

AIA Provider:
Colorado Green Building Guild
Provider Number: 50111120

Lighting the Next Wave of Energy Efficiency
AIA Course Number: EW02.18.15

Speaker: Kyle Hemmi



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Course Description

With LEDs and advanced lighting controls quickly maturing and prices for both dropping steadily, numerous additional opportunities for cost-effective lighting upgrades are now accessible. Join us for an engaging hands-on update that details the latest in LED technology and provides a glimpse into the future of the imminent LED lighting revolution that is upon us. Find out what is new with lighting controls, as wireless options now abound and are getting more economical each day, in great part because of how easily they integrate with LEDs. We'll explore a wide variety of the best and most challenging lighting upgrade opportunities, review some example case studies for each and give you an opportunity to see and play with some of the best-available products on the market. Don't miss this opportunity to get all your lighting questions answered during this exciting time for lighting.

Learning Objectives

At the end of the this course, participants will be able to:

- .. understand the latest technologies in lighting controls and wireless options, and how easily they integrate with LEDs.
- .. consider the application, project requirements and goals, key considerations, and solution comparisons when choosing appropriate lighting through the evaluation of a number of case study examples.
- .. implement the best solution for new or retrofit lighting installations by exploring a wide variety of the best and most challenging lighting technologies.
- .. compare LED options to other viable options, and understand appropriate applications for Troffer, Interior Highbay, Lamp and Downlight, and Exterior HID.



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Lighting the Next Wave of Energy Efficiency

AIA Course Number: EW02.18.15

Kyle Hemmi, Senior Engineer

February 18, 2015

▲ Agenda

- What technologies and strategies where?
- Four Critical Retrofit Application Case Studies
 - Troffer Retrofits
 - Interior Highbay Retrofits
 - Lamp and Downlight Retrofits
 - Exterior HID Retrofits
- Lighting Controls Opportunities
- New Construction Opportunities

Application Case Studies

- Application
 - Building Types
 - Existing Technologies
 - Efficient Technologies
- Project Requirements & Goals
 - Meet Customer Goals
 - Trade Ally Goals
 - Program Goals
- Key Considerations
- Bottom Line: Solution Comparisons
 - Customer Cost of Electricity
 - Project Savings
 - Trade Ally Sales Revenue
 - Important Dates



Case Studies

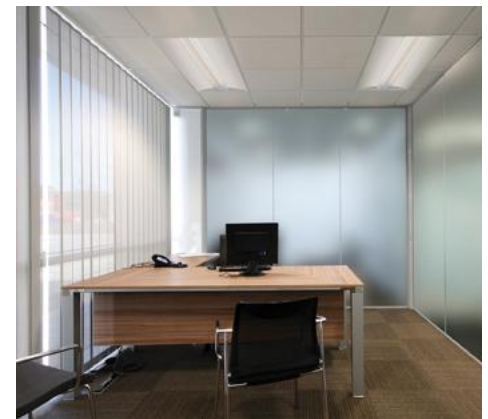
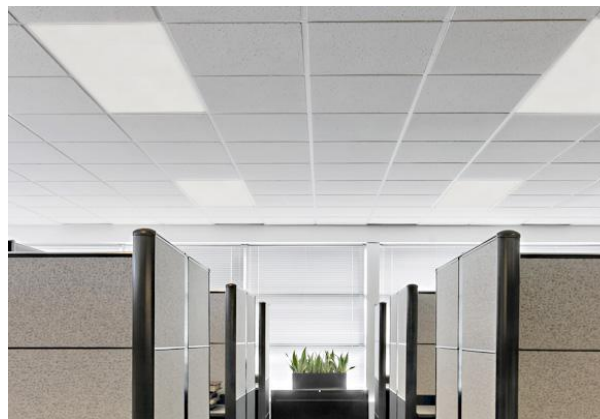
Case Study: Troffer Retrofit

Commercial Office, Education, Healthcare, Others



Application: Troffer Retrofits

- Existing Technology Savings Potential
 - Ideal: T12
 - Good: Standard T8 or T12 Electronic
 - Possible: High-Performance T8 or T5
- Efficient Technology Savings Potential
 - Best: LED Troffer or Kit with Integrated Controls
 - Great: LED Troffer or Kit
 - Good: High-Performance T8 w/ Advanced Optics
 - Caution: LED T8 Replacement Lamps



- Meet Customer Goals
 - **Light levels and uniformity**
 - IES
 - Client perceptions
 - Cost-effectiveness
 - Energy and demand **savings**
 - **Employee productivity**
 - **Aesthetics - Sales**
 - PR
- Trade Ally Goals
 - Good sales and profit margin
 - Reputation and repeat business

A footcandle (fc), the most common unit of measure used for quantifying light levels, is a measure of illuminance with one footcandle being equal to one lumen per square foot. The Illuminating Engineering Society (IES) has established recommended average maintained footcandle levels for a broad range of applications to ensure adequate illumination and safety for occupants. One of the best ways to maximize potential savings in lighting projects is to identify overlit spaces and use these IES recommendations to convince the customer that 'de-lamping' (decreasing their light levels) is both appropriate and desirable. Footcandles are measured with light meters, which cost between \$50 and \$150.





