Climate Smart Communities Building Energy Training

Clifton Park and Saratoga Springs, NY

VHB Engineering, Surveying and Landscape Architecture, P.C.

CDRPC

An Independent Contractor to NYSERDA

NOVUS ENGINEERING, P.C.
SUSTAINABLE SOLUTIONS SINCE 1981

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Technical Consultant Team

Kari Hewitt, CEM, LEED AP
Sustainability Planner for VHB
617-924-1770 x1332
Khewitt@VHB.com

Angela J. Vincent
Sustainability PM for VHB
617-924-1770 x1287
avincent@vhb.com

Todd Fabozzi
Program Manager
Capital District Regional Planning Commission
518-453-0850
todd@cdrpc.org

Workshop Leaders

Mark Bagdon, PE
Principal of Novus Engineering, P.C.
518-439-8235
mbagdon@novusengineering.com

Cara Martin
Project Manager
518-439-8235
cmartin@novusengineering.com

Workshop Purpose

After completing this workshop, you will be able to answer these questions:

- How is energy use measured, billed, tracked, assessed, and managed?
- What contributes to energy use in a facility and how can energy consumption be reduced?

Section 1:
Climate Smart Communities Program

Climate Smart Communities

- Clifton Park adopted the CSC Pledge in 2009 and Saratoga Springs in 2011
- Goal of the program:
  - “Reduce greenhouse gas emissions, save taxpayer dollars, and advance community goals for health and safety, economic vitality, energy independence and quality of life.”
- In 2012, NYSERDA contracted CDRPC to provide technical assistance to Climate Smart Communities throughout the Capital Region. VHB is a subcontractor for the technical assistance program.

CSC Pledge Elements

1. Pledge to Combat Climate Change by Becoming a Climate Smart Community
2. Set Goals, Inventory Emissions, Move to Action
3. **Decrease Energy Demand for Local Government Operations**
4. Encourage Renewable Energy for Local Government Operations
5. Realize Benefits of Recycling and Other Climate Smart Solid Waste Management Practices
6. Promote Climate Protection Through Community Land Use Tools
7. Plan for Adaptation to Unavoidable Climate Change
8. Support a Green Innovation Economy
9. Inform and Inspire the Public
10. Commit to an Evolving Process

Section 2:
Relative Costs of Fuels and How Energy is Billed

What energy sources are used in your facilities?

Energy Sources and Billing Method

Energy Source	Units	Billing Method
Electricity Consumption	Kilowatt hours (kWh)	Utility meter
Electricity Demand	Kilowatt (kW)	Utility meter
Natural Gas	Therms or ccf (100 cubic feet)	Utility meter
Propane	Gallons	Delivery
Fuel Oil and Diesel	Gallons	Delivery

Definitions:

1. kWh – Actual amount of electrical energy used over a time period
2. kW Demand – Peak rate of power consumption (max 15 minute period per month)
3. Therm – unit of heating energy = 100,000 BTU
4. MMBtu – 1,000,000 Btu or 10 Therms
5. ccf – 100 cubic feet = 1.03 therms
6. Mcf = 1000 cubic fee ≈ 1MMBtu

Relative Costs of Energy Sources

Energy Source	Cost per Typical Unit	Cost per MMBtu
Electricity	$0.16 /kWh	$47.37 /MMBtu
Natural Gas	$0.70 /therm	$7.59 /MMBtu
Propane	$2.25 /gallon	$24.73 /MMBtu
Fuel Oil	$3.12 /gallon	$28.06 /MMBtu

Electricity Billing

Delivery Portion:

Electricity Delivery

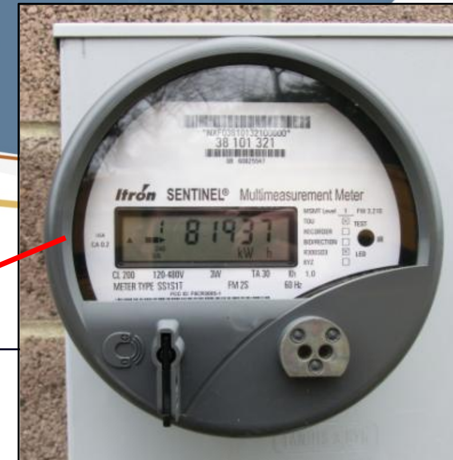
Type of Service	Current Reading	-	Previous Reading	=	Difference	x	Meter Multiplier	=	Total Usage
Energy	70959 *Actual*		70531 *Actual*		428		160		68480 kWh
					Total Energy Usage				**68480 kWh**
					Billed Energy Usage				**68480 kWh**
Demand	246.53 *Actual*		244.75 *Actual*		1.78		160		284.8 kW
					Total Demand Usage				**284.8 kW**
					Billed Demand Usage				**284.8 kW**

METER NUMBER 55455373 NEXT SCHEDULED READ DATE Dec 9

SERVICE PERIOD Oct 7 - Nov 5 NUMBER OF DAYS IN PERIOD 29 METERING TYPE Secondary

RATE Electric SC3 VOLTAGE DELIVERY LEVEL 0 - 2.2 kv

Customer				260.15
First 450 Hours			68480 kWh	777.25
Demand	16.65	x	284.8 kW	4,741.92
SBC/RPS	0.004619	x	68480 kWh	316.30
Incr State Assessment	1	x	284.8 kW	284.80
Transmission Rev Adj	-0.00224	x	68480 kWh	-153.40
Sales Tax	8.0 %			493.16
	Total Electricity Delivery			**$ 6,725.18**



Electricity Billing

Supply Portion:

Electricity Supply

SUPPLIER National Grid

Electricity Supply	0.0633 x 68480 kWh		4 334.78
Sales Tax	8.0 %		346.78
		Total Electricity Supply	**$ 4,681.56**

SUMMARY OF CURRENT CHARGES

	DELIVERY SERVICES	SUPPLY SERVICES	TOTAL
Electric Service	6,725.18	4,681.56	11,406.74
Gas Service	403.54	1,144.32	1,547.86
Total Current Charges	$ 7,128.72	$ 5,825.88	$ 12 954.60

Sample Electrical Energy and Demand Calculations

100, Light fixtures @ 50 Watts Each = 5000 Watts
5000 / 1000 Watts per kW = 5 kW

1, 10 Hp motor
10 x 0.746 kW/Hp = 7.46 kW

200, Desktop Computers @ 125 Watts Each = 25,000 Watts
200 x 125 / 1000 W/kW = 25 kW

TOTAL DEMAND= 37.5 kW
TOTAL ENERGY = 37.5 kW x 720 hours/month
= 27,000 kWh/month

Electricity Cost Calculations

- **Monthly Cost**
  - Energy

    27,000 kWh x $0.10/kWh = $2,700

  - Demand

    37.5 kW x $10/kW-month = $375

Total Monthly Cost = $3,075

What is the Relationship Between Energy and Demand?

How might the energy used in the previous example change while the demand stays the same?

