Project Learning Tree®

Project Learning Tree's *GreenSchools!* Investigations (G.S.I.)

Energy Investigation for Elementary Schools

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Introduction

This Energy Investigation will help students assess how much energy their school uses and the main sources of energy for their school. Reducing energy usage saves natural resources and can save your school a significant amount of money.

This investigation will help students identify current energy management practices in their school and start them thinking about ways to modify these practices to make their school greener and healthier. The results of the investigation will inform school staff and students of areas where they can make improvements, such as encouraging energy-saving behavior and purchasing energy efficient appliances. Regular maintenance of heating, ventilation, and air conditioning systems will improve performance and may prevent a minor repair cost from becoming a major expense. It also helps to maintain indoor air quality and reduce allergy and asthma triggers. The program is designed to support and encourage schools in their quest for a healthy, safe, and environmentally-friendly learning environment.

Information gathered from the investigation can be used to generate ideas and develop action plans for reducing school energy use. Project Learning Tree offers GreenWorks! action grants to help offset the cost of such projects. GreenWorks! is a service learning environmental action program that brings together educators, students, families, and organizations from the community to address local environmental issues. For more information on the GreenWorks! program and how to apply for a grant, please visit www.plt.org and click on 'GreenWorks!'

Overview

Students will conduct an investigation of their school's energy use. Following the investigation, students will generate ideas for ways the school could make improvements. As approval, time, and funding permit, students will work with school officials to implement one or more of their energy improvement strategies. In addition to finding and implementing ways to reduce energy use at their school, it is hoped that this investigation will stimulate students to reduce their own energy consumption.

Objectives

- Students will investigate energy use at their school.
- Students will use monitoring equipment, such as thermometers, watt meters, and light meters, to take various measurements and record results.
- Students will develop an understanding of how individual and collective student actions can affect energy usage.
- Students will discover the connection between energy use and the depletion of natural resources.
- Students will learn about sustainable approaches to energy management and why it is important to adopt sustainable practices.
- Students will generate a plan to reduce their school's energy use and improve the school's overall environmental performance.
- As approval, time, and funding permit, students will implement one or more of their energy improvement strategies.

Background Information for Educators

Why Should Students Study Energy Use at their School?

Energy may be the most important environmental issue of our time. If you think about nearly any other environmental issue — air or water quality, land use, transportation, global climate change, or solid waste management, to name some examples — you will find that it is related to the issue of energy.

Energy affects our lives everyday. It keeps us warm in the winter and cool in the summer, it allows us to easily travel from place to place, and keeps our food fresh and safe to eat. Energy is not just an environmental issue; it is a quality of life issue too.

Energy management challenges bring together the fields of economics, environmental science, sociology, political science, health, and engineering. A more informed citizenry has the potential to come up with better solutions to our energy problems and knows the importance of reducing the amount of energy used in the first place. The role of educators is fundamental to this process. The students in your classroom will be the policy makers, scientists, and voters of tomorrow. It is critical to help students realize that they can make decisions and take responsible action, which in turn can have positive effects on their community.

This investigation will help students become more aware of the energy they use every day. They will see the connections among the energy they use, natural resources, and pollution. The results of the investigation will help students develop action plans for reducing energy use at their school.

Students as Scientists

Throughout the investigation, students will have many opportunities to make observations and record results. Depending on the equipment available, students will also have the opportunity to use scientific equipment, such as light meters, watt meters, and infrared temperature gauges, to take measurements. The use of these tools is optional, but may make the investigation more meaningful to the students. See the Resources section for information on these tools and suggestions for how to borrow or purchase them.

Energy-Saving Tips for Schools

Following are some energy-saving tips that you can share with students. Many of these tips apply to energy use at both school and home.

Trees Save Energy

- Planting trees can help to save energy at school and at home. The U.S. Department of Energy reports that carefully sited trees can cut the average household's energy consumption by 25 percent.
- Strategically placed trees can be as effective as other energy saving improvements, such as insulation and the installation of weather-tight windows and doors. Trees help reduce heating and cooling costs.
- Trees save energy through shading in the hotter months. They provide a wind break during winter. The result is burning less fossil fuels to generate electricity for cooling and heating.

- Deciduous trees provide shade and block heat during hotter months. By dropping their leaves in the fall they admit sunlight in the colder months. Place these trees on the south and west sides of buildings.
- Shade all hard surfaces such as driveways and sidewalks to minimize landscape heat load.
- Use evergreens as windbreaks to save from 10 to 50 percent in energy used for heating. Evergreens offer the best benefits when they are placed to intercept and slow winter winds, usually on the north side of buildings. Do not plant them on the south or west side of your home, because they will block warming sunlight during the winter. These trees also provide some shading benefits during summer.

Maintaining HVAC Saves Energy

- HVAC (Heating, Ventilation, and Air Conditioning) systems are among the largest energy consumers in schools. Regular maintenance of the heating and cooling systems will save energy and money.
- HVAC filters should be replaced or cleaned every month during peak cooling or heating season. Changing filters improves efficiency and helps to reduce allergens in the air.

Phantom Energy Loads

- A "phantom load" is any appliance or electronic device that uses energy even when it is turned off. The "off" button on many appliances may not really mean "off," instead, it means "standby."
- Appliances with phantom loads are appliances with remote controls, such as TVs, DVDs, and audio equipment. They may have a continuous digital display, such as a clock. Other appliances with phantom loads include computers and printers.
- Phantom energy load loss can be minimized by using a power strip. Plug all components of a computer, TV, and so forth into the power strip. Turn off the power strip with a single switch. Anything plugged into the strip now is truly turned off.
- You can also unplug rarely used appliances.
- To check how much energy is being lost through phantom energy use in the classroom, leave appliances in the standby mode, plug them into a power strip, then plug the power strip into a watt meter. Finally, the watt meter gets plugged into a wall outlet. Leave the items plugged in for the school day or for 24 hours, whichever is more convenient for you. The watt meter gives a readout of how much electricity the items used during that time period. If you get the cost per kilowatt hour of electricity in your area (from the electric bill), you can calculate the cost of keeping those appliances in standby mode for a specific amount of time.
- The Resources section that follows provides information on where to get a watt meter.

Vending Machine Misers

- A vending machine miser reduces the energy use of running vending machines that cool drinks and food. Because they reduce energy use, they can save the school money.

- Vending machine misers use a passive infrared sensor to determine when the surrounding area is vacant. When the area is vacant, the device powers down the machine to conserve energy.
- Free vending machine misers may be available from local power companies. In addition, schools can ask the companies that provide the vending machines to install the misers or put in newer vending machines that are more energy efficient.
- For more information on energy efficient vending machines and case studies, visit the following U.S. EPA website: http://www.energystar.gov/index.cfm?c=vending_machines.pr_vending_machines

Additional Energy Saving Tips for Schools

- Form a student energy patrol to educate others about how students can save energy at school and at home. The Energy Patrol can make sure that lights are off when rooms are empty, computer monitors are off when not in use, and computers are turned off at the end of the day. All computer equipment should be turned off at the end of the day and on weekends, unless the school's computer staff instructs otherwise.
- Students can check their classrooms to make sure that the airflow around heating and cooling vents is kept clear. This will prevent items from blocking and absorbing the warm or cool air coming into the room.
- Keeping windows and doors closed will help conserve heat (energy) in the classroom. The same is true when the air conditioning is on. When there is little difference between the outside and inside temperatures, open windows and doors will not have much effect on energy consumption.
- Please see the **Fact Sheet on Fluorescent Lights** provided at the end of this investigation for information on how energy can be saved by using fluorescent lights.

