Light Control for Energy Savings

How light control conserves energy commercial buildings

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Light control for energy savings

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EDUCATION PROVIDER

Light control for energy savings

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Light Control for Energy Savings
AIA/CES HW/SD Program Number LCE1210 (1.0 LU)

Learning Objectives

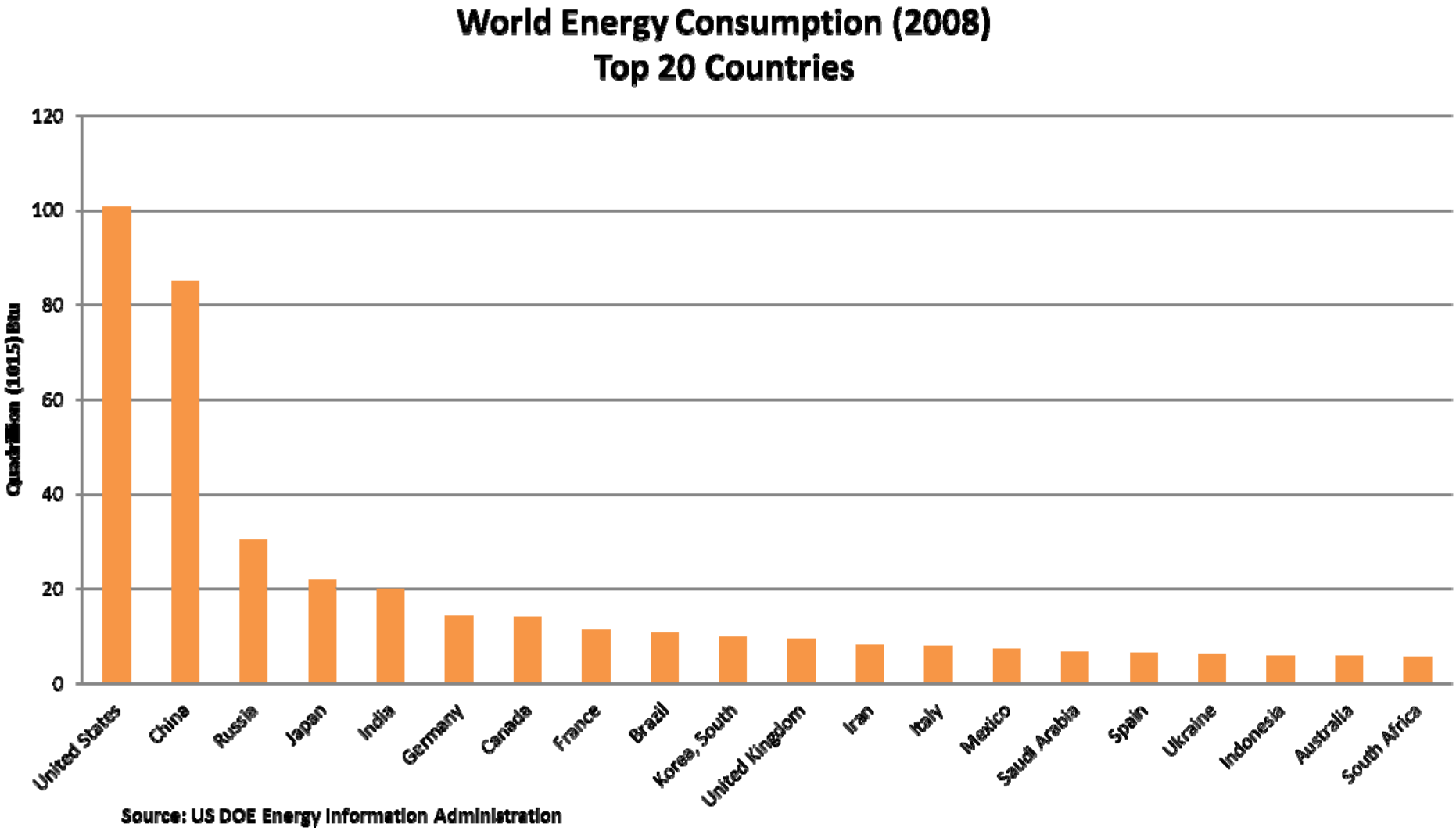
- By reviewing national energy statistics, the participant will be able to describe the importance of light control for energy conservation in commercial buildings.
- Using several light control strategies, the participant will be able to explain how light control saves energy in commercial buildings.
- By reviewing commercial building energy code and LEED green building rating system requirements, the participant will be able to determine how light control helps meets those requirements
- Through examination of the provided real world case studies, the participant will be able to describe how they used lighting controls to save energy.

Light control for energy savings

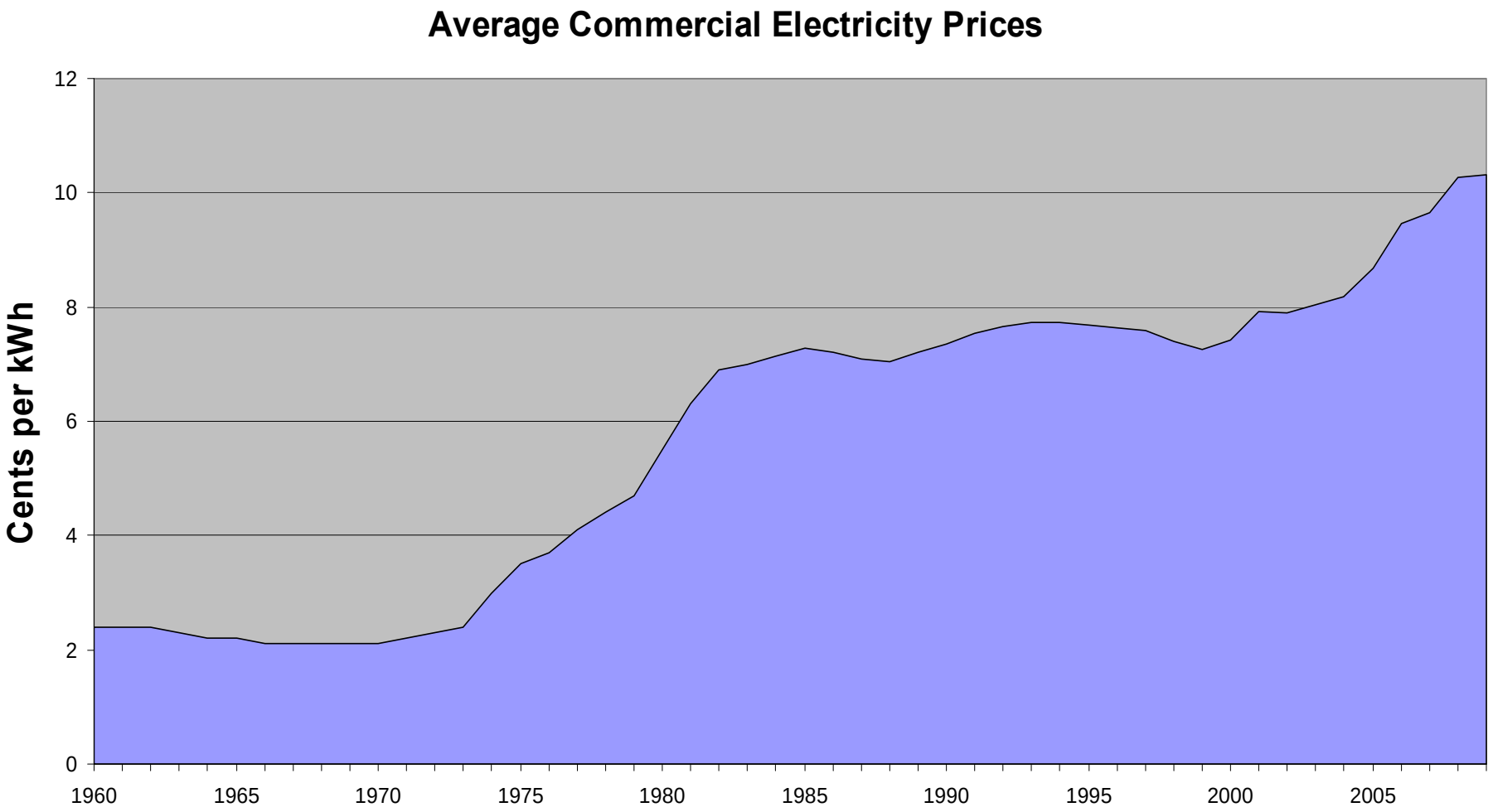
World energy consumption is projected to increase by 44 percent from 2006 to 2030

