Codes and Daylight Controls

Commercial building energy code requirements for lighting controls in Connecticut with a Focus on Daylighting

LUTRON®

Agenda

Big picture

- Energy usage and the importance of light control

Energy code requirements for lighting controls

- Current requirements in CT: IECC 2009
- Future of lighting control requirements
  - IECC 2012
  - ASHRAE 90.1 2010

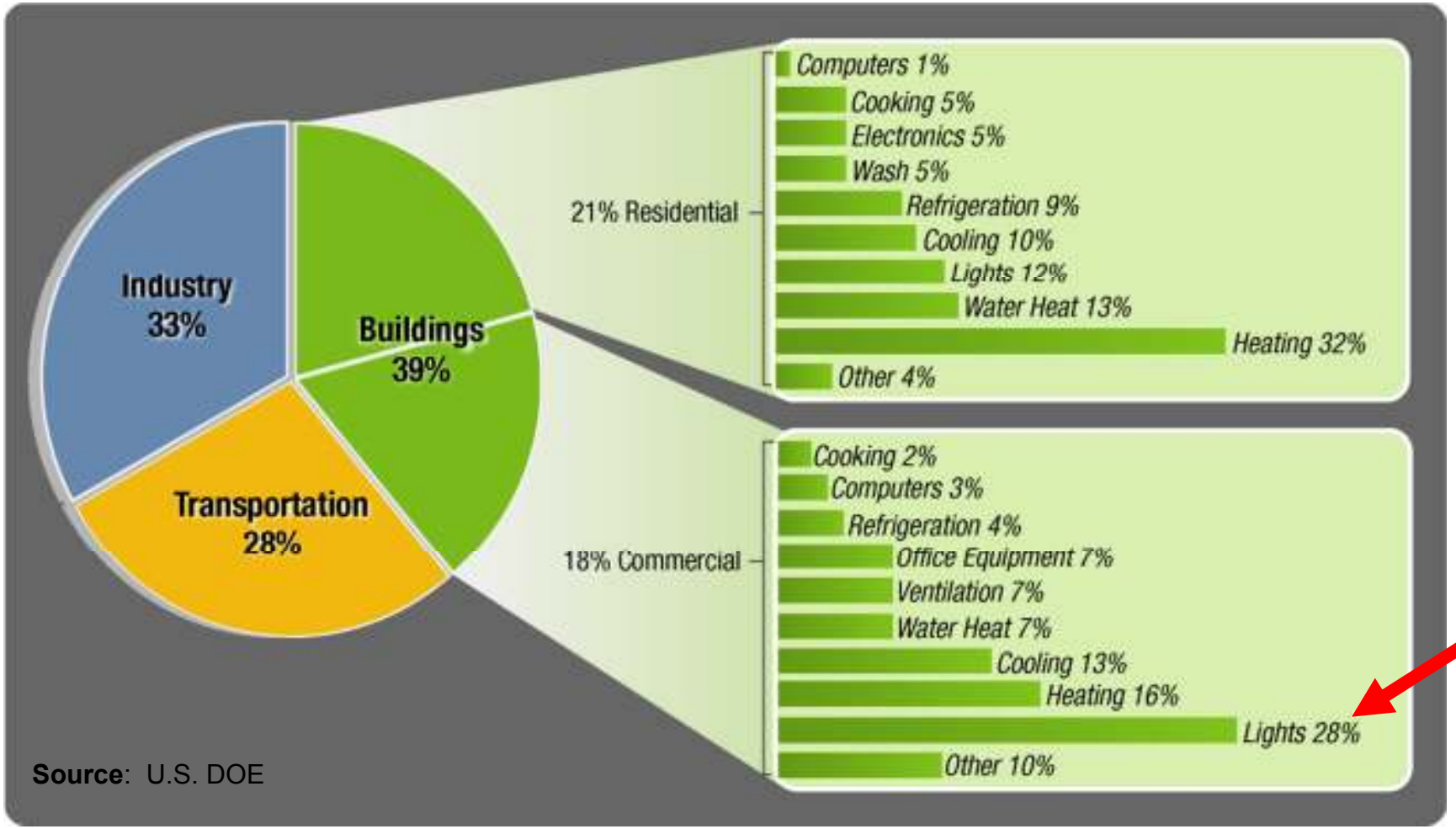
Focus on Daylight Harvesting Controls

- Implementations and Demonstration

Why is Lighting Control Important?

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

•Lights use the most energy in commercial buildings



Problem: Wasted lighting energy

Buildings:

- Are over-illuminated
- Don't take into account daylight
- Leave lights on in vacant spaces or after operating hours
- 75% were built before 1989

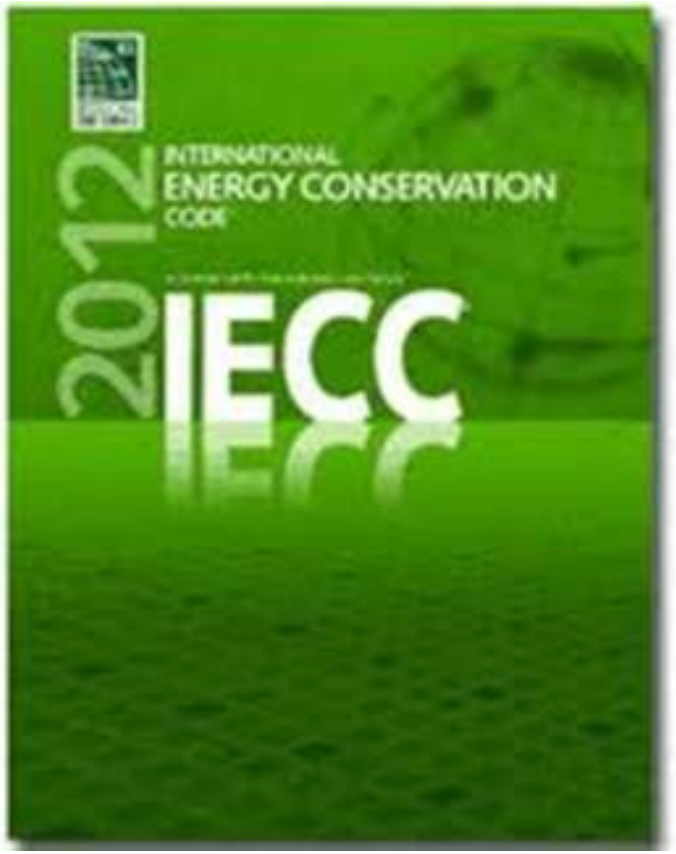
What's wrong with this picture?

"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

Energy Codes – IECC

IECC Basics

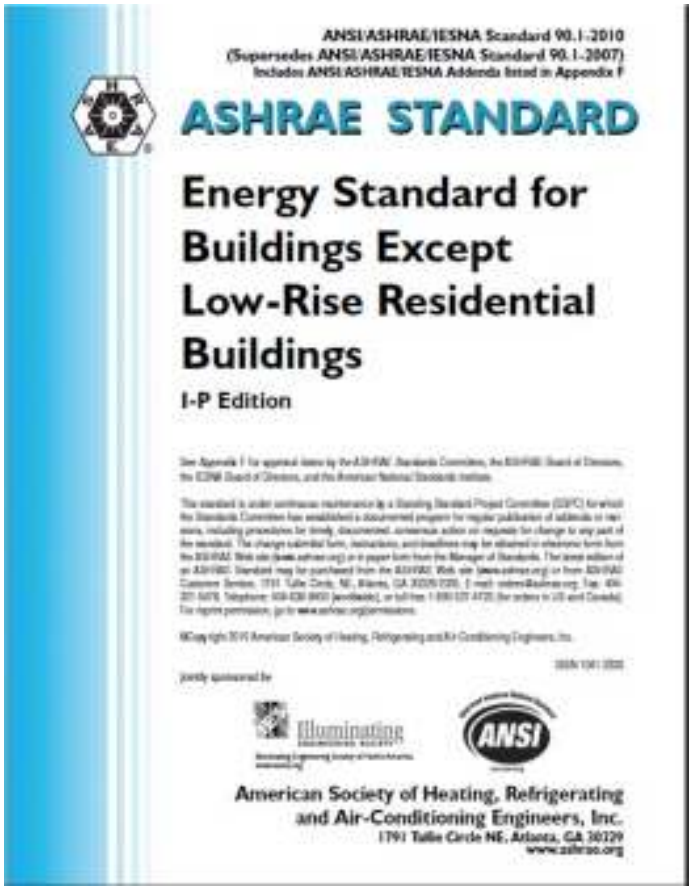
- New version released every 3 years
- Many states use IECC 2009 as their baseline energy code
- **CT adopted IECC 2009 as an amendment to the state building code in October 2011**
- 2012 is the current version
  - CT is considering adopting 2012 in the near future



