NREL
NATIONAL RENEWABLE ENERGY LABORATORY

Teacher(s): Chittenden	**Unit Title:** Energy
Subject: general science	**Lesson Title:** Energy Audit
Grade Level(s): 8th grade	**Lesson Length:** 3-5 days
Date(s):	

- **Learning Goal(s)** [What should students know, understand, or be able to do as a result of this lab or activity.]
    - Students can compare current and potential energy consumption through data collection and analysis.
    - Students can recommend levels of energy saving actions to staff members.

- **Energy Connection** [How is this lesson connected to energy or renewable energy concepts.] Students will measure energy use of various appliances/lights throughout the school and determine behaviors and action that can conserve energy and save money.

- **Connection to Standards** [List local, state, and/or national standards addressed by this lab or activity.]
    - Apply an understanding that energy exists in various forms, and its transformation and conservation occur in processes that are predictable and measurable
        - Use research-based models to describe energy transfer mechanisms, and predict amounts of energy transferred

- **Materials and Resources** [List materials, handouts, and any other resources needed to complete this lab or activity.]
    - Kill-a-Watt Meter
    - Lux Meter
    - Flicker Checkers
    - Student Handouts (attached)

- **Procedure** [List all necessary steps for the lab or activity.]
    - Brain Dump – What uses the most energy?
    - Introduce devices/meters and how to use them.
    - Lighting
        - Recommended Light Levels – test various areas around school and compare to chart.
        - Flicker Checkers – check types of lights throughout school
        - Calculate cost and CO_2 emitted
    - Appliances
        - Kill-a-Watt – measure devices/appliances in rooms
        - Calculate cost and CO_2 emitted
    - Behavior – complete behavior chart
    - Solutions – brainstorm solution ideas and compile into tiers (levels) according to cost/benefit analysis

- **Technology Integration** [List and/or describe the technology that will be used and how it will be integrated into the lesson.]
    - **See Materials Above**

- **Modeling & Guided Practice** [List and/or describe any modeling or guided practice]
    - **Model device use**
    - **Model charts (complete first row together)**
    - **Students will work as a class (or in groups) to complete the behavior chart.**
    -

- **Checks for Understanding** [Identify when and how checks for understanding will be done.]
    - **After device introduction – each group must show proficiency before leaving the classroom**
    - **Students will put data into a shared google spreadsheet and double check one another's work**

- **Independent Practice** [List and/or describe any work students will be asked to do independently to reinforce the learnings associated with this lesson.]
    - **Each student group will collect data for a different space in the school.**
    - **Each student group will also calculate/analyze data they collect.**
    - **Student groups will brainstorm solutions/actions to be taken and then share via Smartboard extreme collaboration**

- **Assessment & Closure** [Describe how this lesson will be brought to a close and how student understanding will be assessed.]
    - Students will write a persuasive letter to the administration outlining their recommendation for improved energy efficiency.

Energy Efficiency and Conservation Informational Text

Introduction

A school building is an energy system made of many interrelated components. Some of the components are obvious—walls, roofs, lights, air vents, doors, and windows. The occupants—students, teachers, and other building users—are also an important part of the system.

