EFFICIENT LIGHTING DESIGN

RESILIENT BUILDINGS

— GROUP —

Superior energy performance

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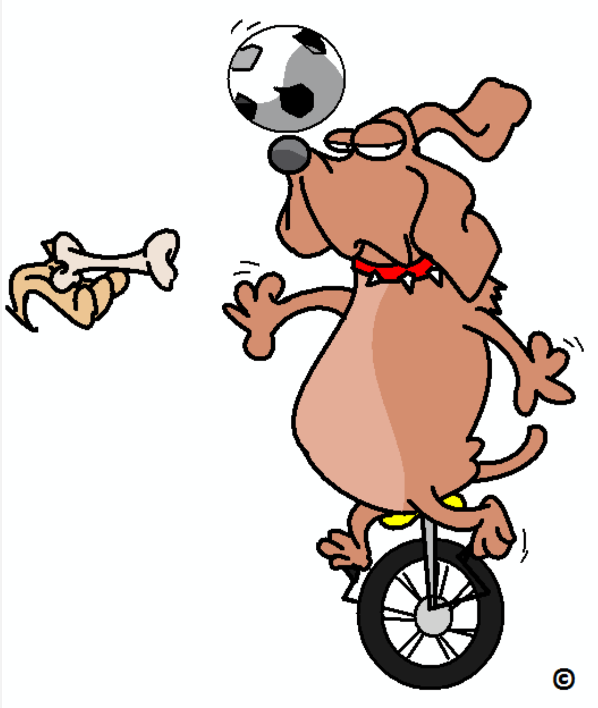
Buisiness Energy Innovation Conference

GOALS

- Establish a fundamental understanding of LED lighting design and controls
  - ➢ Terminology
  - ➢ The math behind the savings
- LED Design Essentials
  - ➢ Determine the best fit system
  - ➢ Integrate Controls
  - ➢ Commissioning
- Examine real-world case-study
- Prove that old dogs can learn new tricks



TERMINOLOGY

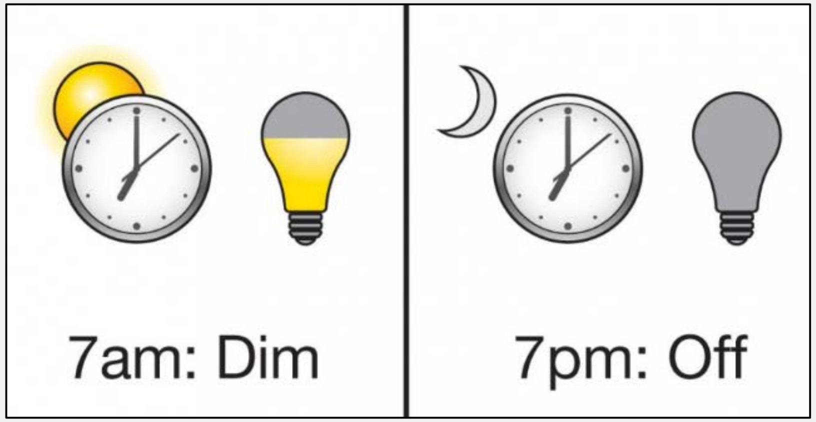
- Luminous Efficacy
  - ➢How well a light source produces visible light. Ratio of luminous flux to power
- Color Temperature
  - ➢Characteristic of visible light expressed in absolute temperature (Kelvin).
- Color Rendering Index (CRI)
  - ➢Ability of a light source to reveal colors of lit objects in comparison with an ideal. Higher = Better
- Watts
  - ➢Unit of POWER, corresponding with one Joule per second.
- kWh
  - ➢Unit of ENERGY, equivalent to power consumption 1,000 Watts for a period of1 hour.