Energy Codes – ASHRAE 90.1

Standard 90.1 Basics

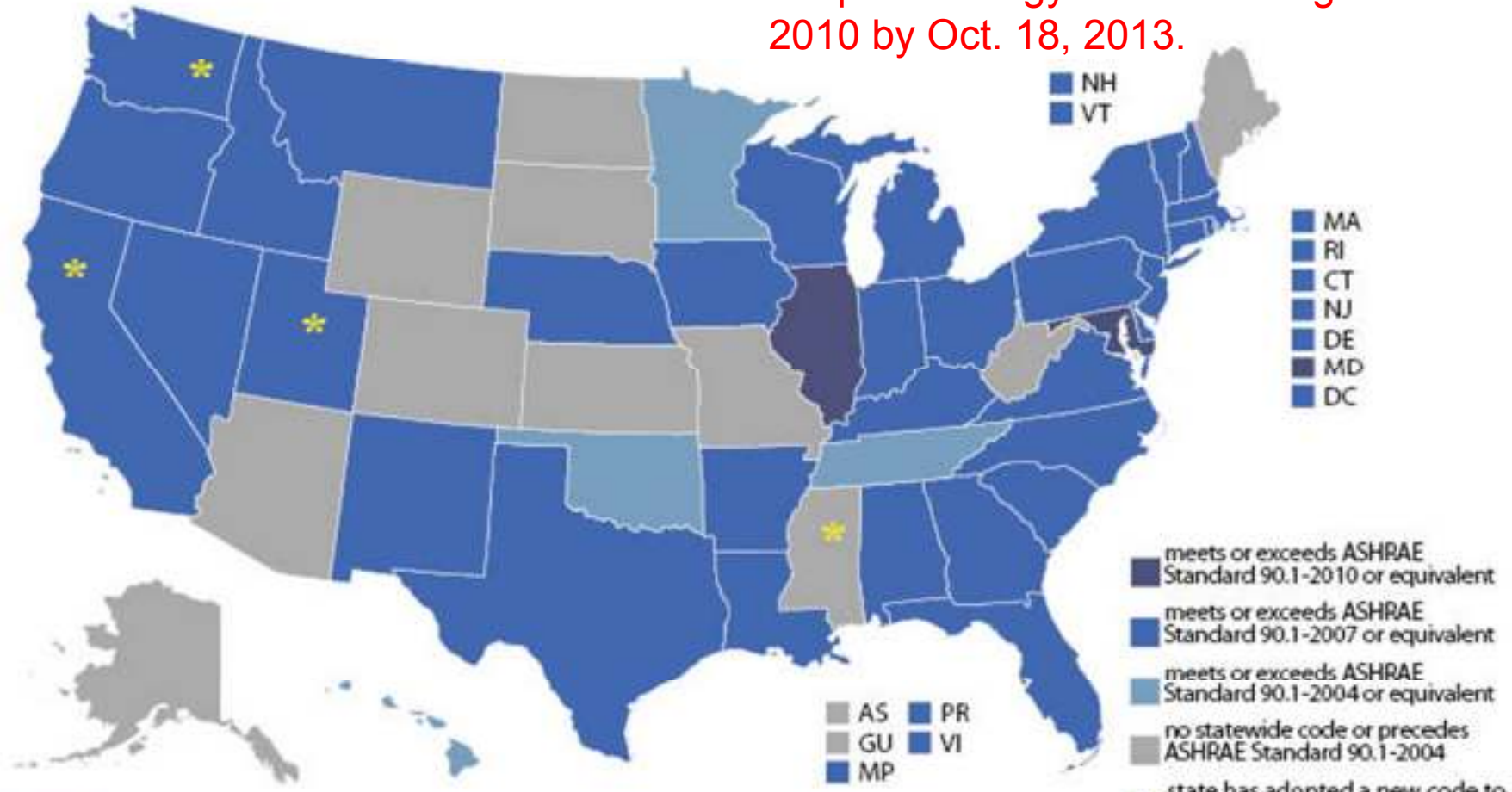
- New versions released every 3 years
- LEED requires a 10% improvement over 90.1 - 2007 as a prerequisite for Energy and Atmosphere credits
  - LEED 4 will reference 90.1 - 2010
- Current version is 2010
  - Requirements for lighting control are significantly more stringent than in 90.1-2007 and even IECC 2012
- **US Dept. of Energy issued ruling that by Oct. 2013 all state must certify they meet or exceed ASHRAE 90.1 - 2010**



Commercial State Energy Code Status

AS OF MAY 1, 2013

DOE Ruling Oct. 19, 2011: All states must adopt an energy code as stringent as 90.1-2010 by Oct. 18, 2013.



NOTE: These maps reflect only mandatory statewide codes currently in effect.

BCAP Dedicated to the adoption, implementation, and advancement of building energy codes

Get all the most up-to-date code status maps and other valuable resources at www.energycodesocean.org

IECC 2009: Required Controls

Manual Light Control

- At least one lighting control for each room or space enclosed by walls or ceiling-height partitions
  - Readily accessible to occupants within area being controlled
  - Remote location is allowed but must have indicator that identifies the lights served and their status (on or off)

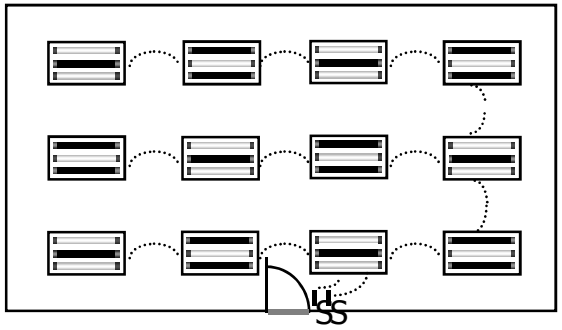
- Exceptions for areas which must be continuously lighted for safety
  - Ex: Stairwells and corridors that are a means of egress

IECC 2009: Required Controls

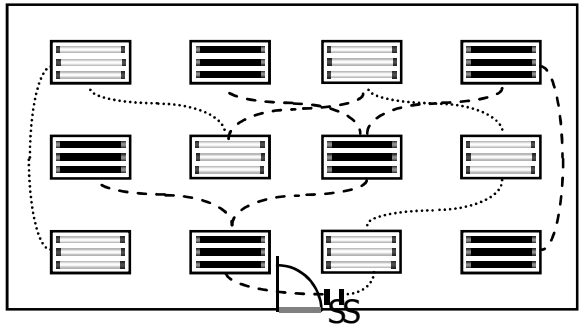
Light Reduction for Rooms With Manual Controls

- Control must allow occupant to reduce the connected lighting load by at least 50% in a reasonably uniform pattern
  - Exceptions:
    - Areas with only one luminaire
    - Areas controlled by occupancy sensors
    - Corridors, restrooms, storerooms, public lobbies
    - Spaces that use less than 0.6 W/sq. ft.

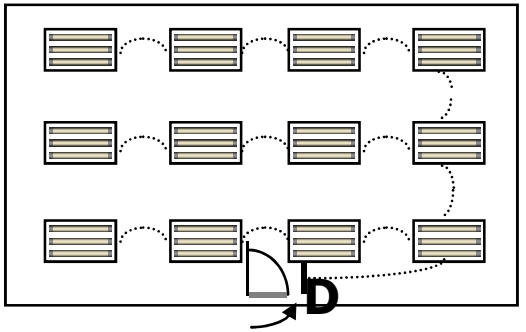
Alternating lamps



Alternating Luminaires



Dimming



Dimmer Switch

IECC 2009: Required Controls

Automatic Lighting Shutoff

- Buildings larger than 5,000 sq. ft. shall be equipped with an automatic control device to shut off lights in areas.
- Shut off may be achieved by one of following methods
  - Time of day shutoff provided each individual timeclock schedule controls no more than 25,000 sq. ft. and not more than one floor
  - Occupancy sensor with no greater than a 30 minute timeout
  - A signal from another control system that indicates the space is unoccupied
- Exceptions:
  - Patient care areas
  - Areas where auto shutoff would endanger safety or security

IECC 2009: Required Controls

Automatic Lighting Shutoff : Special notes on Timeclocks

- Timeclock controlled spaces must provide a manual override switch
  - Switch must be readily accessible and within sight of the lights controlled
  - Provides an override not longer than 2 hours
  - Overrides not more than 5,000 sq. ft. of controlled lights
- Timeclock shall incorporate a method of defining holiday schedules such that lights are turned off for the whole day

IECC 2009: Required Controls

Daylight Zone Control

- Daylight zone is defined *nominally* as the floor space 15 feet back from windows
  - Also includes areas under skylights
- Lighting in daylight zones must be controlled separately
  - Manual control OK
  - Contiguous daylight zones adjacent to windows can be controlled together as long as the zone is not adjacent to windows facing more than two different cardinal directions
  - Areas under skylights more than 15 feet away from windowsmust be controlled separately
- Exception for areas with two or fewer fixtures

IECC 2009: Required Controls

Sleeping Unit Controls

- Hotel/motel rooms shall have a master switch at the main entry door
  - Shuts off all permanently installed luminaires and switched outlets in the room
  - Exception: Bathroom

IECC 2009: Required Controls

Exterior Lighting Controls

- Lighting intended for dusk-to-dawn operation must be controlled by an astronomical time switch or a photosensor.
  - Examples: parking lot lighting, walkway lighting
- Lighting not intended for dusk-to-dawn operation must be controlled via a time switch and a photosensor or an astronomical time switch
  - Example: advertising lighting, architectural accent lighting

IECC 2009 Summary by Space Type

IECC 2009	Space				
	Manual Control (505.2)	Light Reduction Control (505.2.2.1)	Time Based Auto-Shutoff (505.2.2.2)	Occupancy Sensors (505.2.2.2)	Manual Daylight Control (505.2.2.3)
Classroom/Lecture Hall/Training Room	REQ	1	1	2	REQ
Conference/Meeting Room	REQ	1	1	2	REQ
Private Office	REQ	1	1	2	REQ
Open Office	REQ	1	1	2	REQ
Break Room	REQ	1	1	2	REQ
Restroom	REQ				
Storage Room	REQ				

Notes:

1. All REQ's shall be implemented.
2. Daylighting required only when space has windows or skylights and space has more than 2 fixtures
3. Assumes no windows in restrooms or storage rooms
4. For yellow items, pick option #1 (which requires meeting two provisions) or option #2