Source: U.S. Department of Energy

Light control for energy savings

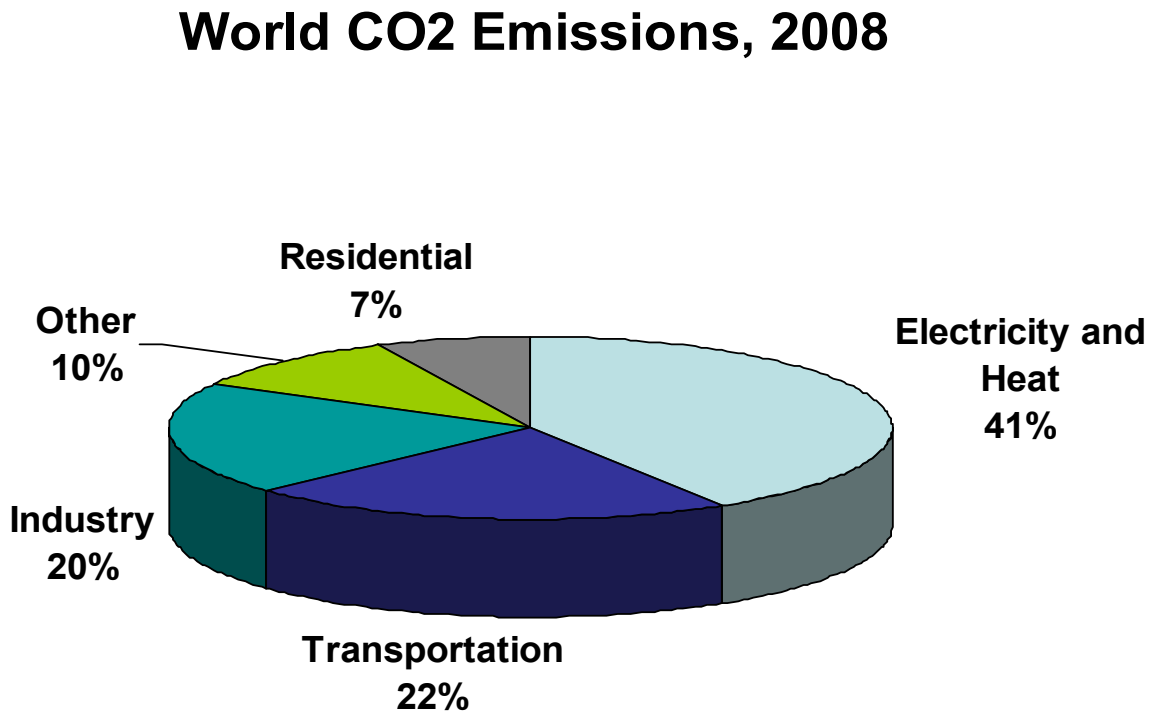


Light control for energy savings



Source: US Dept. of Energy, Energy Information Administration

Light control for energy savings

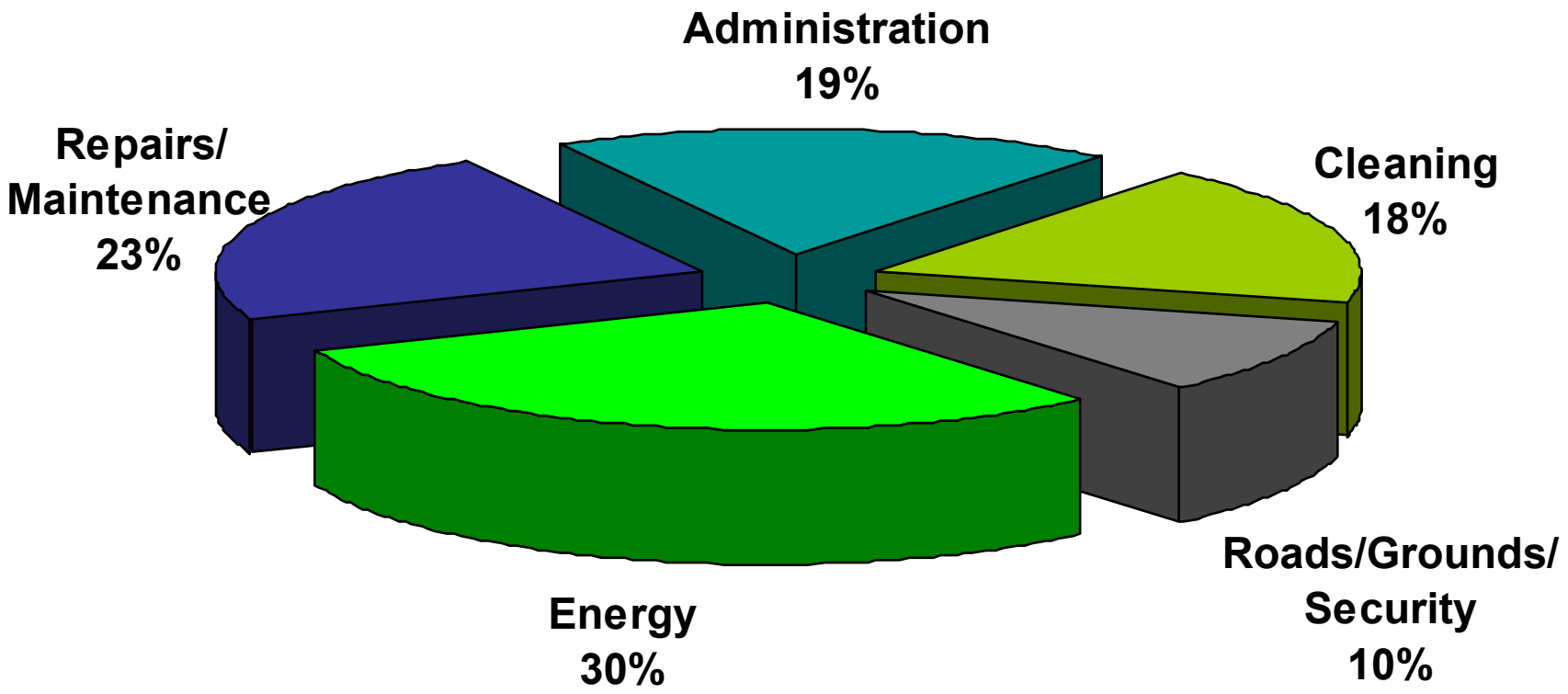


Key point: Generation of electricity and heat represented the most global emissions in 2008

Source: IEA CO2 Emissions from Fossil Fuel Combustion Highlights, 2010

Light control for energy savings

Commercial Building Operating Expenses



Light control for energy savings

“The biggest gains in terms of decreasing the country’s energy bill, the amount of carbon dioxide we put into the atmosphere, and our dependency on foreign oil, will come from energy efficiency and conservation in the next 20 years.”

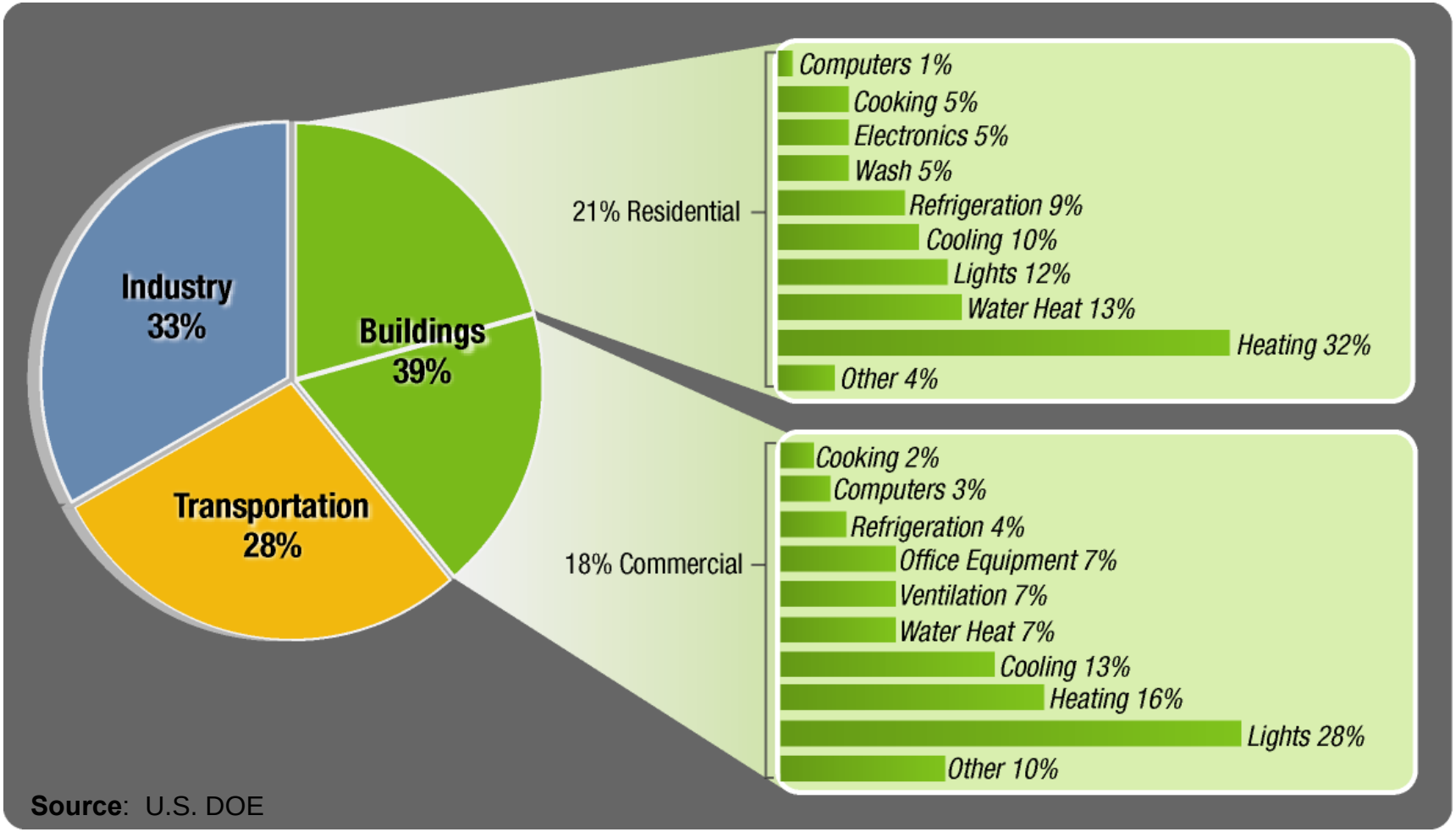
Steven Chu
Secretary of Energy

Source: U.S. News and World Report, April 2009

Light control for energy savings

Buildings consume 39% of total U.S. primary energy

•Lights use the most energy in commercial buildings



Source: U.S. DOE

Light control for energy savings

Problem: Wasted lighting energy

- Building are over-illuminated
- Don’t take into account daylight
- Lights left at full-on in vacant spaces or after operating hours

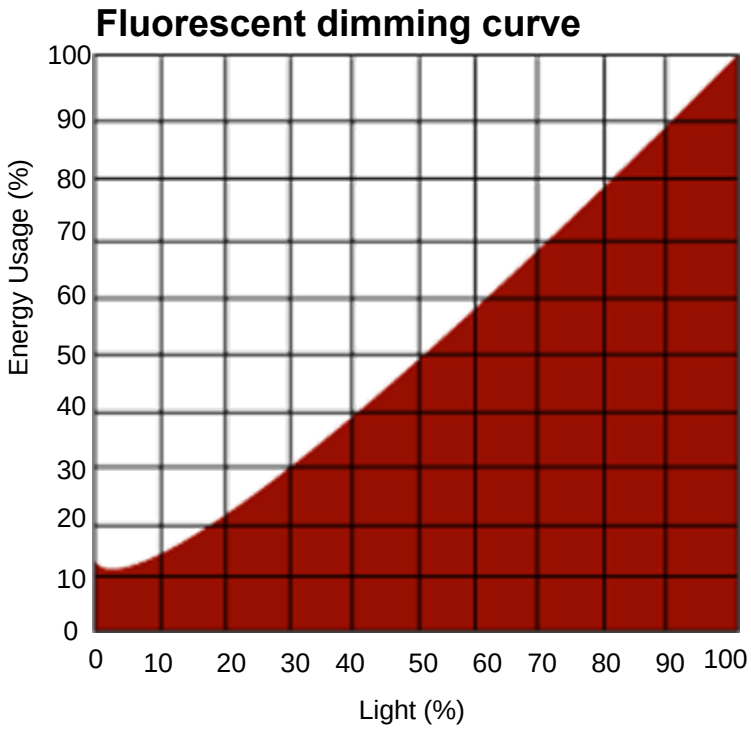
“Most buildings don’t deliver the right amount of light where and when it is needed. Lighting is often set at a ‘worst case’ level, which is usually higher than desired.” -- Stephen Selkowicz LBNL

Light control for energy savings

Solution: Light control

Primary ways light control saves energy:

1. Reduces operating hours (switching off)
2. Reduce watts used when lights are on (dimming)
3. Reduces cooling load
4. Maximizes effective use of sunlight



Light control for energy savings

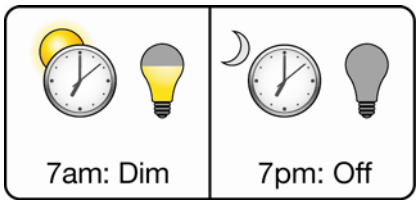
“Zero energy buildings that provide zero comfort or zero productivity increases to the occupants are of zero value”

Kevin Kampschroer

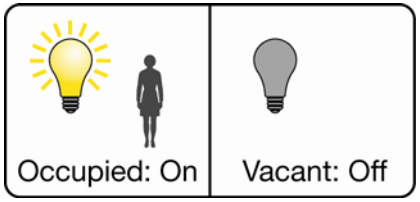
Director, Office of Federal High-Performance Green Buildings

Source: Luncheon on Net Zero Energy Buildings at the House of Representatives in Washington D.C., June 18, 2010.

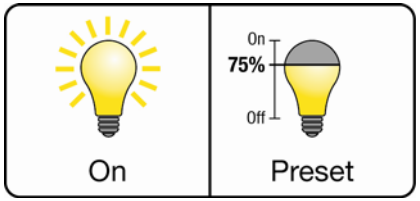
Light control for energy savings



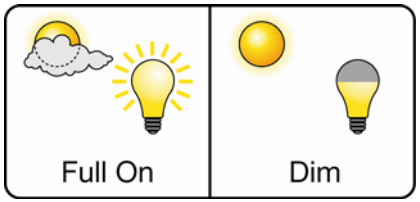
Scheduling: Lights automatically turn off or are dimmed at certain times of the day or based on sunrise or sunset.



Occupancy/Vacancy Sensing: Automatically turning lights off when people vacate the space.