Application and Task	Maintained Horizontal		Maintained Vertical		Comments
	Average (fc) ¹	Range (fc) ²	Average (fc) ¹	Range (fc) ²	
COMMON AREAS					
ATM or Service Kiosk	20	10-40	10	5 - 20	Vertical at face of ATM
Circulation/Corridor	5	2.5 - 10	3	1.5 - 6	Independent Passageway
Conference Room	See Commercial Office				
Filing (Intermittent)	15	7.5 - 30	10	5 - 20	
Restroom (General)	5	2.5 - 10	3	1.5 - 6	
Restroom (Vanities)	15	7.5 - 30	20	10 - 40	See also Fixtures/Lockers/Showers
Lunch & Break Room	10	5 - 20	3	1.5 - 6	
Stairs	5	2.5 - 10	3	1.5 - 6	Not High Activity or Surveillance
COMMERCIAL OFFICE					
Open Office (Desk)	30	20 - 50	-	-	Measured at desk height
Private Office (Desk)	30	20 - 50	-	-	Measured at desk height
Conference Room (Table)	30	15 - 60	-	-	
Whiteboard (Reading)	-	-	15	7.5 - 30	
Whiteboard (Presenting)	-	-	30	15 - 60	
Presentation Screen (Projector)	-	-	1.5	1.5 - 6	
Lunch & Break Room	15	5 - 20	-	-	
EDUCATIONAL (SCHOOLS)					
Classroom (Challenging Applications) ³	25	25 - 100	3.75	3.75 - 15	Arts, Blueprints, Lab Bench; Measured at desk height
Classroom (Typical Applications) ³	15	15 - 60	2.5	2.5 - 10	Reading, Writing; Measured at desk height
Auditorium/Lecture Hall (AV, Notes)	5	2.5 - 10	5	2.5 - 10	
Auditorium/Lecture Hall (AV)	1	0.5 - 2	5	2.5 - 10	
Auditorium/Lecture Hall (no AV)	10	5 - 20	5	2.5 - 10	
Gymnasium-Class I (Pro or Div. 1 College)	100	-	30	-	See NCAA & professional guides; > 5000 spectators
Gymnasium-Class II (Div. 2 or 3 College)	75	-	20	-	Competition; ≤ 5000 spectators
Gymnasium-Class III (High School)	50	-	150	-	Competition; Some spectators
Gymnasium-Class IV (Elementary)	30	-	100	-	Competition or Recreational Play; No provision for spectators

Troffer Key Considerations

- Age of Occupants
 - Some applications require adjustments
 - Think schools and nursing care
- Don't forget about the walls
 - Vertical footcandles
 - Uniformity
- The Cheaper the ...?
 - Ask why
 - Compare Apples to Apples
 - Weigh company history and reputation
 - Think longer term
- Be Objective
 - Watts are Watts
 - Footcandles are Footcandles
- Think Integrated Controls



Bottom Line: Office Building Troffers*

				
	Super T8	LED Integrated Controls	LED Troffer or Kit	LED T8 Lamp
Bottom Line	Lower Initial Cost	Deepest savings	Better Option	Proceed with Caution
Customer Cost of Electricity	\$0.0284 per kWh	\$0.0276 per kWh	\$0.0278 per kWh	\$0.024 per kWh
Project Savings (MWh; %)	27 MWh; 62%	36 MWh; 82%	29 MWh; 66%	27 MWh; 61%
Example** Incentive Levels	\$15/fixture; \$1,500 project	\$62/fixture; \$6,200 project	\$54/fixture; \$5,400 project	\$38/two lamps; \$3,800 project
Important Dates	Inferior in 2015	Best Option in 2015	Best non-control Option in 2015	Lighting Quality?; Lower initial cost

* Small Office example: Retrofit of 100 four-lamp standard electronic T8 fixtures

** **Estimates for illustration ONLY** using Efficiency Works Rebate Application (v1.2); Consult program team for your project

Case Study: Interior Highbay Retrofit

Warehouse, Manufacturing, Gym, Retail, Others



Application: Interior Highbay Retrofit

- Existing Technology Savings Potential
 - Ideal: High Pressure Sodium, Metal Halide, or **Pulse Start MH HID**
 - Good: T12 Magnetic
 - Possible: T8 or T5HO
- Efficient Technology Savings Potential
 - Best: LED Highbay with Integrated Controls
 - Great: LED Highbay
 - Good: High-Performance T8
 - Good: T5HO with reduced-wattage lamps