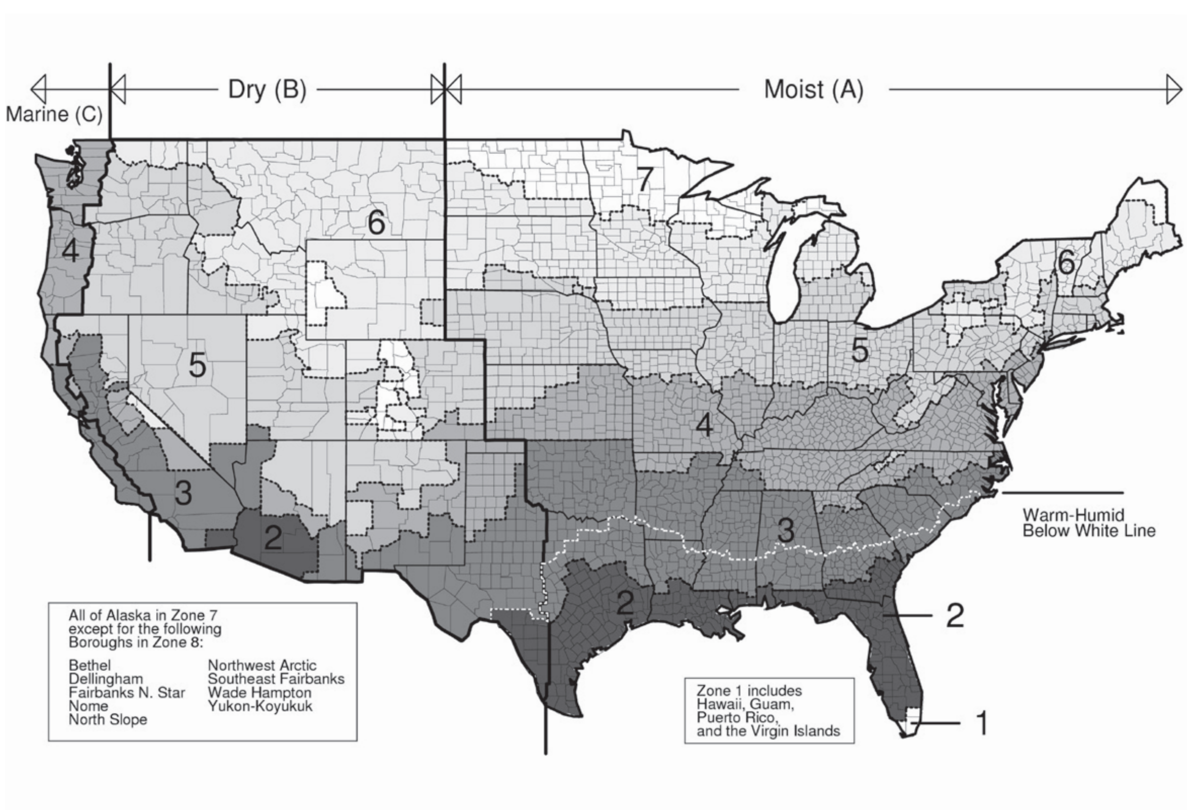
The **energy** use of the system affects everything from the school budget to the global environment. It is important to understand how all of the system components can work together to create an environment that is conducive to teaching and learning. A school building's energy system includes these components:

- **Building Shell/Envelope:** This component includes everything that creates barriers between indoors and outdoors—walls, floors, roofs, windows, and doors.
- **Heating, Ventilation, and Air Conditioning (HVAC) Systems:** This component includes the equipment that provides heating, cooling, hot water, and fresh air to the building. It also includes the devices that control the equipment, such as thermostats.
- **Lighting:** This component includes several types of fixtures that provide lighting for all of the areas and activities in the school.
- **Electrical Devices:** This component includes everything that is plugged into electrical outlets, such as refrigerators, copiers, and computers, as well as kitchen appliances that are wired directly into the school's electrical system, such as ovens and refrigeration units.
- **Occupants:** Buildings don't use energy, people do. The actions of the building occupants dictate how much energy is used by the other system components. The other four components all include points of human interface, and in the sections where they are described, suggestions are provided for how people can use energy more efficiently.

The amount of energy each of these components consumes varies according to where a school is located. The U.S. Department of Energy has determined Climate Zones for all parts of the country.

Schools in the northern part of the country (Zones 6–8) use more energy for heating than any other use, while schools in southern areas of the country (Zones 1–2) use more energy for cooling and lighting. Look at the map below and the chart on the next page to determine what are likely to be the large and small energy tasks in your school.

Climate Zone Map



Data: U.S. Environmental Protection Agency

The School Building is a System

When managing the systems of a school to minimize energy consumption, it is important to maintain the health and comfort of the occupants. After all, the primary reason energy is used in a school is to provide a comfortable and supportive learning environment.

Human beings have specific physical requirements for temperature, relative humidity, and general air quality. They also have requirements for the quality and quantity of lighting. If light levels are too low, or of poor quality, they can cause eyestrain, headaches, and safety issues.

Turning off lights and lowering the heat in winter can save energy, but doing so without consideration of the impact on the building's occupants can cause unsafe or unhealthy conditions in the building. When the building is treated as a system, energy is saved while maintaining or improving the indoor environment.