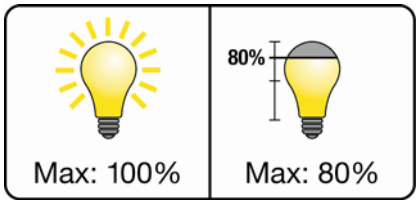


Multi-level Lighting/Dimming: Proving users one or more light levels other than full-on and full-off.

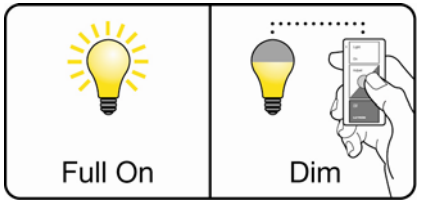


Daylight Harvesting: Automatically adjust light levels based on the amount of daylight in the space.

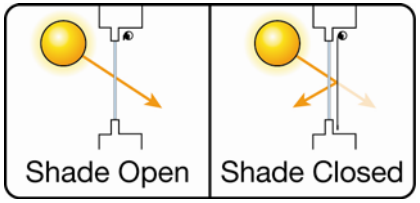
Light control for energy savings



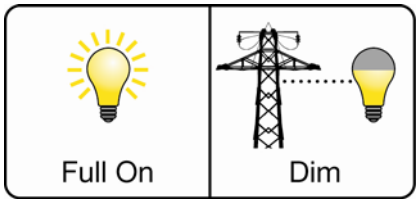
High end trim/Tuning: Set target light level based on occupant requirements in the space.



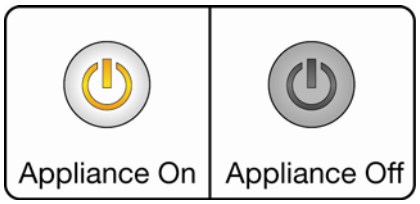
Personal Light Control: Allow users in the space to select the correct light levels for the desired task.



Controllable Window Shades: Allows users to control daylight for reduced solar heat gain and glare.



Demand Response: Reducing lighting load at times of peak electricity pricing.



Plug-load Control: Automatically turning task lighting and other plug loads off when they are not needed.

Light control for energy savings

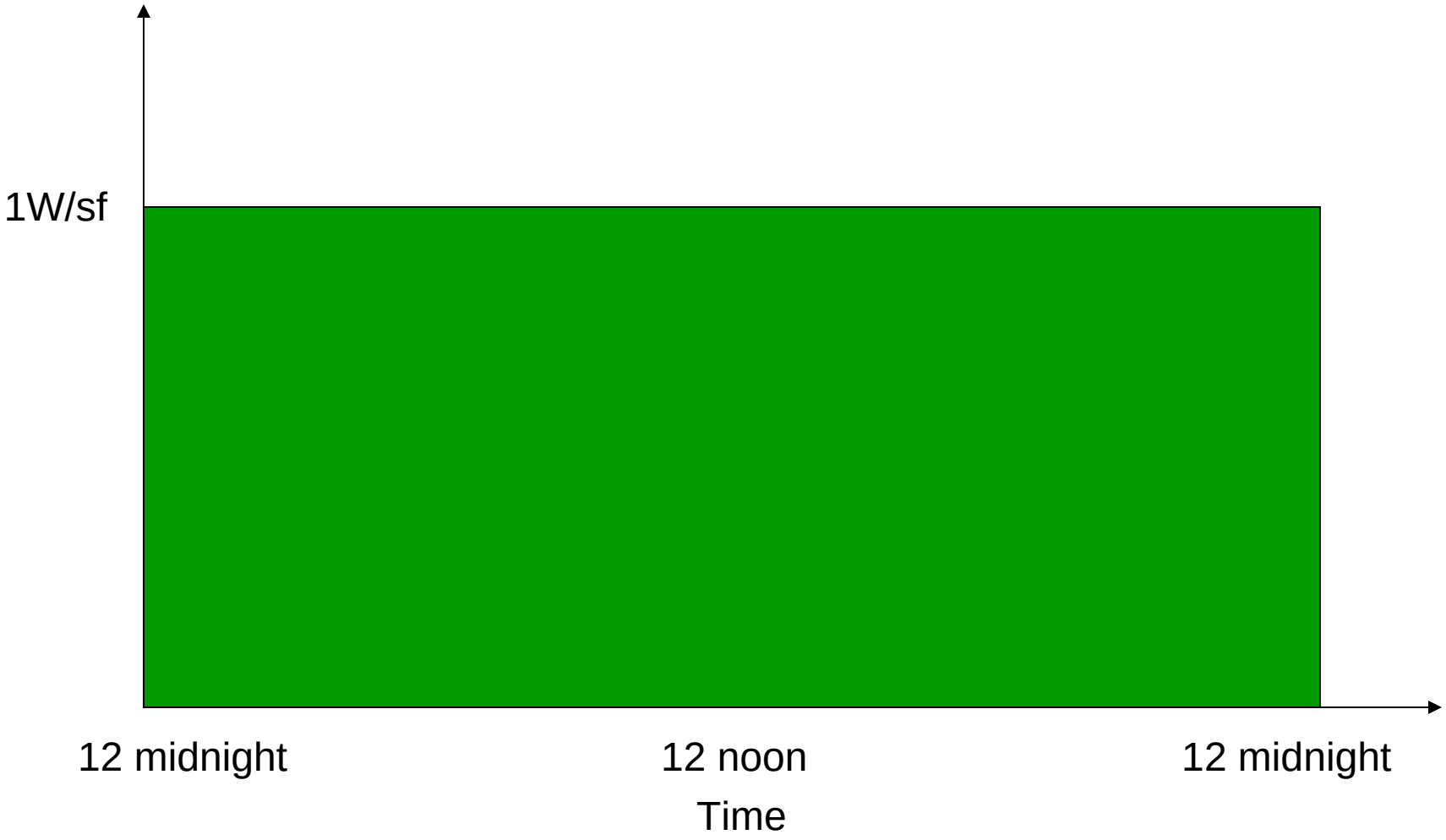
Potential Energy Savings

Energy-saving light control strategy	Lighting	HVAC
High-end trim/tuning	20%	4.5%
Occupancy or vacancy sensing	15%	3.4%
Daylight harvesting	15%	3.4%
Personal dimming control	10%	2.2%
Controllable shades	---	10%
Scheduling	variable	
Demand response	variable	

Light control for energy savings

Lighting Power Used

Annual energy consumption = 8.76 kWh / sf

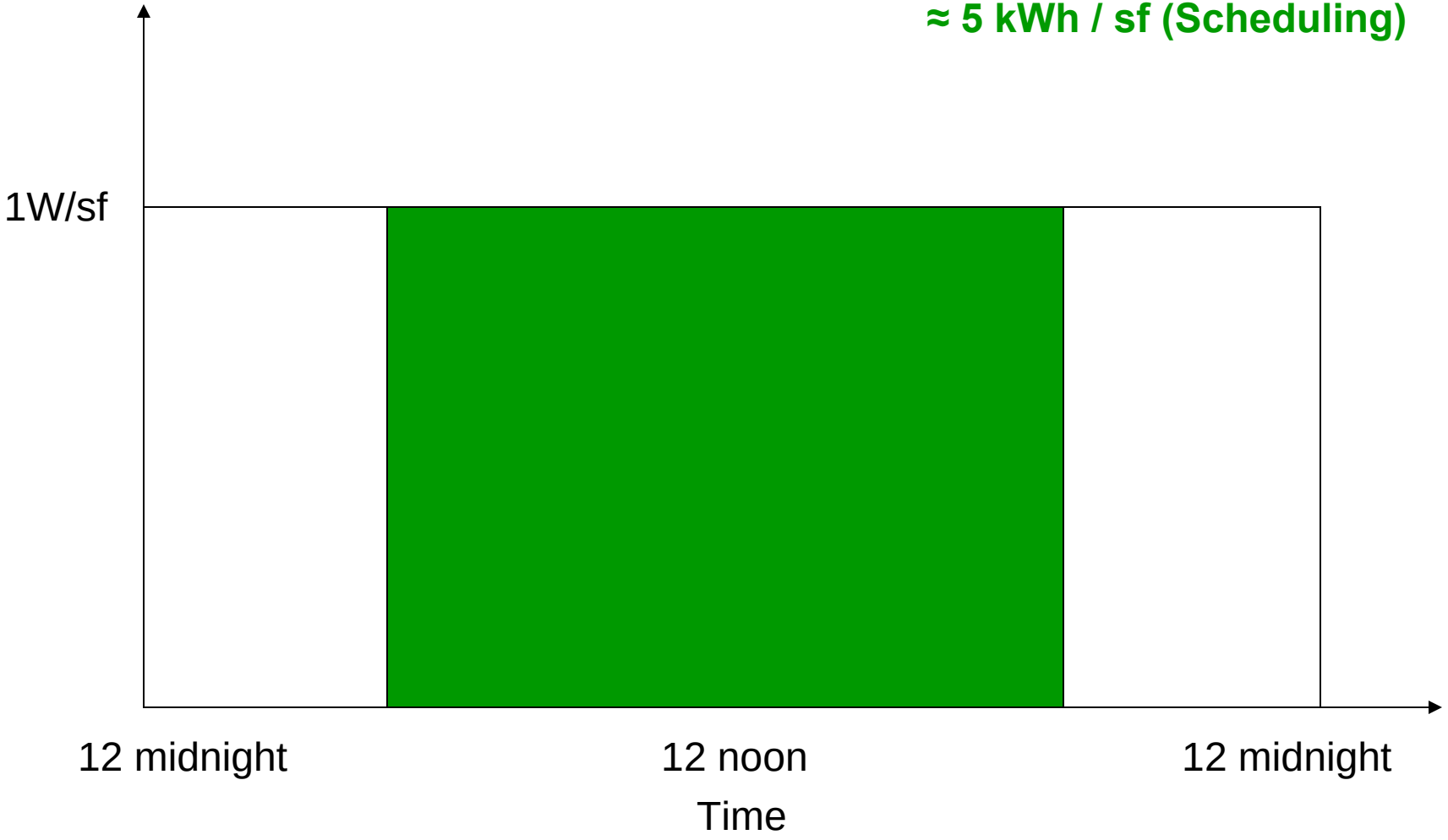


Light control for energy savings

Lighting Power Used

Annual energy consumption = 8.76 kWh / sf

≈ 5 kWh / sf (Scheduling)