Classroom Energy Activities

Project Learning Tree (PLT) has several activities that strongly support and enhance the Energy Investigation.

- In PLT Activity #39, "Energy Sleuths," students identify different energy sources; discuss the pros and cons of various energy sources form economic, social, and environmental perspectives; and describe some of the ways people use energy in their daily lives.
- PLT's *Energy & Society Activity Guide* includes six energy activities, a student energy primer, two educational posters, and an Energy & Me music CD. This guide, designed for PreK-8, is available online at http://shop.forestfoundation.org/ .

Please see Appendix 1, Project Learning Tree Curriculum Connections, for a complete listing of PLT's energy-related activities.

Correlations to National Education Standards

This GreenSchools investigation was designed to correlate with many national science and social studies standards. Please see Appendix 2 for a list of standards that this investigation supports.

Directions for Leaders

This Energy Investigation will help students assess how much energy their school uses and the main sources of energy for their school. Students will see how individual and collective student actions can affect energy usage. Reducing energy usage saves natural resources and can save your school a significant amount of money.

Following the investigation, students will generate ideas for ways the school could make improvements. As approval, time, and funding permit, students will work with school officials to implement one or more of their energy improvement strategies.

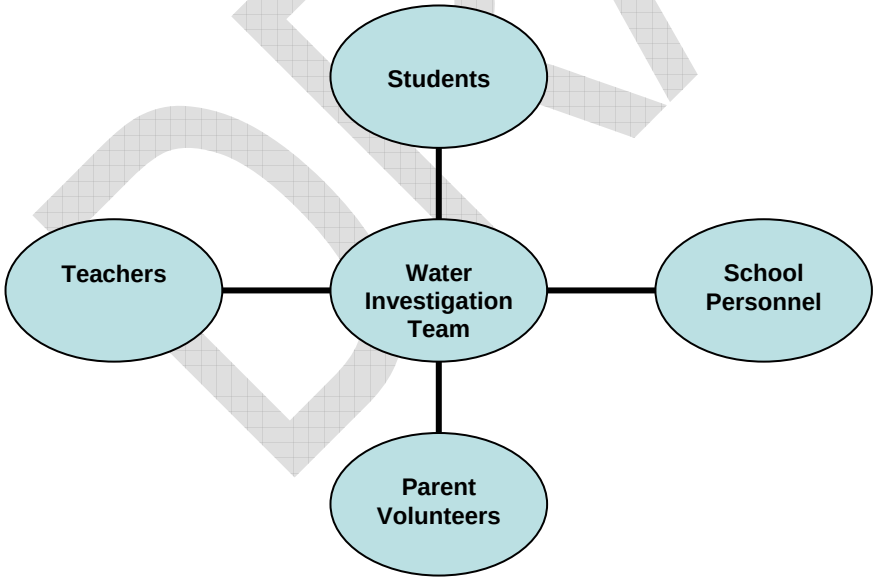
Getting Ready:

1. Permissions

Leaders will want to obtain the necessary permissions from the school before starting the investigation. They should decide how and when the investigation will be conducted to avoid conflicts with school classes and activities. For safety reasons, students should not go into maintenance areas when conducting this investigation.

2. Develop Your Team

Leaders should decide who will be conducting the investigation. We recommend a team approach including representatives from among teachers, administrative staff, school staff, students, and possibly even parent volunteers. The investigation can be done by members of an after school environmental club, an environmental science class, a special elective class, or through other creative school projects.



3. Gather Documents and Supplies

Leaders may want to gather certain documents and materials before starting the investigation with their students. The following items may be useful:

- Monthly and/or Annual Billing Statements from the School's energy providers, (individual schools may not have the energy bills in their office, however, the school district office should be able to provide this information);
- Any written policies the school has related to energy use;
- Optional Equipment: Thermometer, infrared temperature gauge, watt meter, and light meter. See the Resources section for information on these tools and suggestions for how to borrow or purchase them.

Doing the Investigation:

1. What Do You Want to Find Out?

Before you begin the investigation, gather your water investigation team and come up with a list of items and/or questions that you have regarding your school's energy use and practices. Write the items/questions on separate paper or enter them on a computer.

2. Survey Design and Comparison

You can use the items/questions that you have listed to design a survey to investigate your school's energy use or you can compare your list of items to investigate with the survey that follows. If you use the survey that follows, be sure to add any items/questions that you have listed that are not included.

3. Print Your Survey Instrument

Provide a printed copy of the survey instrument to the team conducting the investigation. Students should answer the questions to the best of their ability based on time allotted and documents available to them.

4. Organizing and Scheduling Your Investigation

Discuss how your school is going to conduct the energy investigation. Are you all going to work together or are you going to break into groups and assign sections to each group? Do you need specific school staff (custodial, maintenance, administrative) to be present during certain parts of the investigation? If so, contact them to schedule a time for this part of the investigation. Develop a schedule for how you will conduct the investigation.

Another way to divide the responsibilities is to have specific roles. For example, you could have different groups for specific tasks such as collecting data, analyzing data, generating ideas and specific strategies for making improvements, and reporting/sharing findings.

5. Time Requirements

The Energy Survey will take several 45-minute sessions to complete, depending on the documentation available, equipment being used, and help from supporting school staff. Be sure to gather all of the needed supplies and documents ahead of time.

GreenSchools Investigation:
Energy Survey

Reducing energy use saves natural resources and can save your school money. This investigation will help you find out what uses the most energy at your school and ways that energy is wasted. It will help you find ways to save energy to make your school more environmentally friendly and sustainable. Sustainable practices are those which meet the needs of the present without compromising the ability of future generations to meet their needs.

School Name: _____ **Date:** _____

Conducted By:
(Please include administrators, teachers, school staff, students, and parents involved in this investigation.)

Name	Title/Role

School Population

Students: _____
Staff: _____

Classroom Energy Survey

Complete this energy survey for school classrooms and use the results to complete the school-wide assessment. Make a copy of this Classroom Energy Survey for each classroom being surveyed.

Classroom No. _____ Teacher _____
Grade _____ Date _____
Average number of people using the room each day: _____

A. Where is the Energy?

Give each student a piece of tape and an "energy symbol" from the Energy Symbol Student Page.

Have them look around the classroom for things that use energy to operate. When they find something, they should tape their "energy symbol" on it. For example, lights, computers, TV, and so forth. Once they have finished, use their findings to fill out the charts below.

