CASDEM Energy Management Lighting Control Strategies

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Learning Objectives

1. Discuss basic goals of ASHRAE 90.1 2010 lighting standards

2. Methods of energy savings achieved by efficient lighting control technologies

3. Examples of control technologies and applications
   (wired vs. wireless)

Lighting Control Terminology

- Occupancy vs. Vacancy sensors
  - Auto On/Auto Off vs. Manual On/Auto Off
- Daylight (photocell) harvesting
  - Measures natural available light level in space and adjusts artificial light accordingly (dimming or switching)
- Plug-in appliance module
  - Controls “phantom loads” that draw power even when off

    Ex: computer monitors, phone/laptop chargers, space heaters (any appliance that doesn’t require a start-up or shut-down process, like a computer tower or cable box)
- Personal control
  - Remote control of lighting in space (studies show people tend to use less lighting energy if they have ability to control light level)

What is ASHRAE 90.1 2010?

- **ASHRAE: A**merican **S**ociety of **H**eating, **R**efrigeration, and **A**ir Conditioning **E**ngineers
- ASHRAE 90.1 (Energy Standard for Buildings Except Low-Rise Residential Buildings) is a US standard that provides minimum requirements for energy efficient designs for buildings
- DOE mandates that all states must adopt 90.1 2010 OR accepted equivalent by **October 18, 2013** for all new building construction
- Lighting renovation/alteration of 10% or more of the *connected lighting load* must also follow standards

ASHRAE 90.1-2010 Lighting Control Requirements

- Manual On or Partial On: Vacancy sensors
- Automatic Shut-off: Occupancy and/or Vacancy sensors
- Space (personal) Control
- Occupant Sensor Control
- Multi-level Lighting Control
- Stairwell Lighting Control
- Daylight Zone Control
- Functional Testing

Automatic Lighting Control

Occupancy sensors, timer switch, or multi-scene controls are required in:

- Classrooms (except shop, lab)
- Conference/meeting/training rooms
- Employee break rooms
- Storage and supply rooms between 50 ft^2 and 1000 ft^2
- Rooms used for document copying and printing
- Office spaces up to 250 ft^2
- Restrooms
- Dressing, locker, and fitting rooms

  -Note: occupancy sensors must be manual-on or auto-on to ***not more than 50% lighting power*** except in some spaces (corridors, stairwells, restrooms, building entrances, lobbies)

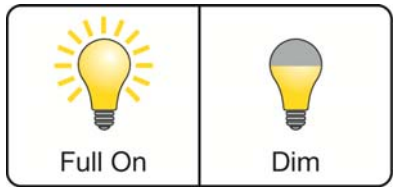
ASHRAE Space Requirements

ASHRAE 90.1-2010	90.1-2010 Requirements by Space							
	Space / Area Control	Restricted to Manual ON *or* Restricted to Partial Automatic ON	Multi-level Lighting Control	Occupant Sensor Control	Automatic Daylight Responsive Controls	Stairwell Lighting	Automatic Lighting Shutoff	Functional Testing
Space Types	9.4.1.2	9.4.1	9.4.1.2a	9.4.1.2b	9.1.14-5	9.4.1.6g	9.4.1.1	9.4.4
Classroom/Lecture Hall/Training Room	REQ	REQ	REQ	REQ	REQ		REQ	REQ
Conference/Meeting/ Multipurpose Room	REQ	REQ	REQ	REQ	REQ		REQ	REQ
Corridor	REQ				REQ		REQ	REQ
Office (enclosed <250ft^2)	REQ	REQ	REQ	REQ	REQ		REQ	REQ
Office (open)	REQ		REQ		REQ		REQ	REQ
Restroom	REQ			REQ	REQ		REQ	REQ
Storage Room	REQ	REQ		REQ	REQ		REQ	REQ
Stairwell	REQ		REQ		REQ	REQ		REQ

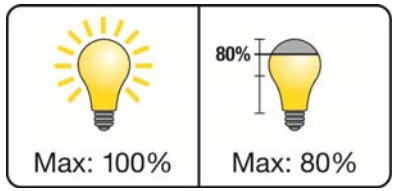
- Table outlines new construction requirements; alterations only require auto shut-off
- All REQ's shall be implemented
- Automatic Daylight Responsive Controls only required in "daylighting zones"

Lighting Control Strategies

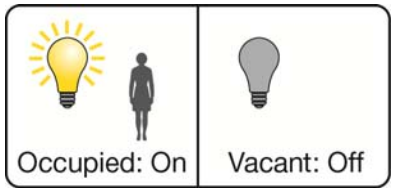
9 Energy Saving Lighting Control Strategies