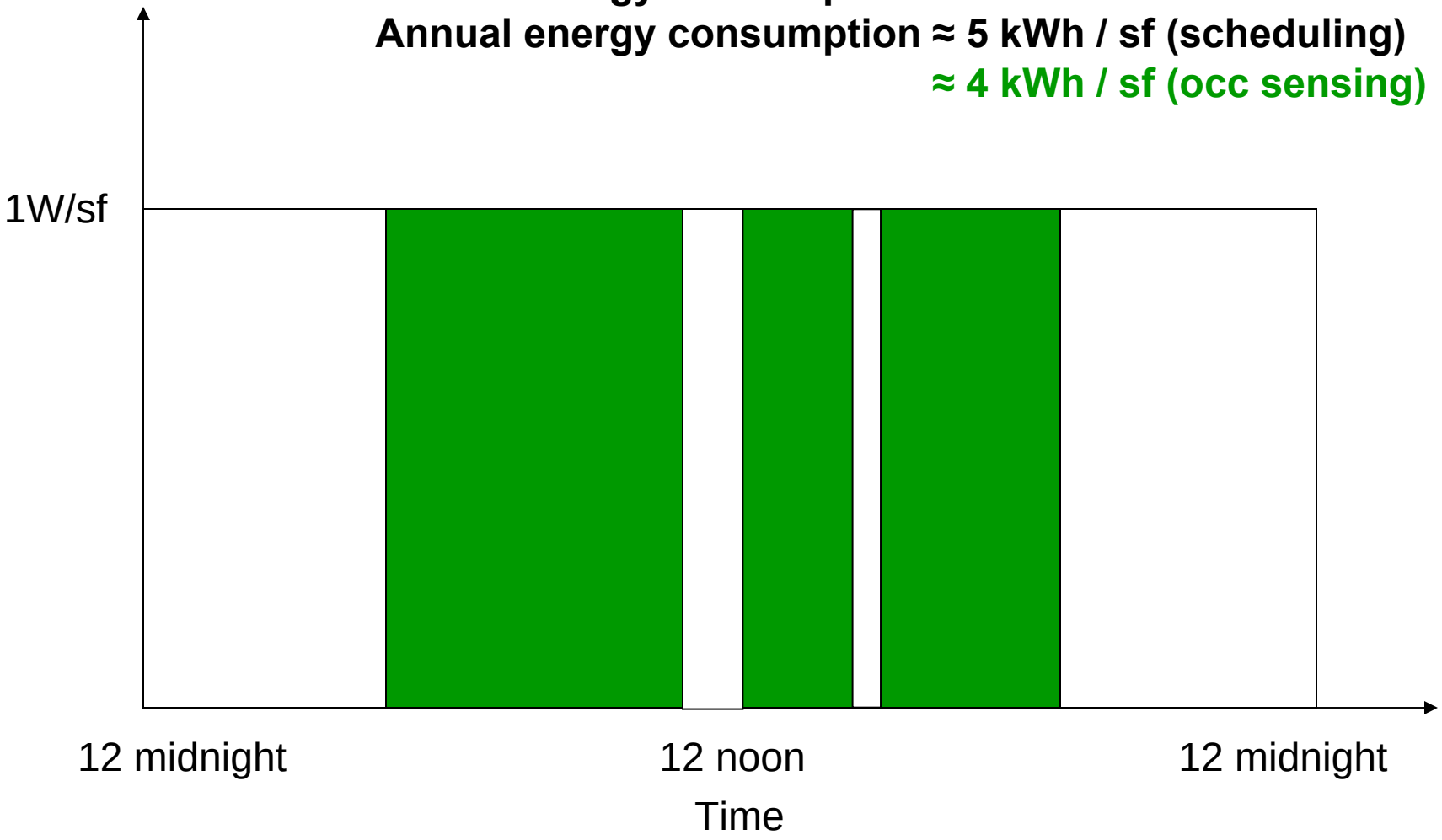
Light control for energy savings

Lighting Power Used

Annual energy consumption = 8.76 kWh / sf

Annual energy consumption ≈ 5 kWh / sf (scheduling)

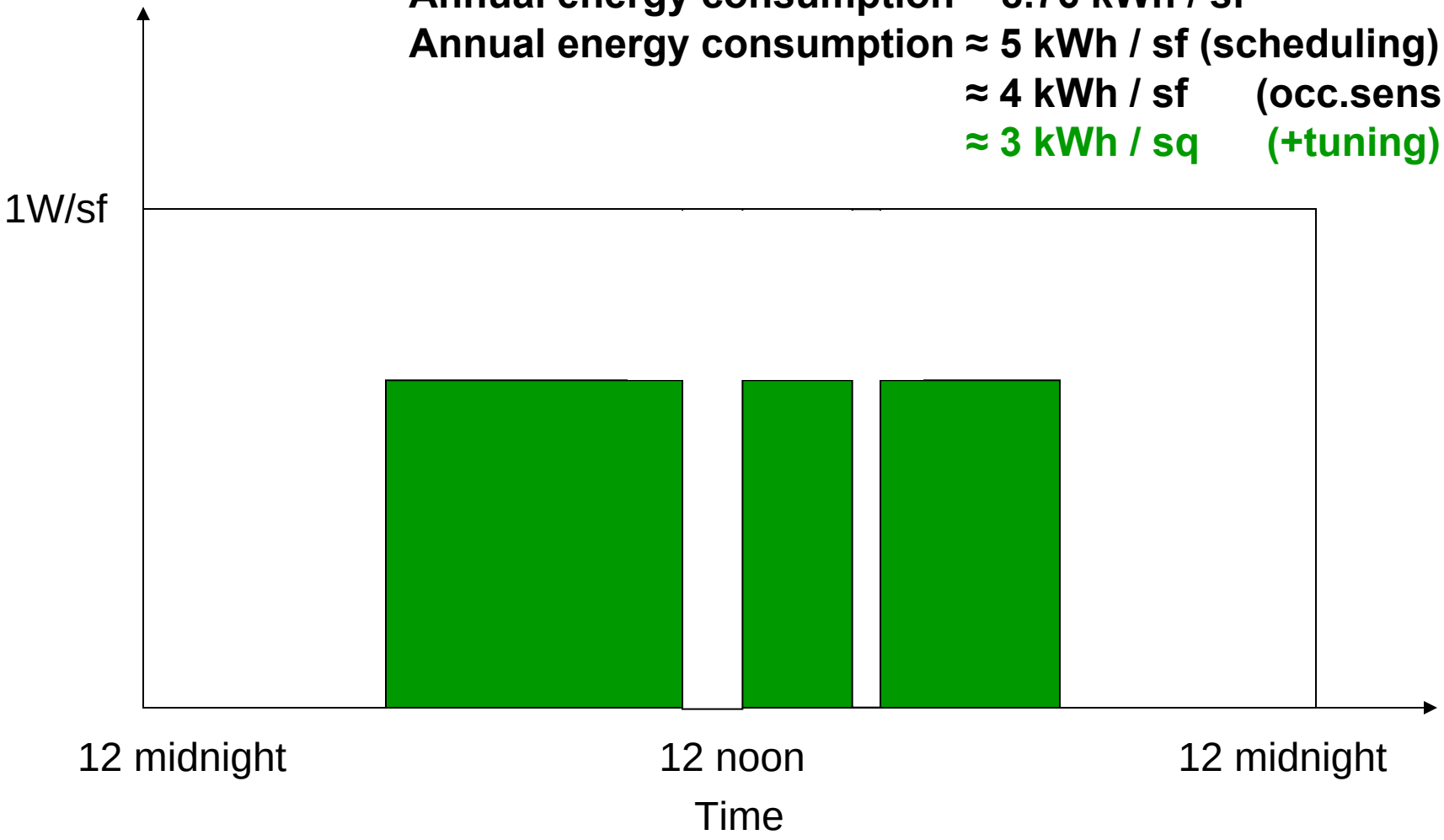
≈ 4 kWh / sf (occ sensing)



Light control for energy savings

Lighting Power Used

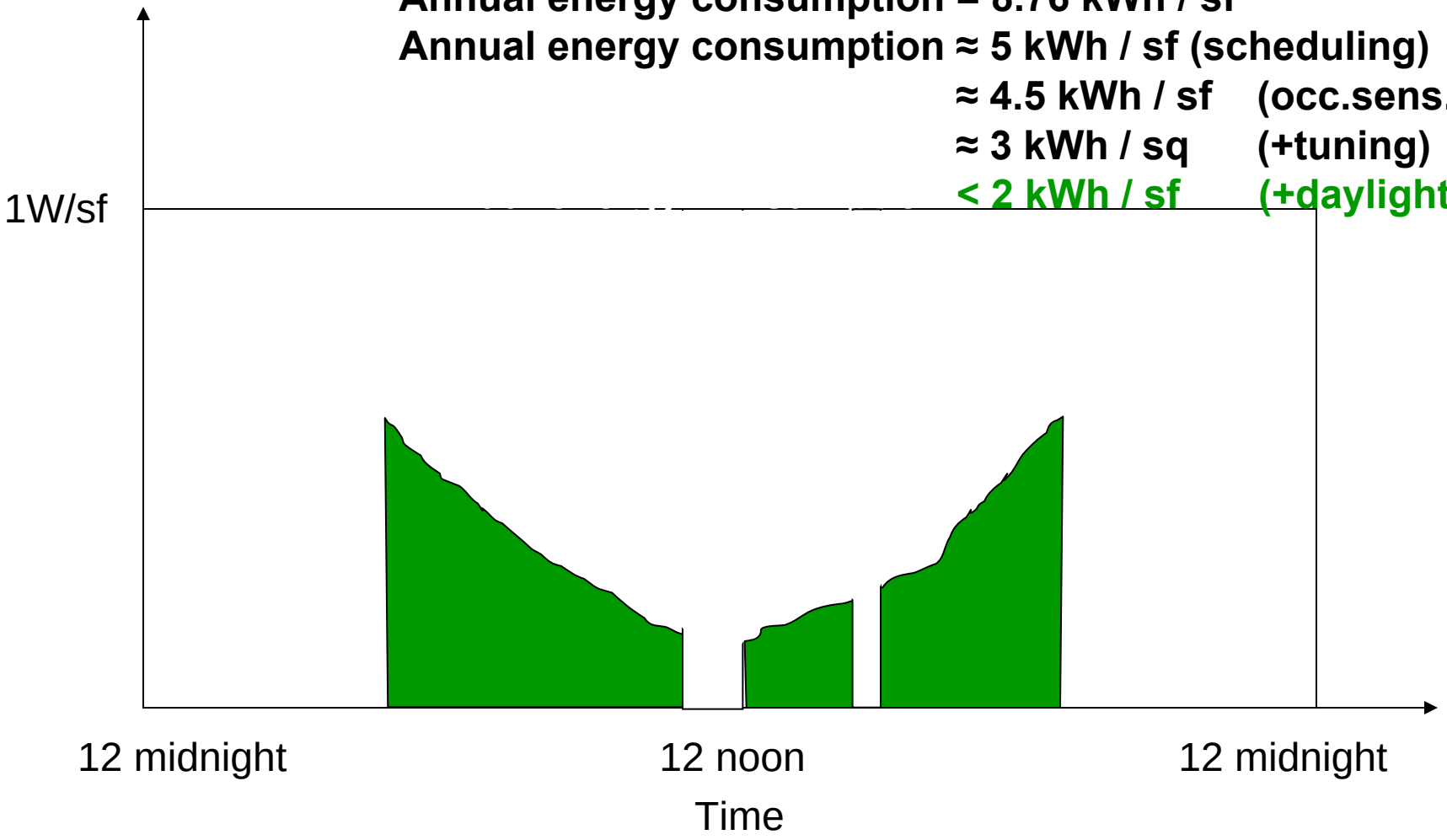
Annual energy consumption = 8.76 kWh / sf
Annual energy consumption ≈ 5 kWh / sf (scheduling)
≈ 4 kWh / sf (occ.sens.)
≈ 3 kWh / sq (+tuning)



