

# Section D

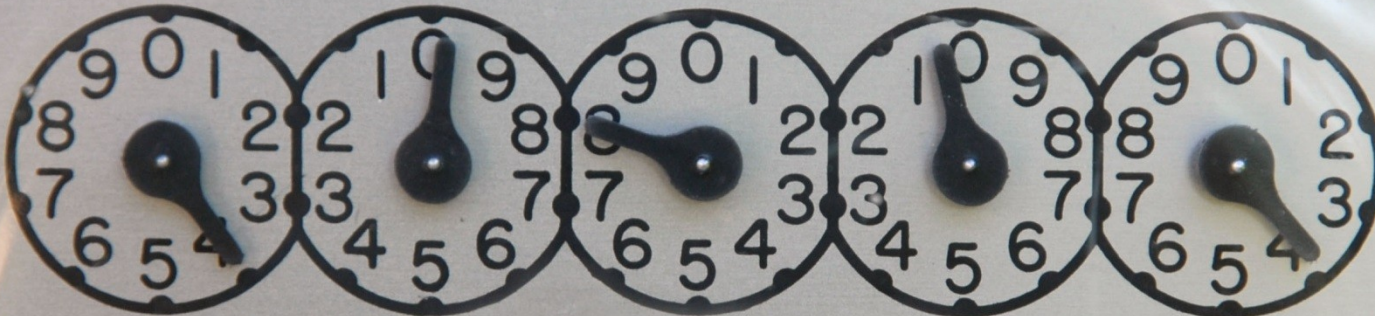
**Electric Energy Conservation & Management: Energy management, Energy Audit, Energy Efficient Motors, Co-generation.**

# Topic Covered

- ▶ **ELECTRIC ENERGY CONSERVATION & MANAGEMENT:** Energy management, Energy Audit,
- ▶ Energy Efficient Motors, Co-generation.

R<sub>r</sub> 13<sup>8</sup>/<sub>9</sub>

KILOWATTHOURS



CI 200

240V

3W

FM2S

60Hz

# What is Energy Management?

- Energy management is doing more with the same amount of energy or less energy.
- Energy management saves money and makes buildings more comfortable, healthy, and safe.



# Efficiency vs. Conservation

## Efficiency

- Energy efficiency involves the use of technology that requires less energy to perform the same function.
- Focuses on the equipment or machinery being used
- One example is installing LED light bulbs throughout the house

## Conservation

- Energy conservation includes any behavior that results in the use of less energy.
- Focuses on the behavior of people
- One example is using daylighting through windows rather than turning on the lights

# Benefits of Energy Management

- Reduces consumption
- Increases comfort & safety
- Reduces pollution
- Makes our economy stronger
- Increases our energy security

# National ENERGY STAR® Program



- Joint program of the U.S. Environmental Protection Agency and the U.S. Department of Energy
- National symbol for energy efficiency
- Products and/or buildings must meet certain standards to display label
- For homes & businesses

# How Efficient are U.S. Schools?

- Average annual energy bill to run America's schools: \$6 billion
- A typical school district with 3,000 students spends \$400,000 on energy per year.
- The least efficient schools use 3 times more energy than the best energy performers.
- Top performing ENERGY STAR<sup>®</sup> labeled schools cost \$0.40/square foot less to operate than the average schools.

**Luckily, energy is a manageable expense.**



# When we look for ways to save energy in a school, we must keep in mind:



# How Does Your School Use Energy?

## Energy System Components

- Building Envelope
- Heating, Ventilation and Air Conditioning (HVAC)
- Lighting
- Electric Appliances

# The Building Envelope



Any part of the building which creates a boundary between indoor and outdoor space.

- Walls
- Roofs
- Ceilings
- Doors
- Windows

# The Building Envelope

The envelope should limit:

- The amount of thermal energy conducting through.
- The amount of air that moves in and out of the building.