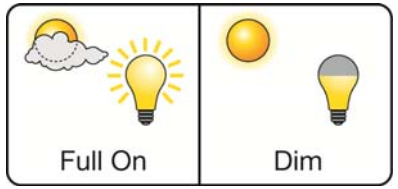
- Dimming



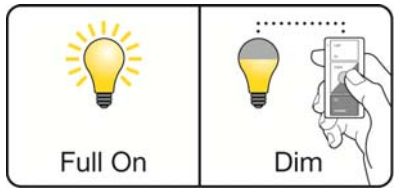
- High-End Tuning



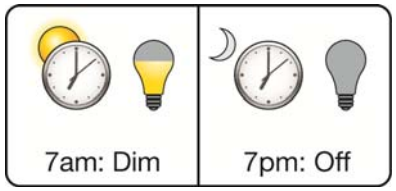
- Occupancy / Vacancy Sensing



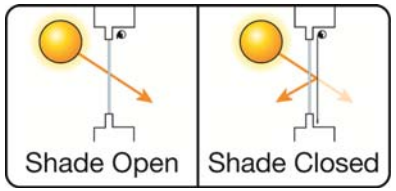
- Daylight Harvesting



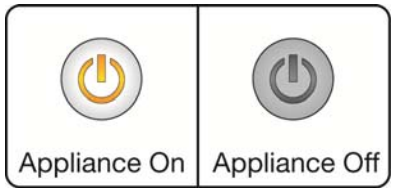
- Personal Dimming Control



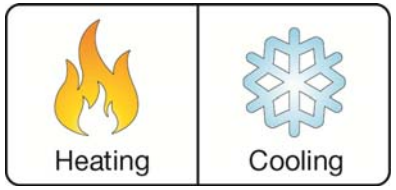
- Scheduling



- Controllable Window Treatments



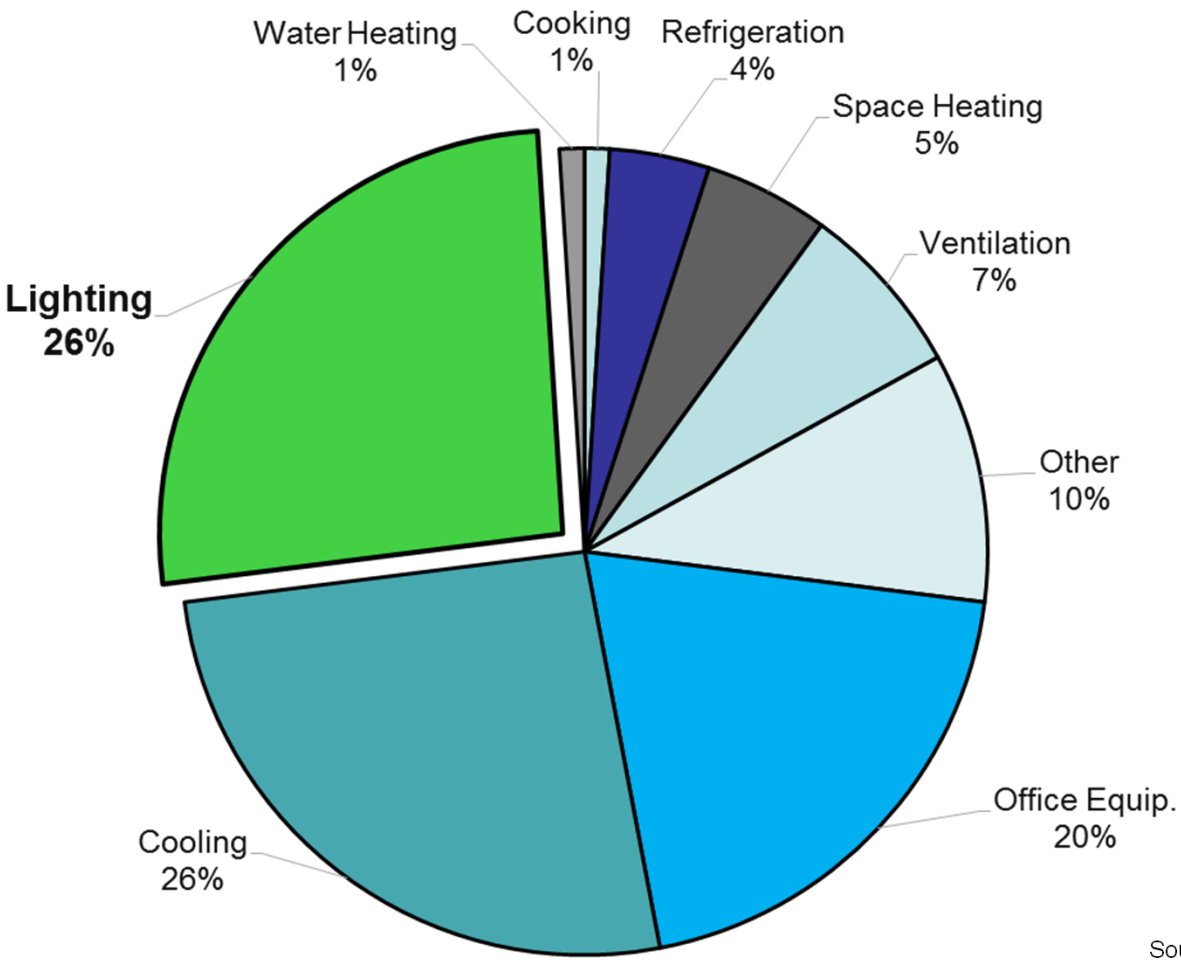
- Plug Load Control



- System Integration

Electricity Usage by K-12's

When used together, these strategies can save significant amounts of lighting energy used in K-12 buildings



K-12 Electricity Usage

- Lighting is the "Low-Hanging Fruit"
- Strategies range from stand-alone to entire campus
- Integration & interaction can lead to further savings

Source: U.S. Energy Information Administration
http://www.energyright.com/business/pdf/Schools_ESCD.pdf

Wired vs. Wireless

- Wireless is fast replacing wired technology in the lighting control industry
- Communication has become very reliable & battery life is much improved
- Benefits are numerous:
  - Faster installs/less material
  - Easily retrofitable/moveable
  - Competitive cost compared to wired options

Wired vs. Wireless

- Example: Adding occ/vac sensor in small office
