Lighting Control Basics for Intelligent Sustainable Commercial Building

Advanced Energy Leadership Conference NYC

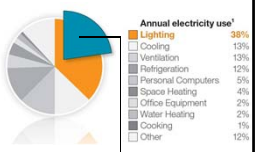
Scott Ziegenfus, LEED AP
Senior Applications Engineer
Lutron Electronics Co., Inc

SSPC 135 BACnet Committee Member ASHRAE
SPC 201 Facility Smart Grid Energy Model Committee Member ASHRAE
Educational Program Chair Delaware Valley Chapter USGBC

save energy with Lutron™

Sustainable Building Lighting Strategies

- Lighting accounts for 38% of annual electricity usage in Commercial buildings.
- Lighting Control's primary focus has shifted from architectural to energy.
  - Architectural Lighting design considers
    - Amount of functional light provided
    - The aesthetic impact supplied by the lighting system
  - Energy Consumption considers
    - Occupancy, vacancy, and daylight sensors and their interdependency and coordination with scheduling, PC control, manual controls to cover all possible sequences of operation.

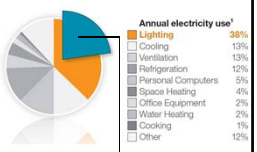


Lighting Control solutions can save 60% or more of the lighting energy used in Commercial buildings

[1] US Department of Energy www.eia.doe.gov/emeu/obecs/obecs2003/lighing/lighting1.html

Sustainable Building Lighting Strategies

- Energy savings cannot impact productivity
  - Average Building Costs
    - Personnel: $200.00 to $400.00/ft2
    - Energy: $2.00 to $4.00/ft2
  - The human eye compensates for lower light levels by allowing more light to enter the pupil
    - 50% of inhabitants could not detect a 15% luminance reduction for paper tasks and a 20% for computer related tasks even with a knowledge of pending reduction.[2]
  - Consider granularity of reduction
    - Multi-level switching or step dimming has a disadvantage over continuous dimming that occupants regard sudden change in light level as disruptive.



Lighting Control solutions can save 60% or more of the lighting energy used in Commercial buildings

[1] US Department of Energy www.eia.doe.gov/emeu/obecs/obecs2003/lighting/lighting1.html
[2] Understanding Light Levels for Load Shed, Lighting Research Center, Rensselaer Polytechnic Institute

Sustainable Building Lighting Strategies

- Lighting accounts for 38% of annual electricity usage in Commercial buildings
  - 7 Total Light Management Strategies can save 60% or more

High-end trim/Tuning: Sets the target light level based on customer requirements in each space.	20% Lighting[1]
Occupancy or vacancy sensing: Automatically turn off lights when people vacate the space .	15% Lighting[1]
Daylight harvesting: Automatically adjusts the electric lighting levels based on the amount of daylight in the space.	15% Lighting[1]
Personal light control: Allows users in the space to select the correct light level for the desired task. Often that is much less light than full-on.	10% Lighting[1]
AC reduction due to lighting reduction: Research estimates that 1kWh lighting savings induces 0.48kWh cooling savings .	
Controllable window shades: Allows quiet control of daylight for improved comfort and productivity	10% AC[1]
Scheduling: Lights turn off or are dimmed and shades are adjusted automatically at certain times of the day or in relation to sunrise and sunset .	Variable
Demand response: Allows the facility manager to reduce lighting load at times of peak electricity pricing to avoid extra charges, black-outs, brown-outs, and create revenue opportunities.	

[1] Sources listed in Energy-savings light control solutions for commercial buildings Lutron Electronics Inc., P/N367-1737

Sustainable strategies with HVAC

- **Look at two lighting control strategies that effect or influence HVAC**

AC reduction due to lighting reduction: Research estimates that 1kWh lighting savings induces 0.48kWh cooling savings .

Demand response: Allows the facility manager to reduce lighting load at times of peak electricity pricing to avoid extra charges, black-outs, brown-outs, and create revenue opportunities.

Lighting Effects on HVAC

- Example in Philadelphia in a Large Building
  - Lighting adds 17% to cooling and 6% decrease in heating

Table 3-1 – Typical Lighting Impacts on HVAC Use by Climate[12]
HVAC interaction with lighting savings

Location	Cooling loads	Heating Loads for Large Building	Heating Loads for Small Building
Phoenix, AZ	-30%	0%	0%
Los Angeles, CA	-23%	0%	0%
San Francisco, CA	-16%	1%	2%
Denver, CO	-16%	7%	22%
Tampa, FL	-33%	0%	0%
New Orleans, LA	-29%	1%	2%
Detroit, MI	-14%	8%	23%
Philadelphia, PA	-17%	6%	18%
Providence, RI	-13%	7%	22%
Knoxville, TN	-21%	4%	11%
Seattle, WA	-7%	4%	13%