Section 3:
Energy Information Management

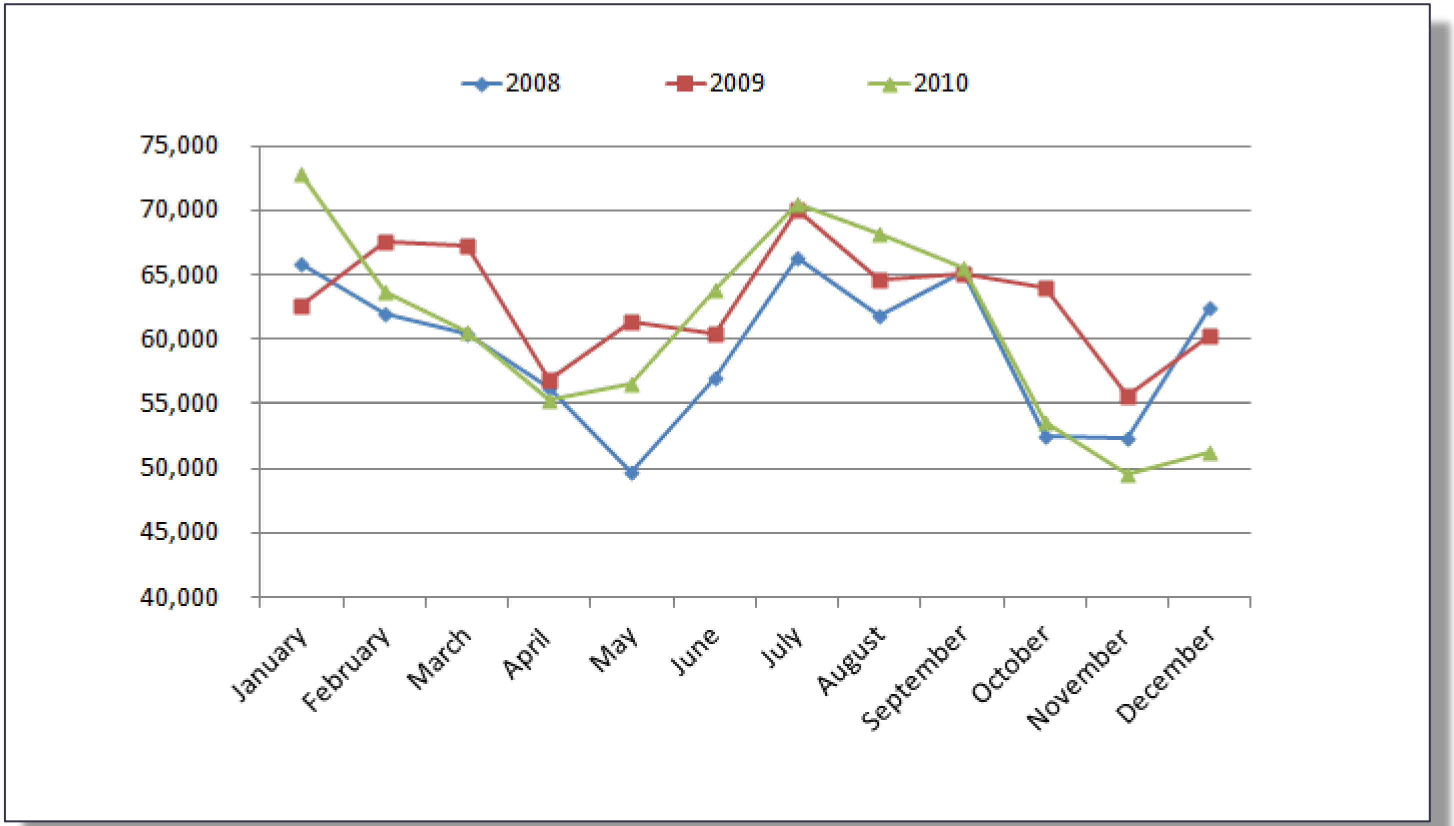
Energy Management:
Useful Metrics to compare energy use

Fuel	Useful Metrics
Electricity	kWh/SF; $/SF; kWh/person; kWh/unit of product
Natural Gas	Therms/SF; $/SF; therms/HDD
Propane and Fuel Oil	Gallons/SF; MMBtu/SF; $/SF

Definitions:
SF = square footage (building area)
HDD = heating degree day

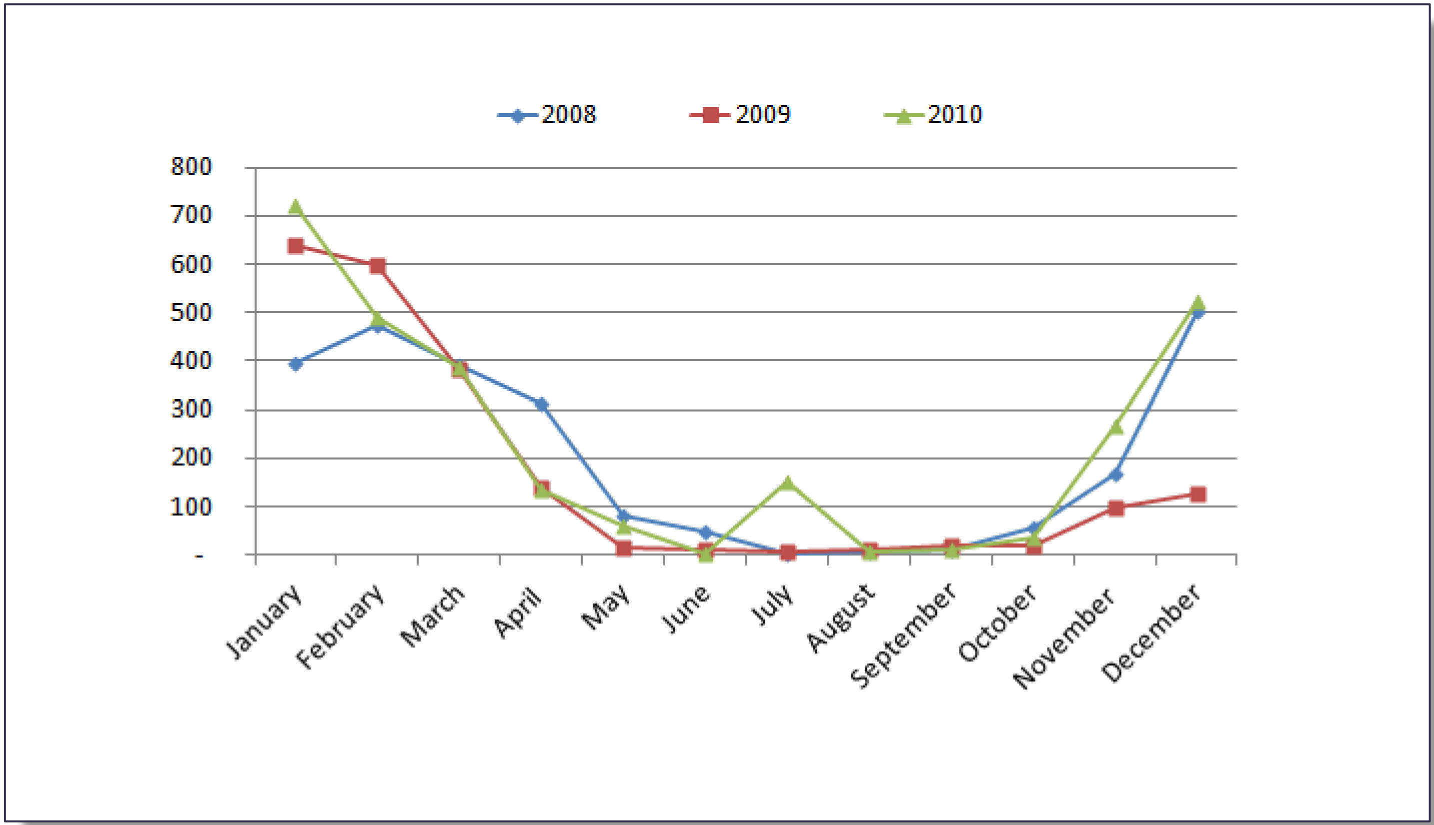
Energy Management: Tracking

Electricity Consumption (kWh) for Sample Building



What Does This Trend Suggest?