- Cost to install wired switches & sensors is greater than wireless
  - -Tangibles: Parts (switch, sensor, wire, conduit, paint, drywall) & labor
  - -Intangibles: Install time, repair/maintenance, interruption time
- Wireless products have higher up-front cost but significantly reduce labor time and need for additional materials to complete project

Wireless Tech & Products

- There are a variety of wireless lighting control products available for almost any solution
- Common products include:
  - Occupancy/Vacancy sensors
  - Daylight sensors
  - Plug-load controls
  - Personal remote control
  - Power Packs
- Many products are designed to work together as small “systems”

Planning A Retrofit

There are many things to consider before choosing a solution for your retrofit or design that fall under ASHRAE:

1. Is Occupancy / Vacancy sensing required
2. Is daylight harvesting required
3. Is control of overhead lighting required
4. Is control of plug-loads required
5. Is integration with 3rd party systems required
6. Are personal / additional points of control required

Many wireless lighting control products are capable of fulfilling all of these requirements to meet ASHRAE code

In-Wall Occupancy/Vacancy Sensors

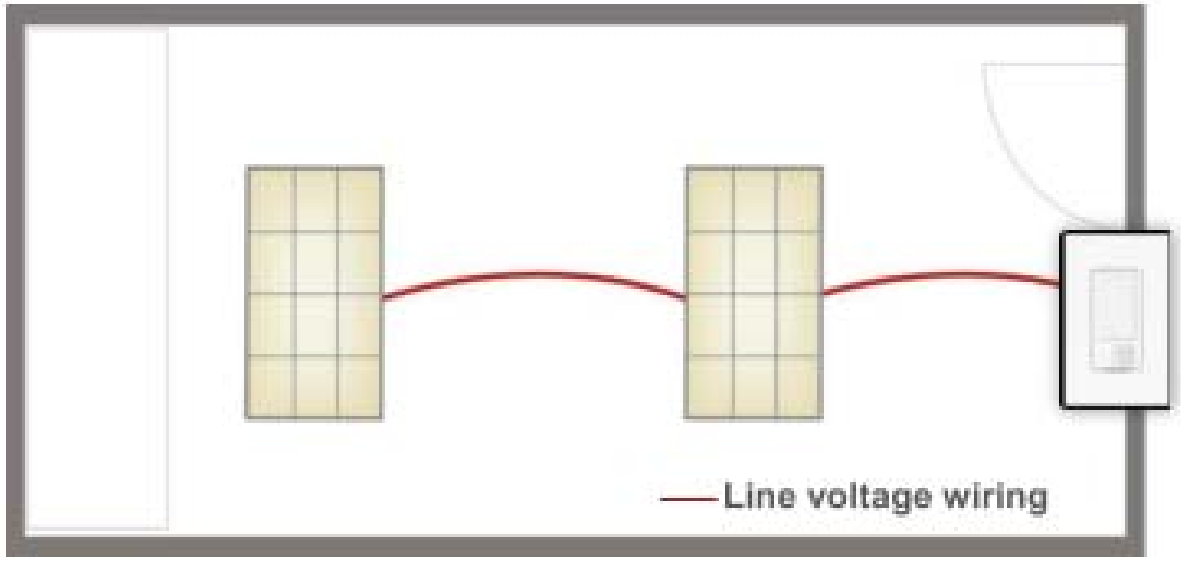
In-Wall sensors are the most simple, cost-effective way to reduce wasted lighting energy