What's new? IECC 2012: Required Controls

Occupancy Sensors

- Occupancy sensors are *required* in the following spaces:
  - Classrooms
  - Conference rooms
  - Storage & janitorial closets
  - Spaces less than 300 sq. ft.
  - Break rooms
  - Private offices
  - Restrooms

- Sensors must turn lights off after 30 minutes of vacancy
- Must either be *manual-on* or auto-on to no more than 50% of installed lighting power
  - Restrooms and other safety critical areas can be auto-on to full power

What's new? IECC 2012: Required Controls

Automatic Daylight Control

- Manual daylight controls still required as in 2009; however . . .
- Daylight zones not to exceed 2,500 sq. ft.
- Automatic daylight controls in day-lit areas required:
  - In buildings with greater than 30% window to wall ratio
  - In spaces where the daylight illuminance is greater than that provided by the general lighting in the day-lit zone
  - Under skylights
  - Stepped dimming permitted
    - Provide two control steps besides on and off
      - One between 50% and 70%
      - Another step less than 35%
  - Continuous dimming permitted provided capable of dimming less than 35%

IECC 2012 Summary by Space Type

IECC 2012	IECC 2012 Requirements by Space					
	Manual Control (405.2.1)	Light Reduction Control (405.2.1.2)	Time Based Auto-Shutoff (405.2.2.1)	Occupancy Sensors (405.2.2.2)	Manual Daylight Control (405.2.2.3.1)	Automatic Daylight Control (405.2.2.3.2)
Classroom/Lecture Hall/Training Room	REQ			REQ	1	2
Conference/Meeting Room	REQ			REQ	1	2
Private Office	REQ			REQ	1	2
Open Office	REQ	1	1, 3	2, 4	1,2	3, 4
Break Room	REQ			REQ	1	2
Restroom	REQ			REQ		
Storage Room	REQ			REQ		

Notes:

1. All REQ's shall be implemented.
2. Daylighting required only when space has windows or skylights and space has more than 2 fixtures
3. Assumes no windows in restrooms or storage rooms
4. For yellow items pick one group of options
5. For orange items, pick one option

What's new? ASHRAE 90.1 -2010

ASHRAE 90.1 is an alternate compliance path for IECC

- 90.1 – 2010 is more strict than IECC 2012
- Multi-level controls required regardless of whether occupancy sensors are used.
- All day-lit zones must be controlled automatically. No manual daylight control options.
- Stairwells must have occupancy controls
  - Occupied state is 100% on. Unoccupied state is 50% on.

What's new? ASHRAE 90.1 -2010

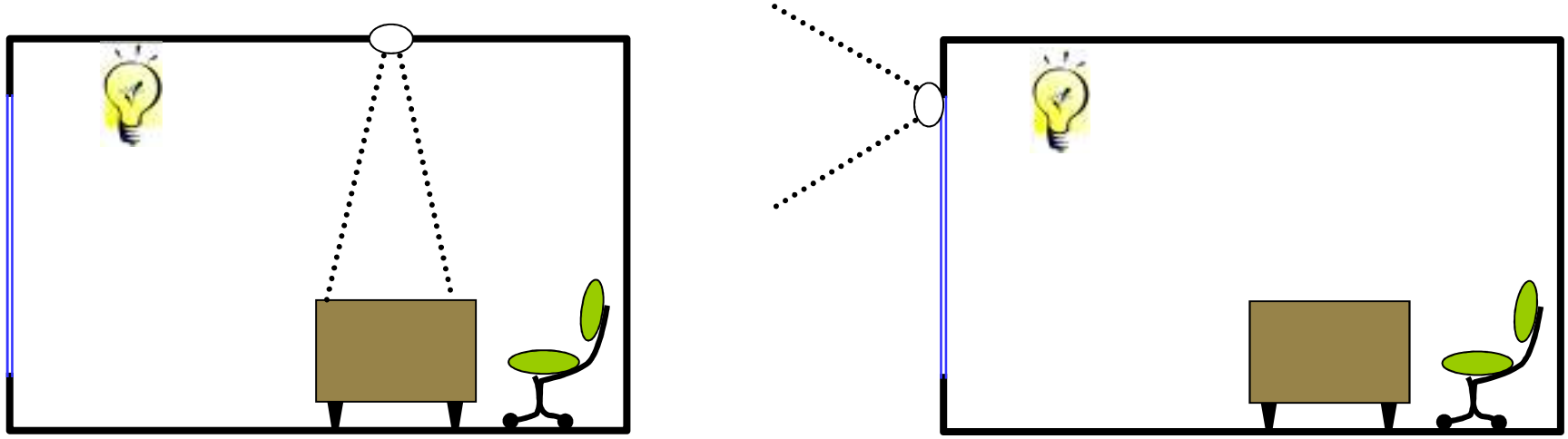
More on ASHRAE 90.1—2010

- Occupancy sensors in hotel bathrooms
  - Allows for a 60 minute timeout
- Parking garage control
  - Occupancy sensors
  - Daylight control near perimeter
- Alterations/renovations to 10% or more of the luminaires in spaces are required to bring entire space up to standard.

Focus on Daylighting

Components in an automatic Daylight Harvesting System

- Photo sensors
  - Closed loop and open loop sensors



Closed Loop

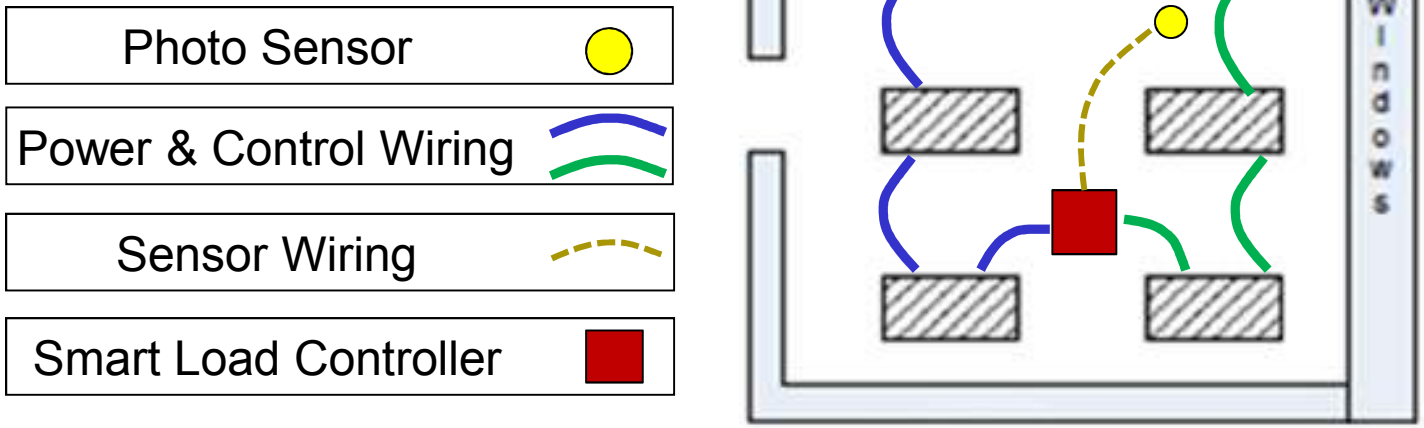
Open Loop

  - Sensors are usually low voltage or battery powered devices that send a signal to a control system