Appliances

Item	Quantity	Watts Used (1)
Computers		
Monitors		
Printers		
Televisions		
DVD/VCRs		
Fans		
Projectors		
Other:		
Other:		
Other:		

(1) If available, use a **watt meter** to see how much electricity the different appliances use. You may be able to borrow a watt meter from your local power provider or from your public library. See the Resources section for information on where to purchase one. Electricity is measured in units of power called watts. The amount of electricity used over a period of time is measured in kilowatt-hours (kWh), or the energy required to power a 1000 watt device for one hour.

Lighting

For more information on lighting types, see the **Fact Sheet on Fluorescent Lights.** You can also ask the school's custodial staff or building engineer about the types of lighting used in the classrooms.

Type of Bulbs	Quantity	Average Wattage
Compact Fluorescent		
Fluorescent		
Incandescent		
Other:		

1. Are any of the survey items A turned on in the morning and left on all day? If yes, list them:
_____

If data are available from watt meter readings, which appliance uses the most power?
_____ The least power? _____

2. Are computer monitors turned off after use?
☐ Yes ☐ No

3. Do classroom computers have a sleep function or sleep mode software that allows them to "sleep" when not in use?
☐ Yes ☐ No

4. Are lights turned off when the room is not in use?
☐ Yes ☐ No ☐ Sometimes

5. Are classroom lights controlled by motion and/or photo sensors?
☐ Yes ☐ No
If yes, what type? _____

(Photo sensors automatically turn lights on /off depending on the amount of natural light in the room. Motion sensors automatically turn lights on/off based on movement in the room.)

6. Are all light bulbs on when class is in use or can lighting be adjusted to take advantage of natural light when available? _____

B. Daylighting: (Optional**)**

A light meter measures the amount of light falling on a surface. Measurements are typically made in units called a foot-candle (fc), which is a unit for measuring illumination. You may be able to borrow a light meter from a photographer. See the Resources section for information on where to purchase one.

If you have access to a light meter, take the following measurements.

Location	**Lights all on**	**Lights half off**	**Lights all off**
On a desk near the windows			
On a desk in the middle of the room			
On a desk away from the windows			

Type of weather on the day measurements were taken: circle one
Sunny Partly Cloudy Cloudy

If the weather was cloudy, try repeating the measurements on a brighter day. Do the readings change? ☐ Yes ☐ No Explain _____

Do the light meter readings vary depending on the location of the reading?
☐ Yes ☐ No Explain _____

How could this information be used to help conserve energy in the room?
_____

Note: Assuming that 50 foot candles (fc) provides adequate lighting for the students, it may be possible to use fewer lights and ultimately less energy. To test if 50 foot candles provides enough light, students can try reading at different light levels and determine what level of lighting is most comfortable for them.

The Illuminating Engineering Society of North America has set standards for indoor lighting. The standards for lighting of a typical classroom should be in the range of 30 to 50 foot candles, depending on the task being performed. For example, reading very small print or examining photographs will require more light than reading large print or viewing a computer screen.

C. Temperature

1. Does your classroom have a thermostat?
   ☐ Yes ☐ No

2. If yes, is it digital?
   ☐ Yes ☐ No

3. If yes, is it programmable?
   ☐ Yes ☐ No

4. If your classroom has a thermostat, what temperature is it set at? _____

5. Are most students comfortable with the temperature in the room?
   ☐ Yes ☐ No Comments: _____

6. After the classroom has been in use for a couple of hours, use a thermometer (regular or infrared temperature gauge) to measure and record the room temperature at waist height in the following locations:

Temperature near the outside wall/windows: _____

Temperature in the middle of the room: _____

Temperature in the open doorway: _____

Temperature next to the thermostat (if there is one in your classroom): _____

Outside temperature: _____

Other location of your choice: _____

Do the indoor room temperatures vary depending on the location of the temperature reading?
☐ Yes ☐ No Explain _____

Where is the warmest temperature in the room?_____

Where is the coldest temperature in the room? _____

How could this information be used to help conserve energy in the room?
_____

D. Recommendations

1. What recommendations can you suggest to save energy in your classroom?

2. What are three energy-saving strategies that you can do in your classroom?

School-Wide Energy Survey

A. General Information

1. What are the main sources of energy for your school?
To find this out, you can contact the electricity provider for your school (try the communications or media relations department). You can also try the following U.S. EPA website to find out your region's energy sources: http://www.epa.gov/cleanenergy/energy-and-you/how-clean.html

- ☐ Coal ____%
- ☐ Nuclear ____%
- ☐ Hydroelectric ____%
- ☐ Oil ____%
- ☐ Natural Gas/Propane ____%
- ☐ Wood ____%
- ☐ Solar ____%
- ☐ Windpower ____%
- ☐ Geothermal ____%
- ☐ Other _____%

2. Does your school have any renewable energy systems?
   - ☐ Solar Photovoltaic
   - ☐ Wind
   - ☐ Geothermal
   - ☐ Solar Thermal
   - ☐ Other _____

3. Where does the electricity enter the school building? _____
Caution: *Students should not enter any maintenance areas of the school. Ask custodial staff or the building engineer for this information.*

4. Where is the electric meter(s) for your school building? _____
Caution*: Students should not enter maintenance areas of the school. Ask custodial staff or the building engineer for this information.*

5. If the electric meter is located in an area that is safe for students, take a reading and record the time and date. Then take another reading 24 hours later. *Most electric meters are digital. If your school has an older meter, please refer to the page "Reading an Electric Meter." If your school has more than one meter, it may be interesting to compare electricity consumption data for different areas of the school.*

Reading #1 _____ Date and time _____ Location _____

Reading #2 _____ Date and time _____

What is the difference between the two readings? _____

This will tell you how many kilowatt hours (kWh) were used during the time period. By looking at an electric bill for your area, you can find out how much one kilowatt hour costs. For example, in northern Virginia one kilowatt hour costs 8.21¢ in February 2009. In addition, the bill may include other costs, such as taxes, surcharge fees, and so forth.

Difference between the two readings multiplied by the cost of one kilowatt hour = energy cost for 24 hrs:

_____

6. Using your school's energy bills, how much did your school pay for energy for one month? For one year?

	Monthly	Yearly
Electricity	_____	_____
Natural Gas/Oil/Propane	_____	_____
Other	_____	_____

7. Optional: Based on the answers to question #6, try to calculate how much money your school spent on energy-related utilities per student last year (Total cost of energy divided by the number of students): _____

8. Optional: The U.S. EPA has an online tool called Portfolio Manager. This tool allows schools to track and assess their energy consumption. It also allows schools to benchmark their energy use and compare their school to others across the country. For more information, visit http://www.energystar.gov/index.cfm?c=evaluate_performance.bus_portfoliomanager .

B. Building Information

1. When was the school building built?
   - ☐ Prior to 1950
   - ☐ Between 1950 and 1975
   - ☐ Between 1975 and 1990
   - ☐ After 1990

2. Has the school been renovated?

   ☐ Yes ☐ No

   If yes, when?