- Ideal solution for maintenance closets, single bathrooms without stalls, and private offices
- Simply replace existing switch and start saving energy
- Many include options for:
  - Occupancy or Vacancy settings
  - Adjustable time-out
  - Daylight sensing with override
  - Adjustable sensitivity settings
  - Integration with motor loads

Application: Storage Closet

Lights are frequently left on in closets when hands are full or you're in a rush. Often times the need for lights to be on is not necessary, given possible ambient light from windows or hallways.

- Replacing the existing switch with a vacancy sensor is cost-effective AND instantly saves energy
- Manual on / Auto off eliminates accidental waste of energy



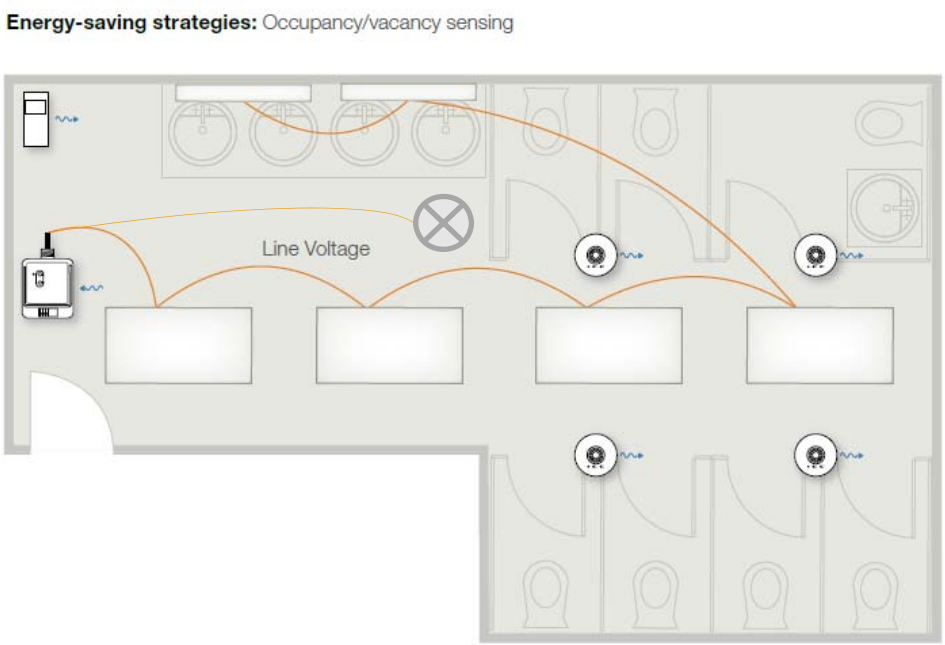
Typical Savings: 30%*

*All savings based on going from manual shutoff to the above mentioned strategies. Cost does not include installation. See final page for references.

Application: Restroom

- Design Strategy:
  - Incorporate occupancy/vacancy sensors
  - Automatic On/Off of lights & exhaust fan

Application: Restroom



- J-box power pack

- Corner-mount occ sensor

- Ceiling-mount occ sensor

- Power Pack installs in the ceiling and switches the lighting & exhaust fan
- Mix of corner mount and ceiling mount sensors to ensure coverage and avoid accidental lights-off