According to the Environmental Protection Agency (EPA), 26.9 percent of the American population—nearly 75 million students—spend their days in our elementary, middle, and secondary schools. In the late 1990s, studies showed that one in five schools reported unsatisfactory indoor air quality. One in four American schools reported an unsatisfactory ventilation system, which impacts indoor air quality.

Students are at increased risk for getting sick during the hours they spend in unacceptable school facilities, because children are more susceptible than adults to environmental pollutants and poor air quality.

When the building is treated as a system, energy can be saved while maintaining or improving the indoor environment, because those managing the system are aware of how decisions regarding energy use— particularly with HVAC systems— impact the indoor environment.

School Energy Survey

You can learn about how your building uses energy by conducting an energy survey. These surveys are also called **energy audits**. The results of the survey will help you understand ways in which the school could use energy more efficiently. The last section of the guide also provides information on how to implement an energy awareness program in your school.

The information you will be gathering during the energy survey is similar to the work done by professionals in the energy

Energy Consumption by Climate Zone

CLIMATE ZONE	HEATING	COOLING	LIGHTING	WATER SYSTEMS	ELECTRICAL DEVICES	FANS
1A	0.5%	27.6%	27.4%	1.0%	19.7%	23.8%
2A	4.6%	19.8%	28.9%	1.4%	20.8%	24.4%
2B	2.0%	22.5%	28.1%	1.2%	20.2%	26.1%
3A	7.2%	14.3%	30.9%	1.7%	22.2%	23.7%
3B	2.9%	15.0%	32.6%	1.7%	23.5%	24.3%
3C	3.7%	6.1%	34.4%	2.2%	24.7%	28.9%
4A	15.1%	9.1%	29.2%	2.0%	21.0%	23.7%
4B	7.1%	10.3%	31.7%	2.0%	22.8%	26.1%
4C	10.6%	3.3%	34.2%	2.4%	24.5%	25.1%
5A	23.8%	6.5%	26.1%	1.9%	18.8%	23.0%
5B	15.6%	6.3%	29.3%	2.1%	21.0%	25.7%
6A	32.8%	3.9%	23.8%	1.9%	17.1%	20.5%
6B	26.5%	3.7%	26.1%	2.1%	18.7%	23.0%
7A	39.6%	2.0%	21.1%	1.9%	15.2%	20.2%
8A	58.7%	0.6%	15.4%	1.5%	11.1%	12.7%

Data: U.S. Environmental Protection Agency

The Light Meter

Operating Instructions

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

Light Output or Luminous Flux

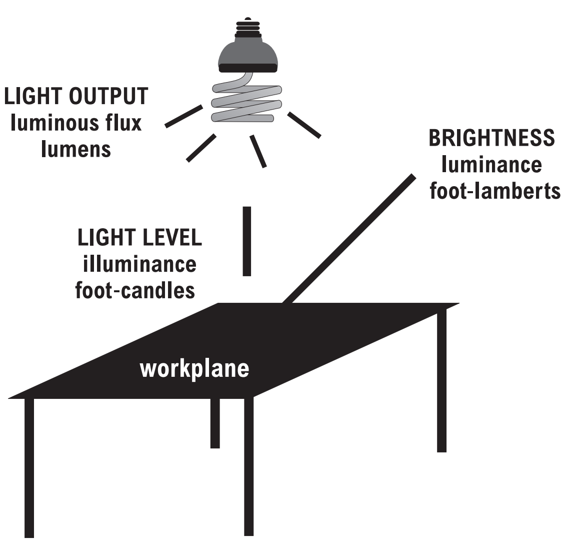
A lumen (lm) is a measure of the light output (or luminous flux) of a light source (bulb or tube). Light sources are labeled with output ratings in lumens. A T12 40-watt fluorescent tube light, for example, may have a rating of 3050 lumens.