Interior Highbay Requirements and Goals

- Meet Customer Goals
 - Light levels and **uniformity**
 - IES
 - Client perceptions
 - Cost-effectiveness
 - Energy and demand savings
 - Employee productivity/**safety**
 - Aesthetics - **Sales**
 - PR
- Trade Ally Goals
 - Good sales and profit margin
 - Reputation and repeat business

Application and Task	Maintained Horizontal		Maintained Vertical		Comments
	Average (fc) ¹	Range (fc) ²	Average (fc) ¹	Range (fc) ²	
EXTERIOR					
Parking (Covered)	5	-	-	-	1 Min; 10:1 Max-Min Uniformity
Parking (Uncovered) Zone 3 (Urban)	1.5	0.75 - 3	0.8	0.4 - 1.6	
Parking (Uncovered) Zone 2 (Suburban)	1	0.5 - 2	0.6	0.3 - 1.2	
Gas Station Canopy	12.5	10 - 15	-	-	
Safety (Planning Emergency)	1	0.5 - 2	-	-	For security issues, raise Avg to 3
INDUSTRIAL/MANUFACTURING					
Assembly & Inspection (Simple)	30	15 - 60	30	15 - 60	
Component Manufacture (Large Part)	50	25 - 100	50	25 - 100	
Component Manufacture (Med. Part)	50	25 - 100	50	25 - 100	
Assembly & Inspection (Difficult)	100	50 - 200	100	50 - 200	
Component Manufacture (Fine Part)	100	50 - 200	100	50 - 200	
Assembly & Inspection (Exacting)	300	150 - 600	-	-	
RETAIL					
Discount/Warehouse/Drug/Convenience (Ambient)	50	25 - 100	20	10 - 40	
Discount/Warehouse/Drug/Convenience (Perimeter)	-	-	50	25 - 100	
Department Store (Ambient)	40	20 - 80	15	7.5 - 30	
Department Store (Perimeter)	-	-	75	25 - 150	
Accent Lighting (Displays)	-	-	-	-	3-10 times more than ambient
RETAIL (AUTOMOTIVE SALES)					
Showroom	50	25 - 100	10	5 - 20	
Service Area	50	25 - 100	30	15 - 60	
Sales Lot (Exterior) Zone 3 (Urban)	20	10 - 40	20	10 - 40	
Sales Lot (Exterior) Zone 2 (Suburban)	15	7.5 - 30	15	7.5 - 30	
RETAIL (GROCERY)					
Circulation	20	10 - 40	7.5	3.5 - 15	
General Retail	50	25 - 100	20	10 - 40	
Perimeter	-	-	50	25 - 100	
WAREHOUSING & STORAGE					
Bulky Items - Large Labels	10	5 - 20	5	2.5 - 10	
Small Items - Small Labels	30	15 - 60	15	7.5 - 30	
Receiving/Shipping Dock	10	5 - 20	3	1.5 - 6	
Receiving/Staging	30	15 - 60	10	5 - 20	
EDUCATIONAL (SCHOOLS)					
Gymnasium-Class I (Pro or Div. 1 College)	100	-	30	-	See NCAA & professional guides; > 5000 spectators
Gymnasium-Class II (Div. 2 or 3 College)	75	-	20	-	Competition; ≤ 5000 spectators
Gymnasium-Class III (High School)	50	-	150	-	Competition; Some spectators
Gymnasium-Class IV (Elementary)	30	-	100	-	Competition or Recreational Play; No provision for spectators