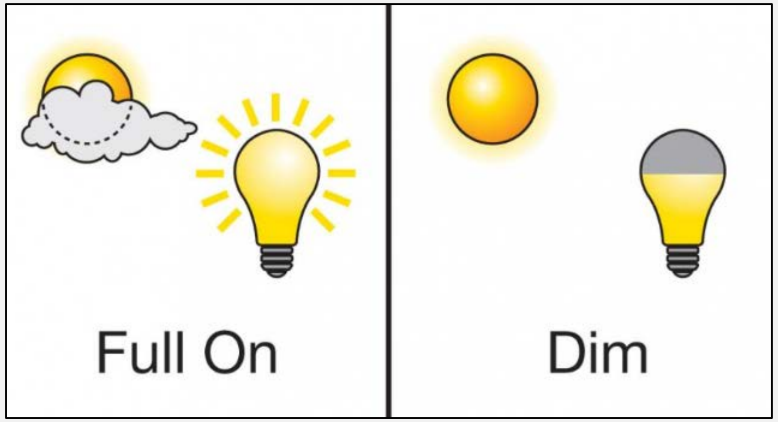
COMMON INTERIOR LIGHTING TYPES

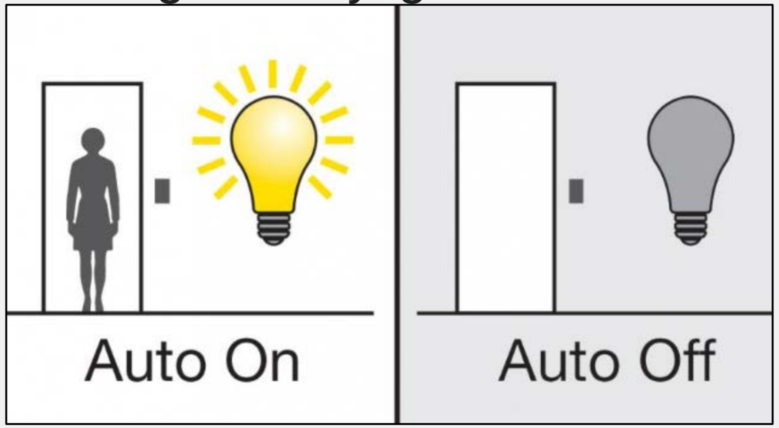
- Incandescent
  - ➢Electric current that passes through a wire filament in inert gas heating it up enough to glow.
- Fluorescent
  - ➢Electric current ignites mercury vapor which produces UV light and causes a phosphorus coating to glow. Typically tube style.
- Compact Fluorescent (CFL)
  - ➢Similar technology to tube-style technology. CFLs replace bulbs.
- Light Emitting Diode (LED)
  - ➢Current is applied to leads allowing the electrons to recombine with electron holds, releasing energy in the form of photons.

COMMON LIGHTING CONTROLS

- Scheduling – 10 to 20% Electric Load Savings
  - ➢Lights automatically turn off at certain times of the day or in relation to sunrise or sunset.
- Occupancy Vs. Vacancy Sensors – 20 to 60% Electric Load Savings
  - ➢Automatically turns lights off when the space is vacant.
  - ➢Rooms with ambient lighting should use vacancy sensors.
- Daylight Dimming – 25 to 60% Electric Load Savings
  - ➢Dims fixtures automatically for ambient light levels to take advantage of daylight in the







LED SUPERIORITY - TUBE STYLE LIGHTING

	Typical Tube Style Fluorescent Fixture	Typical Replacement LED Fixture
Wattage	64, 96, or 128 Watts (2, 3, or 4 T8 lamp fixture)	38 Watts
Lumens	4200, 6050, or 8400 Lumens (2, 3, or 4 Lamps)	5000 Lumens
Efficacy	65 Lumens / Watt	130 Lumens / Watt
Usage Assuming 3500 Hrs/Year		
kWh/Year	224 kWh	133 kWh
Cost/Year	(0.12 $/kWh) * 224 kWh/year = $26.88	(0.12 $/kWh) * 133 kWh/year = $15.96
Savings/Year	$0	$10.92