3. How old is the school's heating, ventilation and air conditioning (HVAC) equipment?

4. Does your school follow a schedule for servicing HVAC equipment?

   ☐ Yes ☐ No

5. How often are furnace and ventilation filters cleaned or replaced?

6. If your school has central air conditioning, is the outside unit in direct sunlight during most of the day?

   ☐ Yes ☐ No

7. Are trees located closely around the building to provide shade during sunny days?

   ☐ Yes ☐ No

8. Are trees placed on the north and west sides of the school to provide a wind break?

   ☐ Yes ☐ No

C. Temperature

1. Ask a sample of students if they are comfortable with the temperature in most rooms of the school.
Record their comments below.

1. How is the temperature in your building controlled?
   - ☐ Whole school is set at same temperature
   - ☐ Individual thermostats for each room or group of rooms

3. Who sets the thermostats?
   - ☐ Individual teacher controls the thermostat
   - ☐ Thermostat is set by administration/maintenance staff

4. Does your school use programmable thermostats?
   ☐ Yes ☐ No

5. Can the school's Heating Ventilation and Air Conditioning (HVAC) be controlled remotely, allowing the heating and cooling system to be turned off when the building is not occupied?
   ☐ Yes ☐ No

6. Does your school (or school district) have standards or guidelines for thermostat temperature settings?
   ☐ Yes ☐ No

If yes, what are the thermostat temperature settings for the following?

Heating Season:		Cooling Season:	
Occupied	_____	Occupied	_____
Unoccupied	_____	Unoccupied	_____

D. Lighting

See the Fact Sheet on Fluorescent Lights for more information on lighting types. High Intensity Discharge (HID) lights may be used in gymnasiums.

1. What type of lighting is used inside of the school?

Rooms	Compact Fluorescent Light bulbs (CFL's)	Fluorescent Light bulbs	Incandescent Light bulbs	High Intensity Discharge (HID) Light bulbs	Other (Please specify)
Classrooms					
Office					
Restrooms					
Cafeteria					
Auditorium					
Gym					
Hallways					
Library					
Other					

2. Does your school have a plan for properly disposing of light bulbs such as compact fluorescents that contain mercury?
   ☐ Yes ☐ No

   The following U.S. EPA website has information on proper disposal/recycling of mercury- containing light bulbs:
   http://www.epa.gov/epawaste/hazard/wastetypes/universal/lamps/index.htm

3. Are lights controlled by motion and/or photo sensors? If so, what type and where? *Photosensors automatically turn lights on/off depending on the amount of natural light in the room. Motionsensors automatically turn lights on/off based on movement in the room.*

Rooms	Sensors- Type: Motion/Photo/Both/None
Classrooms	
Office	
Restrooms	
Cafeteria	
Auditorium	
Gym	
Hallways	
Outdoors	

4. Is natural lighting or skylighting (also referred to as Daylighting) used as an alternative to artificial lighting? If so, where?

Rooms	Natural Lighting Only	Primarily natural lighting with artificial lighting as needed	Natural and artificial lighting both used some times	Artificial Lighting Only
Classrooms				
Office				
Restrooms				
Cafeteria				
Auditorium				
Gym				
Hallways				

E. Appliances/Machines

1. If your school has vending machines, does your school use Vending Machine Misers or timers to control vending machine lighting and cooling so the machine can use less power when it is not in use?

☐ Yes ☐ No

2. Which energy-using appliances does your school have?

Appliance	Quantity	Is it turned off when not in use? Yes/No	Is it turned off at night? Yes/No	Watts Used (1) Unit On Unit Off
Computer/Monitor				
Printer				
Television				
DVD/VCR Player				
Overhead Projector				
LCD Projector				
Scanner				
Copier				
Vending Machine				
Ice Maker				
Dishwasher				
Stove				
Oven				
Other:				
Other:				
Other:				

(1) If available, use a **watt meter** to see how much electricity the different appliances use. You may be able to borrow a watt meter from your local power provider or from your public library. See the Resources section for information on where to purchase one. Some appliances, like DVD players and TVs with remotes, use energy even when they are turned off. That is because they are not really turned off, they are in standby mode. For more information, see the section on Phantom Energy Loads in the Background Information for Educators Section.

Optional:

If data are available from watt meter readings, which appliances use the most power?

_____

The least power? _____

How can this information be used to help reduce energy use at the school?

_____

F. Curriculum and Community

To answer the following questions, you may want to interview the personnel who manage the school's environmental policies and teacher training. Information on academic standards may be available on school websites.

1. Do your school's academic standards include energy?
☐ Yes ☐ No

If yes, in what grades is this being taught?

2. Has your school staff participated in training programs/workshops that include energy education? (For example, Project Learning Tree's Energy & Society workshop or workshops offered by your local energy provider)?
☐ Yes ☐ No

3. Does your school participate in energy projects that benefit the community?
☐ Yes ☐ No

If yes, what are they?

4. Some energy providers offer tours and educational programs. What facilities are found in your community?

Fossil Fuel Power Station ☐ Yes ☐ No; Location: _____

Hydro Power Station ☐ Yes ☐ No; Location: _____

Geothermal ☐ Yes ☐ No; Location: _____

Wind ☐ Yes ☐ No; Location: _____

Bio-Energy ☐ Yes ☐ No; Location: _____

Nuclear ☐ Yes ☐ No; Location: _____

Other: Name and Location _____

5. Has your school/class ever taken a tour of these facilities?
☐ Yes ☐ No

6. Does your school have an energy plan for students and staff that emphasizes saving energy?
☐ Yes ☐ No

7. Are students encouraged to save energy?
☐ Yes ☐ No

8. Are staff encouraged to save energy?

☐ Yes ☐ No

9. Does your school website and/or other media outlets, such as newsletters, emphasize the school's energy saving goals or programs?

☐ Yes ☐ No

G. Action Plan

Based on the information you found out from this investigation, what recommendations do you have for the school to reduce its energy use?

Home Connection

When you drive to the store, take a shower, or turn on a computer, you're using energy. Electricity is the most common form of energy we use at home. While electricity is itself a clean source of energy, the majority of electricity in the United States is generated from power plants that burn fossil fuels (coal, oil, and natural gas). These power plants emit large amounts of carbon dioxide, carbon monoxide, nitrogen oxides, sulfur dioxide, and other emissions that affect air quality. Consuming less energy reduces the amount of carbon dioxide and other pollutants released into the atmosphere.

There are many simple ways that you can save energy at home, including adjusting the heating or air conditioning thermostat to reduce energy use, using compact fluorescent bulbs, caulking doors and windows to minimize drafts, lowering the temperature setting of the water heater, insulating the hot water tank, and turning off lights and appliances that are not in use.

Use the following questions to help you identify places where you can save energy.