# Savings Opportunities: Building Envelope

Inadequate weatherstripping



Windows left open

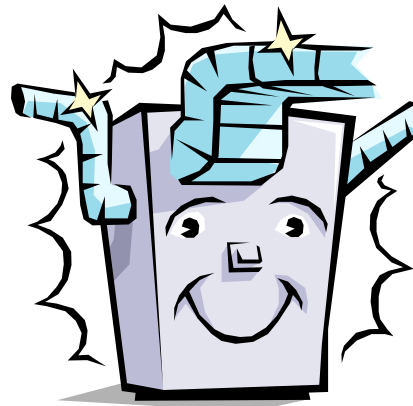
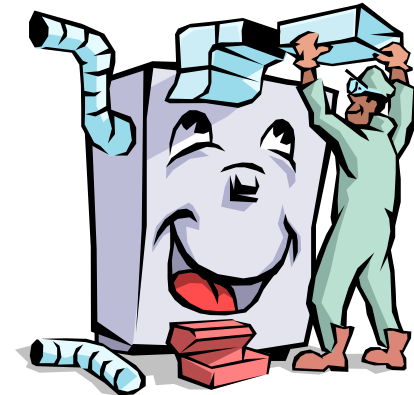
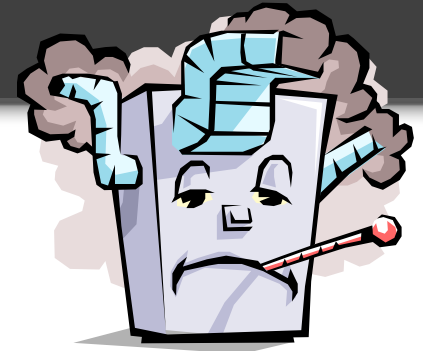
Single-paned windows





# HVAC

- Heating System (boiler, furnace)
- Ventilation System
- Air Conditioning (chillers)
- Hot Water
- Thermostats
- Ducts and Pipes



# Building Automation System (BAS)

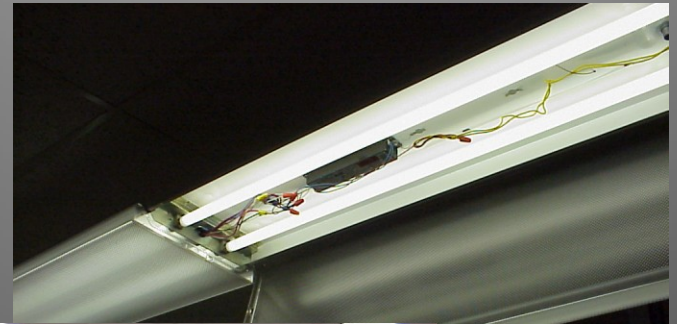
Provides school personnel with real time energy and performance data to manage the building's energy needs.

Temperature  
Sensor



# Types of Lighting Found in Schools

- Incandescent
- Fluorescent
- High Intensity Discharge (HID)
- Light Emitting Diode (LED)



Fluorescent



# Ballast

- Required for operation of fluorescent lamps.
- Provides initial arc to start lamp.
- Regulates current during operation.
- Two main types:
  - magnetic
  - electronic



# Compact Fluorescent



# Light Emitting Diodes (LEDs)



- Energy Star bulbs rated at 25,000 hours.
- Can use up to 50% less energy than a CFL.
- Widespread use over the next 20 years could reduce lighting energy demand by 33%.
- Currently more expensive to purchase compared to incandescent and CFLs.

# Light Bulb Comparison



## INCANDESCENT BULB

## HALOGEN

## COMPACT FLUORESCENT (CFL)

## LIGHT EMITTING DIODE (LED)

Brightness	850 lumens	850 lumens	850 lumens	850 lumens
Life of Bulb	1,000 hours	3,000 hours	10,000 hours	25,000 hours
Energy Used	60 watts = 0.06 kW	43 watts = 0.043 kW	13 watts = 0.013 kW	12 watts = 0.012 kW
Price per Bulb	\$0.50	\$3.00	\$3.00	\$20.00

# Facts of Light Answer Key



All bulbs provide about 850 lumens of light.

	INCANDESCENT BULB	HALOGEN	COMPACT FLUORESCENT (CFL)	LIGHT EMITTING DIODE (LED)
<b>COST OF BULB</b>				
Life of bulb (how long it will light)	1,000 hours	3,000 hours	10,000 hours	25,000 hours
Number of bulbs to get 25,000 hours				
x Price per bulb	\$0.50	\$3.00	\$3.00	\$20.00
= <b>Cost of bulbs for 25,000 hours of light</b>				
<b>COST OF ELECTRICITY</b>				
Total Hours	25,000 hours	25,000 hours	25,000 hours	25,000 hours
x Wattage	60 watts = 0.060 kW	43 watts = 0.043 kW	13 watts = 0.013 kW	12 watts = 0.012 kW
= Total kWh consumption				
x Price of electricity per kWh	\$0.10	\$0.10	\$0.10	\$0.10
= <b>Cost of Electricity</b>				
<b>LIFE CYCLE COST</b>				
Cost of bulbs				
+ Cost of electricity				
= <b>Life cycle cost</b>				
<b>ENVIRONMENTAL IMPACT</b>				
Total kWh consumption				
x Pounds (lbs) of carbon dioxide per kWh	1.33 lb/kWh	1.33 lb/kWh	1.33 lb/kWh	1.33 lb/kWh
= <b>Pounds of carbon dioxide produced</b>				