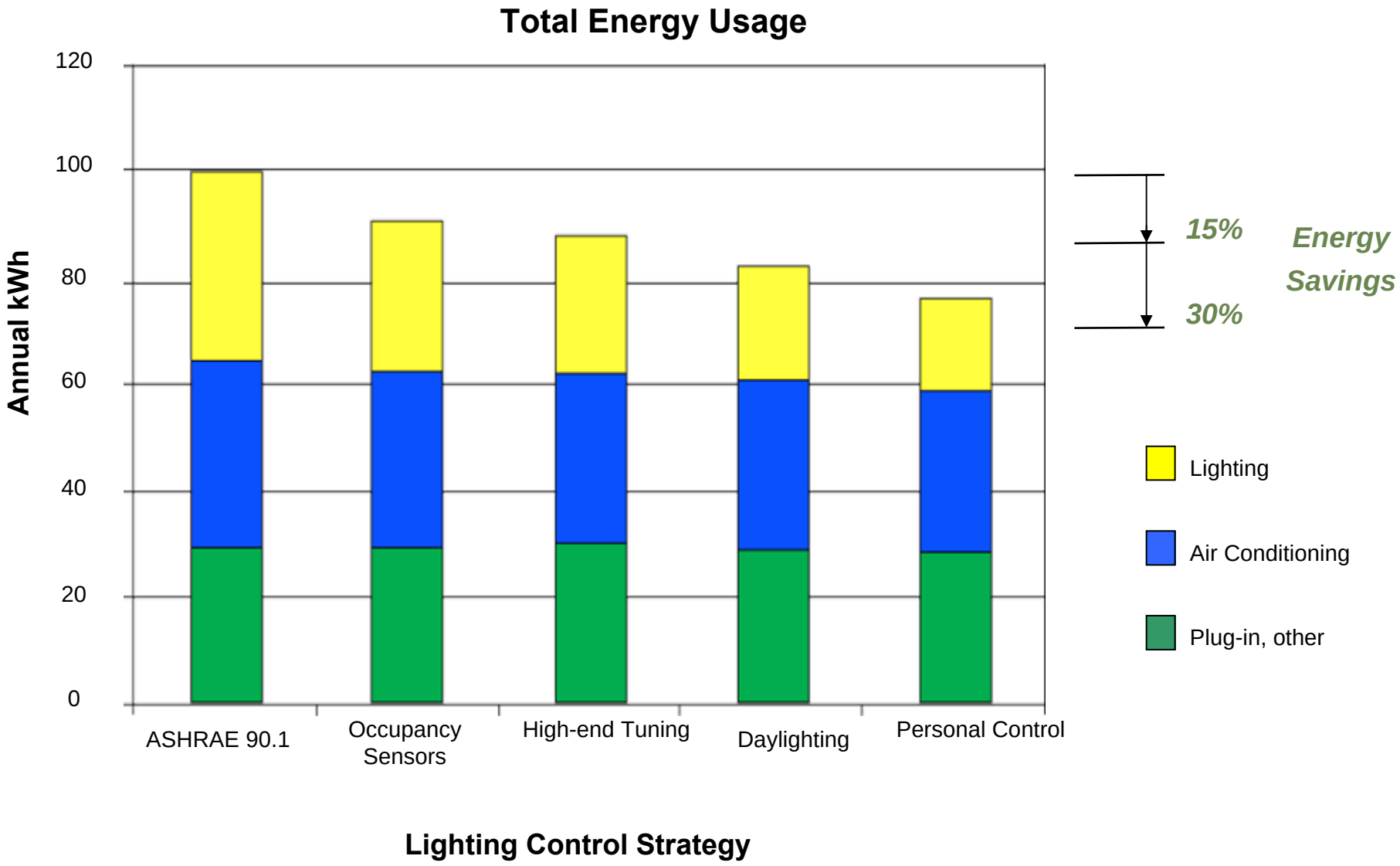
Light control for energy savings

Lighting Power Used

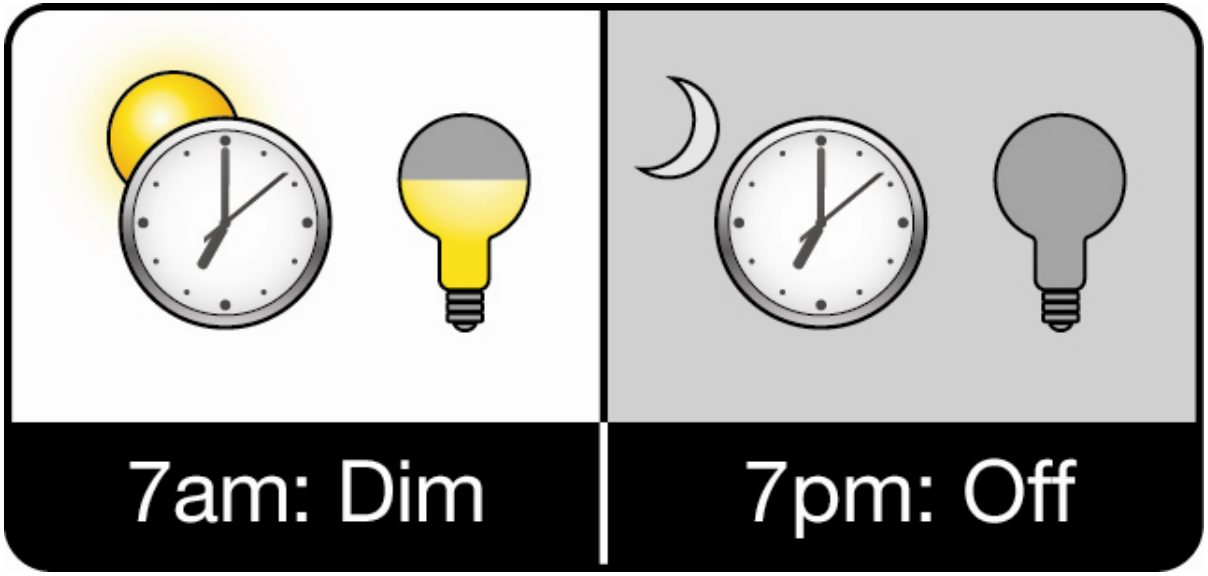
Annual energy consumption = 8.76 kWh / sf
Annual energy consumption ≈ 5 kWh / sf (scheduling)
≈ 4.5 kWh / sf (occ.sens.)
≈ 3 kWh / sq (+tuning)
< 2 kWh / sf (+daylight)



Light control for energy savings



Scheduling



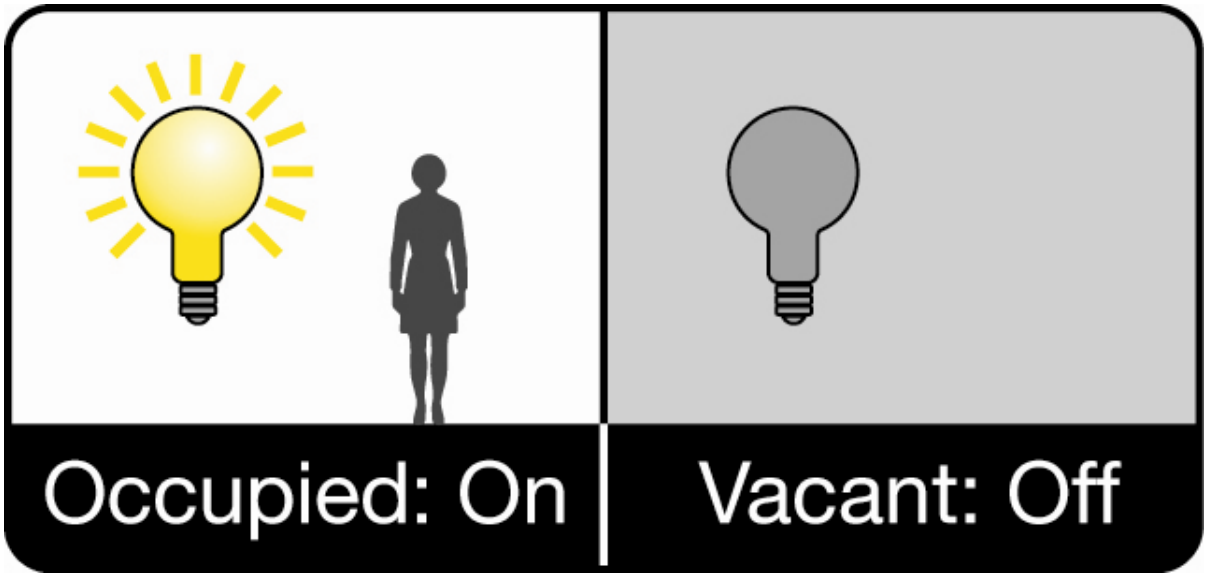
Controls light levels based on time of day or astronomical events

Scheduling

How is this applied in the real world?

- Building lighting sweeps after hours
- Regularly scheduled settings in public spaces
- Astronomic schedules to ensure that the lights are at the right level and energy use is optimized

Occupancy/vacancy sensing



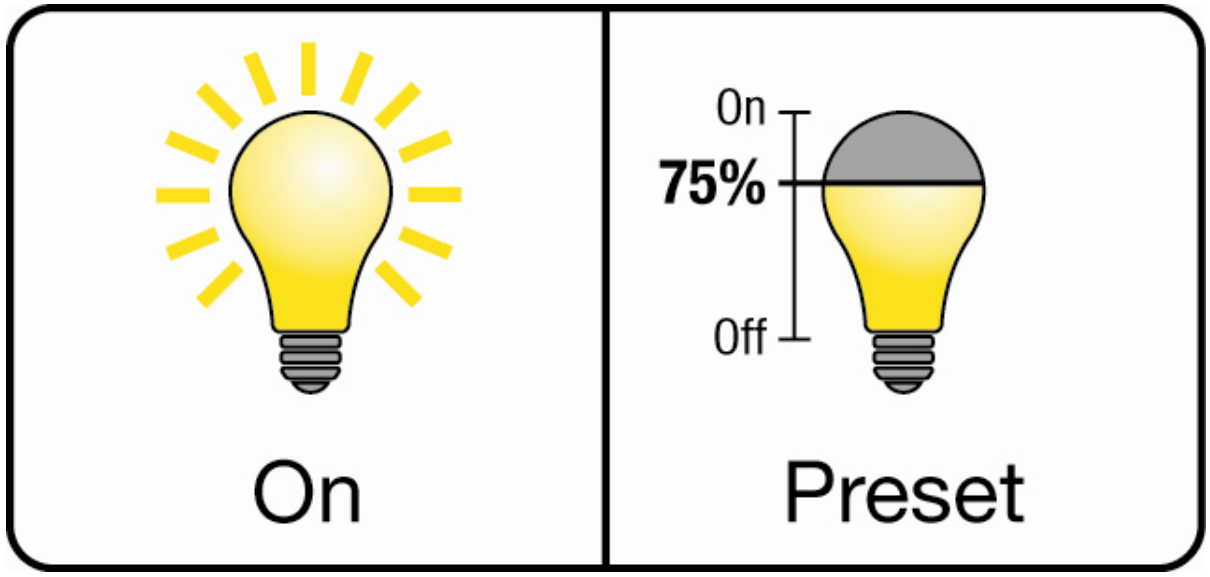
Turns lights off when people vacate the space

Occupancy/vacancy sensing

How is this applied in the real world?

- Use occupancy sensors in most spaces
- Use vacancy sensors to save more energy
- Can be use to control plug loads and HVAC too
- Wireless sensors are available for easy retrofit

Multi-level lighting/dimming

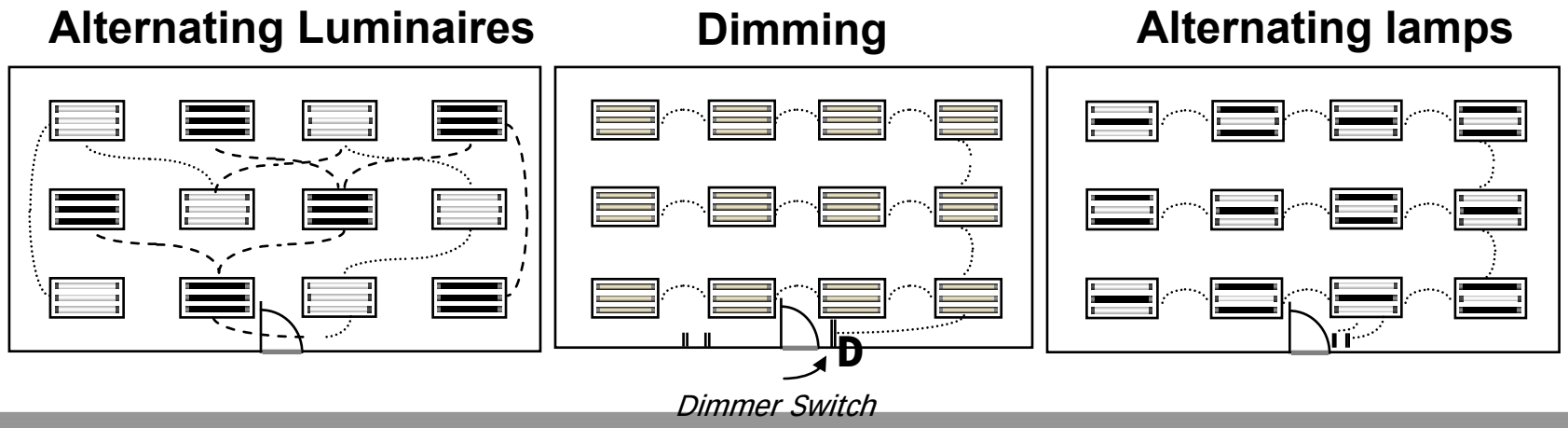


Proving users one or more light levels other than full-on/off.