Natural Gas Consumption (therms) for Sample Building



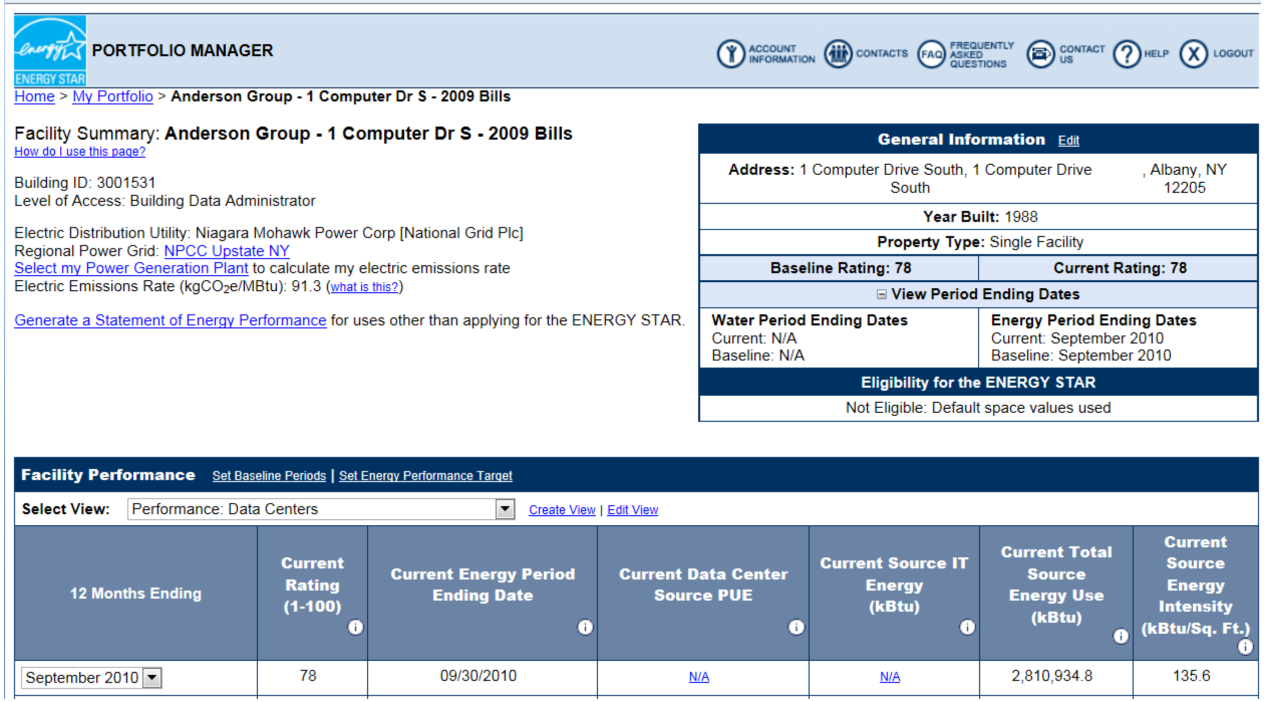
Heating Energy versus Heating Degree Days

2011 Natural Gas Consumption (therms) and Heating Degree Days for Sample Building

Month	Gas Consumption (therms)	Heating Degree Days for Billed Period	Therms / Heating Degree Day
January	3,752	825	4.6
February	3,940	702	5.6
March	2,299	317	7.3
April	1,652	45	36.7
May	459	1	459
June	161	0	N/A
July	117	0	N/A
August	142	39	3.6
September	603	303	2.0
October	1,845	432	4.3
November	2,588	748	3.5
December	3,344	903	3.7

Benchmarking

- Calculate electric, gas, and cost metrics per building
- Compare to typical averages:
  - EPA Portfolio Manager



PORTFOLIO MANAGER

ACCOUNT INFORMATION | CONTACTS | FREQUENTLY ASKED QUESTIONS | CONTACT US | HELP | LOGOUT

Home > My Portfolio > **Anderson Group - 1 Computer Dr S - 2009 Bills**

Facility Summary: **Anderson Group - 1 Computer Dr S - 2009 Bills**
How do I use this page?

Building ID: 3001531
Level of Access: Building Data Administrator

Electric Distribution Utility: Niagara Mohawk Power Corp [National Grid Plc]
Regional Power Grid: NPCC Upstate NY
Select my Power Generation Plant to calculate my electric emissions rate
Electric Emissions Rate ($kgCO_2e/MBtu$): 91.3 (what is this?)

Generate a Statement of Energy Performance for uses other than applying for the ENERGY STAR.

General Information Edit	
Address: 1 Computer Drive South, 1 Computer Drive South	, Albany, NY 12205
Year Built: 1988	
Property Type: Single Facility	
Baseline Rating: 78	**Current Rating: 78**
View Period Ending Dates	
Water Period Ending Dates Current: N/A Baseline: N/A	**Energy Period Ending Dates** Current: September 2010 Baseline: September 2010
Eligibility for the ENERGY STAR	
Not Eligible: Default space values used	

Facility Performance Set Baseline Periods | Set Energy Performance Target

Select View: Performance: Data Centers | Create View | Edit View

12 Months Ending	Current Rating (1-100)	Current Energy Period Ending Date	Current Data Center Source PUE	Current Source IT Energy (kBtu)	Current Total Source Energy Use (kBtu)	Current Source Energy Intensity (kBtu/Sq. Ft.)
September 2010	78	09/30/2010	N/A	N/A	2,810,934.8	135.6

Benchmarking

- Compare to typical averages:
  - Commercial Building Energy Consumption Survey (CBECS)

Table C15A. Electricity Consumption and Conditional Energy Intensity by Census Region for All Buildings, 2003

	Total Electricity Consumption (billion kWh)				Total Floorspace of Buildings Using Electricity (million square feet)				Electricity Energy Intensity (kWh/square foot)			
	North-east	Mid-west	South	West	North-east	Mid-west	South	West	North-east	Mid-west	South	West
All Buildings	172	234	452	185	13,899	17,725	26,017	12,541	12.4	13.2	17.4	14.7
Building Floorspace (Square Feet)												
1,001 to 5,000	14	30	52	19	1,031	1,742	2,410	1,296	13.5	17.4	21.5	14.6
5,001 to 10,000	11	17	37	21	1,128	1,558	2,640	1,319	9.8	10.8	14.0	15.8
10,001 to 25,000	22	33	59	28	2,094	3,317	4,746	2,338	10.4	10.0	12.5	12.1
25,001 to 50,000	14	33	48	21	1,388	2,628	3,318	1,764	9.8	12.6	14.6	12.1
50,001 to 100,000	29	32	68	24	2,272	2,376	4,059	1,558	12.6	13.5	16.8	15.7
100,001 to 200,000	28	37	84	22	2,238	2,475	4,105	1,353	12.4	15.1	20.5	16.6
200,001 to 500,000	24	29	42	17	1,781	2,288	2,104	1,196	13.3	12.9	20.0	14.0
Over 500,000	32	22	61	32	1,967	1,341	2,635	1,717	16.1	16.4	23.2	18.7

Section 4: Common Mechanical Equipment and Associated Efficiencies / Energy Savings Opportunities

What mechanical systems (heating, cooling and ventilation) are included in your facilities?