Heating and Cooling

What is the temperature setting of your thermostat? _____

Is your thermostat programmable so that it automatically controls it at night or during the day when no one is home? _____

If you have an outdoor air conditioning unit, is it in shade most of the day to help save energy? _____

Are trees planted around the house to provide shade in the summer and serve as a windbreak in the winter? _____

Lights

Are there light fixtures where you could install compact fluorescent light bulbs to save energy? _____

Do you turn off lights when you leave a room? _____

Appliances

Are radios, TVs, DVDs, and so forth turned off when they are not in use? _____

Some appliances, such as TVs and DVDs, that use remotes are not really turned off when they are in standby mode. They continue to use energy in the standby mode. Are these appliances plugged into a power strip so they can easily be turned off? _____

Windows and Doors

Check for drafts around windows and doors. If there are drafts,

do you use weather stripping and caulking to reduce drafts? _____

Water

Is the hot water heater set at a temperature that is warm enough to provide hot water, but not set so high that it wastes energy or could burn a child? (120°F is the recommended setting for home hot water heaters) _____

Does the hot water heater have an insulated cover to help save energy? _____

Do you wash clothes in cold water to save energy? _____

Other Energy Saving Practices

Do you clean the lint trap on the clothes dryer before using it to help it run more efficiently and save energy? _____

Do you run the drying cycle on the dishwasher or let dishes air dry? _____

Do you wait for a full load before running the dishwasher? _____

Do you regularly service the heating and cooling units so they run more efficiently and save energy? _____

Do you regularly change the filters on the heating unit to Increase its efficiency and reduce allergens in the air? _____

Resources

The U.S. EPA has a website that you can use to calculate the greenhouse gas emissions for your home. Go to: http://www.epa.gov/climatechange/emissions/ind_calculator.html .

http://www.epa.gov/climatechange/kids/index.html

This U.S. EPA climate change website for kids provides information on how simple actions can help our environment.

http://hes.lbl.gov/
The Home Energy Saver website provides an online home energy audit with tips, ideas, and tools to calculate your energy usage and emissions levels.

Energy Symbol Student Page

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Fact Sheet on Fluorescent Lights

What is a Fluorescent Light?

A fluorescent light consists of a glass tube coated on the inside with a fluorescent material. Mercury vapor in the tube emits ultraviolet radiation that is converted to visible light by the fluorescent material.

Compact Fluorescent Lights (CFLs) contain an average of 4 milligrams of mercury sealed within the glass tubing. No mercury is released when the bulbs are intact (not broken) or in use. EPA recommends that CFLs be recycled to prevent mercury from being released if it is sent to a landfill and broken. The following U.S. EPA website has information on proper disposal/recycling of mercury- containing light bulbs:
http://www.epa.gov/epawaste/hazard/wastetypes/universal/lamps/index.htm

Why Should We Use Compact Fluorescent Lights? (CFLs)

Source U.S. EPA website:
http://www.energystar.gov/ia/partners/promotions/change_light/downloads/Fact_Sheet_Mercury.pdf

According to the U.S. EPA, switching from traditional light bulbs (called incandescent) to CFLs is an effective, simple change that can be made to reduce the amount of electricity being used. ENERGY STAR qualified CFLs use up to 75 percent less energy (electricity) than incandescent light bulbs, last up to 10 times longer, and provide a quick return on investment.

EPA estimates the U.S. is responsible for the release of 104 metric tons of mercury emissions each year. Most of these emissions come from coal-fired electrical power. Electricity use is the main source of mercury emissions in the U.S. CFLs use less electricity than incandescent lights, meaning CFLs reduce the amount of mercury into the environment.

Should You Turn Fluorescent Lights Off?

Some people think that fluorescent lights should be left on unless you will be leaving the room for a long time. With the newer technology of fluorescent lights, the initial power surge used to turn on the fluorescent light is so brief that its energy use is the equivalent of a few seconds or so of normal operation, according to estimates from the U.S. Department of Energy. There is, however, some wear and tear on the bulb from turning it on and off. So it may make the most sense to turn the fluorescent lights off when you are leaving the room for more than one minute.

Picture of Fluorescent Light Tube

Picture of Compact Fluorescent Light

Picture of an Incandescent Bulb

Reading an Electric Meter

Many non-digital electric meters consist of four or five round dials. To determine the number of kilowatt-hours used, start by reading the dial on the right. If the dial lies between two numbers, record the smaller number. If the dial is between 9 and 0, you record 9. In the first example the dial is between 1 and 2. You record 1. Moving to the left, the next dial is between 3 and 4. You record the 3. (The dial is 1/10th of the way between the two numbers because the previous dial was on 1). You repeat this process for the remaining dials. The answer for the first meter is 4131.

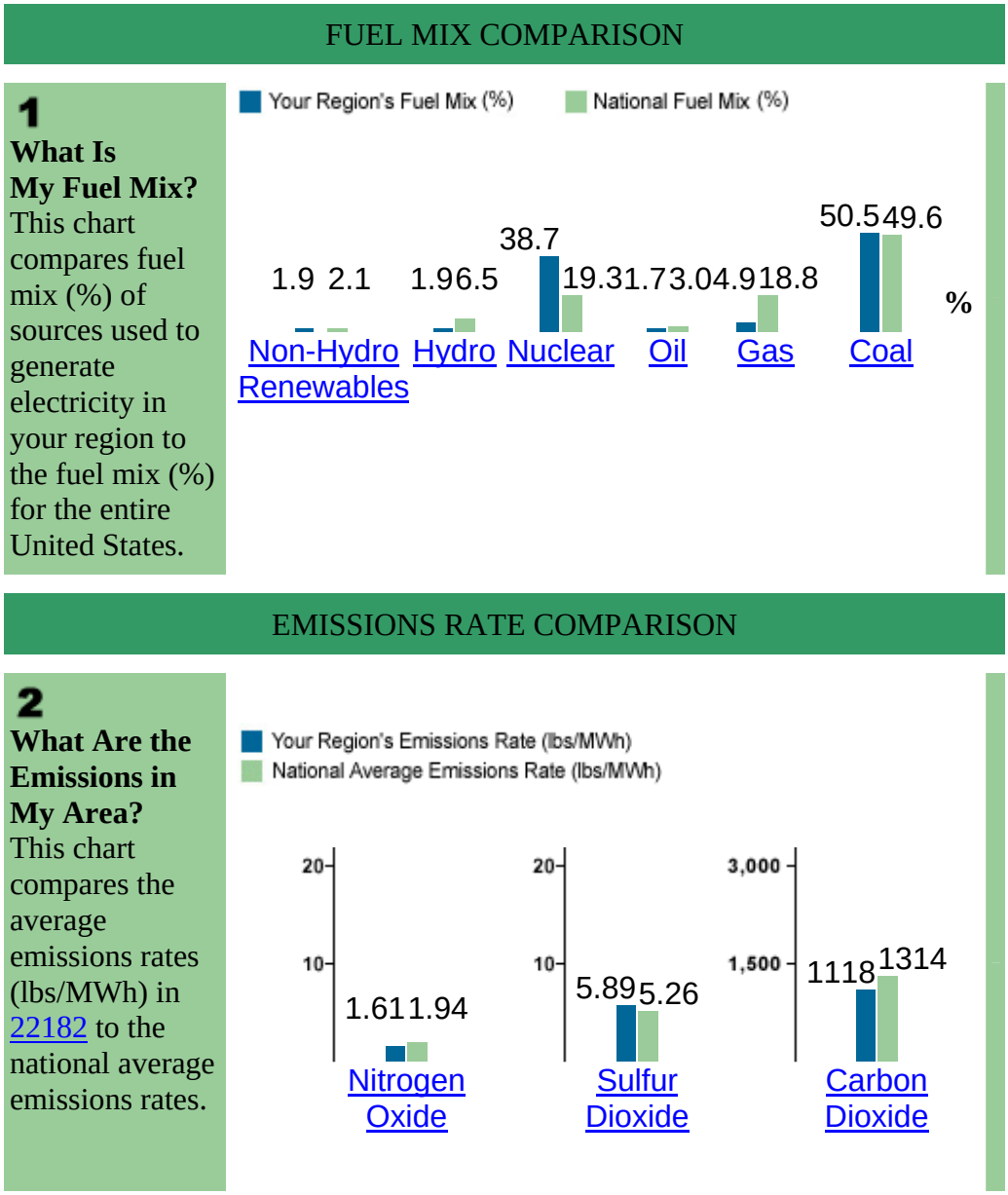
Next, work with the students to determine the second meter reading. Covering the answer, have the students work through each of the four dials to figure out the reading.