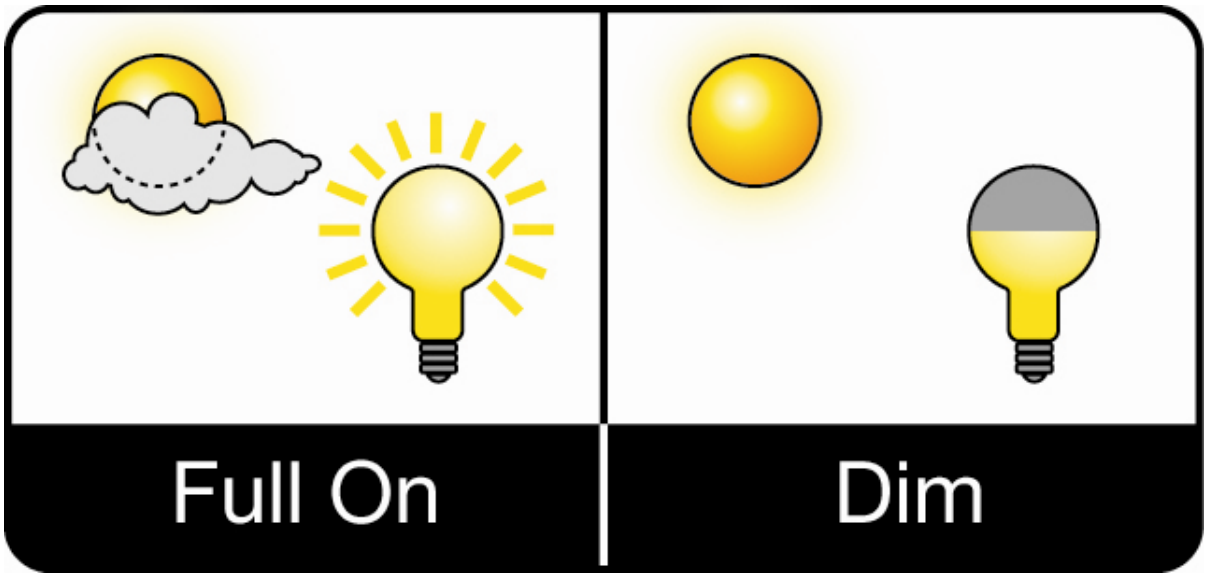
Multi-level lighting/dimming

How is this applied in the real world?

- Controlling all lamps or luminaires (i.e. dimming)
- Dual switching of alternate rows of luminaires, alternate luminaires or lamps
- Switching middle lamp luminaires independently from the outer lamps
- Switching or dimming each luminaire or each lamp (i.e. personal control)



Daylight harvesting



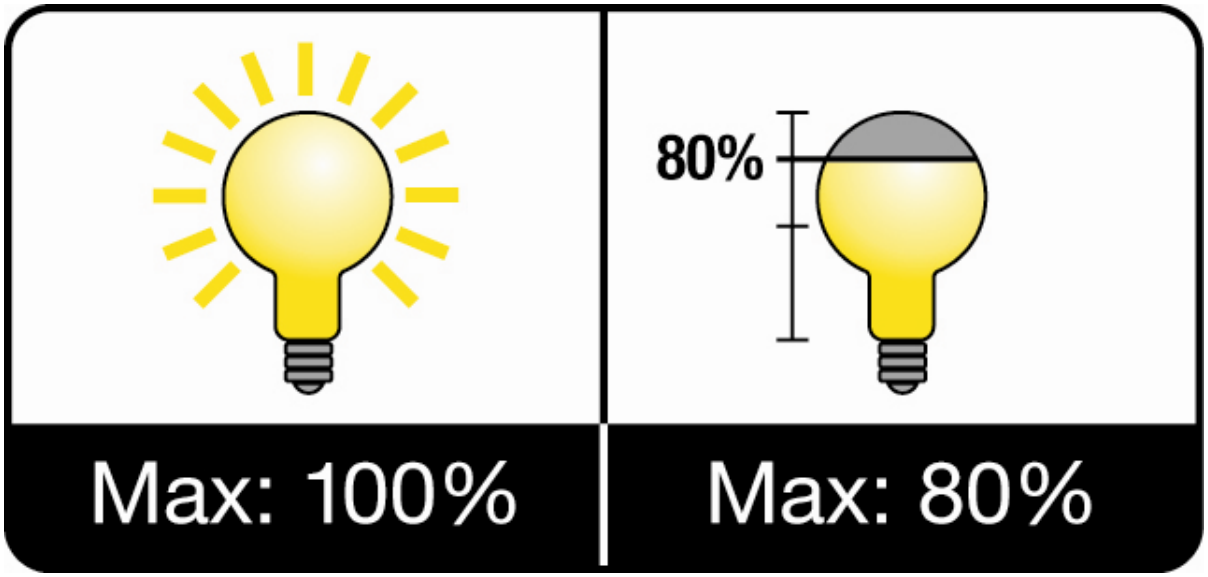
Dims fixtures to take advantage of available daylight

Daylight harvesting

How is this applied in the real world?

- Use daylight sensors with dimming ballasts on lights within 15 feet of the window (or 2x window height or possibly deeper with light shelves) and lights adjacent or near skylights (within 70% of the ceiling height) to take advantage of daylight
- Different gain rates for different lighting zones based on proximity to the window
- Shades are incorporated to ensure that the daylight that is available is indirect and diffuse – not a source of glare
- Wireless sensors are available for easy retrofit

High-End Trim/Tuning



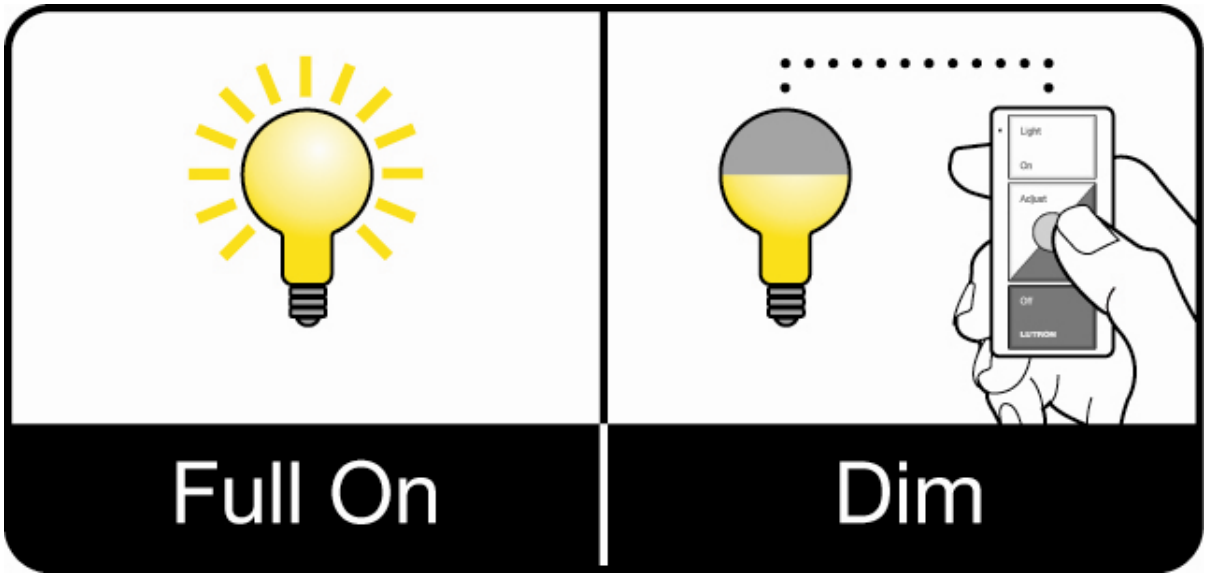
Limit the maximum light output of fixtures

High-End Trim/Tuning

How is this applied in the real world?

- Existing spaces are over-illuminated.
- Lower light levels might be preferred
- The reflectances within a space may allow for lower light levels
- Lumen depreciation--Light sources reduce their lumen output over time. Adjust for this by reducing light output initially and increase it over the life of the lamp.
- Allows for future flexibility (easier to tune lights that add or remove fixtures)

Personal light control



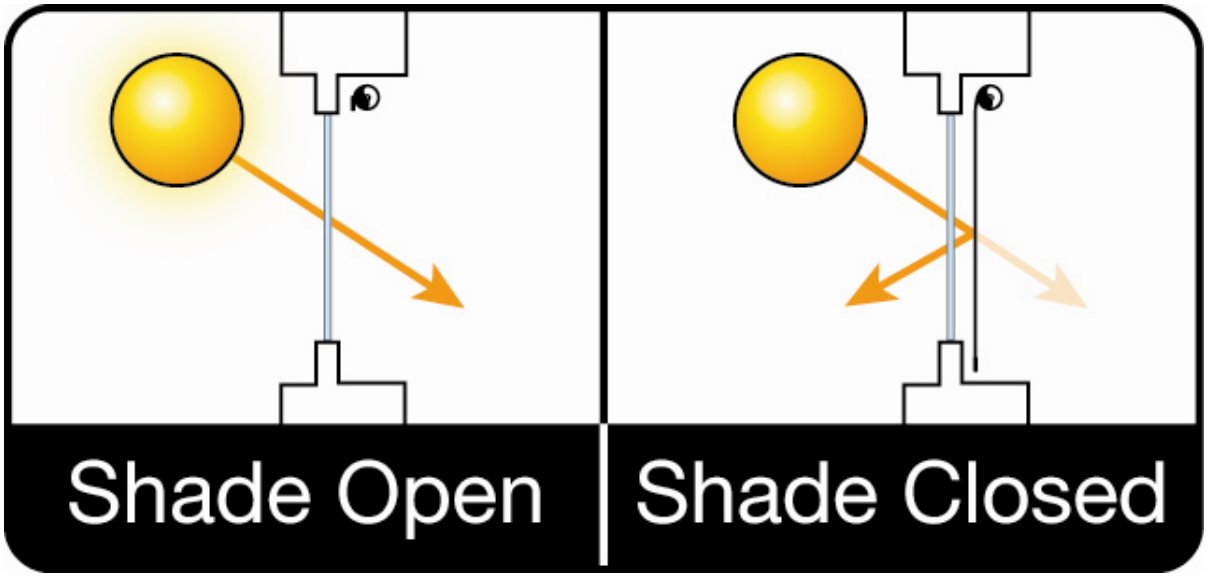
Gives occupants control of the lighting

Personal light control

How is this applied in the real world?