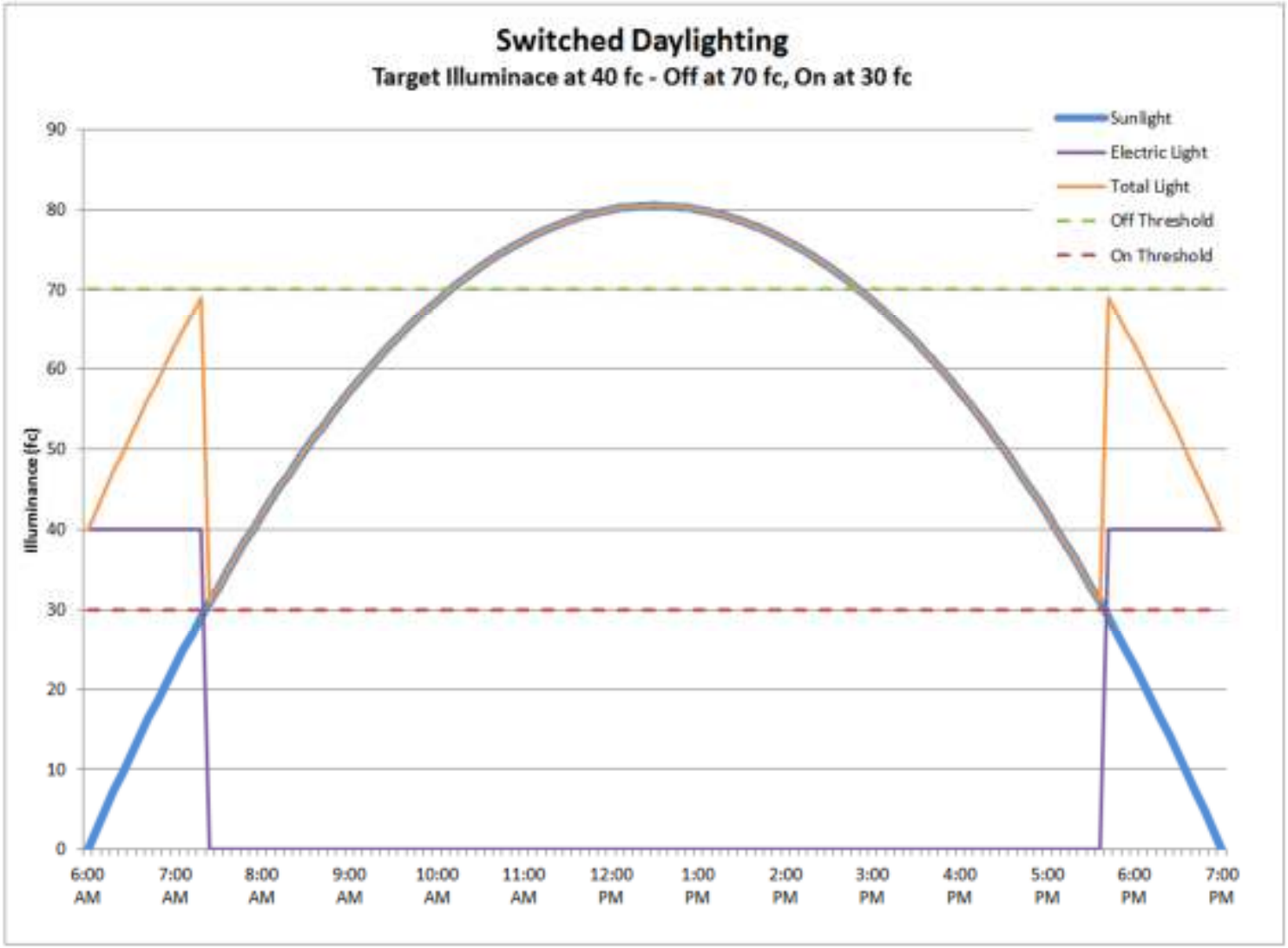
Focus on Daylighting

Components in an automatic Daylight Harvesting System

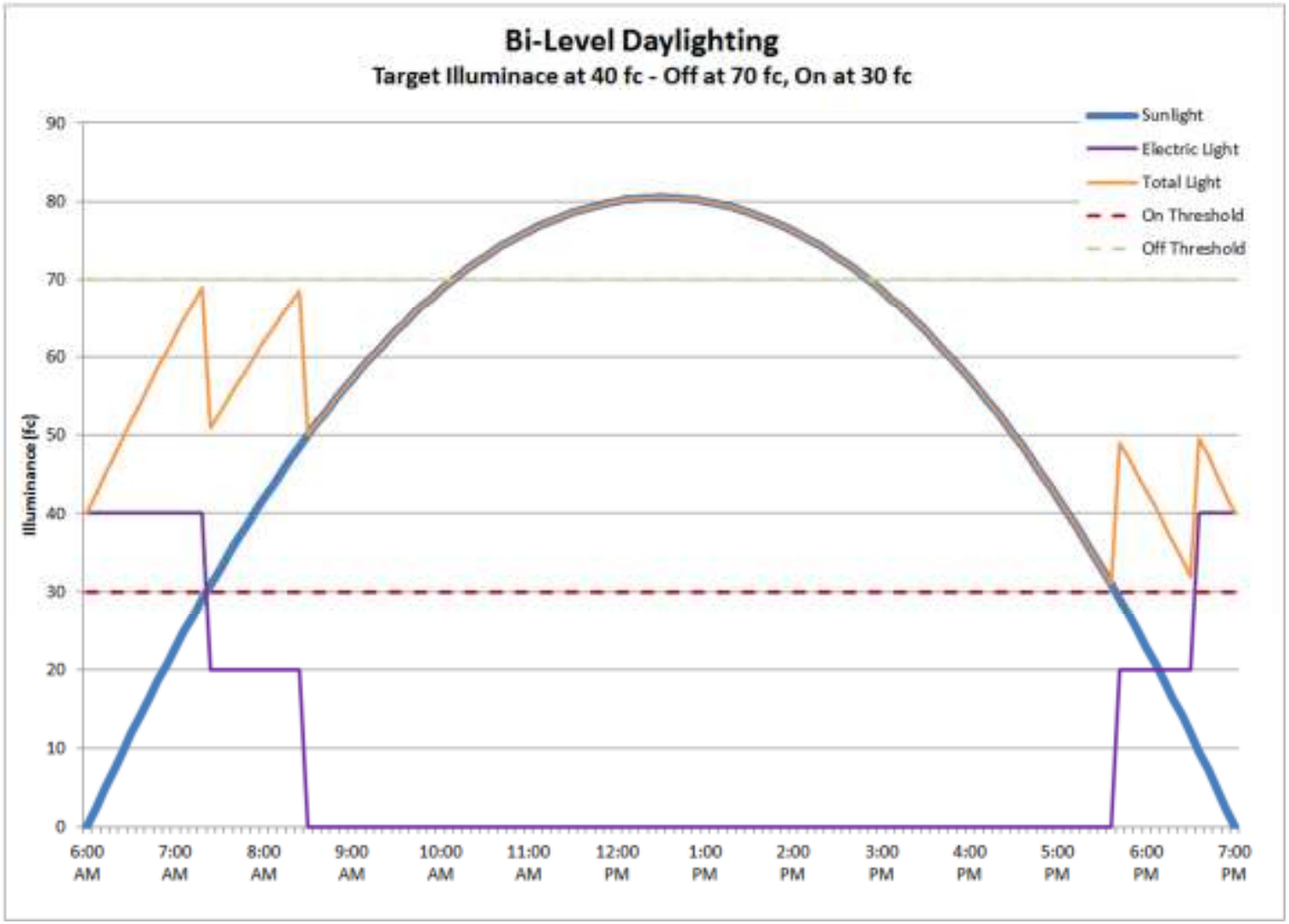
- Control system (a brain)
  - Takes in analog or digital signal from photo sensor and determines correct level for lights
  - Includes some way to calibrate (either manually or automatically)



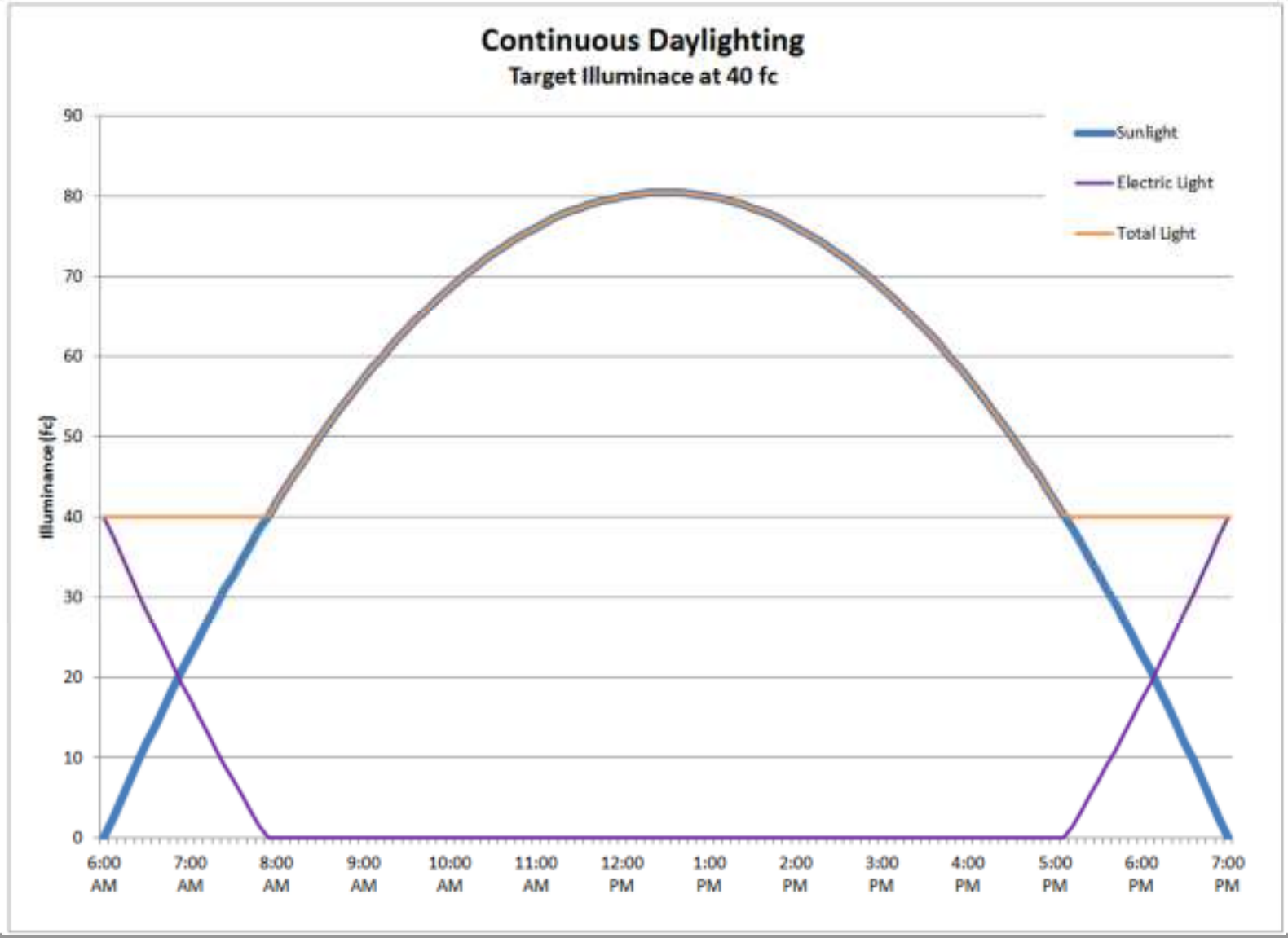
Daylighting Curves – Switched Daylighting