Light Level or Illuminance

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

Brightness or Luminance

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



Flicker Checker

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

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

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

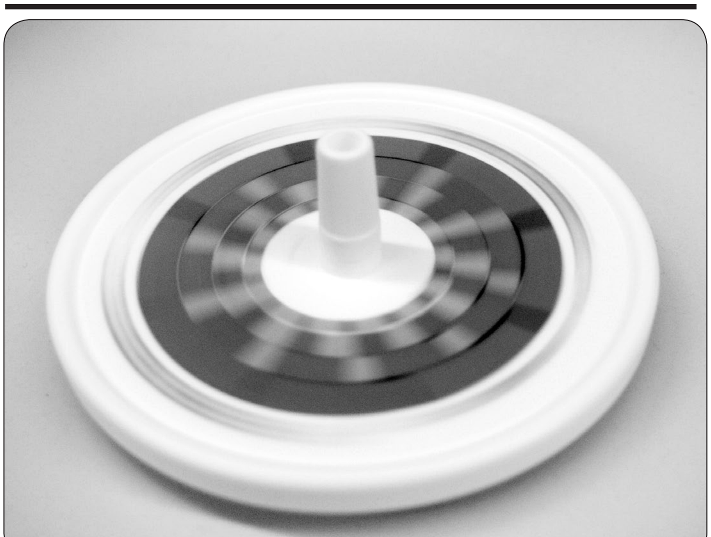
The part of a fluorescent light bulb that sends and controls the current through the gas is called a ballast. There is a part of the ballast at each end of the tube. The ballast is an electromagnet that can produce a large voltage between the two parts. It is this voltage that gives the electrons of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

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

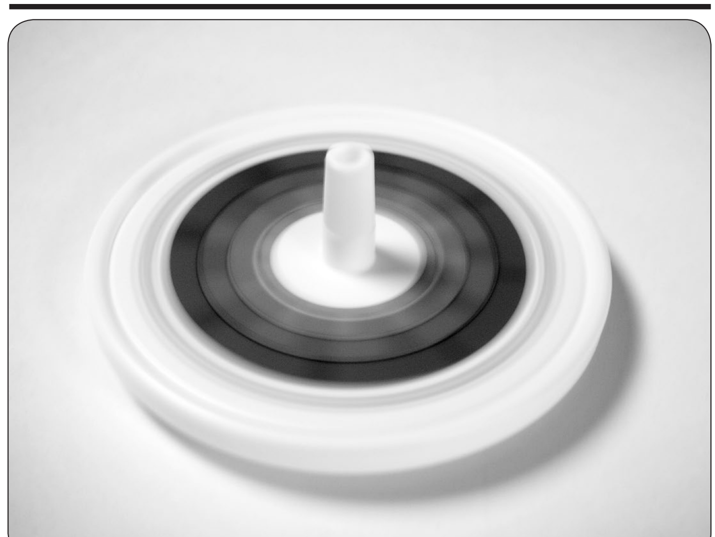
An electronic ballast has a microchip, like that found in a computer, instead of the coils of wire. This ballast is about 30 percent more efficient in turning electrical energy into light than a magnetic ballast. Some heat is produced in the gas, but not in the ballast itself.

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

MAGNETIC BALLAST



ELECTRONIC BALLAST



Recommended Light Levels

Below is a list of recommended illumination levels for school locations in foot-candles.

AREA	FOOT-CANDLES
Classrooms (Reading and Writing)	50
Classrooms (Drafting)	75
Computer Labs (Keyboarding)	30
Computer Labs (Reading Print Materials)	50
Computer Labs (Monitors)	3
Labs-General	50
Labs-Demonstrations	100
Auditorium (Seated Activities)	10
Auditorium (Reading Activities)	50
Kitchens	50
Dining Areas	30
Hallways	20-30
Stairwells	15
Gymnasiums (Exercising and Recreation)	30
Gymnasiums (Basketball Games)	75
Locker Rooms	10
Libraries and Media Centers (Study Areas)	50
Libraries and Media Centers (Other Areas)	30
Shops (Rough Work)	30
Shops (Medium Work)	50
Shops (Fine Work)	75
Offices (Reading Tasks)	50
Offices (Non-Reading Tasks)	30
Teacher Workrooms	30
Conference Rooms	30
Washrooms (Grooming Areas)	30
Washrooms (Lavatories)	15
Maintenance Rooms	30
Building Exteriors and Parking Lots	1-5

Electrical Devices and Appliances

A school building has many electrical devices and **appliances** (called plug loads) that aid in the learning process and help occupants stay comfortable and safe. It's estimated that about 20 percent of the total electricity consumed by a school is used to power electrical devices. Managing the use of such equipment can greatly reduce a school's electricity consumption.