- Personal lighting control of overhead ambient light
- Allows occupants to select their preferred light level for the task at hand
- Improves productivity by 4 to 7%

Controllable window shades



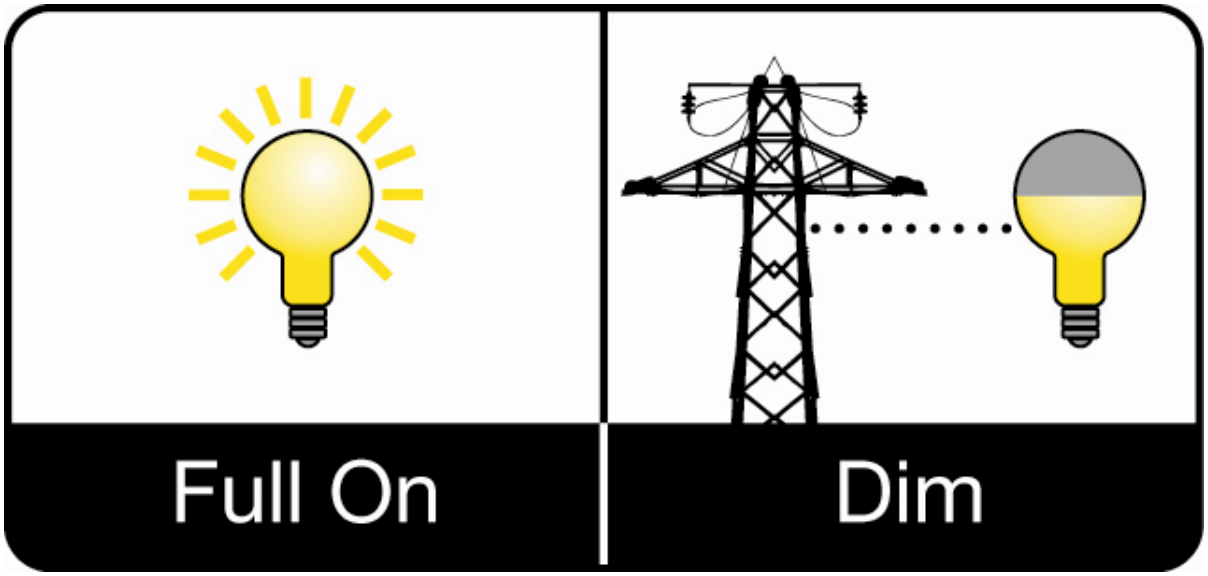
Reduces glare and solar heat gain

Controllable window shades

How is this applied in the real world?

- Automated vs. manual shades
- Maintain views while reducing glare and solar heat gain
- At night--prevents light pollution, enhances security, adds a layer of insulation to keep warmth inside
- Maximizes energy savings potential of daylight harvesting

Demand response



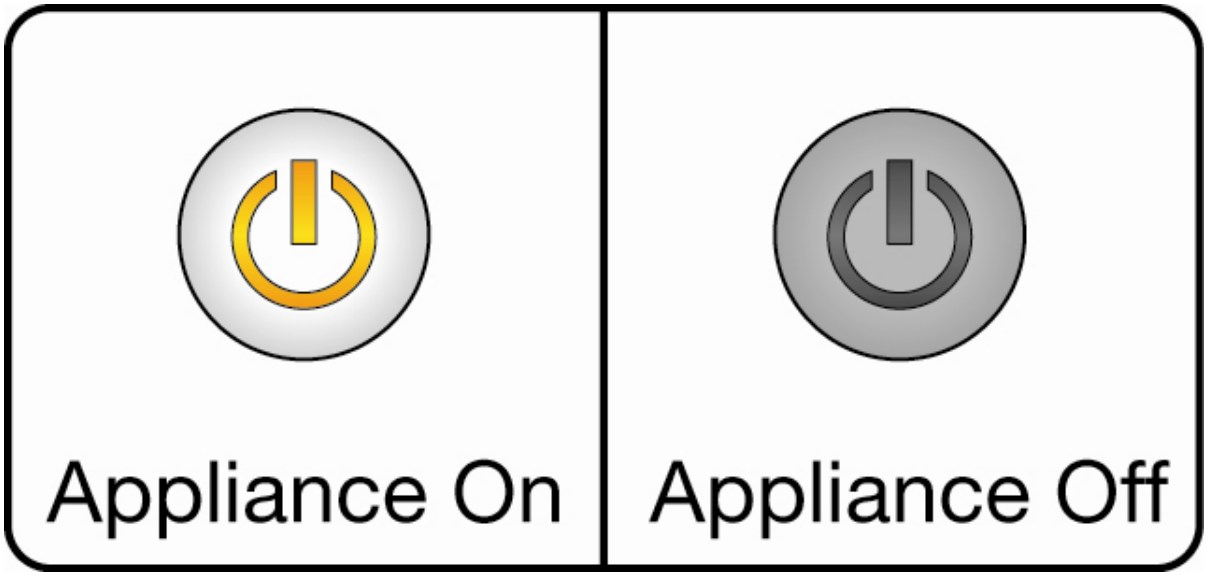
Sheds lighting load during peak energy usage times

Demand response

How is this applied in the real world?

- Utility changes price or declares a demand response
- Light control system responds with pre programmed response:
  - Lights dim
  - Non essential plug loads are turned off
  - Shades move to preset
  - Cooling set point increased
- Utility returns to normal pricing or cancels demand response event
- System returns to normal operation

Plug load control



Automatically turning task lighting and other plug loads off when they are not needed.

Plug load control

How is this applied in the real world?

- Extends occupancy-based or time-based control to:
  - Computer monitors
  - Task lighting
  - Fans
  - Printers
  - Speakers…

Light control for energy savings

Reduce operating expenses

- Reduce energy usage and peak demand charges (i.e. energy costs)
- Reduce “churn” costs when renovating/reallocating space
- Monitoring of lighting power

Capitalize on tax deductions and utility incentives

- EPAct (www.lightingtaxdeduction.org)
- Utility Rebates (www.dsireusa.org or www.lutron.com/incentives)

Help your top line revenues

- Support higher tenant retention rates and reduce vacancies
- Generate revenue through demand response contracts

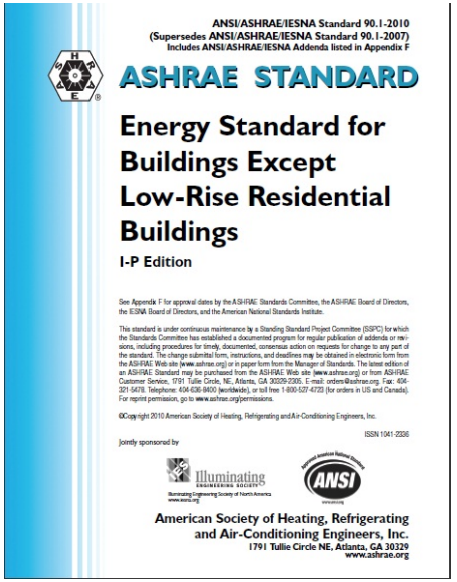
Light Control Impacts these LEED® Categories and Credits

Category	Credit
Sustainable Sites	• Light Pollution Reduction
Energy & Atmosphere	• Commissioning • Energy Performance • Measurement and Verification
Materials & Resources	• Recycled Content
Indoor Environmental Quality	• Controllability of Systems • Daylight & Views
Innovation in Design	• Innovation in Design and LEED AP
Regional Priority	• Varies by zip code

Lighting controls and services provide solutions that contribute to up to 40 of the 110 possible points in LEED-NC 2009.

Energy Code – Lighting Control Requirements

- Area control
- Automatic lighting shut-off
- Daylight control
- Multi-level lighting/Light reduction control
- Exterior lighting control
- Manual-on control
- Stairwell lighting control
- Allowable increases in lighting power for using “beyond code” controls
- Plug load control
  (i.e. controllable receptacles)



Light control for energy savings

Payback depends on the type of system installed:

System	Typical payback period based on energy savings	Typical payback period based on energy savings and a 1% productivity gain
simple wall-mounted dimmers	1 year	less than 1 year
fluorescent lighting control system for 30-person area	2 – 3 years	less than 1 year
whole-building lighting control system	3 – 5 years	less than 1 year

Real world example – The NYT Building

"We designed our building to use 1.28 watts per square foot of lighting power...with light management it's using only 0.39 W/sq.ft. on average — that's about 70% less."

Strategy:

- Light level tuning
- Daylight harvesting
- Occupancy sensing
- Monitoring

Results:

- 70% lighting energy saved
- Over $1 per square foot per year saved

Glenn Hughes
Director of Construction
The New York Times Co.

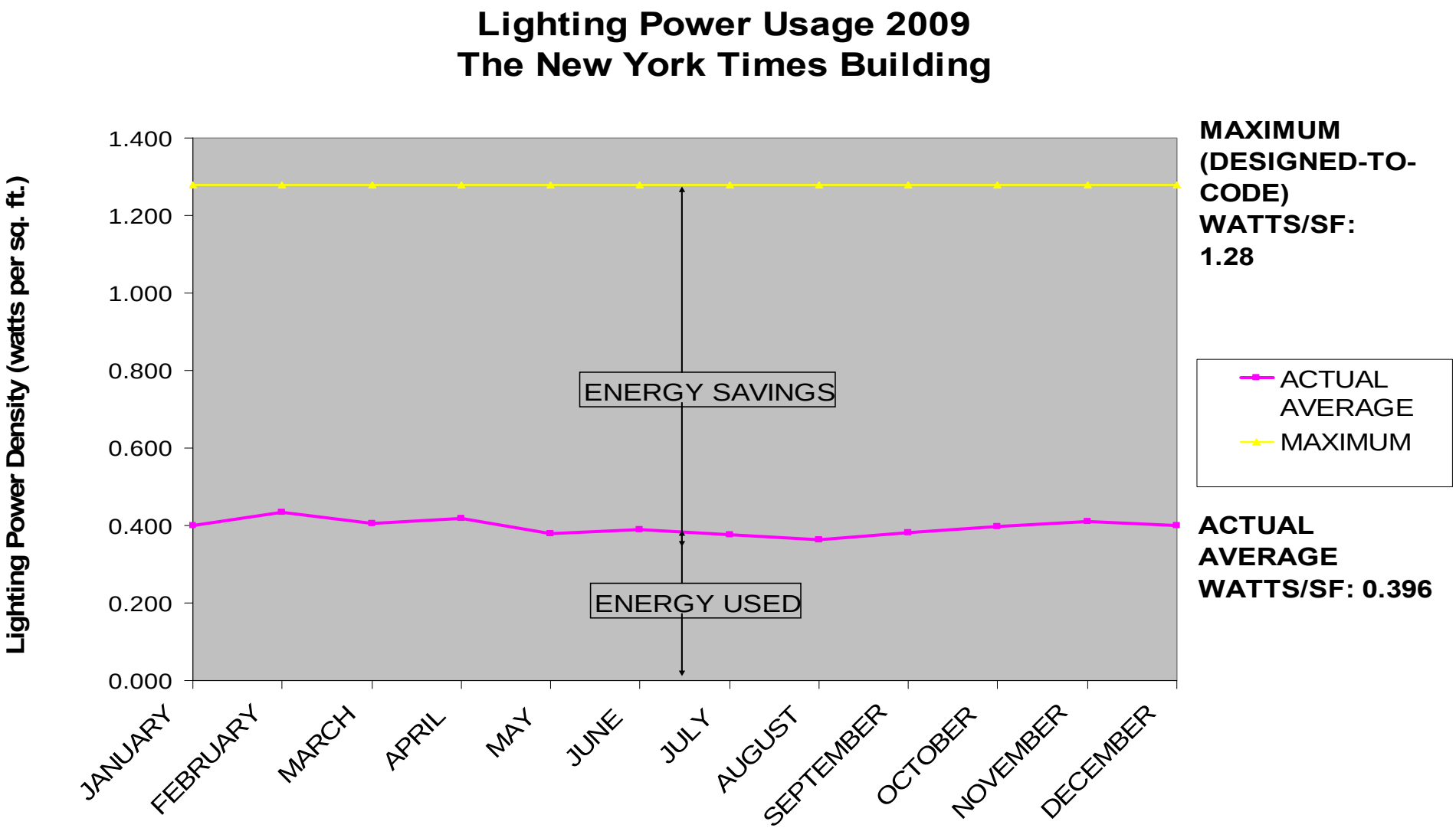
Light control for energy savings

Real world example – The NYT Building

Light control solutions

- Total light management system
  - Digital dimming ballasts
  - Daylight sensors
  - Occupancy sensors
  - Light management software