# Electric Appliances in Schools

- Electric Space Heaters
- Air Conditioning
- Electric Water Heaters
- Refrigerators/Freezers
- Lighting
- Computers and Office Equip





# Savings Opportunities: Electric Appliances



# Personal Computers

## Enable Power Management Settings

- Set your computer to automatically go into STANDBY mode after 10 minutes.
  - To bring it back up, either move your mouse or hit the power button (depending on your machine).
- Disable screensavers!**



# Saving with Vending Machines

Unplug during vacations



Install timers





# Plug Loads

- Students count electrical devices
- Students estimate number of hours per week device is used
- Excel spreadsheet uses formulas to compute cost

Phantom Load Savings Model									
Average Electricity Cost =		\$ 0.10 per kWh			Average CO <sub>2</sub> Emitted per kWh =				
Equipment	Quantity In Use <sup>1</sup>	Typical Hours "off" Daily	Wattage	Monthly kWh	Months/Year	Yearly kWh	Annual Cost Each	Total Annual Cost	En
Coffee Maker	25	21	1.5	15.8	9	142	\$0.57	\$14	
Computer&Monitor	90	17	4	122.4	9	1,102	\$1.22	\$110	
Laptop/Tablet <sup>4</sup>	150	16	4.4	211.2	9				
Fan	10	21	0	-	9	-	\$0.00	\$0	
Desk Lamp	30	19	0	-	9	-	\$0.00	\$0	
Microwave	15	23.5	2.5	17.6	9	159	\$1.06	\$16	
Digital Projector	25	19	3.15	29.9	9	269	\$1.08	\$27	
Television	25	23	3.5	40.3	9	362	\$1.45	\$36	
DVD player	25	23	5.2	59.8	9	538	\$2.15	\$54	
Space Heater	15	17	0	-	4	-	\$0.00	\$0	
Window AC (8,000 Btu/hr)	3	16	0.5	0.5	4	2	\$0.06	\$0	
Window AC (12,000 Btu/hr)	3	16	1	1.0	4	4	\$0.13	\$0	
Other	0	0	0	-		-			
<b>TOTAL</b>				<b>498</b>		<b>2,578</b>		<b>\$258</b>	

**Notes:**

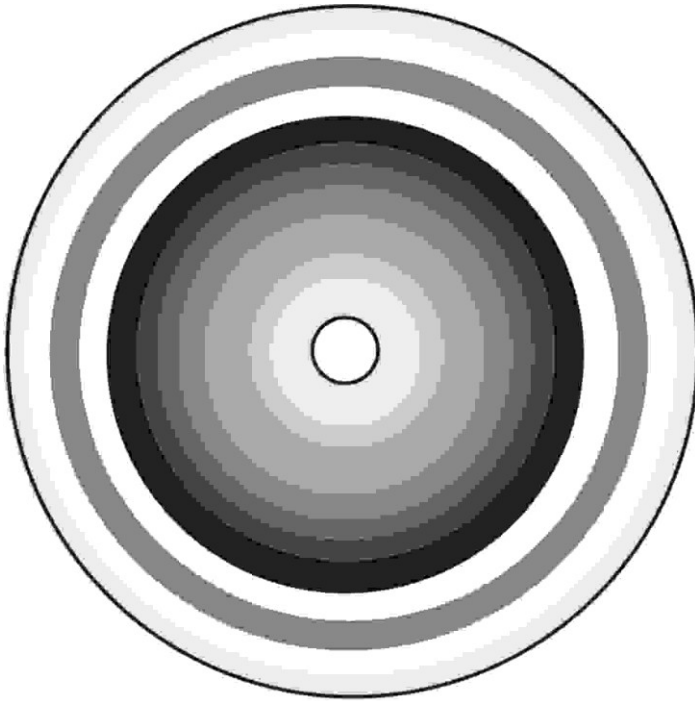
- Quantities shown are for a typical, 25-classroom, 100,000 sq. ft., K-12 school.
- Amount of time the appliance is off but remains plugged in.
- If necessary, change input in yellow for equipment you are analyzing. You can change other numbers if needed.
- Laptop wattage denotes when tablet or notebook is off and NOT charging. If the device is charging, its wattage will be higher.
- Assumes most items are unplugged and unused for any breaks (summer, etc).