Daylighting Curves – Stepped Daylighting

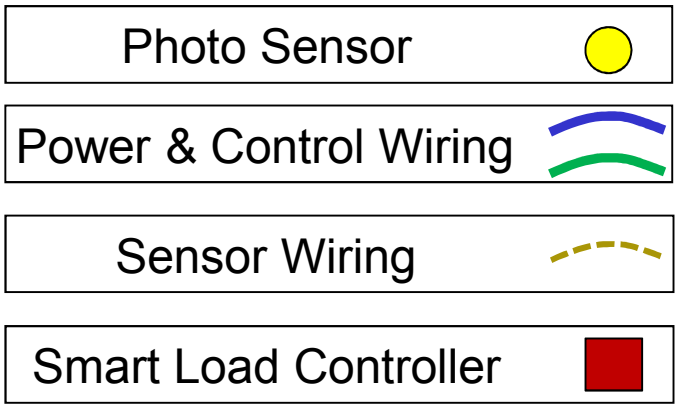


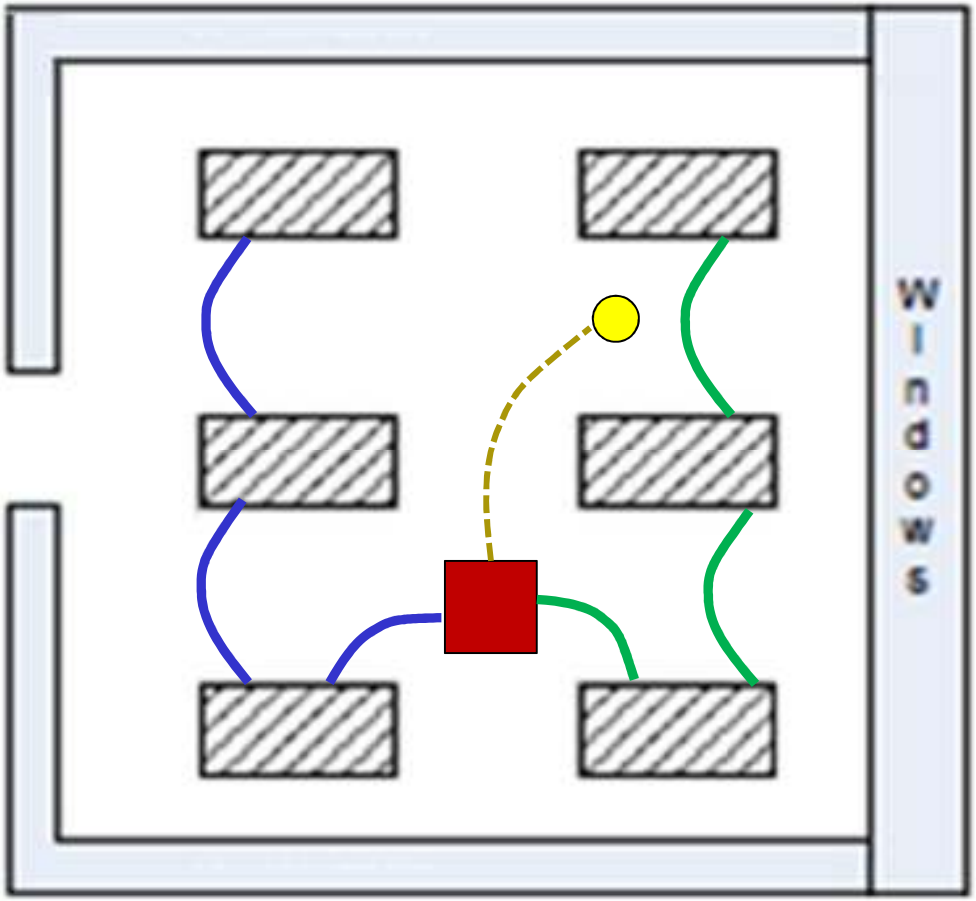
Daylighting Curves – Continuous Daylighting



Focus on Daylighting

What's wrong with this picture???



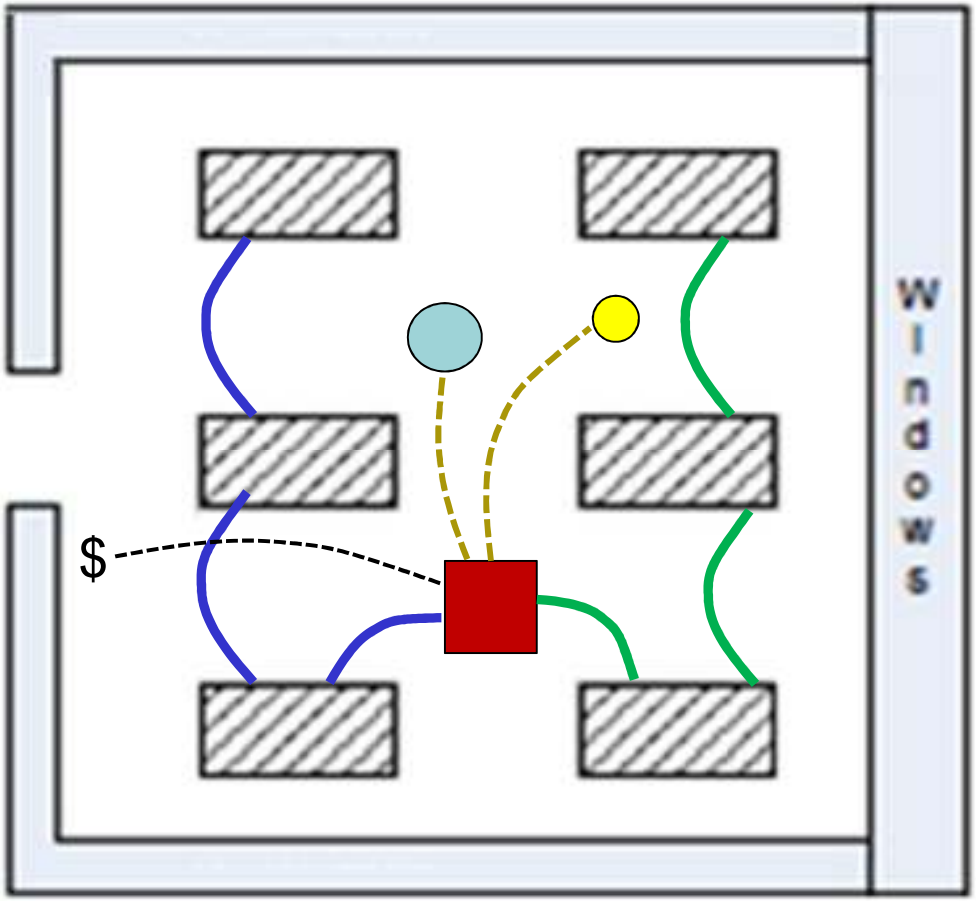


Focus on Daylighting

I need more controls!!!

- My control system needs to be smarter too

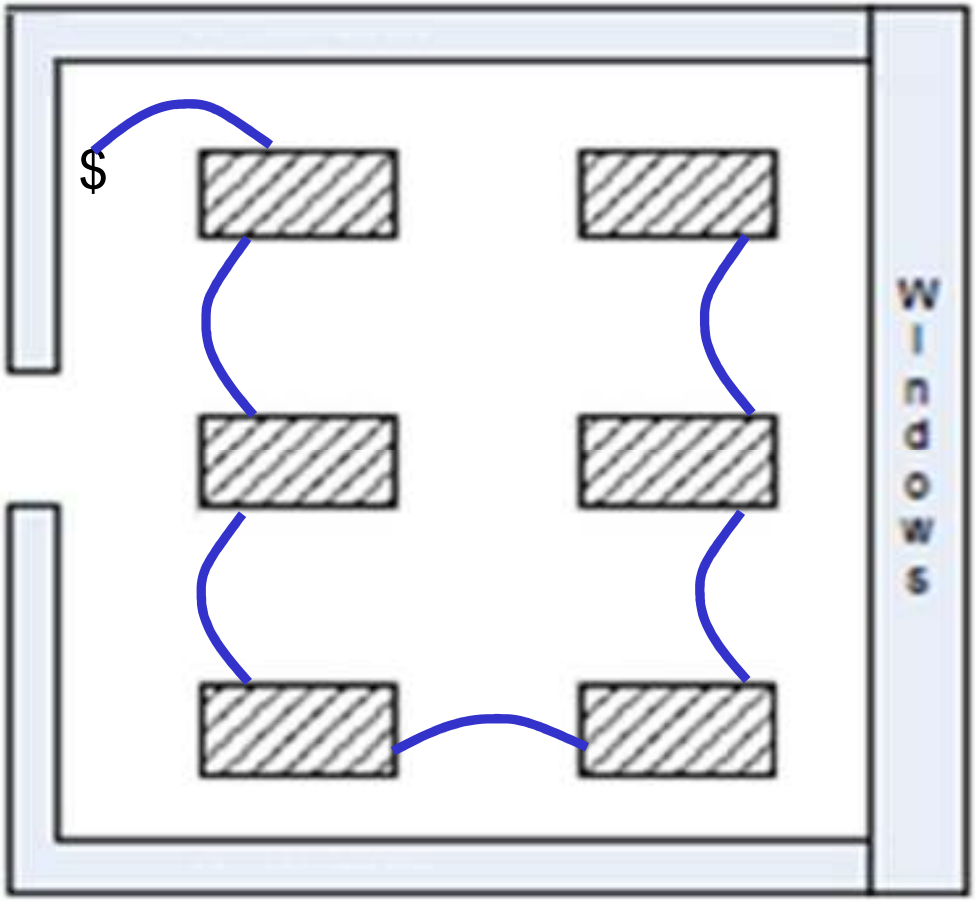
Manual Control	$
Low Voltage Wiring	
Occ Sensor	
Photo Sensor	
Power & Control Wiring	
Sensor Wiring	
Smart Load Controller	



Implementation

How do I go from an existing space to one that meets IECC 2009?