How to the Find the Fuel Mix for Your School

To find out the main sources of energy for your school, you can contact the electricity provider for your school (try the communications or media relations department). You can also try the following U.S. EPA website to find out your region's energy sources: http://www.epa.gov/cleanenergy/energy-and-you/how-clean.html

Following is a sample page from the U.S. EPA's website that shows the fuel mix for the zip code area for 22182. The table below contains two charts:

- The first chart compares the fuel mix used to generate electricity in the zip code region of 22182 (Virginia) to the national fuel mix.
- The second chart compares the average air emissions rates in the zip code region of 22182 to the national average emissions rates.



Case Study

Following is an excerpt from the U.S. EPA Energy Star website. Other case studies are available at this site: http://www.energystar.gov/index.cfm?c=pt_awards.2008_council .

Energy Star Partner of the Year — Energy Management
Council Rock School District
Newtown, Pennsylvania

Council Rock School District in southeastern Pennsylvania serves more than 12,000 students in 17 facilities, totaling 1.8 million square feet of space. Council Rock School District started an energy efficiency program in November 2005 when the school board passed an energy policy and an incentive program to share savings with individual schools. The initial goal of improving energy efficiency by 10 to 15 percent was quickly surpassed. The district became an ENERGY STAR partner in 2006 and used EPA tools and resources to help set new goals. Key accomplishments include:

- Saving more than $2.5 million in just 2 years, helping to address budget shortfalls while preventing tax increases and educational program cuts.
- Achieving a 30 percent improvement in energy efficiency among its school buildings by the end of 2007. This earned the district recognition as an ENERGY STAR Leader.

To achieve these savings, Council Rock School District partnered with Aramark Education to implement a comprehensive energy reduction program. This program included many operational improvements, staff training, control system enhancements, and repairs to HVAC equipment field controls. The district focused attention on re-commissioning newer buildings and requiring ENERGY STAR qualified products, when possible, for new purchases. School officials also completed their 10 year facility master plan for building renovations, making energy efficiency a high priority.

Council Rock School District educates staff and promotes its achievements through various media, including newsletters, its Web site, closed-circuit and public television broadcasts, committee meetings, and visits to schools. This education is critical because the district has discovered that success in any particular building depends on the active involvement of the administration, the building manager, and custodians. Elementary grade students have been involved in the program through development of a logo and slogan. Further, a scholarship fund was established for middle and high school students selected for their energy conservation efforts and ideas. District officials are also committed to promoting the benefits of energy efficiency and acting as a model for other school districts. The district officials do this by educating their peers about the district's energy management system through presentations and published articles.

Resources

Resources for Supplies

Watt Meter, Plug Power Meter and Vending Machine Miser Sources

Light Meter
Light meters are available from photography stores and internet stores. If your school offers a photography course, check if you can borrow a light meter. The typical cost for light meters is $50 and up.

Watt Meter
Public utility companies and public libraries may have watt meters available for loan. They can be purchased from home improvement stores or internet stores. The typical cost for watt meters is $25 and up. When searching on the web for sites that sell watt meters, use the keywords watt meter, Kill-A-Watt, and so forth.

Thermometer/Infrared Temperature Gauge
A regular thermometer or an infrared temperature gauge can be used to take measurements in the classroom. The advantage of the infrared temperature gauge is that you can point it at an object and get a quick readout of the surface temperature of that object. The typical cost for an infrared temperature gauge is $25 and up. When searching on the web for sites that sell these items, use the keywords thermometers and Infrared temperature gauges.

Vending Machine Miser
Public utility companies may provide free vending machine misers, offer rebates, or offer them for loan. They can be purchased from internet stores. The U.S. EPA provides information on vending machines at:
http://www.energystar.gov/index.cfm?c=vending_machines.pr_vending_machines .
When searching on the web for sites that sell this item, use the keyword vending miser or vending machine miser.

Resource People

Contact your state PLT coordinator for local resource contacts:
(see www.plt.org to find your state PLT coordinator)

Resource Links

http://www.plt.org/greenworks/greenworksguide.pdf
Project Learning Tree's ***GreenWorks!*** Guide can be found at this website. The guide provides a detailed explanation of how to plan and implement an environmental action project.

http://www.plt.org/cms/pages/21_22_21.html
Information on how to apply for a Project Learning Tree ***GreenWorks!*** grant can be found at this webpage.

http://www.energystar.gov/ia/business/challenge/learn_more/Schools.pdf
Schools: An Overview of Energy Use and Energy Efficiency Opportunities. This information is provided by Energy Star, a government-back program that focuses on energy efficiency.

http://www.epa.gov/climatechange/kids/index.html
This U.S. EPA climate change website for kids provides information on how simple actions can help our environment.

http://www.eia.doe.gov/kids/
This Energy Information Administration's Kids' Site provides an explanation of the different kinds of energy, in addition to a wealth of other resources like energy-related links.

http://hes.lbl.gov/
The Home Energy Saver website provides an online home energy audit with tips, ideas, and tools to calculate your energy usage and emissions levels.

http://www.eere.energy.gov/kids/
This is the website for Kids Saving Energy by the U.S. Department of Energy. It includes games, tips, and facts on saving energy.

http://www.eere.energy.gov/kids/pdfs/EnergyActionList.pdf
This poster by the U.S. Department of Energy provides simple tips for saving energy at home.

http://apps1.eere.energy.gov/consumer/your_home/appliances/index.cfm/mytopic=10040
This U.S. Department of Energy website provides information on how to estimate appliance and home energy use.

Resource Organizations

Northeast Sustainable Energy Association
http://www.nesea.org
50 Miles Street
Greenfield, MA 01301
Phone: 413-774-6051
Email: NESEA Education Department
The Northeast Sustainable Energy Association (NESEA) is the nation's leading regional membership organization promoting sustainable energy solutions. For more than thirty years NESEA has supported and inspired a growing network of professionals and sustainable energy advocates committed to responsible energy use. The Association operates primarily in the ten Northeastern states, from Maine to Washington, DC. NESEA's K-12 Education Department offers professional development opportunities and resources, as well as curriculum and programs on energy efficiency/conservation and on renewable energy forms and applications.