Interior Highbay Key Considerations

- Maintenance Good Selling Point

- Those ceilings are HIGH



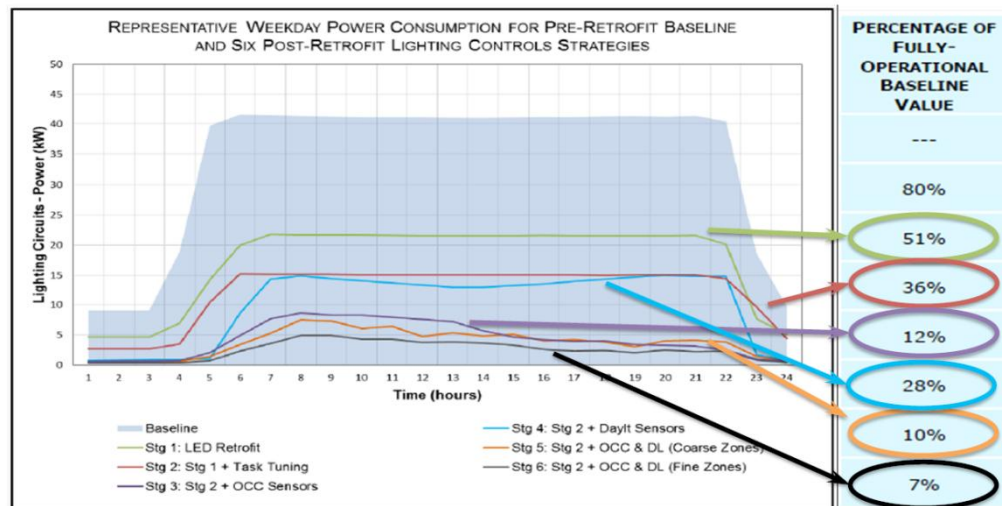
- Delivered Footcandles

- Know what you need
- Speak to Uniformity
- All Highbay/Lowbay jobs are not created equal







- Controls Opportunities

- Big opportunities with Granular Control
- Both demand and energy
- Task Tuning/Lumen maintenance alone may justify



Bottom Line: Interior Highbay*

				
	LED Highbay	LED Highbay w/ Integrated Controls	High- Performance T8	T5HO Reduced- Wattage Lamps
Bottom Line	Okay Option in 2015	Big savings; Best w/ Low Occupancy	Most Cost-effective Option	Good Option
Customer Cost of Electricity	\$0.0177 per kWh	\$0.0189 per kWh	\$0.0137 per kWh	\$0.0182 per kWh
Project Savings (MWh; %)	106 MWh; 67%	127 MWh; 80%	95 MWh; 60%	85 MWh; 53%
Example** Incentive Levels	\$220/fixture; \$22,000 project	\$250/fixture; \$25,000 project	\$95/fixture; \$9,500 project	\$90/fixture; \$9,000 project
Important Dates	Prices drop & Savings Up in 2015	Best Option in 2015 if Applies	Think LED & Controls in 2015	Think LED & Controls in 2015

* Medium Warehouse example: Retrofit of 80 Metal Halide (400W) Luminaires

** **Estimates for illustration ONLY** using Efficiency Works Rebate Application (v1.2); Consult program team for your project

Case Study: Lamp/Downlight Retrofit

Ubiquitous Indoors for Commercial and Residential



Application: Lamp and Downlight Retrofits

- Existing Technology Savings Potential
 - Ideal: Incandescent
 - **Good: Halogen or Halogen IR**
 - Possible: CFL
- Efficient Technology Savings Potential
 - Best: LED Trim Kits*
 - Great: LED Lamps
 - Not Recommended: CFLs



* LED Downlight or Pendent Luminaires for High Ceilings

Lamp and Downlight Requirements and Goals

- Meet Customer Goals
 - Light levels and uniformity
 - IES
 - Client perceptions
 - Cost-effectiveness
 - Energy, demand and **Maintenance** savings
 - Employee productivity and opinion
 - **Aesthetics - Sales**
 - PR
- Trade Ally Goals
 - Good sales and profit margin
 - Reputation and repeat business

Application and Task	Maintained Horizontal		Maintained Vertical		Comments
	Average (fc) ¹	Range (fc) ²	Average (fc) ¹	Range (fc) ²	
EXTERIOR					
Parking (Covered)	5	-	-	-	1 Min; 10:1 Max-Min Uniformity
Parking (Uncovered) Zone 3 (Urban)	1.5	0.75 - 3	0.8	0.4 - 1.6	
Parking (Uncovered) Zone 2 (Suburban)	1	0.5 - 2	0.6	0.3 - 1.2	
Gas Station Canopy	12.5	10 - 15	-	-	
Safety (Building Exterior)	1	0.5 - 2	-	-	For security issues, raise Avg to 3
INDUSTRIAL/MANUFACTURING					
Assembly & Inspection (Simple)	30	15 - 60	30	15 - 60	
Component Manufacture (Large Part)	50	25 - 100	50	25 - 100	
Component Manufacture (Med. Part)	50	25 - 100	50	25 - 100	
Assembly & Inspection (Difficult)	100	50 - 200	100	50 - 200	
Component Manufacture (Fine Part)	100	50 - 200	100	50 - 200	
Assembly & Inspection (Finishing)	300	150 - 600	-	-	
RETAIL					
Discount/Warehouse/Drug/Convenience (Ambient)	50	25 - 100	20	10 - 40	
Discount/Warehouse/Drug/Convenience (Perimeter)	-	-	50	25 - 100	
Department Store (Ambient)	40	20 - 80	15	7.5 - 30	
Department Store (Perimeter)	-	-	75	25 - 150	
Accent Lighting (Displays)	-	-	-	-	3-10 times more than ambient
RETAIL (AUTOMOTIVE SALES)					
Showroom	50	25 - 100	10	5 - 20	
Service Area	50	25 - 100	30	15 - 60	
Sales Lot (Exterior) Zone 3 (Urban)	20	10 - 40	20	10 - 40	
Sales Lot (Exterior) Zone 2 (Suburban)	15	7.5 - 30	15	7.5 - 30	
RETAIL (GROCERY)					
Circulation	20	10 - 40	7.5	3.5 - 15	
General Retail	50	25 - 100	20	10 - 40	
Perimeter	-	-	50	25 - 100	
WAREHOUSING & STORAGE					
Bulky Items - Large Labels	10	5 - 20	5	2.5 - 10	
Small Items - Small Labels	30	15 - 60	15	7.5 - 30	
Receiving/Shipping Dock	10	5 - 20	3	1.5 - 6	
Receiving/Staging	30	15 - 60	10	5 - 20	