# Student Energy Audit

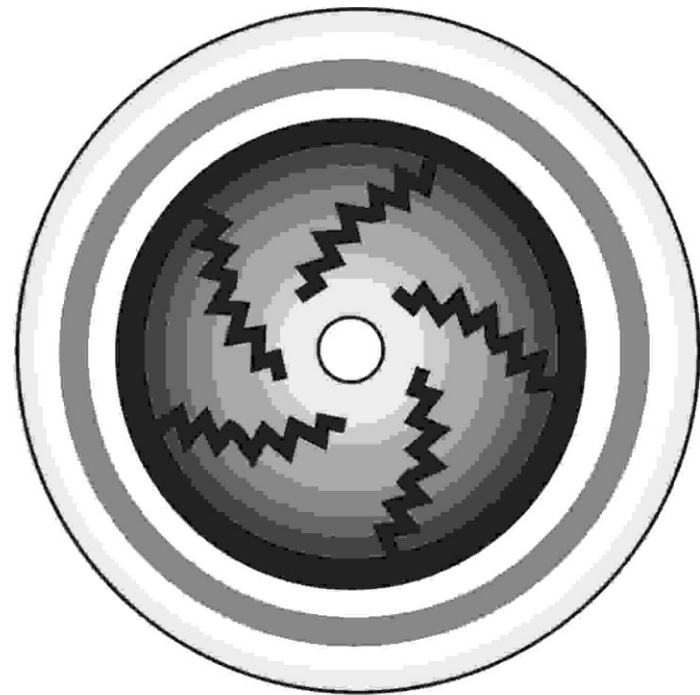
- Investigate your building and look for the following:
  - Fluorescent light ballast type
  - Light levels
  - Humidity levels
  - Temperature
  - Electricity usage
- Reporting Form (Before and After)