Reduced lighting energy use can result from either a more efficient lighting system, or from better controls to decrease the hours of lighting use. With a more efficient system, less heat is added to the building per unit of useful light. With fewer hours of operation due to lighting controls, there's less time for the lights to contribute heat to the building. Lighting efficiency improvements work uniformly across all hours of operation to reduce overall lighting energy use. Controls, on the other hand, can differentially reduce lighting energy use during key periods of HVAC demand. Examples include photocontrols for daylighting systems or demand shedding systems. Such lighting control systems can have a proportionately bigger effect on HVAC energy cost per unit of energy savings, since energy prices are often higher during peak periods. Chapter 8 discusses lighting control systems in detail. New Building Institute "Advanced Lighting Guidelines 2003"

Demand Response and Lighting

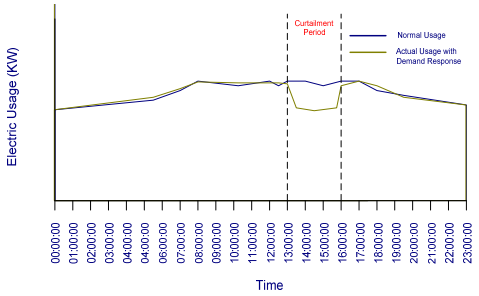
Demand Response (DR)

- Demand response can involve temporarily **curtailing power used** or by starting **on site generation**.
- Current demand response schemes often implement the use of control systems to **shed loads.** Load shed is the action to demand Response
- Lighting is the easier strategy with little management "set it and forget it"

New Standards include DR

Section 7.4.5.1 of ASHRAE 189.1

- Peak Load Reduction/Load Factor. Building projects shall contain automatic systems such as demand-limiting or load shifting to reduce electric peak demand of the building by not less than 10%. Standby power generation shall not be used to achieve the reduction in peak capacity.



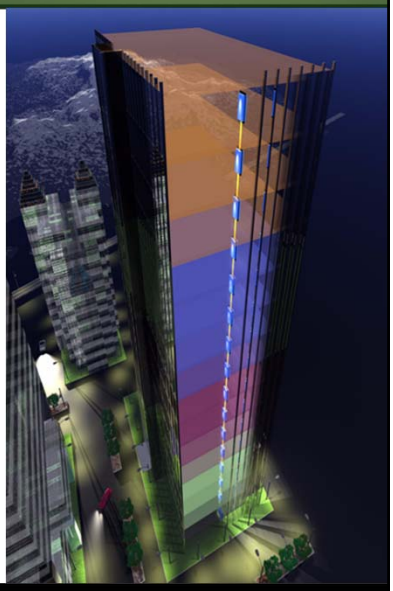
Lighting / Shades, and HVAC

- Lighting / Shades and HVAC can work together in sustainable strategies
  - Occupancy status is needed by all systems
  - In addition to temperature and humidity, air movement and **radiant temperature (from exterior glazing)** have large influences on personal comfort.
  - Heat from Lighting is cooled from AC
  - Lighting & HVAC account for over 2/3 of all electricity in commercial buildings and the number 1 & 2 loadshed strategies for Demand Responce
  - All systems use scheduling reductions during non working hours as a savings strategy.
- BMS systems can trigger a cohesive and controlled sustainable strategy between HVAC and Lighting.

Intelligent Buildings

- Integration Categories in Intelligent Buildings
  - Under Division 25 2004 CSI Specifications
    - Integrated Automation
  - Building Management Systems impact sustainability

Building Management Systems (BMS/EMS/BAS)	**Theatrical Media Production**	**Audio / Video Presentation Integration**
• Building and Campus • Life Safety • Energy Reporting	• Auditorium • Lecture Halls • Stage	• Board rooms • Interactive Class Rooms • Conference Rooms

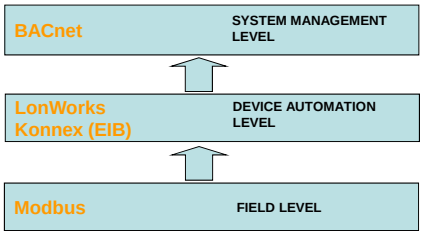


Advanced Energy Leadership Conference NYC

Building Management Systems (BMS)

Centralized integration system controlling – HVAC / Security / **Lighting /Shades** / Metering

- Most Common Integration Protocols
  - BACnet - Developed (2005) for System Integration and Based Networking Model
  - LonWorks - Developed (1995) for Device Automation and based on Neuron Chips in each device (DOMESTIC)
  - Konnex- Developed (1999) formally EIB (1990) for Device Automation and based on TPUART chips for each device (INTERNATIONAL)
  - Modbus - Developed (1979) for PLCs
- Integration without gateways
  - Gateways are interfaces that translate BMS protocols like BACnet from Pro A/V protocols like Serial (RS232) and sing a gateway, like any translation, information is lost and many times does not have the same meaning.



Advanced Energy Leadership Conference NYC

Building Management Systems (BMS)

- A lighting control system should make it easy to modify, adjust, change or add occupancy, vacancy, and daylight sensors and their interdependency and coordination with scheduling, PC control, manual controls to cover all possible sequences of operation on a daily basis. While making sure device hierarchy never puts people in the dark.
- It is beneficial to share information from a lighting control system with other building systems like HVAC.
- Sustainable Lighting Control strategies are cumulative and can lead to a 60% or more savings of light energy.

QUESTIONS?