EnergySmart Schools Department of Energy
http://www1.eere.energy.gov/buildings/energysmartschools/index.html
EnergySmart Schools is a campaign of the Department of Energy and its Rebuild America program. EnergySmart Schools offers schools training workshops, publications, recognition, direct technical assistance, financing options, and a host of other resources toward making school facilities more energy efficient. Resources available on the website include step-by-step guidance for making schools more energy efficient, classroom materials and activities, and information about school buses.

National Clearinghouse for Educational Facilities
http://www.edfacilities.org/rl/high_performance.cfm
NCEF's High Performance School Buildings.
National Institute of Building Sciences
1090 Vermont Ave., NW Suite 700
Washington, D.C. 20005
Phone: Toll free - 888-552-0624 *or* 202-289-7800
Sponsored by the U.S. Department of Education, this website provides extensive resource lists that cover planning, design, financing, construction, and the operation and maintenance of school facilities. The lists are annotated bibliographies and include links to full text publications and related Web sites, descriptions of books, studies, reports and journal articles. Specific topics pertaining to green building include daylighting, high performance school buildings, energy savings, indoor air quality, and much more. Look for the resource list on their website.

Readings

Why Should I Save Energy? by Jen Green. Barron"s Educational Series (February 1, 2005). ISBN: 0764131567. Grades K-5. In this story book, children take electricity for granted until one day their community has a power blackout. They come to realize that in lighting homes and keeping houses warm, we are using up natural resources that can't be easily replaced.

Energy (Reduce, Reuse, Recycle) by Alexandra Fix. Heinemann Educational Books (August 2007)
ISBN-10: 1403497230. Grades K-6. This book helps children discover where energy comes from, how we use it, and how energy waste affects our environment. The book covers how recycling can save energy and how to reduce energy waste.

Everyday Conservation: Eye on Energy by Jill Wheeler. Checkerboard Books (July 2007) ISBN:
1599288044. Grades K-6. Provides practical tips on conserving energy.

The Wind at Work: An Activity Guide to Windmills by Gretchen Woelfle. Chicago Review Press; 1st edition (June 28, 1997). ISBN 1556523084. Grades 4-9. An introduction to windmills and their advantages as a renewable energy source; includes educational and fun wind-related activities.

Case Study – Davis School District: ENERGY STAR Qualified Vending Machines Combat High Energy Costs in Utah Schools
http://www.energystar.gov/ia/products/vending_machines/Davis_Case_Study.pdf

Media Connections

Earth & Sky – "Energy Cost" (radio/interview transcript)
This radio transcript addresses a listeners question about what the best ways are to reduce our environmental impact on the earth. See
http://earthsky.org/teachers/article/energy-cost

Earth & Sky – "Humanity has been on an Energy "Binge" (radio/interview transcript)
This radio transcript discusses how our use of energy is affecting global warming and the importance of reducing our energy consumption.
See http://earthsky.org/teachers/article/expert-humanity-has-been-on-an-energy

School Action Projects

There are a variety of projects that students can do to help their school conserve energy. Please refer to the Energy Saving Tips for Schools found in the

"Background Information for Educators" section. Many of these tips can be used to generate action project ideas.

For detailed information on how to design and implement an environmental action project, go to http://www.plt.org/greenworks/greenworksguide.pdf . This link is to a PDF of Project Learning Tree's ***GreenWorks!*** Guide. For information on how to apply for a Project Learning Tree ***GreenWorks!*** grant, go to http://www.plt.org/cms/pages/21_22_21.html .

Share Your Findings and Celebrate Your Successes

There are many ways that students can share the information that they gathered in the Energy Investigation with other students and their community. Students can share what they learned, data collected, and any action plans or projects completed.

Following are some ways that students can share their findings, celebrate their successes, and educate others about waste reduction and recycling:

- School TV broadcasts
- Local TV broadcasts
- School and local newspaper articles
- Persuasive essay
- Op Ed piece for a newspaper
- Public Service Announcements
- Reflections
- Poetry
- Posters/Poster contests
- Assembly

APPENDIX 1

Project Learning Tree Curriculum Connections

Project Learning Tree (PLT) has a variety of environmental education curriculum materials that support and enhance the *GreenSchools!* Energy Investigation. Educators may want to conduct one or more of the following PLT activities to prepare students for the investigation. Through these activities, students will learn energy terminology, why it is important to reduce energy use, and ways students can reduce energy use at school and at home.

Energy & Society Activity Guide
(Energy Education PreK-8; Available online at
http://shop.forestfoundation.org/)

#1 Energy Detectives
Students search their classroom for energy connections and record the ways they use energy throughout a typical day in an energy journal.

#2 May the Source Be with You
Students learn about various renewable and nonrenewable energy resources. They research one energy resource and create a poster that describes that resource in detail.

#3 Energy Chains
Students will identify the different forms of energy and construct an "energy chain" showing how different energy forms change.

#4 What Powers the Move?
Students will examine transportation systems vital to their community. They will identify transportation methods and design a future transportation system for their community.

#5 In the Driver's Seat
Students learn about gasoline, then explore fuel conservation and energy efficiency by simulating the distance they can travel on a set amount of gasoline using different vehicles.

#6 Energy Challenge Game
Students review energy concepts and information through the use of a game similar to *Jeopardy*.

PLT's PreK-8 Environmental Education Guide:

#14 Renewable or Not?
Students learn the terms renewable, nonrenewable, recyclable, and reusable and then they discover why sustainable use of natural resources is important.

#36 Pollution Search
Students take a closer look at pollution: what it is, what its sources are, and what people can do about it.

#39 Energy Sleuths

Students learn about renewable and nonrenewable sources of energy, advantages and disadvantages to their use, and how energy is used in their daily lives.

#52 A Look at Aluminum

Students will learn about the sequence of steps that go into making aluminum products and participate in a service learning project to encourage aluminum recycling in their community.

#53 On the Move

Students compare various transportation methods for getting to and from school, and research transportation systems used in their community.

#55 Planning the Ideal Community

Students survey the area around their school to look for components of the human community in which they live. They then plan an ideal community that meets all the needs of its residents.

#57 Democracy in Action

Students learn about the roles and responsibilities of citizens' groups in environmental policies and decision-making, and about how young people can become involved in the process.

#72 Air We Breathe

Students will learn about indoor air quality at home and at school, and ways that they can assess and improve indoor air quality.

#73 Waste Watchers

Energy seems easy to use, but obtaining it is often not easy on the environment. When we reduce the amount of energy we use, we decrease the pollution that results from producing that energy. In this activity, students conduct an audit of the energy they use in their own homes and create an action plan to reduce energy use.

#82 Resource-Go-Round

This activity gives students the opportunity to explore a variety of natural resources and products that people depend on every day. They learn about product life cycles, using a pencil as an example, and then they research a specific product to find out the sources of its various components.