- One lighting zone
- One line voltage wall switch

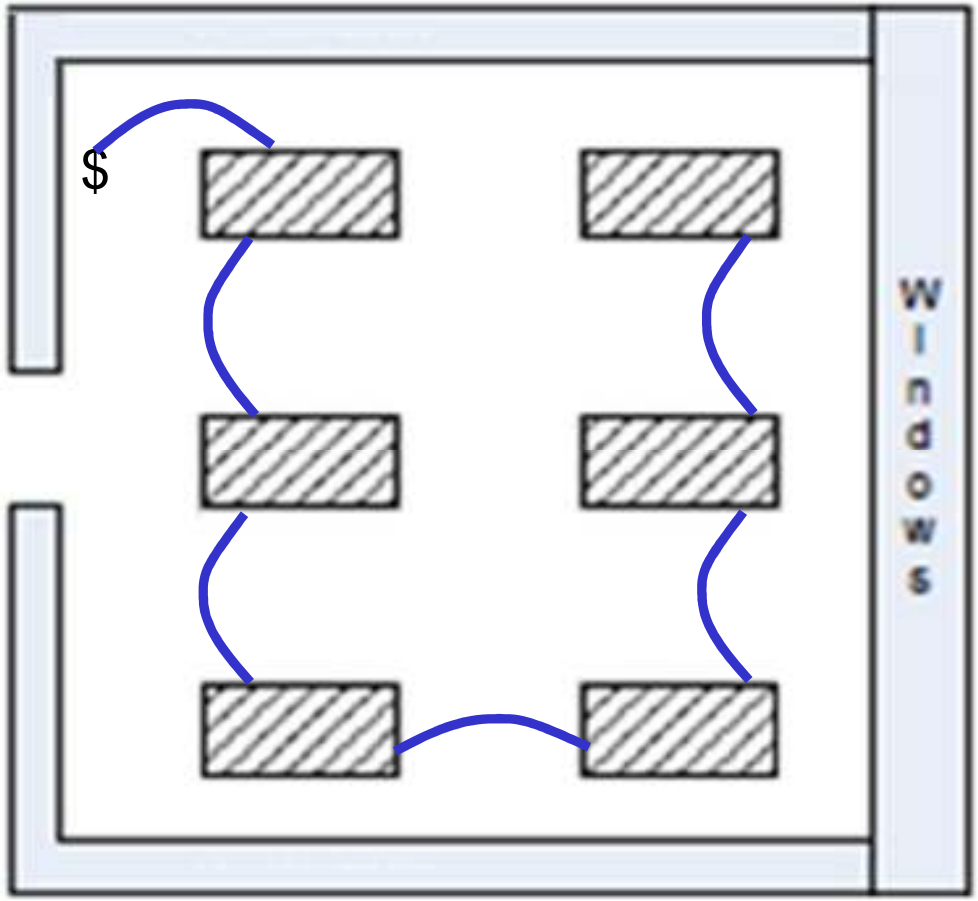


Line Voltage Switch	$
Power Wiring	

Implementation

How do I go from an existing space to one that meets IECC 2009?

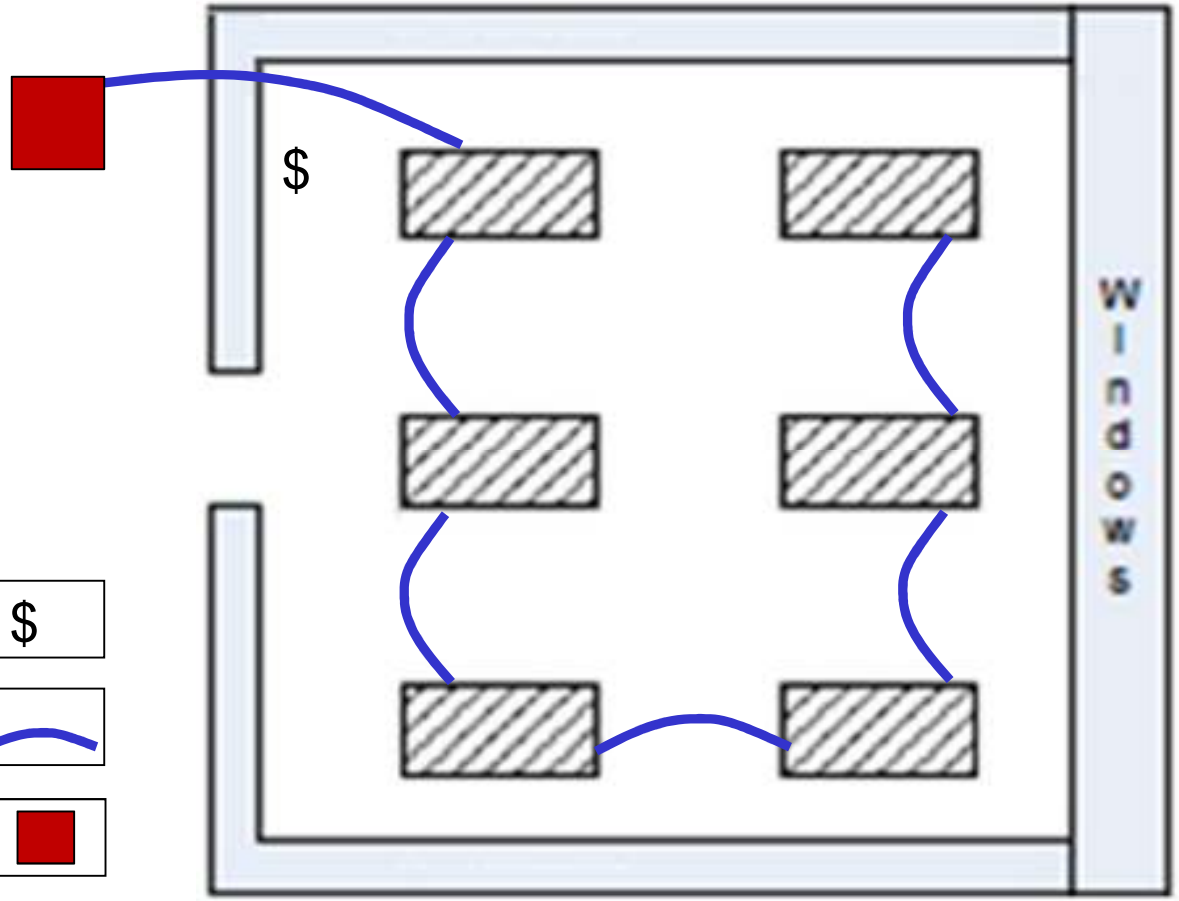
- Install Time Clock
- Separate Zone for Daylighting



Line Voltage Switch	$
Power Wiring	

Implementation

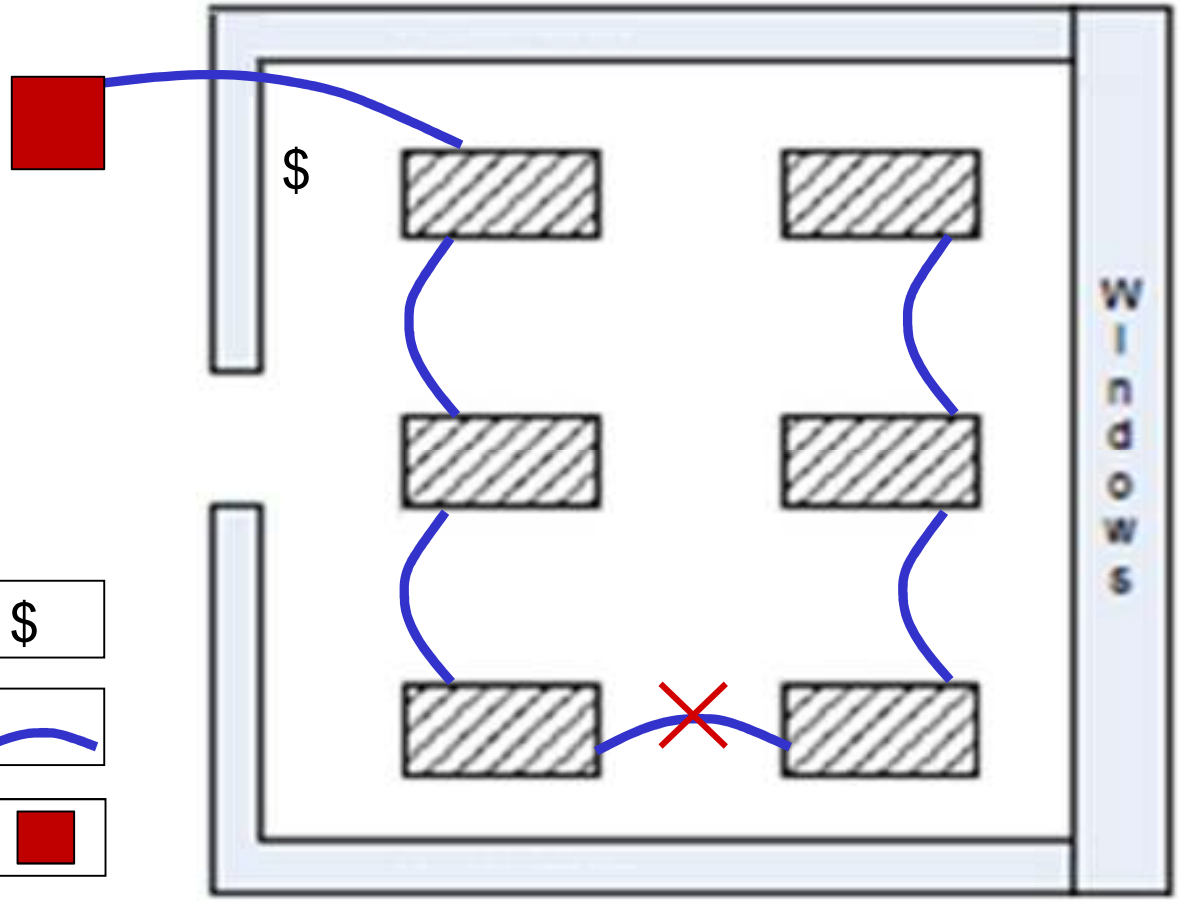
How do I go from an existing space to one that meets IECC 2009?