Source: All recommendations from the 'The Lighting Handbook' 10th Edition from the Illuminating Engineering Society (IES); Format adapted from Foot Candle Light Guide produced by Energy Trust of Oregon and Lighting Design Lab

- It is the responsibility of the specifier to determine and provide appropriate light levels, so it is strongly recommended that lighting professionals refer to the full IES Handbook or Recommended Practices
- Horizontal - Average maintained foot-candles are measured at horizontal plane
- Vertical - Average maintained foot-candles are measured at vertical plane

¹ At least half of users (occupants) are in the 25 - 65 age range

² Ranges are based on situations where at least half of users are < 25 years of age (Low value) and > 65 years of age (High value)




³ Recommendation for Classrooms assume at least half of users are < 25 years of age (Low range value); When designing the space for students, allowances should be made for the instructor (e.g. task lighting or downlight over desk)

▲ Lamp and Downlight Key Considerations

- Maintenance Savings
 - Don't leave it out of equation
 - Shifting baselines to Halogen IR and CFL
- Don't forget about CFLs...
 - **AS A BASELINE**
 - Maintenance savings is driver
 - Don't pass up a socket
- EASY sale
 - Use these to drive the program savings and activity you need
- Trim Kits have longer EUL
 - Means greater net benefits for program
Don't just stick in lamp 'cuz it is easy
- Controls will come for these too!



Bottom Line: Lamps and Downlights*

			
	LED Trim Kit	LED Lamp	CFLs
Bottom Line	Best Option where Trim Desired	Best Option where No Trim Needed	Inferior Option, in particular pin-base
Customer Cost of Electricity	\$0.010 per kWh	\$0.012 per kWh	\$0.018 per kWh
Project Savings (MWh; %)	69 MWh; 78%	69 MWh; 78%	55 MWh; 62%
Example Incentive Levels	\$17/fixture; \$4,250 project	\$17/fixture; \$4,250 project	\$24/fixture; \$6,000 project
Important Dates	Best option now; Longer EUL	Great option now if don't need trim	No longer best option

* Small Retail : Retrofit of 250 Halogen IR Lamps and Downlights

** **Estimates for illustration ONLY** using Efficiency Works Rebate Application (v1.2); Consult program team for your project

Case Study: Exterior HID Retrofit

Parking Lots, Garages, Wallpacks, Canopies, Others



Application: Exterior HID Retrofits

- Existing Technology Savings Potential
 - Ideal: High Pressure Sodium, **Metal Halide** or Mercury Vapor HID
 - Great: Halogen
 - Possible: CFL or T5HO
- Efficient Technology Savings Potential
 - Best: LED Luminaire with Integrated Controls
 - Great: LED Luminaire
 - Good: LED Retrofit Kit (Caution)



Exterior HID Requirements and Goals

- Meet Customer Goals
 - Light levels and uniformity
 - IES
 - Client perceptions
 - Cost-effectiveness
 - Energy and demand savings
 - Safety
 - Aesthetics – Sales and PR
 - Codes/Ordinances
 - Dark Sky MLO
- Trade Ally Goals
 - Good sales and profit margin
 - Reputation and repeat business

Application and Task	Maintained Horizontal		Maintained Vertical		Comments
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EXTERIOR					
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Gas Station Canopy	12.5	10 - 15	-	-	
Safety (Building Exterior)	1	0.5 - 2	-	-	For security issues, raise Avg to 3
INDUSTRIAL/MANUFACTURING					
Assembly & Inspection (Simple)	30	15 - 60	30	15 - 60	
Component Manufacture (Large Part)					
Component Manufacture (Med. Part)	50	25 - 100	50	25 - 100	
Assembly & Inspection (Difficult)	100	50 - 200	100	50 - 200	
Component Manufacture (Fine Part)					
Assembly & Inspection (Exacting)	300	150 – 600	-	-	
RETAIL					
Discount/Warehouse/Drug/ Convenience (Ambient)	50	25 - 100	20	10 - 40	
Discount/Warehouse/Drug/ Convenience (Perimeter)	-	-	50	25 - 100	
Department Store (Ambient)	40	20 - 80	15	7.5 - 30	
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Service Area	50	25 - 100	30	15 - 60	
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General Retail	50	25 - 100	20	10 - 40	
Perimeter	-	-	50	25 - 100	
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³ Recommendation for Classrooms assume at least half of users are < 25 years of age (Low range value); When designing the space for students, allowances should be made for the instructor (e.g. task lighting or downlight over desk)