Light control for energy savings



Light control for energy savings

The Plaza at PPL Center

Overview:

- Allentown, PA
- 280,000 ft^2
- Corporate headquarters
- LEED® Gold certification
- Green drivers:
  - LEED rating for marketing and public image
  - Reduced energy consumption; return on investment

Architect: Robert A. M. Stern

Consulting Environmental Designers and Engineers: Atelier Ten, NY, NY

Light control for energy savings

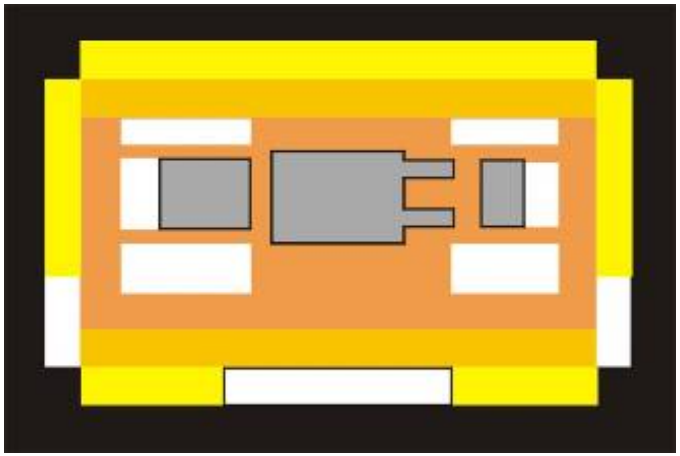
The Plaza at PPL Center

Low Energy Design Features:

- South Façade sun screening
  - 3’ deep louvers at every level
  - High performance solar control glass
- Thermal control glass on north facades
- Heat recovery ventilation
- Optimized HVAC systems with variable speed drives
- Occupant and daylight responsive lighting controls
- 30% improvement over ASHRAE 90.1

Light control for energy savings

The Plaza at PPL Center



Advanced lighting controls:

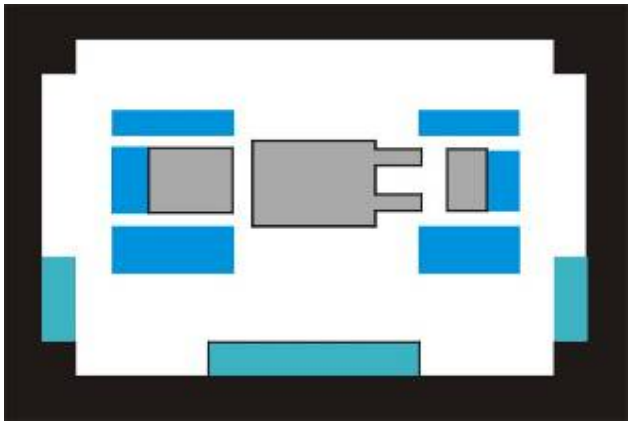
- Open plan office areas
  - South & North open office areas divided into three control zones:
    - Perimeter (15’ from façade)
    - Middle (15-30’ from façade)
    - Interior (30’ to core)

Perimeter and Middle zones have dedicated daylighting controls to set electric light levels based on available daylight.

Interior zone has only central on/off time clock control.

Light control for energy savings

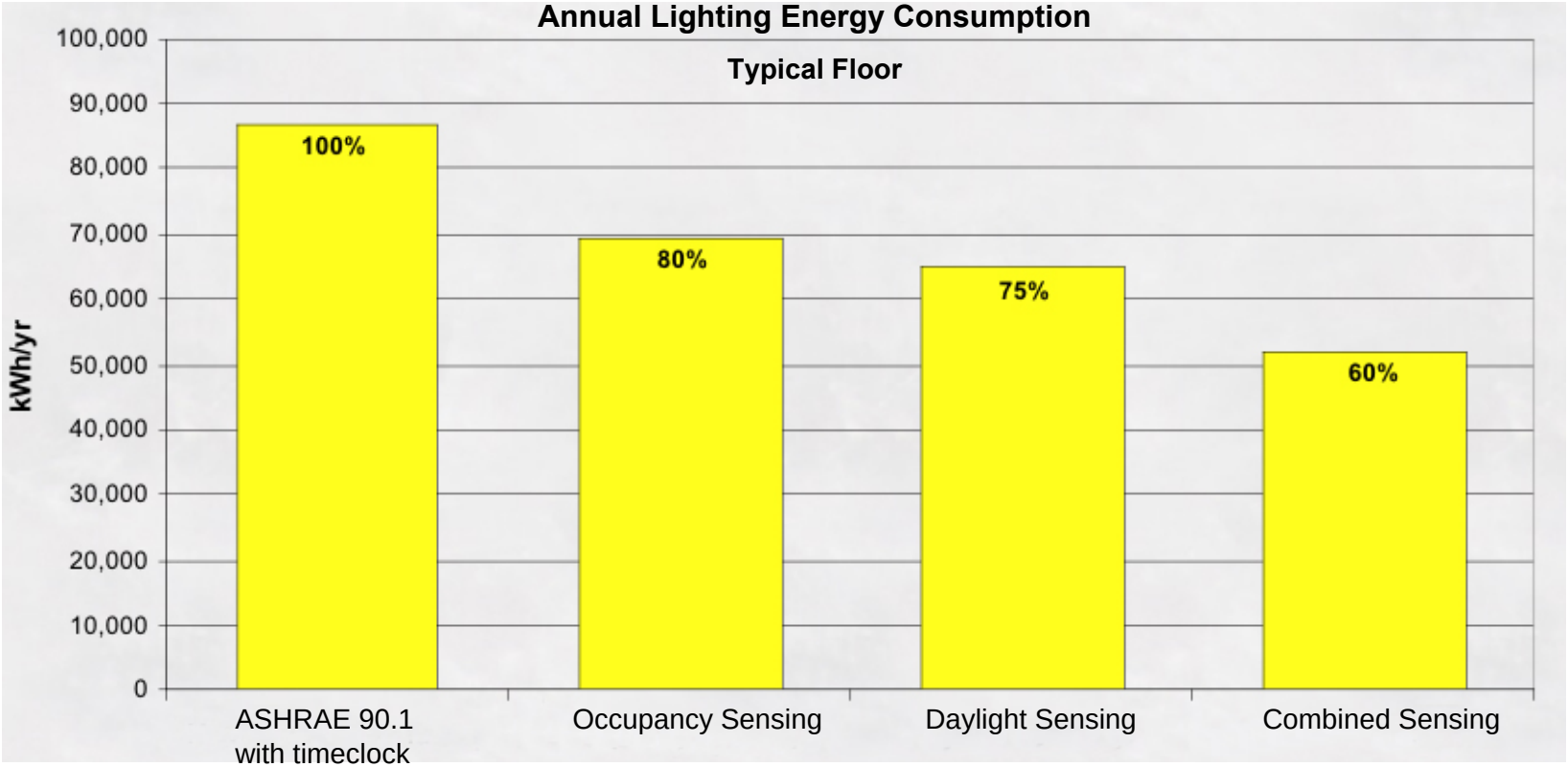
The Plaza at PPL Center



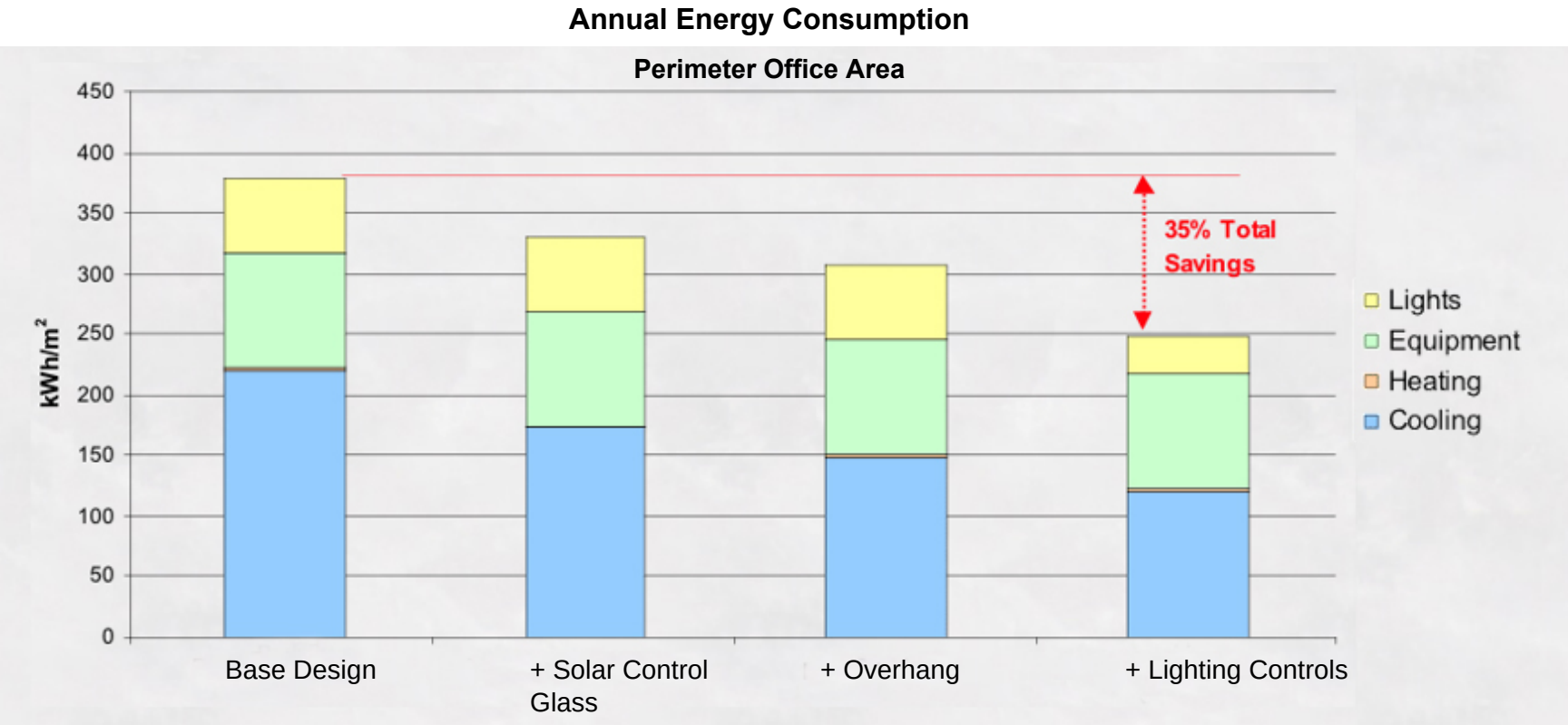
Advanced lighting controls:

- Perimeter offices, conference rooms
  - Vacancy switches/sensors to switch lights on/off
  - Daylight sensor to set electric light levels based on available daylight
- Interior offices, copy rooms, restrooms
  - Vacancy switches/sensors to switch lights on/off

Lighting Energy Savings



Total Energy Savings



Light control for energy savings

Any Questions?