Line Voltage Switch	$
Power Wiring	
Timeclock	

Implementation

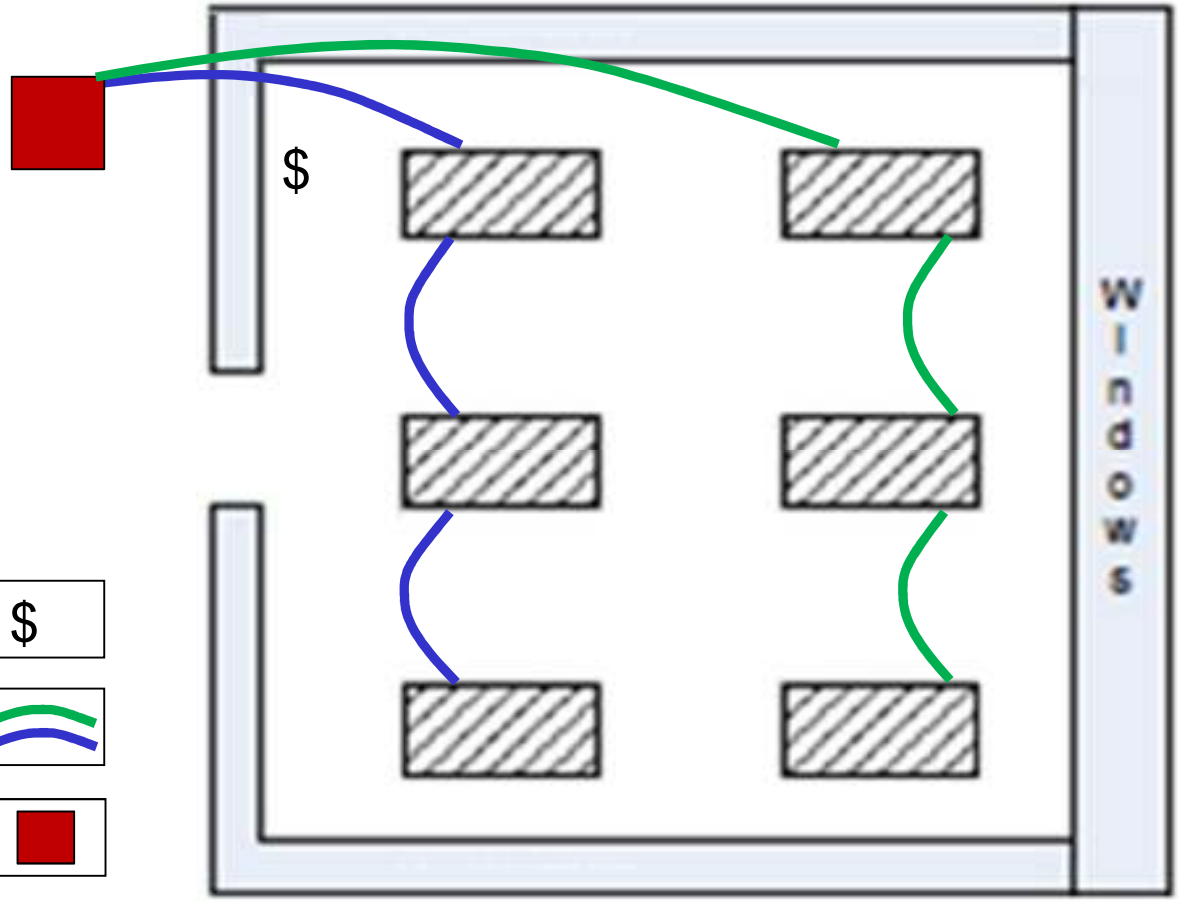
How do I go from an existing space to one that meets IECC 2009?



Line Voltage Switch	$
Power Wiring	
Timeclock	

Implementation

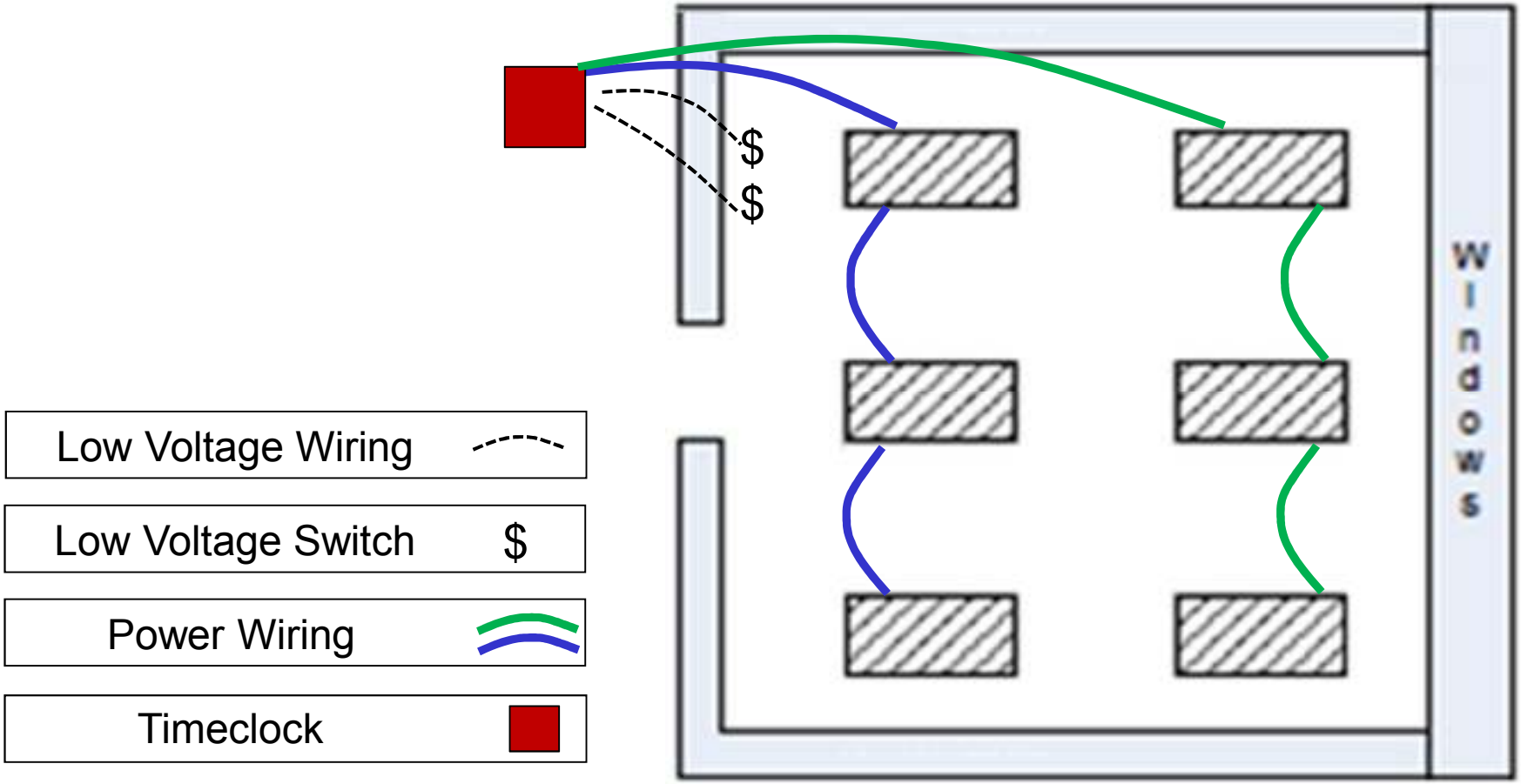
How do I go from an existing space to one that meets IECC 2009?



Line Voltage Switch	$
Power Wiring	
Timeclock	

Implementation

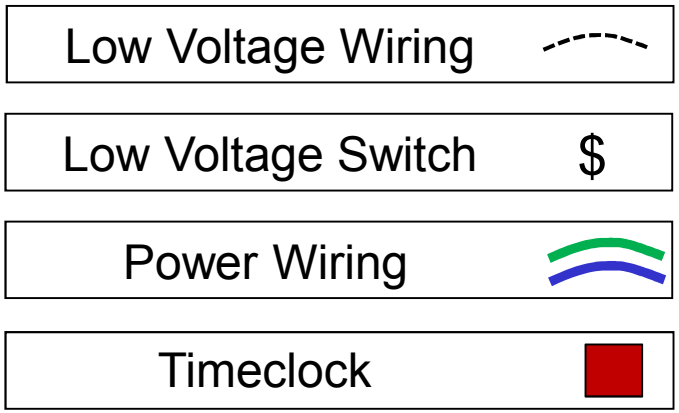
How do I go from an existing space to one that meets IECC 2009?