#84 The Global Climate

Students will learn about the relationship between carbon dioxide ($CO_{2)}$ and the Earth's climate, and explore ways to reduce the amount of CO_2 they generate.

#85 In the Driver's Seat

Students keep a log of their family's transportation for a week, learn how petroleum is refined, and then explore fuel conservation and energy efficiency by simulating the distance they can travel using different vehicles.

#96 Improve Your Place

Students learn about the steps involved in developing a service learning project. They plan and conduct a project that focuses on making positive environmental changes in their community.

(Secondary Level Activity Guide)

#4 Neighborhood Design

Students explore the current design of their neighborhood, critically evaluate a variety of development options, and formulate ideas for guiding further change or growth in their neighborhood.

#7 Far-Reaching Decisions

Students develop graphic organizers and creative presentations to illustrate how individual decisions can affect the local environment, as well as distant communities. They will also measure their own ecological footprint.

APPENDIX 2

Correlations to National Education Standards

National Science Education Standards:
PLT's GreenSchools Energy Investigation addresses the following National Science Education Standards:

Science as Inquiry
Content Standard A:

- abilities necessary to do scientific inquiry
- understandings about scientific inquiry.

Physical Science
Content Standard B:

- transfer of Energy

Science and Technology
Content Standard E:

- abilities of technological design
- understandings about science and technology.

Science in Personal and Social Perspectives
Content Standard F:

- personal health
- populations, resources, and environments
- risks and benefits
- natural hazards
- science and technology in society.

Curriculum Standards for Social Studies:

PLT's GreenSchools Waste and Recycling Investigation addresses the following National Curriculum Standards for Social Studies:

I. Culture
a. Compare similarities and differences in the ways groups, societies, and cultures meet human needs and concerns.

II. Time, Continuity, and Change
f. Use knowledge of facts and concepts drawn from history, along with methods of historical inquiry, to inform decision-making about and action-taking on public issues.

III. People, Places, and Environments
c. Use appropriate resources, data sources, and geographic tools such as aerial photographs, satellite images, geographic information systems (GIS), map projections and cartography to generate, manipulate, and interpret information such as atlases, data bases, grid systems, charts, graphs, and maps.

k. propose, compare, and evaluate alternative policies uses of land and resources in communities, regions, nations, and the world.

IV. Individual Development and Identity
h. work independently and cooperatively to accomplish goals.

V. Individuals, Groups, and Institutions
g. Apply knowledge of how groups and institutions work to meet individual needs and promote the common good.

VII. Production, Distribution, and Consumption
a. Give and explain examples of ways that economic systems structure choices about how goods and services are to be produced and distributed.

b. Describe the role that supply and demand, prices, incentives, and profits play in determining what is produced and distributed in a competitive market system.

f. Explain and illustrate how values and beliefs influence different economic decisions.

i. Use economic concepts to help explain historical and current developments and issues in local, national, or global contexts.

j. Use economic reasoning to compare different proposals for dealing with a contemporary social issue such as unemployment, acid rain, or high quality education.

VIII. Science, Technology, and Society

b. Show through specific examples how science and technology have changed people's perceptions of the social and natural world, such as in their relationship to the land, animal life, family life, and economic needs, wants, and security.

c. Describe examples in which values, beliefs, and attitudes have been influenced by new scientific and technological knowledge, such as the invention of the printing press, conceptions of the universe, applications of atomic energy, and genetic discoveries.

IX. Global Connections

d. Explore the causes, consequences, and possible solutions to persistent, contemporary, and emerging global issues, such as health, security, resource allocation, economic development and environmental quality.

X. Civic Ideals and Practices

c. locate, access, analyze, organize, and apply information about selected public issues—recognizing and explaining multiple points of view.

d. practice forms of civic discussion and participation consistent with the ideals of citizens in a democratic republic.

i. construct a policy statement and an action plan to achieve one or more goals related to an issue of public concern.

j. examine strategies designed to strengthen the "common good," which consider a range of options for citizen action.

Appendix 3
Acknowledgements
GreenSchools Advisory Committee

Karen Anderson
Green Schools Program Manager
Montgomery County Public Schools
Rockville, MD

Margo Appel
EnergySmart Schools Program Manager
Washington, DC

Stefany Arsenault
Maine Energy Education Program
Augusta, ME

Vicki Arthur
USDA Forest Service – Conservation Education
Washington, DC

Greg Bisbee
Arrowhead High School
Hartland, WI

Gary Boyd
International Paper
Memphis, TN

Dionn Brown
Baltimore Public Schools
Baltimore, MD

Shelia Brown
University of Houston Clear Lake
Houston, Texas

Laura Burris
Sacramento Tree Foundation
Sacramento, CA

Arianna Alexsandra Collins
Northeast Sustainable Energy Association
Greenfield, MA

Julie Dieguez
Maryland Association for Environmental and Outdoor Education
Annapolis, MD

Julia Feder
U.S Green Building Council
Washington DC

Kaifa Anderson Hall
The Washington Youth Garden
Washington, DC

Brita Hampton
Star of the Sea Catholic School
Virginia Beach, Virginia

Carrie Hembree
TN Department of Environment & Conservation
Tracy City, TN

Janet Hutchens
Wisconsin Department of Natural Resources
Madison, WI

Mike Irvin, Principal
Oil City Elementary School
Oil City, LA

Kristyn Ivey
Booz Allen Hamilton Inc.
Washington, DC

Netosh Jones
Martin Luther King School
Washington, DC

Mike Kaspar
District of Columbia Public Schools
Washington, DC

Jude Kesl
Milwaukee Public Schools
Milwaukee, WI

Laurel L. Kohl
Institute for Sustainable Energy
Williamtic, CT

Janette Monear
Texas Trees Foundation
Dallas, TX

Susan Schultz
NACD Stewardship & Education
Greenfield, IN

Jennifer Seitz
Alachua County Public Works
Gainesville, FL

Brenda Sims-Grant
Miner Elementary
Washington, DC

Angie Soldinger, PLT State Coordinator
Texas Forest Service
College Station, TX

Sheri Sykes Soyka
Environmental Education Consultant
Vienna, VA

Cathlyn D. Stylinski
Environmental Science Education
University of Maryland
Frostburg, MD

Lisa Tolley
Office of Environmental Education
NC Department of Environment and Natural Resources
Raleigh, NC

Eric Triche
Wolftrap Elementary School
Vienna, VA

Sally Wall
Seabrook Intermediate School
Seabrook, TX

Brenda Weiser
Environmental Institute of Houston
Houston, TX

Mimi Westervelt
Park View High School
Sterling, Virginia

Cindy Wolf
Georgia Green and Healthy Schools
Georgia Department of Natural Resources
Atlanta, GA

Sarah Yelton
Office of Environmental Education
NC Department of Environment and Natural Resources
Raleigh, NC

Writing Workshop Participants, Washington, DC:
Karen Anderson
Stefany Arsenault
Vicki Arthur
Greg Bisbee
Shelia Brown
Arianna Alexsandra Collins
Julia Feder
Safiya Samman
Brenda Sims-Grant
Sheri Sykes Soyka

Writer: Sheri Sykes Soyka

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