Heating Sources

- Hydronic and Steam Heating Systems
- Boilers
  - Hot water vs. Steam
  - Condensing vs. Non-condensing

Town Hall, Clifton Park

Visitor's Center, Saratoga Springs

Heating Sources

- Terminal Units
  - Fin Tube Radiation (FTR)
  - Air handling units (AHUs)
  - Fan coils (FCUs)
  - Radiators
  - Unit Heaters
    - Gas
    - Electric
    - Hot Water
- Unitary Equipment
  - Rooftop Unit
  - Indoor furnace/AC units

Unit Heater, Clifton Park Garage
Why was the temperature so high?

Air Handling Unit, Ice Rink, Saratoga Springs

Ventilation

- Ventilation is providing outside air inside a building for proper indoor air quality
- Minimum ventilation is required by code, depending on the building type and occupancy
- Under ventilated spaces will seem “stale” or have odor issues
- Over ventilated spaces will have very low CO_2 concentrations and can waste energy since ventilation air has to be heated
- Common methods in use:
  - **Set it and forget it**
  - **Measure CO2 level**
  - **Measure outside air flow**

Fans

- Used in most heating / cooling equipment for circulating air
- Can be large percentage of building energy consumption
- Small fans are inefficient
- Energy consumption is proportional to air volume (cfm) and pressure (inches water column)
- Can waste energy if throttled
- Reduce speed through sheave adjustment or Variable Frequency Drives (VFDs)

Pumps

- Sizing by engineers based on formulas with safety factors thrown in
- Typically adjusted by throttling down flow with balance valve – wastes energy
- Speed reduction to correct balance point via VFD can save substantial energy
- Small (<5 Hp) permanent magnet, variable speed pumps are much more energy efficient (Wilo Stratus or Gundfos Magma)

Circulating Pumps, Town Hall, Clifton Park

Outdoor Chiller Pumps, Ice Rink, Saratoga Springs

Variable Frequency Drives (VFDs)

- Solid state devices that slow down motors on pumps and fans in response to load
- Prices have dropped significantly in the past few years
- Energy use is proportional to cube of speed
  ½ speed = 1/8 power
- Can be used for balancing or continuous control with active sensors (generally pressure)

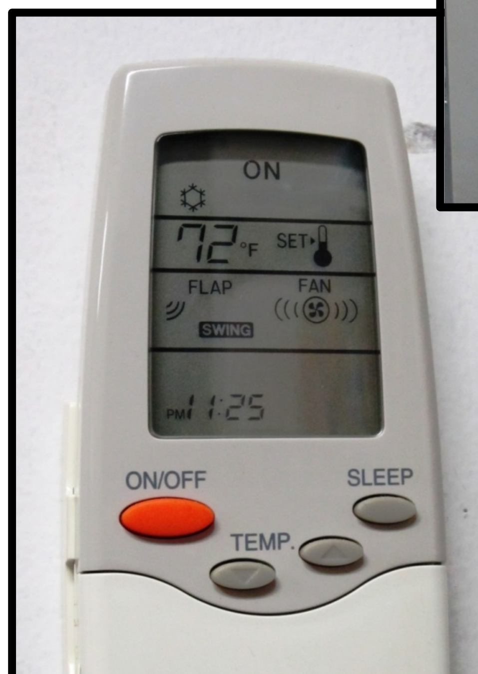
Mechanical System Sizing

- One-to-one replacement not always optimal; systems typically oversized by design engineers (CYO syndrome)
- Oversized systems do not run as efficiently as properly sized systems and increase up-front capital cost
- Typical rules of thumb:
  - Cooling – 400 – 600 SF/ton
  - Heating 12 – 50 MBH/SF
  - Air Flow – 0.6 – 1.5 cfm/SF

Section 5: Controls

Mechanical System Controls:
Types

- Time Clock
- Thermostat
- Control Valves and Dampers
- Digital Controls



Mechanical System Controls:
Uses

- Turn equipment on and off
- Control equipment or space parameters
  - Temperature
  - Pressure
  - Flow
- Main types
  - On-off control
  - Modulating control

Mechanical System Controls:
Benefits

- Reduces energy consumption
- Saves time and effort
- Assists maintenance staff

Examples to Improve Performance:

- Periodically review setpoints for infrequently inhabited spaces that can tolerate lower temperatures (lobbies, storerooms, etc.)
- In areas that need temporary conditioning, such as garages, use digital thermostats with a temporary override, rather than a manual thermostat

Time Clocks

- Typically one day on/off control only
- 1, 7 and 365 day and astronomical versions are available
- Uses
  - Exterior lighting
  - Pneumatic systems
  - Fans
- What to check:
  - Proper setting of pins
  - Proper current time
  - Schedule posted

What's Missing?

Thermostats

- Temperature Control
- Range of control
  - One Day
  - Seven Day
  - Fully Programmable
- Features
  - Password Protected
  - Temporary versus permanent hold
- What to check:
  - Proper setting of schedules and set points
  - Proper current time
  - Schedule posted