Look around any classroom and school building and you will see many electrical devices, such as:

- coffee makers
- fans
- microwaves
- televisions
- window air conditioners
- printers and scanners
- copiers
- digital or overhead projectors
- vocational equipment
- refrigerated fountains
- computers/monitors
- laptops/tablets
- desk and table lamps
- refrigerators
- VCRs/DVD players
- vending machines
- fax machines
- fish tanks
- ranges and stoves
- clocks

Most of these devices are important to the learning environment. In addition, there are appliances that teachers and staff bring from home that are not related to teaching, but are routine devices found in any office.

Devices such as computers, printers, and copiers waste energy when they are left on 24 hours a day. Often they are left on as a matter of convenience, because they have long warm–up times. Turning these machines off at the end of the day and turning other machines off when they are not being used can save a lot of energy.

Many computers, TVs, VCRs, DVD players, and other electrical devices use electricity even when they are turned off. This type of electricity consumption is known as a **phantom load**, because it can easily go unnoticed. Phantom loads are also known as standby power or leaking electricity.

Phantom loads exist in many electronic or electrical devices found in schools. Equipment with electronic clocks, timers, or remote controls, portable equipment, and office equipment with wall cubes (small box-shaped plugs that plug into AC outlets to power appliances) all have phantom loads. These devices can consume 3–20 watts even when turned off.

CHANGE FOR THE BETTER WITH ENERGY STAR

Guidelines for Devices

When shopping for a new electrical device or appliance, look for the **ENERGY STAR®** label—your assurance that the product saves energy. ENERGY STAR® appliances have been identified by the U.S. Environmental Protection Agency and Department of Energy as the most energy efficient products in their classes.

If the average American were to equip his/her home only with products with the EnergyStar® label, he/she would reduce his/her energy bills, as well as **greenhouse gas emissions**, by about 30 percent. A list of these appliances can be found on the ENERGY STAR® web site at www.energystar.gov.

Another way to determine which appliance is more energy efficient is to compare energy usage using EnergyGuide labels. The Federal Government requires most appliances to display bright yellow and black **EnergyGuide labels**. Although these labels do not say which appliance is the most efficient, they provide the annual energy consumption and average operating cost of each appliance so you can compare them.

Electrical Devices: Savings Opportunities

Start by looking at the computers in your building. Survey the building's computers after school and see if they are being shut down or left on overnight. Turning computers off at the end of the day saves energy and will not harm the equipment.

Check to see that the computer's power options are set to save energy during periods the computer is on, but not being used. For PCs, click on the "Power Options" icon in the Control Panel. For Macs, click on the Apple logo on the top-left of the screen, click on "System Preferences", and select the "Energy Saver" icon.

Look at all peripherals, such as monitors, printers, scanners, and copiers. Are they set up to go into standby or sleep mode when idle? These should also be shut down at the end of the day. Check for phantom loads. You can use a meter to see if devices are using

LIGHTING DATA FORM

Was the room/area occupied upon arrival?
Were the lights off or on?
Is natural light allowed into the room?
FLUORESCENT TUBE LIGHTING
What kind of ballasts? ____ Electronic ____ Magnetic
What kind of tubes? ____ T 12 ____ T 8 ____ T 5
COMPACT FLUORESCENTS & INCANDESCENTS
Are there compact fluorescent lights in the room? If so, how many? Describe them.
Are there incandescent lights in the room? If so, how many? Describe them.
LIGHTING CONTROLS
Can the lights be controlled by dimmer switches?
Are there occupancy sensors?
Can the lights be turned off and on individually or in banks?
EXIT SIGNS
What kind of lighting do the exit signs use? ____ Incandescent ____ CFL ____ LED

<u>Conduct a School Energy Audit: Lighting</u>

Lighting measures in blue indicate that an exchange of information with the Behavior group is needed.