Exterior HID Key Considerations

■ Maintenance Selling Point

- Poles are HIGH
- Streetlighting can be monitored



■ Delivered Footcandles

- Know what you need
- Speak to Uniformity
- Exterior light levels are LOW, don't over light areas



■ Get them while their hot

- Find the projects before they get converted
- Market saturation will occur quickly outdoors – particularly in key niches



Bottom Line: Exterior HID*

				
	LED Luminaire w/ Controls	LED Luminaire: Parking Lot	LED Retrofit Kit	LED Luminaire: Wallpack
Bottom Line	Deepest Savings where Applicable	Great Option if No Controls	Proceed with Caution	Great Option; Can Add Controls
Customer Cost of Electricity	\$0.020 per kWh	\$0.023 per kWh	\$0.013 per kWh	\$0.008 per kWh
Project Savings (MWh; %)	290 MWh; 64%	242 MWh; 54%	234 MWh; 52%	26 MWh; 76%
Example Incentive Levels	\$260/fixture; \$52,000 project	\$230/fixture; \$46,000 project	\$220/fixture; \$44,000 project	\$165/fixture; \$4,950 project
Important Dates	Best option now if controls	Best option now if no controls	Some decent options, but careful	Best option now; Good w/ controls

* Parking lot example: Retrofit of 200 Metal Halide (400W) Heads plus 30 Wallpacks (250W)

** **Estimates for illustration ONLY** using Efficiency Works Rebate Application (v1.2); Consult program team for your project

Case Study: Lighting Controls

Ubiquitous






Application: Lighting Controls

- Existing Technology Savings Potential
 - Ideal: Intermittent Use Areas with Daylight Contribution
 - Good: Intermittent Use Areas or Daylight Contribution Only
 - Possible: High-use areas with integrated controls
- Efficient Technology Savings Potential
 - Best: Integrated Controls Built into Luminaire
 - Wireless communications help with commissioning and wiring costs
 - Size matters



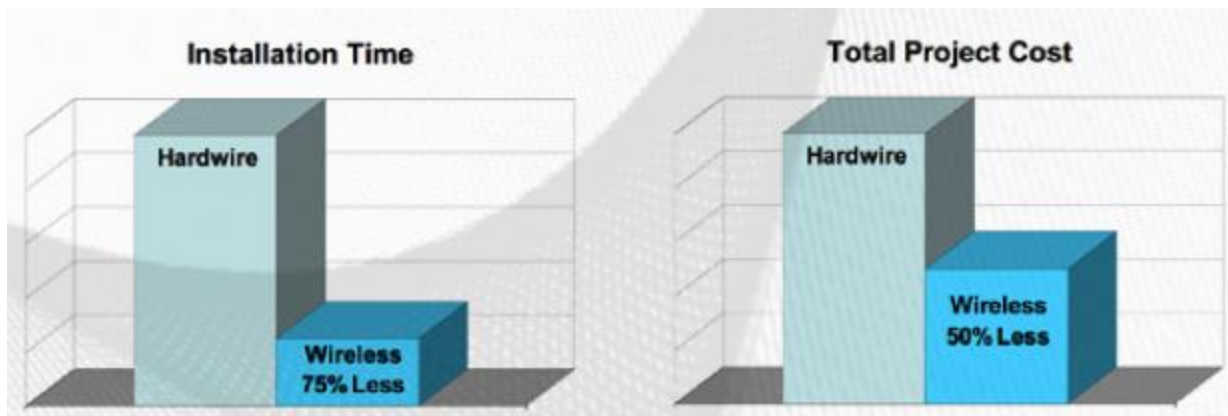
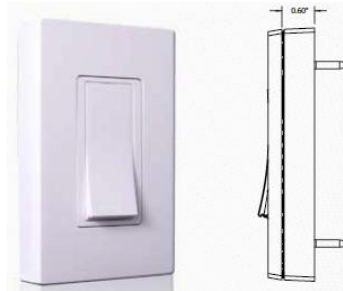
Application: Lighting Controls

- Efficient Technology Savings Potential
 - Best: Integrated Controls Built into Luminaire