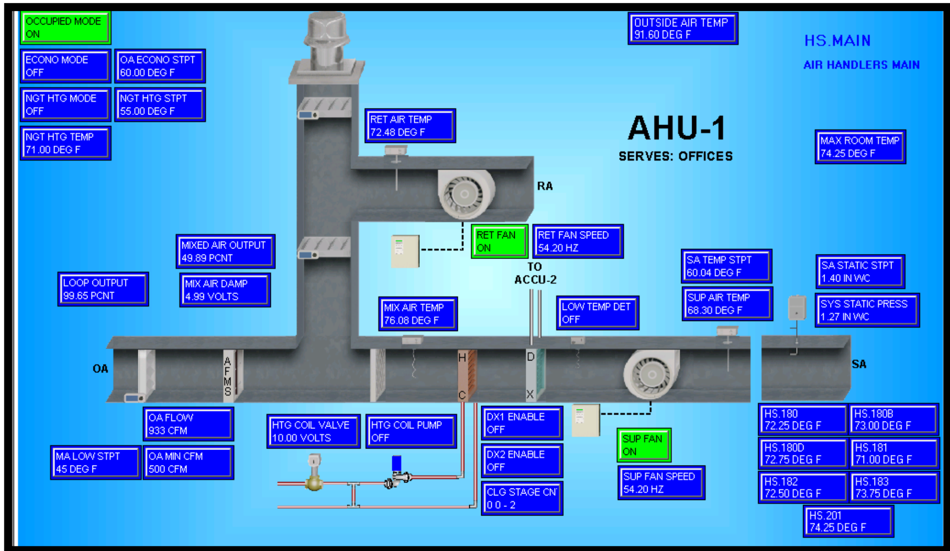
Hydronic/Steam Control Valves

24 V Pop Top Valve

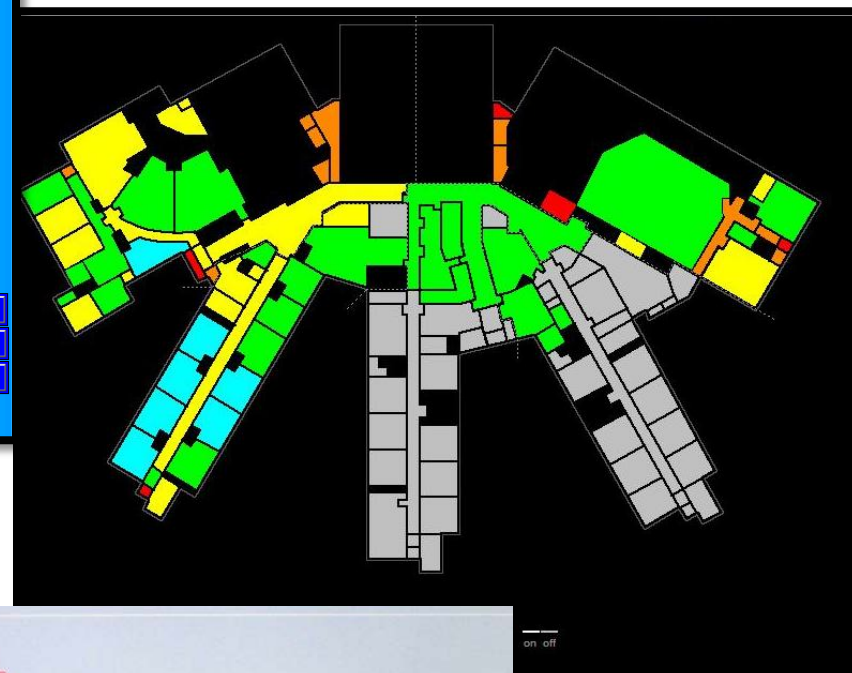
Saratoga
Town Hall

Self Contained Non-Electric Valve

Digital Controls



Room-by-room temperature control and monitoring



System details, settings, and alarms

System trending

It is important to receive full and adequate training for these types of systems!

Section 6: Weatherization

Windows

- Single pane vs. Double pane
- U-value and Solar Heat Gain Coefficient (SHGC)
- Common Problems:
  - Improper sealing
  - Cracks
  - Rust
- Solutions:
  - Proper caulking
  - Replacement
  - Windo-Therm

(Advanced Energy Panels)

Visitor's Center, Saratoga Springs

Highway Garage, Clifton Park

Doors

- Common Problems:
  - Gaps between
  - Gaps above and below
  - Improper sealing
- Solutions:
  - Weatherstripping
  - Proper alignment
  - Door bottoms

Roof Penetrations

- Installed for building relief, exhaust, etc.
- Need to be properly sealed and controlled
- Building renovations may eliminate need for penetrations, but openings are not always closed

Dampers

- Wall or roof penetrations to allow in outside air
- Spring loaded or controlled
- Check for:
  - Adequate sealing
  - Proper actuator function

Weatherstripping

- Commercially available products
  - Door bottoms
  - Between door weatherstripping
  - Door edge weatherstripping

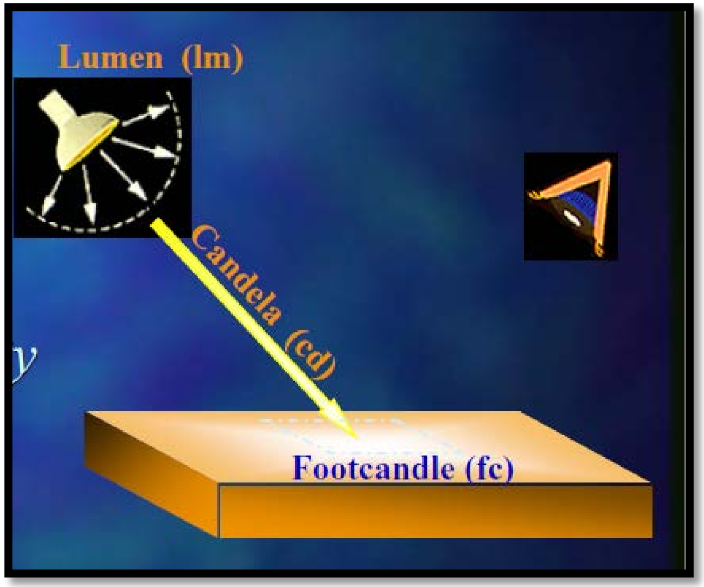
Section 7:
Lighting

Key Terms

- **Lumen**
  Total amount of visible light emitted by a source

- **Watt**
  Power required by light source

- **Efficacy** (lumens per watt)
  Rated light output per unit power

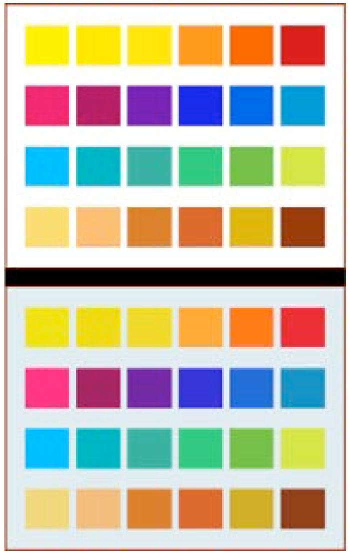


- **Footcandle** (lumens per square foot)
  Measure of Illuminance: amount of light arriving on a surface

- **Lighting Power Density** (Watts per square foot)
  Amount of watts of installed lighting relative to room size

Key Terms

- **Lifetime**
  Number of rated hours a light source will operate
- **Fixture Efficiency**
  Percentage of lumens from light source exiting fixture
- **Color Rendering Index (CRI)**
  Scale from 1 to 100 of color accuracy; higher the number, the better the light source reveals true colors
- **Correlated Color Temperature (CCT)**
  Measured in degrees kelvin (K) – scale: ~1,500 to 10,000+



Key Terms

- **Lamp Lumen Depreciation (Lumen Maintenance)**
  Loss of light over time; loss of 15-20% is generally acceptable.

- **Warm-Up Time**
  Amount of time needed for lamps to come to full brightness
- **Re-Strike Delay**
  Amount of time needed for lamps to turn back on after being turned off