Lighting Measure	Number	Wattage saved with measure	Hours/ month (each)**	Potential monthly kWh reduced	Months in operation/ year	Potential annual kWh reduced	Potential annual dollar savings	Potential annual CO2 reduced (lbs.)	Cost per measure	Total cost of measure	Payback period (years)
Replace lamps and magnetic ballast with efficient lamps and electronic ballast (per flicker checker)		74							$50		
Replace incandescent bulb with compact fluorescent bulb		76							$2		
Turn hall and other light fixtures off when not needed		117 if magnetic ballasts; 43 if electronic ballasts							$0		
Remove a lamp from a light fixture because more light is provided than needed (per light meter)		29 if magnetic ballasts; 11 if electronic ballasts							$0		
Remove lights from drink and vending machines		117							$0		
Turn athletic field lights off in daylight hours		400*							$0		
Replace older-looking (compact fluorescent) Exit sign with LED Exit sign		11							$100		
					Total						

*Per lamp

**Enter an average number of hours the various types of lights are on per month or a default of 200

Assumptions

The electric rate can be either $0.08/kWh or your actual rate, if known

One BTU (British Thermal Unit) = 3,413 kWh

One kWh = 1.4 lbs. CO_2

Kill A Watt™ Monitor Instructions

Kill A Watt™ Monitor

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

Operating Instructions

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

What is Power Factor (PF)?

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

Volts x Amps x PF = Watts Consumed

ELECTRICAL DEVICES DATA FORM

COMPUTER DATA:

How many computers are in the room?

How many computers were on?

Were screen savers in use?

Were computers in stand-by mode?

ELECTRICAL DEVICES IN ROOM	ON?	VOLTAGE	CURRENT	WATTAGE

Cost of Using Electrical Devices

Calculate how much it costs to operate the machines in your classroom that you looked at before. You need to know the wattage, the cost of electricity, and the number of hours a week each machine is used.

You can estimate the number of hours the machine is used each week, then multiply by 40 to get the yearly use. We are using 40 weeks for schools, because school buildings aren't used every week of the year. Using the copier as an example, if it is used for ten hours each week, we can find the yearly use like this:

Yearly use = 10 hours/week x 40 weeks/year = 400 hours/year

Remember that electricity is measured in kilowatt-hours. You will need to change the watts to kilowatts. One kilowatt is equal to 1,000 watts. To get kilowatts, you must divide the watts by 1,000. Using the copier as an example, divide like this:

kW = W/1000

kW = 1265/1000 = 1.265

The average **cost of electricity for schools in the U.S. is about ten cents ($0.10)** a kilowatt-hour. You can use this rate or find out the actual rate from your school's electric bill. Using the average cost of electricity, we can figure out how much it costs to run the copier for a year by using this formula:

Yearly cost	**=**	**Hours used**	**x**	**Kilowatts**	**x**	**Cost of electricity (kWh)**		
Yearly cost	**=**	**400 hours/year**	**x**	**1.265 kW**	**x**	**$0.10/kWh**		
Yearly cost	**=**	**400**	**x**	**1.265**	**x**	**$.10**	**=**	**$50.60**

MACHINE OR APPLIANCE	HOURS PER WEEK	HOURS PER YEAR	WATTS (W)	KILOWATTS (kW)	RATE ($/kWh)	ANNUAL COST
Copier	*10*	*400 hours*	*1,265 W*	*1.265 kW*	*$0.10*	*$50.60*

Environmental Impacts

When we breathe, we produce carbon dioxide. When we burn fuels, we produce carbon dioxide too. Carbon dioxide (CO_2) is a greenhouse gas. Greenhouse gases hold heat in the atmosphere. They keep our planet warm enough for us to live, but since the Industrial Revoluation we have been producing more carbon dioxide than ever before. Since 1850, the level of CO_2 in the atmosphere has increased about 40 percent.

Research shows that greenhouse gases are trapping more heat in the atmosphere. Scientists believe this is causing the average temperature of the Earth's atmosphere to rise. They call this global climate change or global warming. Global warming refers to an average increase in the temperature of the atmosphere, which in turn causes changes in climate. A warmer atmosphere may lead to changes in rainfall patterns, a rise in sea level, and a wide range of impacts on plants, wildlife, and humans. When scientists talk about the issue of climate change, their concern is about global warming caused by human activities.

Driving cars and trucks produces carbon dioxide because fuel is burned. Heating homes by burning natural gas, wood, heating oil, or propane produces carbon dioxide too.