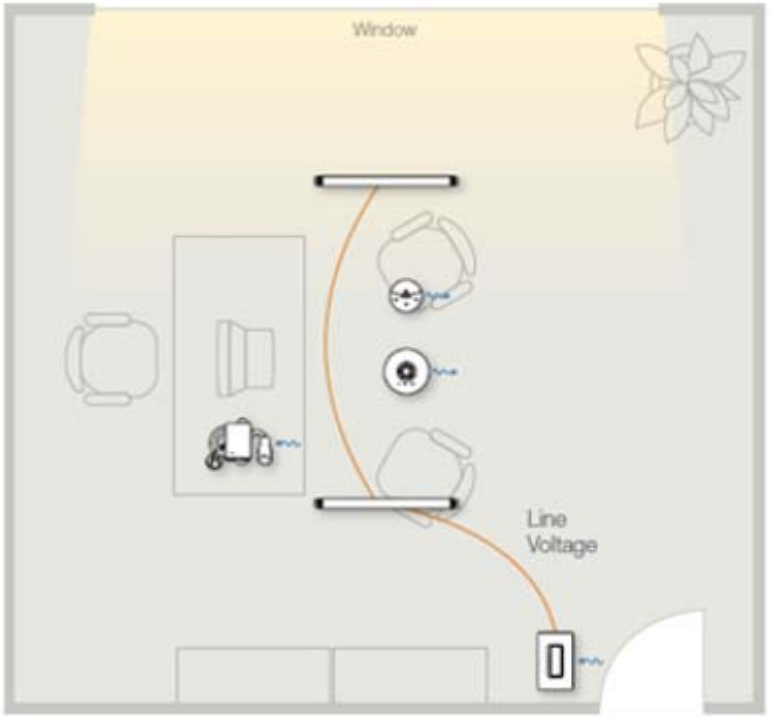
Typical Savings: 50%*

*All savings based on going from manual shutoff to the above mentioned strategies. Cost does not include installation. See final page for references.

Application: Private Office

- Design Goals:
  - Automatic shutoff of lights when the room is empty
  - Daylight harvesting
  - Appliance Control

Application: Private Office

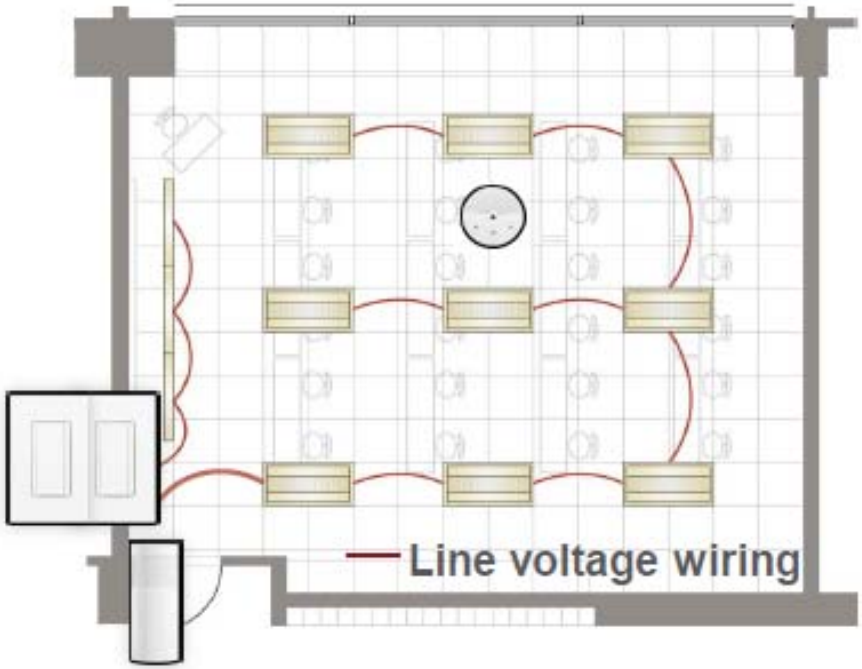


- Wireless switch easily replaces existing wall switch
- Plug-in appliance module controls plug loads (monitor, phone charger, etc)
- One wireless occupancy sensor communicates with all load controllers (controls lights and plug-in module)
- Daylight sensor can override occupancy/vacancy sensor if enough natural light is present (desired light levels can be determined by occupant)

Application: Classroom

- Design Goals:
  - Incorporate occupancy/vacancy sensor
  - Daylight harvesting along window

Classroom: Perimeter Retrofit



Lighting Control Strategies

- Occupancy/Vacancy sensing
- Wireless switching
- Daylight harvesting

Typical Savings: 45%*

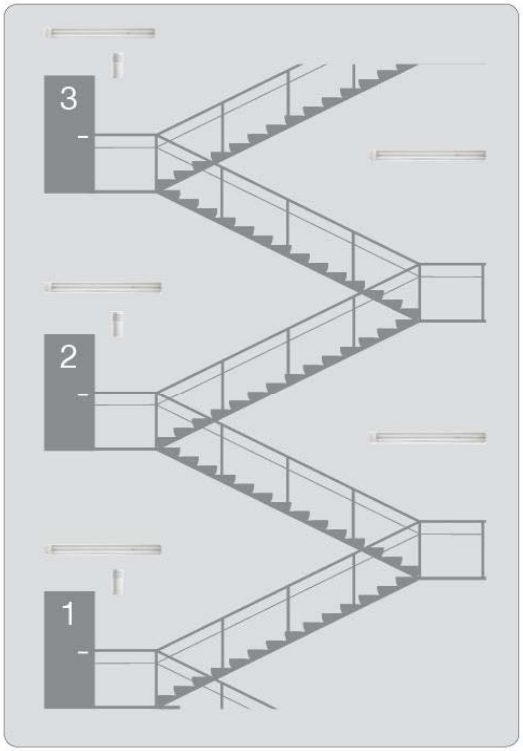
*All savings based on going from manual shutoff to the above mentioned strategies. Cost does not include installation. See final page for references.