Department of Energy Lighting Facts Label

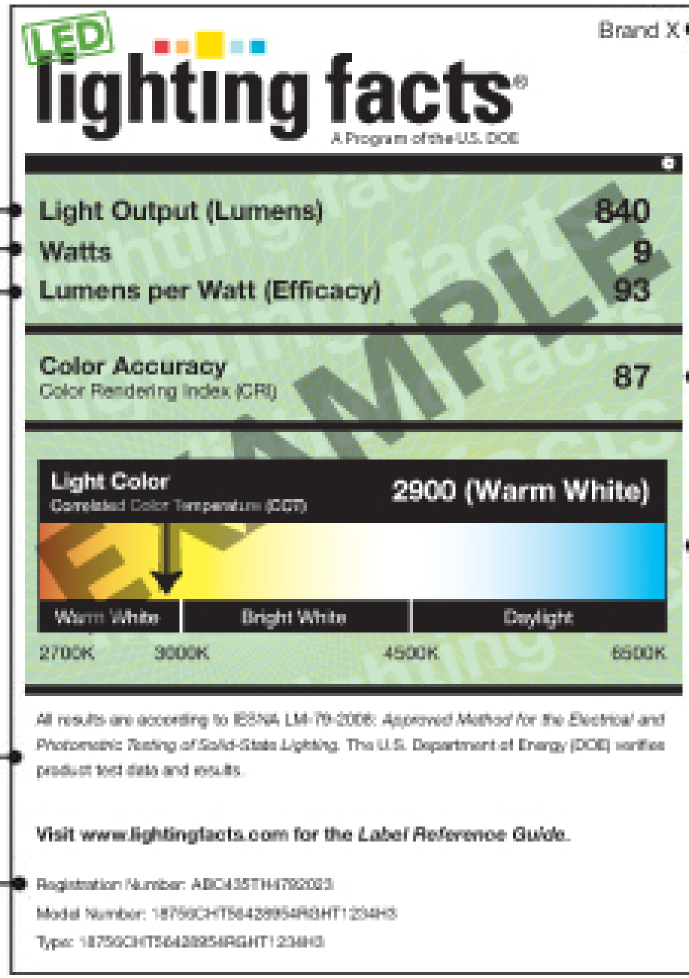
Light Output/Lumens
Measures light output. The higher the number, the more light is emitted.
Reported as "Total Integrated Flux (Lumens)" on LM-79 test report.

Watts
Measures energy required to light the product. The lower the wattage, the less energy used.
Reported as "Input Power (Watts)" on LM-79 report.

Lumens per Watt/Efficacy
Measures efficiency. The higher the number, the more efficient the product.
Reported as "Efficacy" on LM-79 test report.

IESNA LM-79-2008
Industry standardized test procedure that measures performance qualities of LED luminaires and integral lamps. It allows for a true comparison of luminaires regardless of the light source.

Registration Number
Model Number
Type



Brand

Color Rendering Index (CRI)
Measures color accuracy.
Color rendition is the effect of the lamp's light spectrum on the color appearance of objects.

Correlated Color Temperature (CCT)
Measures light color.
"Cool" colors have higher Kelvin temperatures (3600–5500 K); "warm" colors have lower color temperatures (2700–3500 K). Color temperatures higher than 6500 are outside of the defined region for white light, but may be appropriate for outdoor applications.

Lighting Technologies

- Fluorescent
- Incandescent
- High Intensity Discharge
  - High Pressure Sodium (HPS)
  - Metal Halide (MH)
- Light Emitting Diode (LEDs)

Lighting Technologies: Fluorescent

Parameter	Compact Fluorescent	T8	High Performance T8	T5	T12
Lamp / System Type	13W Lamp & Elec. Ballast	32W Lamp & Elec. Ballast	32W Lamp & Elec. Ballast	28W Lamp & Elec. Ballast	34W Lamp & Magnetic Ballast
Light Output (Lumens)	850	2,800	3,100	2,900	2,600
Power Used (Watts)	13	32	32	28	38
Efficacy (Lumens per Watt)	65	88	97	103	68
Lifetime (Hours)	10,000	20,000	25,000	25,000	18,000
Warm-Up Time	Instantaneous	Instantaneous	Instantaneous	Instantaneous	Instantaneous
Re-Strike Delay	None	None	None	None	None
Lamp Lumen Depreciation	10%	10%	5%	5%	20%
Color Rendering Index (CRI)	80 - 90	80 - 90	80 - 90	80 - 90	60-80
Color Temperature (°K)	2,700 – 6,500	2,700 – 6,500	2,700 – 6,500	2,700 – 6,500	2,700 – 6,500

Lighting Technologies: Other

Parameter	Incandescent	HID / HPS	HID / MH	LED
Lamp / System Type	60W Lamp	250W Lamp & Elec. Ballast	400W Lamp & Magnetic Ballast	13W Lamp & Elec. Driver
Light Output (Lumens)	850	26,000	40,000	850
Power Used (Watts)	60	285	450	13
Efficacy (Lumens per Watt)	14	91	89	65
Lifetime (Hours)	1,000	30,000	20,000	50,000
Warm-Up Time	None	3 – 5 minutes	3 – 5 minutes	None
Re-Strike Delay	None	5 - 10 minutes	5 - 10 minutes	None
Lamp Lumen Depreciation	None	Up to 50% before failure	Up to 50% before failure	10%
Color Rendering Index (CRI)	100	22	65	82
Color Temperature (°K)	2,700	2,100	4,100	2,700

Lighting Technologies: Pros and Cons

Technology Type	Pros	Cons
Incandescent	• Very high CRI - 100 • Warm color temperature • Dimmable	• Low efficiency • Short lifetime • Heat sources
Fluorescent	• Instant strike and no re-strike time • High efficiency	• Shorter lamp life as compared to HID or LED • Warm-up required in exterior applications
High Intensity Discharge (HID) / High Pressure Sodium (HPS)	• High efficiency • Long lamp life	• Long warm-up time and re-strike delay; poor choice for use with occupancy and day-light controls • Yellow looking , poor color rendering
High Intensity Discharge (HID) / Metal Halide	• High efficiency • Long lamp life	• Long warm-up time and re-strike delay; poor choice for use with occupancy and day-light controls • Inconsistent color shift over time, poor color rendering and harsh shadows
Solid State Light Emitting Diode (LED)	• Lower Power • Long lamp life • Dimmable without color change • Instant strike and no re-strike time	• High Initial Cost