			
	Office	Warehouse	Parking Garage/Lot
Bottom Line	Use in all New Construction; Carefully consider in all Retrofits	Use in all projects in all intermittent spaces	Use in all dusk-to-dawn applications w/ intermittent (low night) traffic
Savings from Efficient Tech (%)	40% to 60%	50% to 80%	40% to 60%

Wireless (or Low Volt) Controls with LED Retrofits

- **Additional Energy Savings**
- **Flexibility**
- **Scalability**
- **Ease of Installation**
 - low voltage almost as easy



▲ Lighting Controls & Control Strategies

- New controls technologies offer flexibility at reasonable price
- Enables getting all “the juice out of the orange”
- Best candidates
 - Spaces with no local switching
 - Spaces with variable occupancy

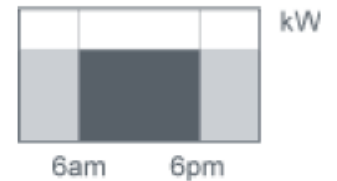
▲ Leveraging Multiple Control Strategies



Smart Time Scheduling

In areas of a building where occupancy sensor control is not appropriate, time scheduled switching or dimming of lights can be employed for zones as small as a room or even individual light fixture.

10-40%



Daylight Harvesting

Through the use of photo sensors, light levels are automatically adjusted to take into account ambient natural sunlight entering the building. Appropriate light levels are maintained and artificial lighting is dimmed when necessary.

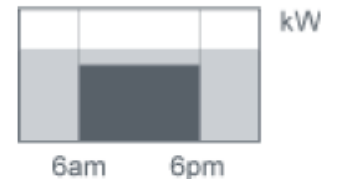
5-15%



Task Tuning

Setting default (maximum) light levels to suit the particular task or use of a workspace in order to eliminate over lighting.

5-20%



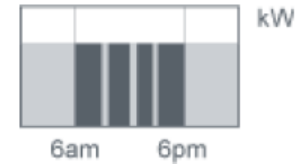
▲ Leveraging Multiple Control Strategies (Cont.)



Occupancy Control

Through the use of occupancy sensors, lights are automatically turned on or off or dimmed based on occupancy detection.

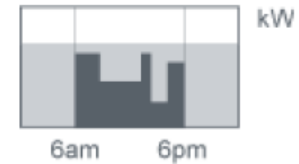
25-50%



Personal Control

Through the Personal Control Software, individuals can control (dim) the light levels in their workspace to suit their personal preferences from their desktop PC.

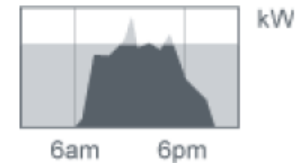
5-15%



Variable Load Shedding

The automatic reduction of electrical demand in a building by shedding lighting loads dynamically (through dimming or switching) either to shave peak demand or to respond to a utility price or demand response signal. Load shedding can be done selectively by lowest priority areas first.