Application: Stairwell

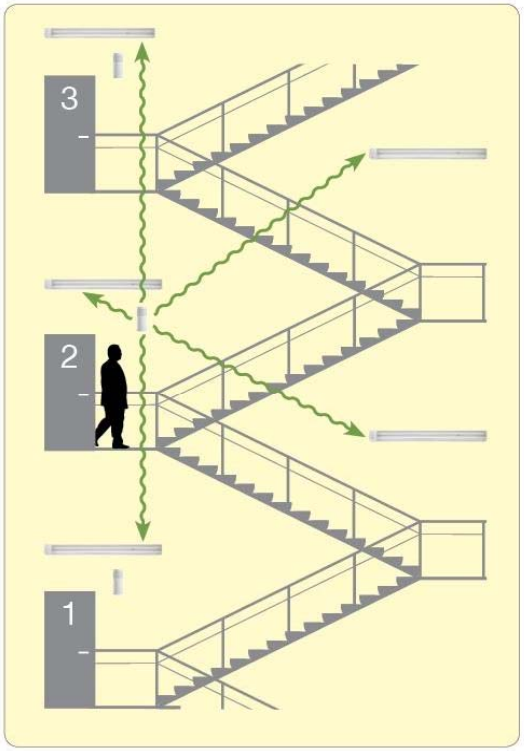
- Design Goal:
  - Eliminate wasted energy in unoccupied stairwells
  - Incorporate wireless sensors and fixture-based receivers
  - Unoccupied light level = 10%
  - Occupied light level = 80%