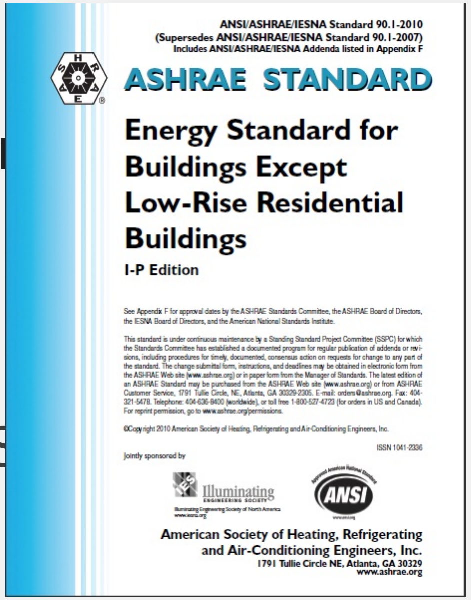
LED SUPERIORITY – BULB COMPARISON

	Incandescent Bulb	CFL Bulb	LED Bulb
Wattage	60 Watts	13 Watts	9 Watts
Lumens	800 Lumens	800 Lumens	800 Lumens
Efficacy	13 Lumens / Watt	62 Lumens / Watt	89 Lumens / Watt
Usage Assuming 3500 Hrs/Year			
kWh/Year	112 kWh	45.5 kWh	31.5 kWh
Cost/Year	(0.12 $/kWh) * 112 kWh/year = $25.20	(0.12 $/kWh) * 45.5 kWh/year = $5.46	(0.12 $/kWh) *31.5 kWh/year = $3.78
Savings/Year	$0	$19.74	$21.42

LED DESIGN

STEP 1 – CHOOSING THE SYSTEM

- Energy Codes
  - ➢Examine state and local energy codes to determine minimum criter
    - Controls, Lighting density, and plug load controls
- Rebates
  - ➢Get informed on the existing lighting rebate programs such as NHS
  - ➢Start the conversation with utility representative
- Impact of Installation
  - ➢Consider the different complexities between each LED lighting system and how they will impact your business



STEP 2 – DESIGNING THE SYSTEM

- Lighting Placement
  - ➢Dependent on the space's usage and lighting needs
- Spec'ing Lighting Fixtures
  - ➢Determine the design and style criteria for the lighting installation
  - ➢Look for fixtures with DLC or Energy Star Certifications - Consider NHSaves rebate opportunities
- Choose the Controls
  - ➢Consider space's occupancy patterns and density for the best fit controls

STEP 3 – COMMISSIONING THE SYSTEM

"Verify that all components of the installed system are functioning to the design specifications"

- Verify the operation of the lighting system
  - ➢Does the system turn on and off?
- Determine that the spaces are lit according to their usage types
  - ➢Use a lighting meter to verify. Are the spaces over lit, under lit, or just right?
- Program scheduling
  - ➢Set a schedule for the lighting system that reflects the occupancy patterns of the space
- Set sensor sensitivity, delays and modes
  - ➢Be sure to set the installed sensors light and occupancy delays, modes, and sensitivitys

CASE STUDY – SCOTT & WILLIAMS APARTMENTS

BACKGROUND

- History
  - ➢Scott & Williams were manufacturers of knitting machines used in the large knitting mills running at the time.
  - ➢In 2006 the large mill complex was rehabilitated into 60 apartments, 23,000 square feet of commercial space and a public park.
- 10 years after rehab, the owners began to suspect that the building was an energy hog
  - ➢RBG conducted an energy audit and determined that lighting was a major contributor to its high energy usage.

BEFORE THE LIGHTING UPGRADE

- Existing Lighting
  - ➢The common spaces were lit with 4 lamp, T8 fixtures that were on 24 hours/7 days a week.
  - ➢No controls, dimmers or occupancy sensors.
- Electric Usage Before Lighting Retrofit
  - ➢519,424 kWhs/Year
  - ➢$62,460 /Year

DURING THE LIGHTING UPGRADE

- Tenants Notified
  - ➢The residential and commercial tenants in the building were notified to the lighting upgrade.
- Section-by-Section
  - ➢The building was broken up into sections so there would be minimal impact on the tenants.

AFTER THE LIGHTING UPGRADE

- Increased Light Quality & Safety
  - ➢The common areas receive a higher CRI and luminous efficacy with the installed LEDs.
  - ➢The LEDs have a much higher expected lifetime – No more burnt out fluorescent bulbs
- Controls Upgrades
  - ➢Occupancy Sensors control ever-other fixture in the hallways.
  - ➢Any common space with ambient lighting received daylight harvesting controls
- Energy Usage After LED Fixtures
  - ➢379,179 kWhs/ Year
  - ➢$45,501 / Year
  - ➢73% reduction in costs and usage

QUESTIONS?