Making electricity can also produce carbon dioxide. Some energy sources—such as hydropower, solar, wind, geothermal, and nuclear—do not produce carbon dioxide, because no fuel is burned. Almost half of our electricity (42.2 percent), however, comes from burning coal. Another 26.8 percent comes from burning natural gas, petroleum, and biomass.

On average, every kilowatt-hour of electricity produces 1.3 pounds of carbon dioxide. Let's use this rule to figure out how much carbon dioxide is produced by the machines and electrical devices in your classroom. You can put the figures from the earlier worksheets in the boxes below. Here are the figures for the copier:

CO_2 a year = wattage x hours of use = rate of CO_2/kWh = total pounds of CO_2 per year

CO_2 a year = 1.265 kW x 400 hr/yr x 1.3 lb/kWh = 657.8 lbs/year

MACHINE OR APPLIANCE	KILOWATTS (kW)	HOURS PER YEAR	ANNUAL kWh	RATE OF CO_2/kWh	ANNUAL CO_2 PRODUCED
Copier	*1.265 kW*	*400 hours*	*506 kWh*	*1.3 lbs/kWh*	*657.8 lbs/yr*

Conduct a School Energy Audit: Appliances

Appliances in blue indicate that an exchange of information with the Behavior group is needed.

	CURRENT*						POTENTIAL****								
120 V LOAD**	Watts - on	Watts - off	Hours on/ day	kWh/ month - on	kWh/ month - off	kWh/ year***	Watts - on	Watts - off	Hours on/day	kWh/ month - on	kWh/ month - off	kWh/year	Potential annual kWh reduced	Potential annual dollar savings	Potential annual CO2 reduced (lbs.)
projector															
computer															
computer monitor															
personal space heaters															
personal or group mini-refrigerators															
Total															

*To enter "Current" data, use a power monitor to measure appliance wattage when the appliance is "on" and "off" and enter results in appropriate columns. Estimate "hours-on/day" and calculate results for other columns.

**Most power monitors only work with 120 volt appliances so check voltage carefully before attempting to measure appliance electricity use.

***Multiply "kWh/month - on" times 9 and "kWh/month - off" times 12 and add the results

****See below to enter "Potential" data:

For "Watts-on", use a power monitor to measure wattage by using certain appliances (i.e. fans) at lower settings and enter that number; otherwise enter the "Current" on wattage.

For "Watts-off", enter "0" if the appliance can be unplugged, plugged into a "smart strip", or plugged into a power strip that can be turned off; otherwise enter the "Current" off wattage.

For "hours-on", enter your best estimate of the lowest number of hours this appliance can be run to save energy per day; otherwise enter the "Current" hours on/day.

Conduct a School Energy Audit: Behavior

Interview custodial staff and school employees as appropriate to fill out the following behavior-related energy checklist. A score of 1 indicates "strongly agree" while a score of 5 indicates "strongly disagree".

	Score (1-5)	If 3 or above, provide reason	Current responsible party	Comments
HVAC				
Exterior doors and windows closed when running heating or cooling system				
Thermostats adjusted during unoccupied hours (manually or automatically - including use of a building automation system)				
LIGHTING				
Non-essential hallway and common area lights off or dimmed when not needed and/or when daylighting is adequate				
Non-essential gymnasium lights off or dimmed when not needed				
Athletic field lights off when not needed				
Classroom lights off when not needed				
Administrative office lights off when not needed				
APPLIANCES				
Limited or no use of personal space heaters				
Limited or no use of personal or group mini-refrigerators				
Computers turned off when not in use				
Computer monitors turned off when not in use				
Projectors turned off when not in use				
OTHER				

Conduct a School Energy Audit: Class Summary

Category	Total potential annual therms reduced	Total potential annual kWh reduced	Total potential annual dollar savings	Total potential annual CO_2 reduction (lbs.)	Total cost of all upgrades	Payback period (years)
~~HVAC~~						
Lighting						
Appliances						
All combined						
Behavior only						