Application: Stairwell

Unoccupied: 10% Light Level



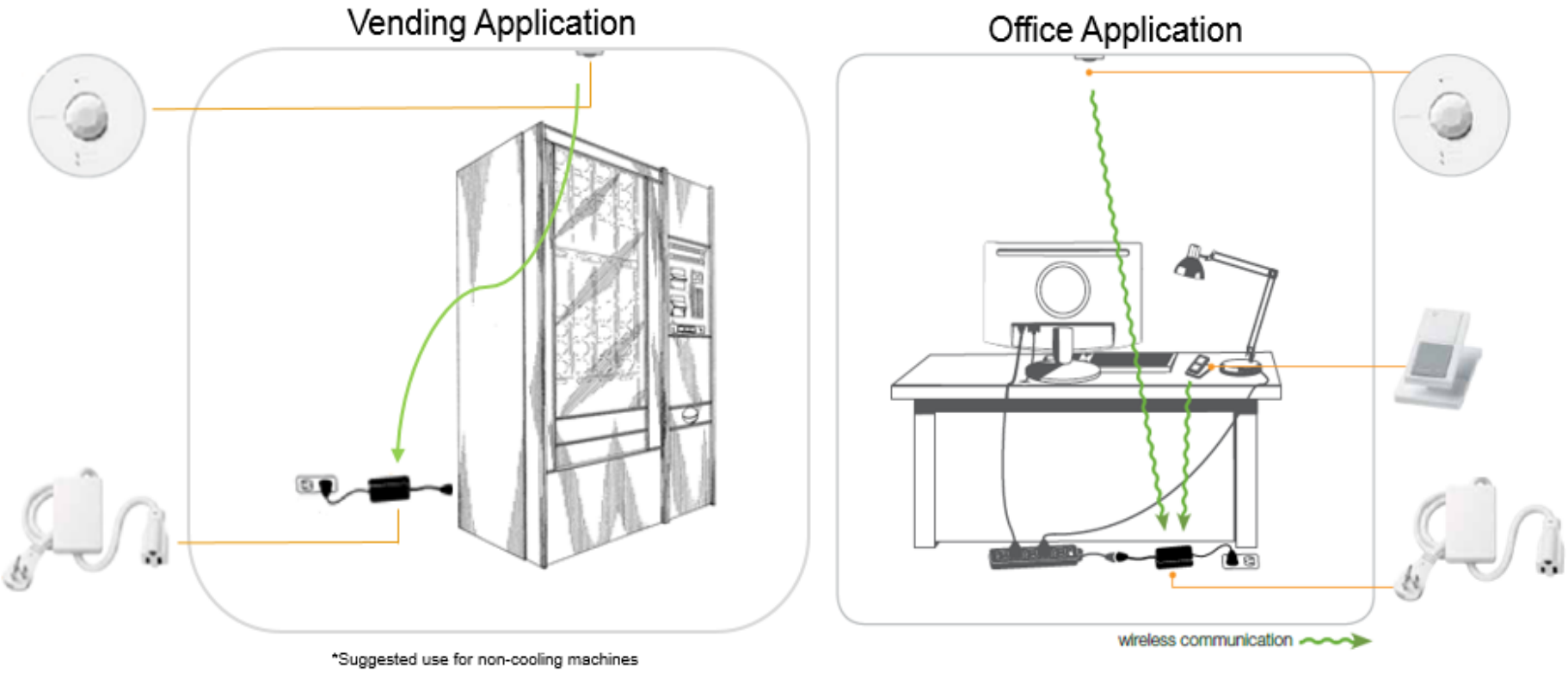
Occupied: 80% Light Level



- Wireless sensors can associate to as many fixtures as desired, given they are within communication range
- Wireless sensors communicate to fixture-embedded receivers, bringing the lights down to minimum required level when unoccupied and back to high-end when occupied

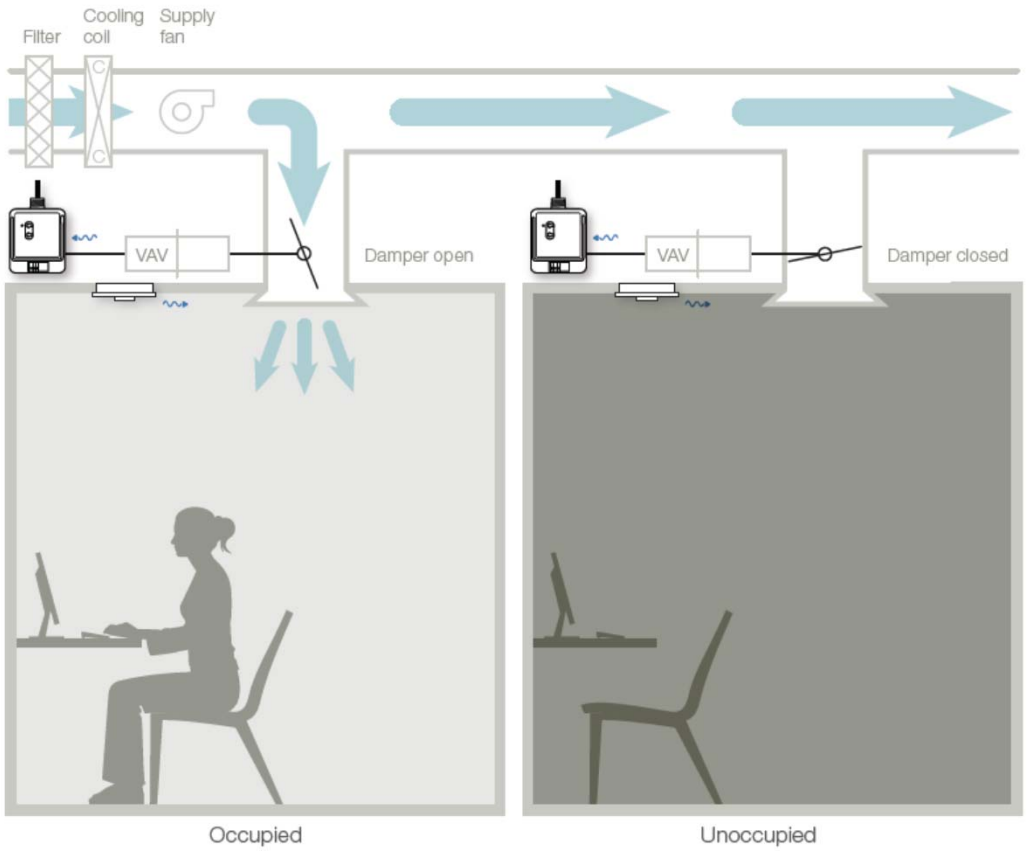
Plug-In Modules

- Switches plug loads off when not in use through manual and/or automatic controls
- ASHRAE 90.1 requires offices & computer classrooms to have 50% “switched” outlets
- Use with task lighting, monitors, printers, personal heaters, chargers, and even vending machines*
- Easy plug-in installation, no tools required



*Suggested use for non-cooling machines

Application: HVAC Integration



- The wireless sensor indicates room occupancy to the power pack tied into the VAV terminal unit to open & close the HVAC damper in the room
- When associated to a wireless switch, the sensor can also shut off the lights when the room becomes unoccupied
- Associating a plug-in module further increases energy savings in the room

Additional Energy Code Info

Energy codes by state

- www.energycodes.gov
- www.energycodesocean.org
- www.ashrae.org
- www.iccsafe.org

Energy Savings References

All savings numbers based on data collected from independent studies and the following journal articles:

- 1.VonNieda B, Maniccia D, & Tweed A. 2000. An analysis of the energy and cost savings potential of occupancy sensors for commercial lighting systems. Proceedings of the Illuminating Engineering Society. Paper #43.