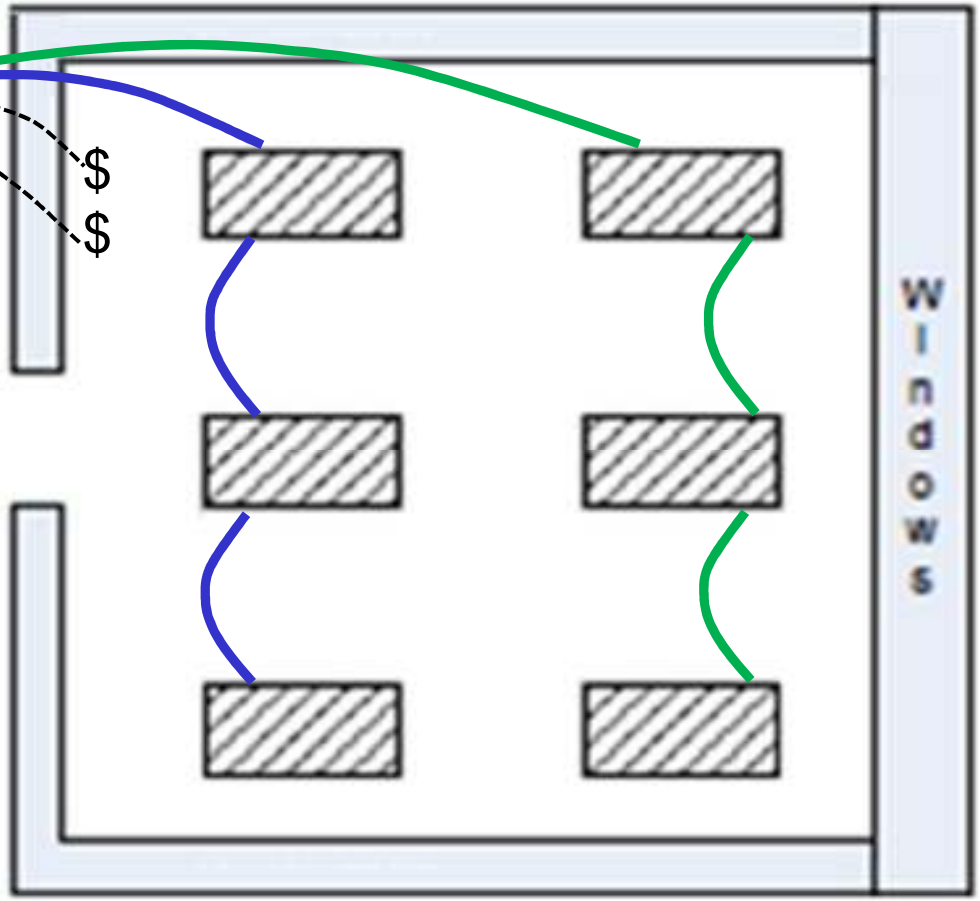


Implementation

How do I go from an existing space to one that meets IECC 2009?

This is normally installed in an electrical closet and controls multiple circuits in multiple rooms



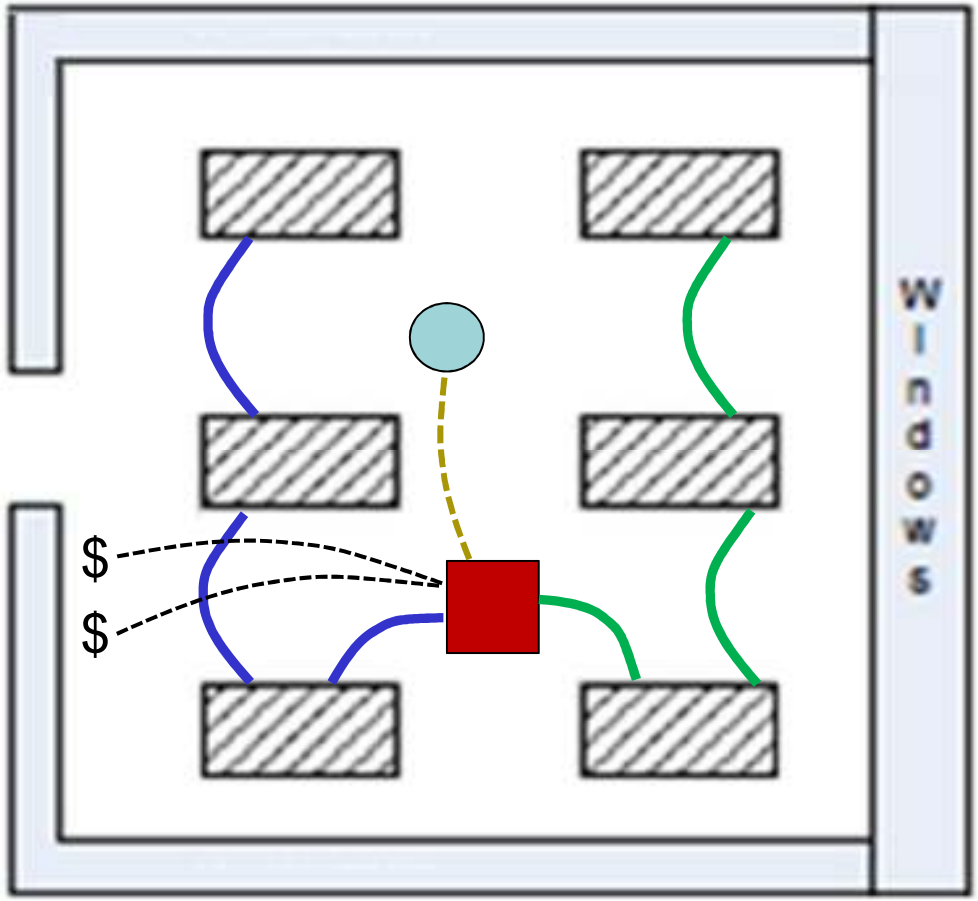


Implementation

How do I go from an existing space to one that meets IECC 2009?

- Use Occupancy Sensor instead

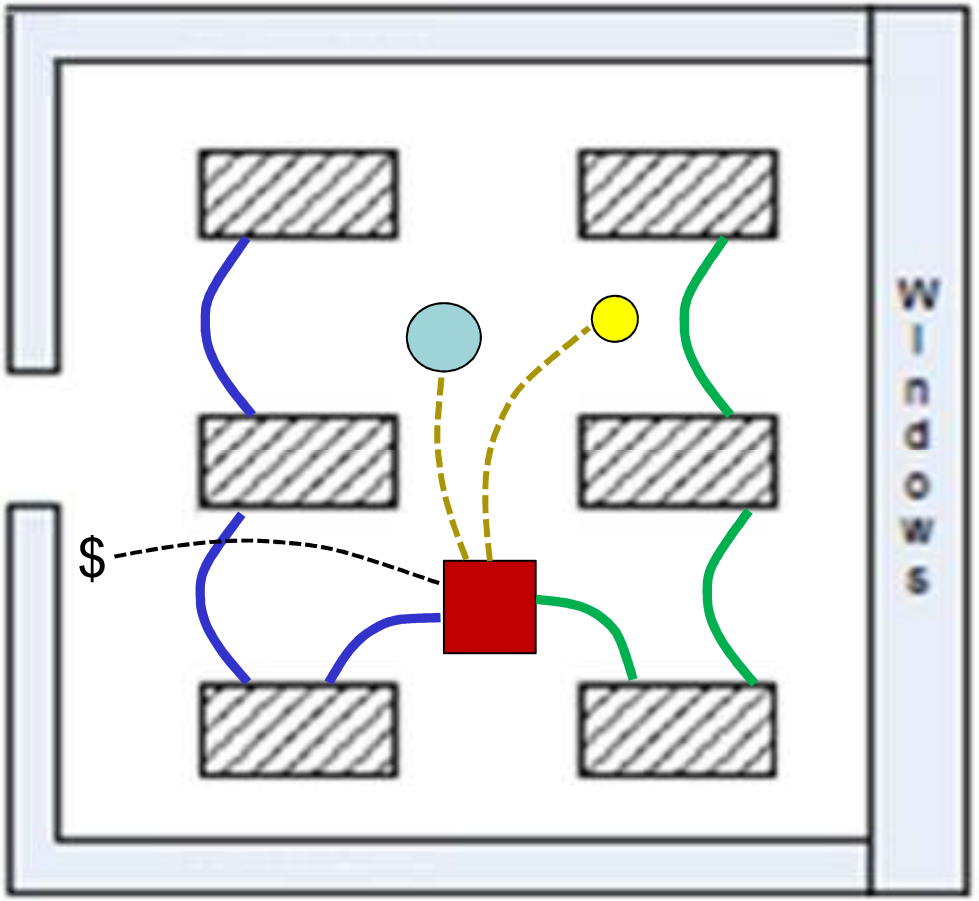
Using an occupancy sensor, I avoid home-running control and power wiring back to a central timeclock device.



Implementation

Back to our example with IECC 2012 . . .

- The power/control wiring could be one of many things:
  - Step-dimming with 3 x #12 wires
  - 0-10V dimming with a pair each of line and low voltage wires
- How can I make this simpler?
  - Control independent of power wiring
  - Wireless control



Implementation

Wireless and Digital Dimming Control

- Digital dimming ballasts
  - Simplify design
- The power/control wiring:
  - A pair each of line and low voltage wires
  - Independent of zoning
- Wireless control
  - No low voltage wires to run
  - Reconfigure space without re-wiring