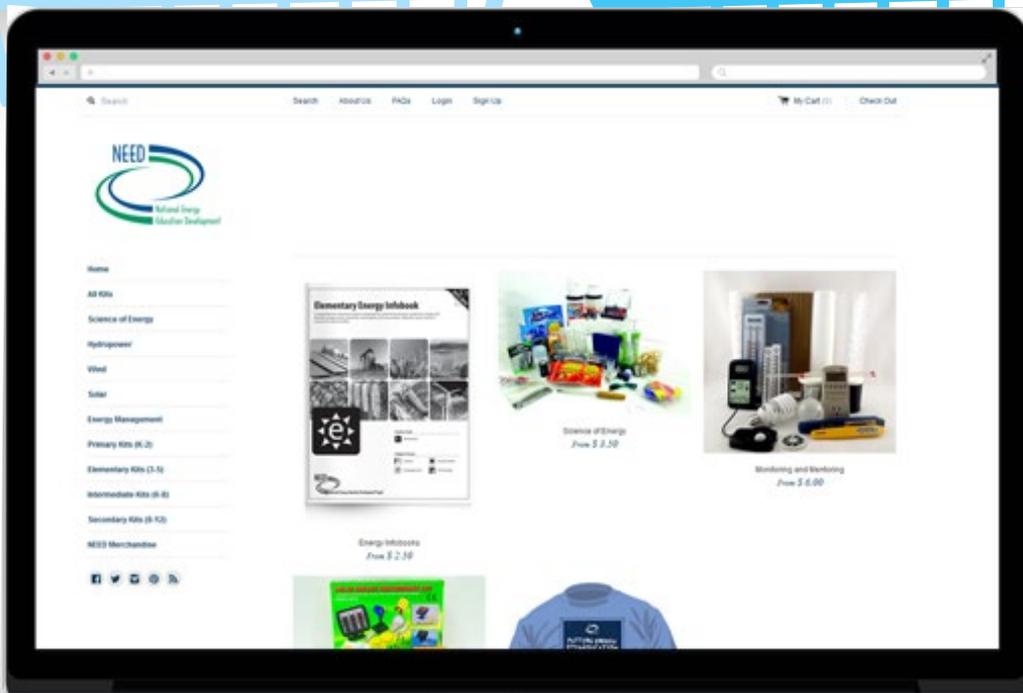
- Students will be able to determine trends in energy consumption by monitoring utility use over time.
- Students will be able to monitor the progress of their action plans and make adjustments to their plans based on their observations.

Procedure

1. Ask students how they will know if their action plan is working. Explain to students that if they want to determine how well their plan is working, they will need to monitor results over time. Explain that two of the most common ways of measuring progress are tracking energy use over time and observing behaviors of building occupants.
2. Hand out copies of the school's utility bills for the past year. Explain that they will be using these bills to create a baseline. A baseline is the building's energy consumption prior to implementing their action plans. Explain that they will be constructing a table that shows the consumption for the month, the rate that is paid, and the total cost. The table can be constructed as a spreadsheet.
OPTIONAL: Students can also track demand charges. In determining demand charges, a meter is used that records kilowatt power use during either a 15 or 30 minute time window. The average power used during that window is used to calculate the kilowatt demand. The metering system determines the highest usage of any time window during the previous month and charges the customer based on that usage.
3. Explain that after they have completed data entry for the past year, they will continue to enter data for future months as a comparison.
4. Review tables after they are completed to ensure that students have entered the data correctly.
5. Explain to students that in addition to monitoring the data, it is important to monitor the energy-related behaviors by students and teachers in the building.
6. Ask students to share the energy-saving actions they chose for their action plans. Ask students how they would find out whether these actions were taking place or not. Record student responses.
7. Instruct students to design a way to monitor the actions they prescribed. Explain that they will have to determine the following:
 - Actions to be monitored; how to monitor; and how often to monitor.
8. Share the worksheet provided in the Student Guide as an example. Instruct student teams to write up the steps in their monitoring plan and submit it along with any forms they develop. Work with student groups to ensure that the plan is effective and realistic before approving.

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School Energy Survey 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
8408 Kao Circle
Manassas, VA 20110
FAX: 1-800-847-1820



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