Lamp Statistics

Incandescent

- Light Output: 850 Lumens
- Lifetime: 1,500 Hours
- Cost Per Bulb: $0.50

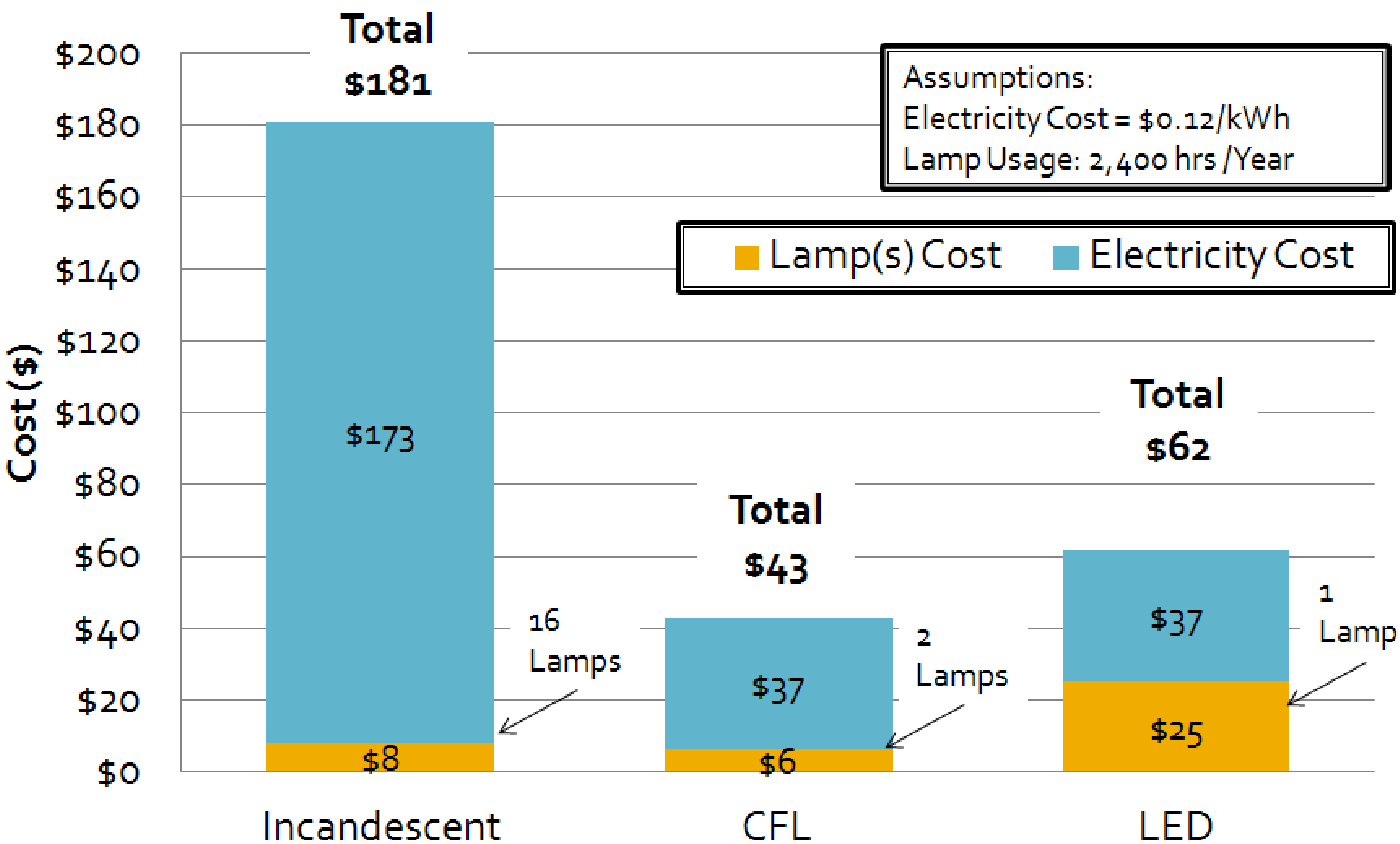
Compact Fluorescent (CFL)

- Light Output: 850 Lumens
- Lifetime: 12,000 Hours
- Cost Per Bulb: $3.00

Light-Emitting Diode (LED)

- Light Output: 850 Lumens
- Lifetime: 25,000 Hours
- Cost Per Bulb: $25.00

10-Year Lamp Cost Comparison

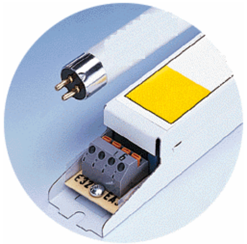


Fixtures

Luminaire

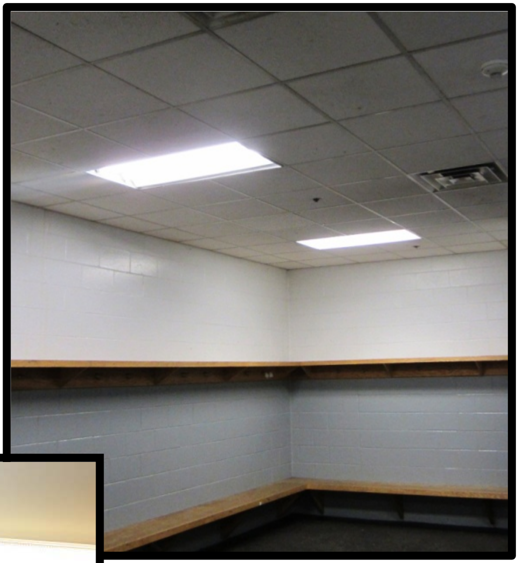
A complete lighting unit, consisting of the housing, lamp, lamp socket, and ballast, often referred to as a 'Light Fixture'

- Lamp
- Housing
- Lamp Sockets
- Reflector
- Lens
- Ballast



Most Common Fixture Types:

- Troffer
- Recessed Can
- Pendant
- Wrap
- Strip



Lighting Controls: Key Terms

- Switches
  - Breaks electrical circuit manually.
- Occupancy Sensors
  - Breaks electrical circuit automatically when occupancy signal is absent.
- Photocells
  - Breaks electrical circuit automatically when ambient light (daylight is present).
- Time Clocks
  - Break electrical circuit by pre-set time schedules.

Occupancy Sensor Technologies

- **Passive Infrared (PIR)**
  Detects movement in direct line of site from sensor changes in heat patterns; electronic sensor detects infrared radiation
- **Ultrasonic Sensors**
  Emits inaudible, high frequency sound pattern; can detect movements outside direct line of sight
- **Microphonic**
  Listens for sounds in space; typically used alongside PIR technology

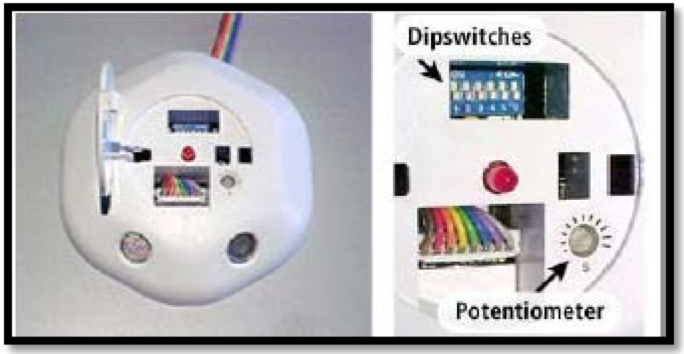
Occupancy Sensors

- **Dual Technology Occupancy Sensors** Combine either PIR and ultrasonic or PIR and microphonic

- Mounting Locations
  - Ceiling
  - Wall / Corner
  - Wall Switch

Lighting Controls: Occupancy Sensors

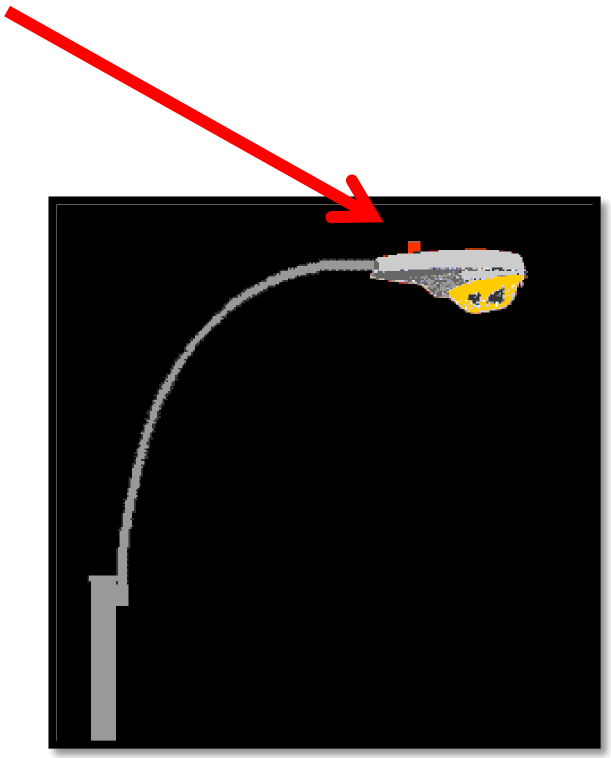
- **Placement**
  Important to place and orient correctly depending on room application and layout.
- **Sensitivity**
  High sensitivity could cause “false positive” triggering; low sensitivity could turn lights off when occupants still in room.
- **Time Delay-Off**
  Amount of time before sensor will turn light off; can be adjusted based on application.