Questions

1. Which category of energy upgrades has the lowest cost?

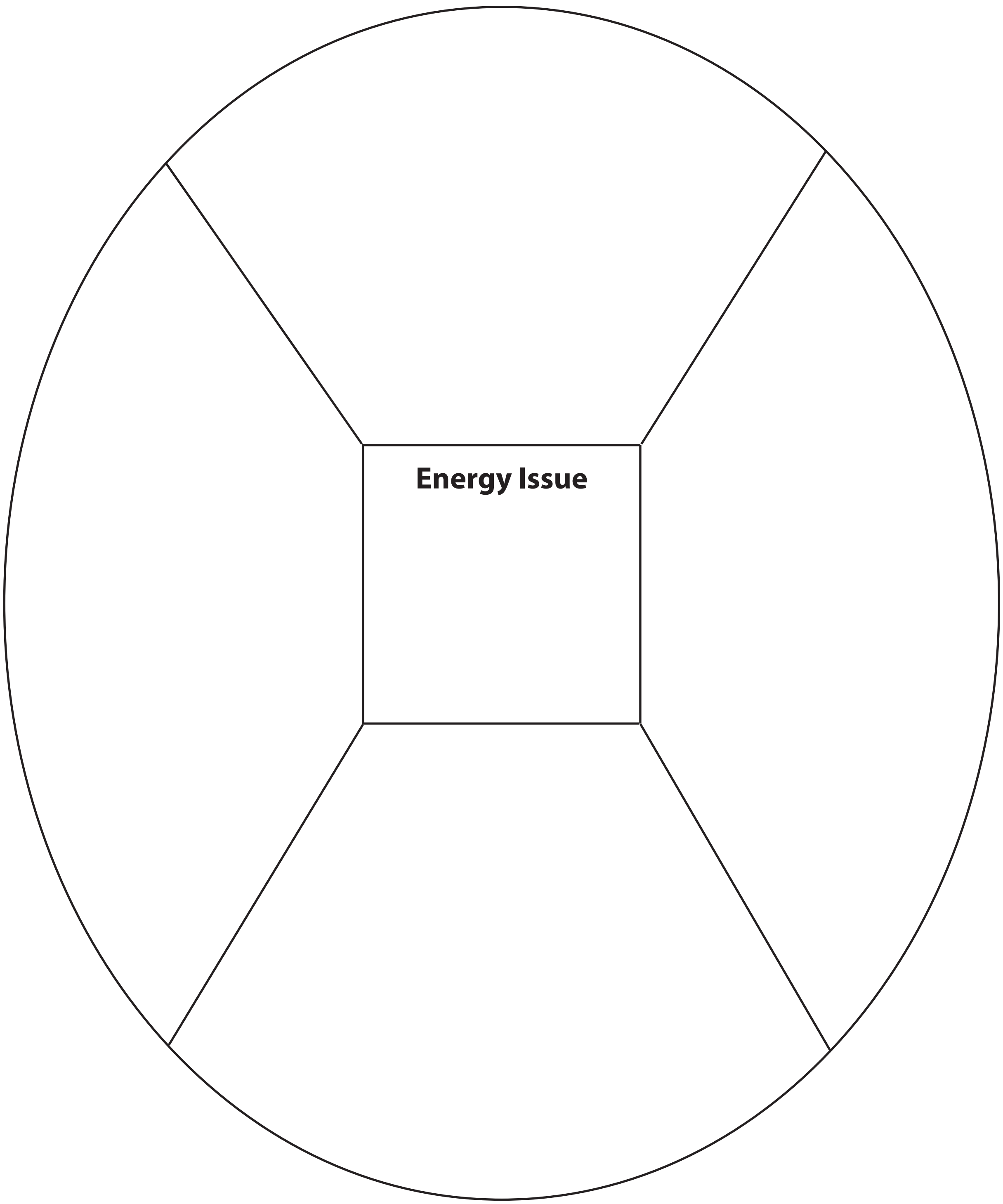
2. Which category of energy measures has the greatest potential savings?

3. Which category of energy measures has the quickest payback period?

4. What is the average cost to reduce one ton of CO_2/year?

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

Make a chart like the one below for each energy issue 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:**
Costs/Barriers				
Benefits				
Benefits Rating (+1, +2, or +3)				
Costs Rating (-1, -2, or -3)				
Score (Benefits-Costs)				
Conclusion				