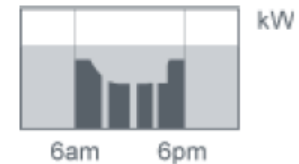
10%



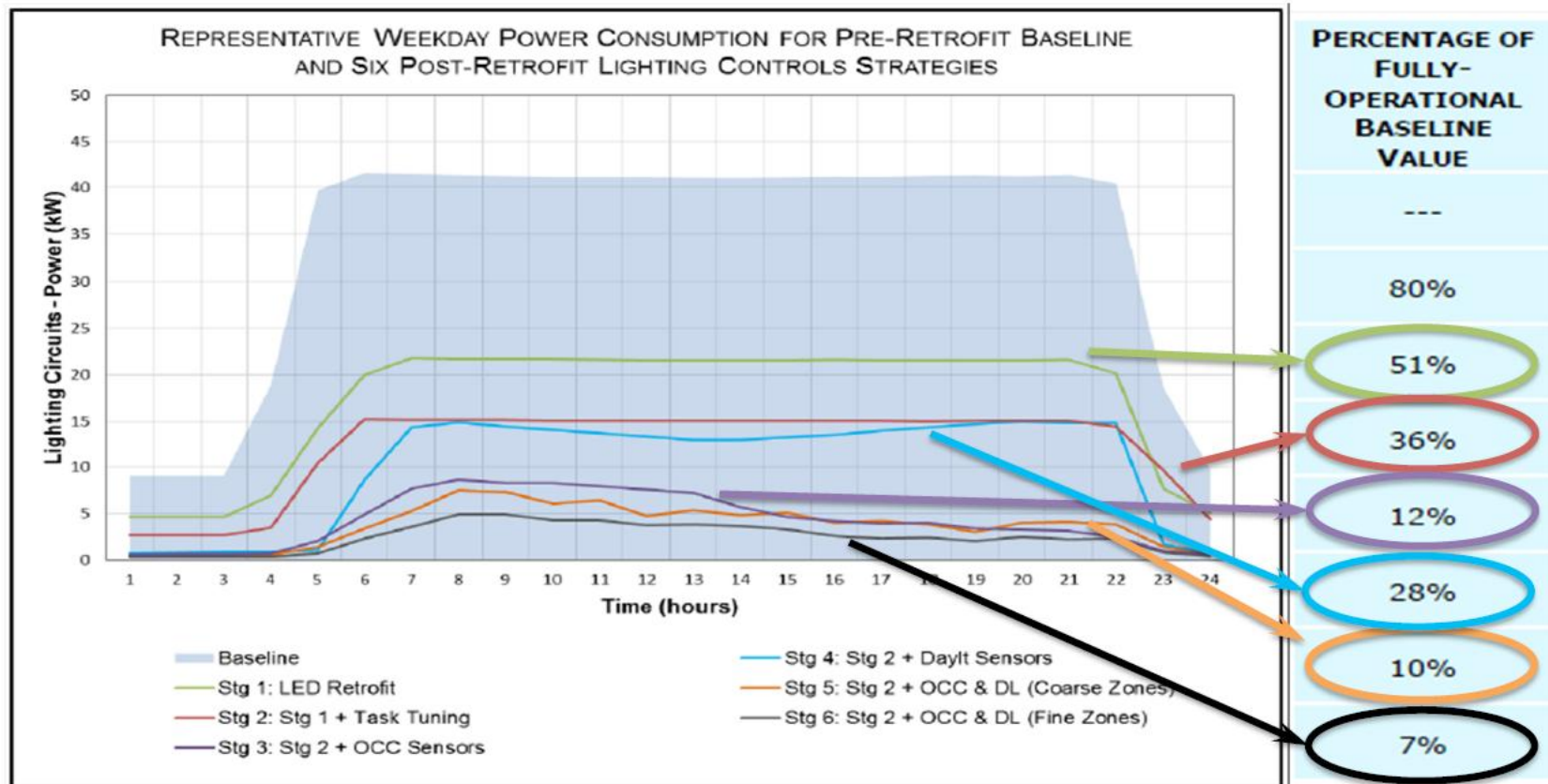
Combined Energy Savings

Potential cumulative savings from above strategies.

Up to 50 - 75%



How deep can controls go?



PG&E's Emerging Technologies Program

ET12PGE3361

Ace Hardware LED High-Bay Lighting and Controls Project

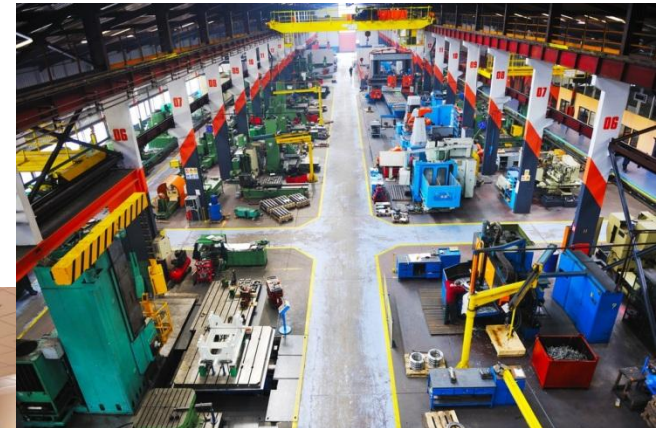
Case Study: New Construction

Indoor and Outdoor Spaces with LPD Requirements





Application: New Construction

- Existing Technology Savings Potential
 - Ideal: Buildings or Spaces with Higher LPD Allowances
 - Great: **Any building that is a good target for LEDs and controls**
 - Good: Any building or space with LPD requirements



100,000 SqFt Office Lighting Example

Code Lighting Power Density (W/ft ²) Baselines	IECC 2009 ASHRAE 90.1-2007	IECC 2012 ASHRAE 90.1-2010	IECC 2015 ASHRAE 90.1-2013
	1.0	0.9	0.8

			
	Super T8 w/ Few Occ Controls	LED Integrated Controls	LED Troffer/Kit w/ Few Occ Controls
Bottom Line	Previous Industry Practice	Biggest Savings; Best Option Now	Good Option
Watts/SqFt	0.7 1600 Luminaires	0.5** 1500 Luminaires	0.6 1500 Luminaires
Project Savings* (MWh; %)	163 MWh; ~ 35%	279 MWh; ~ 60%	192 MWh; ~ 41%

* Using ASHRAE 2009/IECC 2009 as Baseline; ** Effective W/SqFt

Questions?

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This concludes The American Institute of Architects Continuing Education Systems Course

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