Photocells Technology

Light sensing resistor controlling a relay

- When light, current flows freely
- When dark, resistance increases



Time Clocks

- Mechanical Time Clocks
  - Twist Timer Switches
  - Pin-based mechanical time clocks.
- Digital Time Clocks
  - Incorporate advanced daily schedules & holidays.
  - Incorporate astronomical features (sunrise, sunset, daylight savings time adjustments).

Section 8: Preventative Maintenance

Preventative Maintenance

- Regular inspection and servicing of equipment to correct minor deficiencies before they turn into major defects.
- Benefits:
  - Longer equipment life
  - Lower operating costs
  - Fewer breakdowns
  - Fewer occupant complaints
  - Advance notification of equipment purchases and/or part replacements

Preventative Maintenance Tools

- Operations & Maintenance manuals
- Spare belts/ filters
- Lubricants - grease / oil / silicone
- Belt tension testers
- Temperature and pressure gauges
- Volt / amp meter
- Leak detector
- Preventative Maintenance Software

How to Set up a Preventative Maintenance Program

- Develop a full equipment inventory
- Review O&M manuals to determine maintenance requirements and intervals
- Pre-order replacement parts (filters, belts, filter driers, etc.)
- Develop a complete schedule of equipment needs and checks
- Check operating parameters periodically (temperatures, current draw) to warn of possible failures

Preventative Maintenance – 2

Record Keeping

- Use a pre-packaged program or develop your own using spreadsheets, database software, etc.
- Generate calendar reminders or work orders with weekly and monthly tasks
- Track completed tasks

Services Contracts

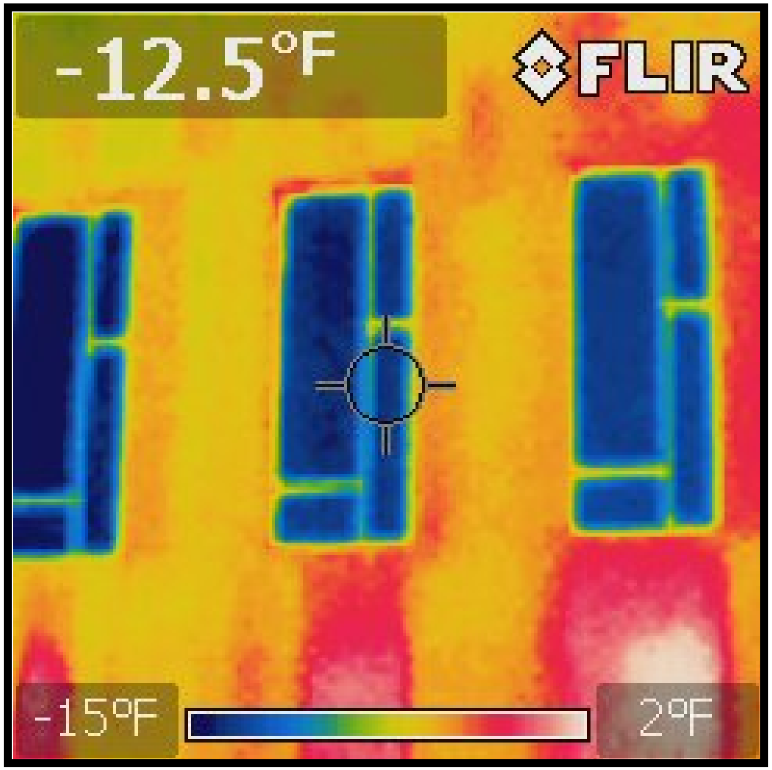
- Rebid periodically using RFP
- Include full list of equipment covered and expected maintenance measures in RFP
- Develop your own contract rather than relying on vendor's

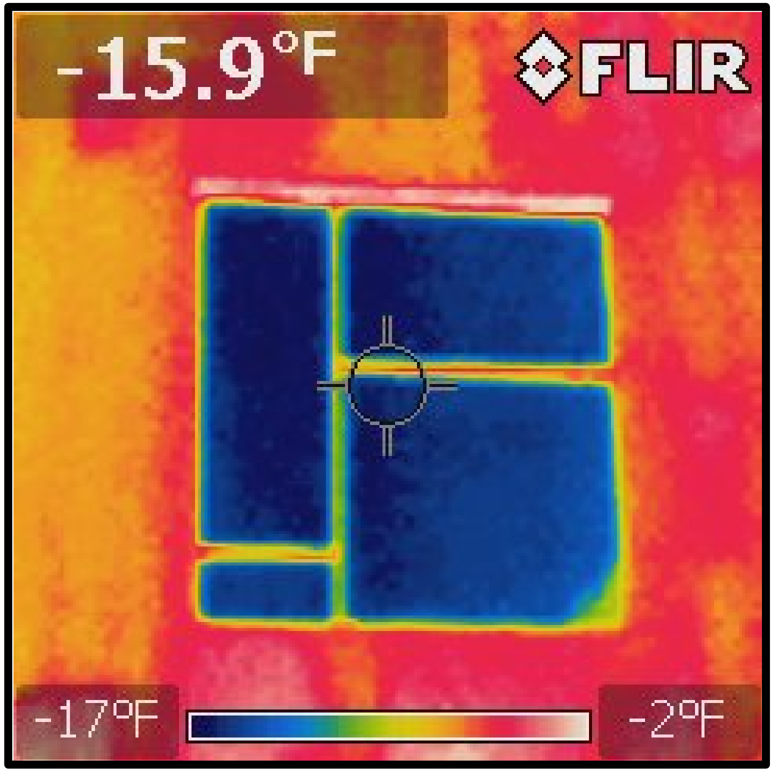
Section 9:
Useful Tools

Energy Performance Tools

Tool	Capabilities	Uses
Infrared Thermometer	Measure surface temperatures	Identify room temperatures, pipe temperatures, potential sources of heat loss
Infrared Camera	Provides visual representation of thermal differences	Identify temperature gradients and potential sources of heat loss
Carbon Dioxide Meter	Measures CO2 concentration	Determine if a space has too much or too little ventilation
Anemometer	Measures airflow	Determine if too much of too little air is flowing into a space or into an HVAC unit
Light Meter	Measures light levels	Determine if a space is adequately or over lit
Flicker Checker	Identify magnetic ballasts	Determine which fixtures are using magnetic and electronic ballasts

Infrared Camera Pictures





Summary Review

- What energy source is the most expensive?
- What is the difference between electricity consumption and demand?
- Why is it important to know and track energy consumption?
- What are some strategies for saving energy in a facility (mechanical, control, weatherization, and lighting)?

Example Energy Savings Opportunities

Clifton Park

- Link overhead door operation with unit heaters in highway garages
- Improve overhead door sealing
- Reduce heating setpoints in garages
- Install condensing unit heaters when existing units fail

Saratoga

- Use windo-therm to insulate Visitor's Center
- Install bottom storm windows (only screens installed)
- Implement more scheduling and temperature set back
- Install condensing boilers when existing units fail

Wrap Up

- What will you do differently based on what you learned today?
- Please complete your course evaluation before leaving.