# Determining Ballast Type

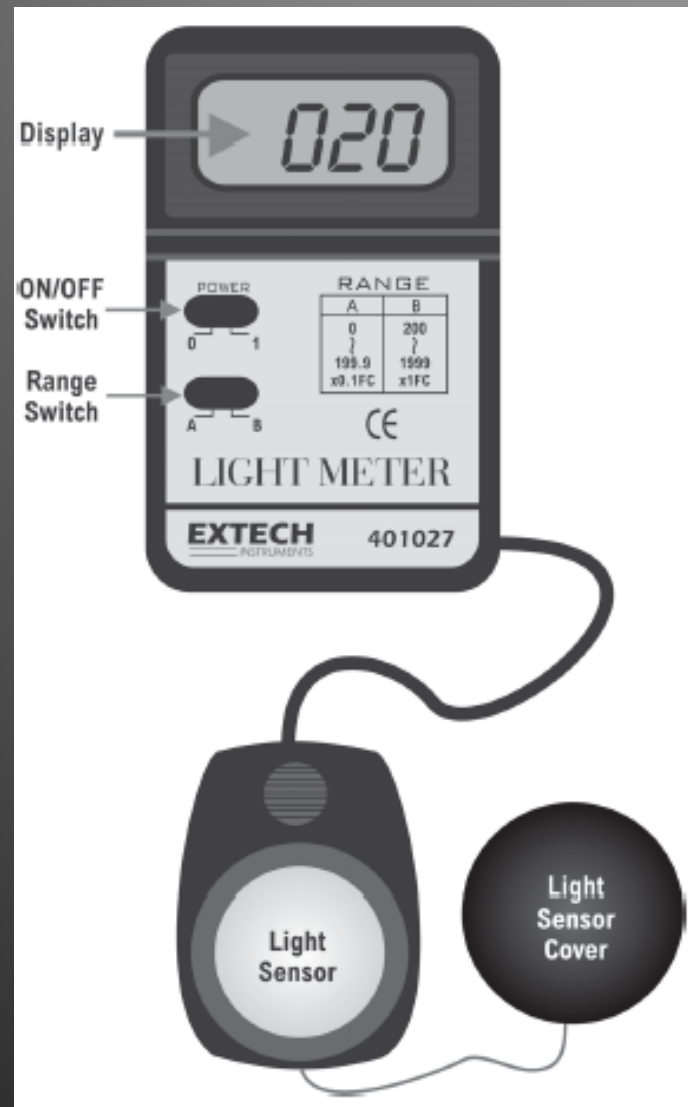


**Electronic Ballast**



**Magnetic Ballast**

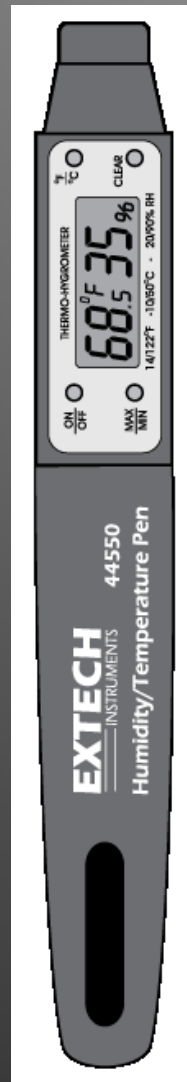
A flicker checker is a small plastic top-like device used to identify ballast type. A gray scale pattern indicates an electronic ballast, while a checkerboard pattern indicates a magnetic ballast.



## Light Meter

A light meter  
candle

the amount of light in a space in units of foot  
are overly lit may be using more energy than  
necessary.



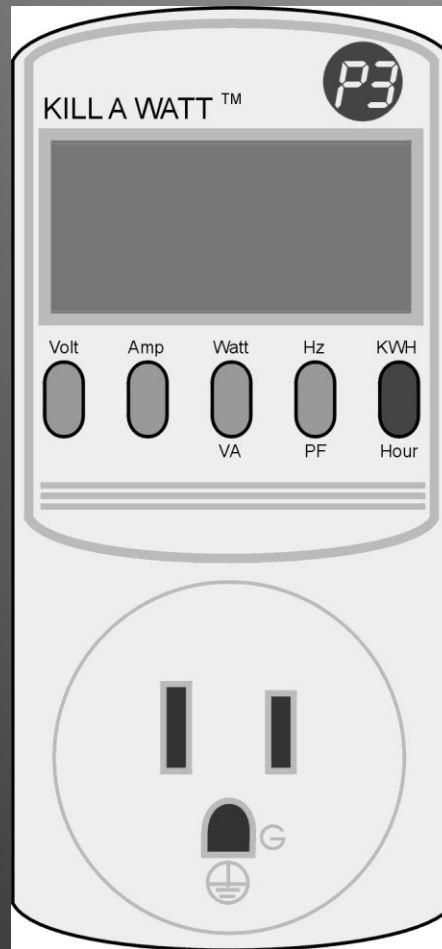
## Hygrometer >>

A hygrometer measures relative humidity. Warmer air can hold more moisture, so if cold air is heated, it will feel very dry unless humidified.



thermometer >>>

The digital thermometer can be used to tell if a room is of the appropriate temperature, and compare how spaces may be infiltrated by moving air. Waterproof versions can also help check the temperature setting of your water heating system.



## Kill A Watt meter >>

This tool allows you to measure how much power (Watts) an electrical device uses at any given time. By changing the display, it can also measure kWh consumed over a period of time.



# Energy Efficiency: The Assessment

Recording Form	
<b>DATE:</b> _____	<b>DATE:</b> _____
<b>TIME:</b> _____	<b>TIME:</b> _____
<b>Common Area #</b> _____	<b>Non-Class Room #</b> _____
Number of Windows _____	Number of Windows _____
Indoor Temperature _____	Indoor Temperature _____
Relative Humidity _____	Relative Humidity _____
Light Meter Reading _____	Light Meter Reading _____
Hot Water Temperature _____	Hot Water Temperature _____
Is there a thermostat?      Yes    No	Is there a thermostat?      Yes    No
Are there adjustable vents?    Yes    No	Are there adjustable vents?    Yes    No
Are there adjustable lights?    Yes    No	Are there adjustable lights?    Yes    No
Are the lights on?      No    Some    All	Are the lights on?      No    Some    All
Are the windows open?    No    Some    All	Are the windows open?    No    Some    All
Are the blinds closed?    No    Some    All	Are the blinds closed?    No    Some    All
Are doors tightly closed?    No    Some    All	Are the faucets dripping?    No    Some    All
List the electrical appliances that are turned on. Are they in use?	List the electrical appliances that are turned on. Are they in use?
Other Comments:	Other Comments:

# Energy Efficiency: Take Action

## Awareness Campaign

### What Makes a Campaign Effective?

- Clearly defined message
- Motivational components
- Delivering message via multiple media
- Persistence in delivering message