- 2.Williams A, et al. 2012. Lighting Controls in Commercial Buildings. Leukos. 8(3) pg 161-180.

- 3.Reinhart CF. 2002. Effects of interior design on the daylight availability in open plan offices. Study of the American Commission for an Energy Efficient Environment (ACE) Conference Proceedings. To achieve maximum lighting savings, automated shades are utilized.

Questions / Concerns

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ROCKY MOUNTAIN ASSOCIATION OF ENERGY ENGINEERS (RMAEE)

Who Are We?

AEE MISSION

- The mission of the Association of Energy Engineers is to promote the scientific and educational interests of those engaged in the energy industry and to foster action for sustainable development.
- www.aeecenter.org

AEE MISSION (CONT)

- The Association of Energy Engineers (AEE), a nonprofit organization of 9,500 members in 69 countries, is your source for information on the dynamic field of energy efficiency, utility deregulation, facility management, plant engineering, and environmental compliance. With a full array of information outreach programs from technical seminars, conferences, books, job listings, and certification programs, AEE offers a variety of information resource tools.

AEE OFFERINGS

- ~60 local chapters
- Technical publications/online journals
- Professional books
- Divisions/councils and newsletter
- Conferences and expos
- Seminars

AEE CERTIFICATIONS

- CRM – Certified Carbon Reduction Manager (New!)
- CEA – Certified Energy Auditor (New!)
- CSDP – Certified Sustainable Development Professional
- BEP – Certified Business Energy Professional
- DGCP –Certified Distributed Generation and Cogeneration Professional
- CBCP – Certified Building Commissioning Professional
- CGD – Certified GeoExchange Designer
- GBE – Certified Green Building Engineer
- CIAQP – Certified Indoor Air Quality Professional
- CLEP – Certified Lighting Efficiency Professional
- CPQ – Certified Power Quality Professional

RMAEE MISSION

- Help raise the level of awareness on energy engineering best practices, trends, and new developments/technologies
- To build a community of resources of fellow energy nerds (*this is meant as a compliment*)
- Recognize CO individuals/organizations through National AEE awards
- Scholarship opportunities (and mentoring) for students

http://www.rmaee.org/

RMAEE MISSION

- Provide annual CEM (certification) training curriculum
  - Typically held annually in the Spring
  - Provide instructor and 4 day course followed by test day
- Hope to eventually offer other AEE certification courses

RMAEE MEMBERSHIP INFO

- National CO members
- ~75+ local members
- Monthly attendance 30-60 members
  - Members & non-members
  - Good cross section of vendors, consultants, energy focused professionals
- Membership is $50/person ($40 if national AEE member)
  - Lunch discount (members $20, non-members $30)
  - Access to past presentations online

RMAEE MEMBER BENEFITS

- Networking opportunities
- Part of an organization
- Learning (through monthly luncheons)
- Reduced monthly meeting fees ($20 vs $30)
- Members only website access
  - Copies of previous monthly presentations
- Free annual events (baseball and holiday mixers)
- Newsletter
  - Advertise open job positions, events, conferences

MONTHLY PRESENTATION TOPICS

- Industry specific topics
- Technical product presentations
- Case Studies
- Governmental programs
- Company sustainability/energy efficiency programs
- Tours
- Other “non-engineering” topics

- Meeting typically held in Arvada (Indian Tree Golf Course)

PAST MONTHLY TOPICS

Month	2013	2012
Jan	How to improve your sales tactics	Solar Gardens
Feb	Vail Resorts sustainability program	E-Star updates and relationship with LEED
Mar	CU-Boulder energy efficiency & RCx efforts + tour	How to use social media
Apr	NREL and Better Building Challenge Program	Risk mitigation (common engineering mistakes in ESPC analysis/contracts)
May	Marriott energy efficiency efforts	Data Center case studies
June July (no meeting)	LED Lighting Technologies	No meetings
Aug	Baseball Game	Baseball Game
Sept	Boiler Technologies and Best Practices	Creative financing for energy efficiency projects
Oct	Annual Forum	Annual Forum
Nov	Thermal Energy Storage and Demand Reduction	NREL Tour of Research Support Facility (RSF) and its energy efficiency features
Dec	Holiday Mixer	Holiday Mixer

FUTURE?

How can RMAEE be useful to CASDEM?

RMAEE PRESIDENT
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