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Questions related to specific materials, methods, and services will be addressed at the conclusion of this presentation.

Efficiency Vermont
BBD | 2013
BETTER BUILDINGS BY DESIGN

Efficiency Vermont

Learning Objectives

By the end of this program, participants will be able to:

- Through review of todays impacts and motivation towards efficient and effective building lighting, participants will be able to appraise these factors and how they influence building design that fosters sustainable and occupant enhancing elements.
- By examining the foundation of electric light and daylight controls, the participant will be able to describe the benefits such controls bring to the building environment, enhancing both operational efficiency and occupant comfort.
- Through evaluation of available light control strategies in buildings today, the participant will be able to specify such strategies into their building designs, ensuring energy and operationally efficient building design that enhance occupant well-being.
- Through evaluation of relevant case studies, the participant will be able to describe how the strategies of total light management achieved sustainable and efficient design outcomes.

Course Evaluations

In order to maintain high-quality learning experiences, please access the evaluation for this course by logging into CES Discovery and clicking on the Course Evaluation link on the left side of the page.

Lighting Control Strategies for Energy Efficiency and Comfort

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Dan Engelhardt
Lutron Lighting Control Specialist
Yusen Associates
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CLTC CALIFORNIA LIGHTING TECHNOLOGY CENTER

UC DAVIS UNIVERSITY OF CALIFORNIA

YUSEN

LUTRON Lutron controls your light.™

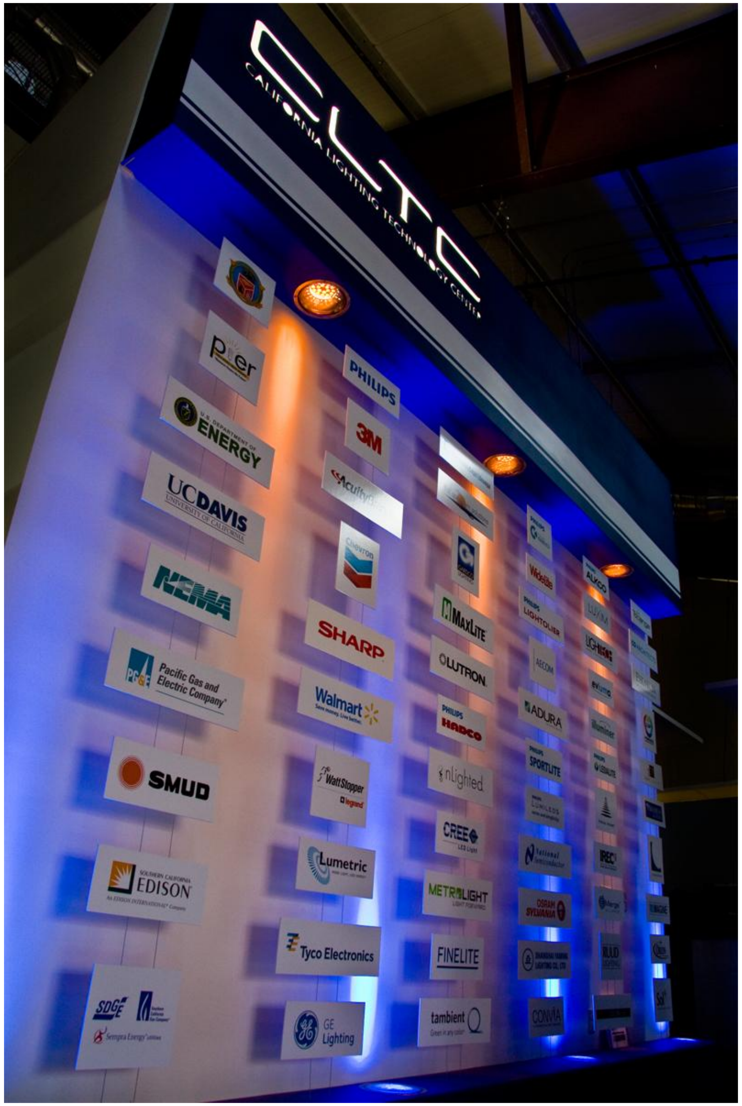
CLTC Mission

To stimulate, facilitate & accelerate the development, application and commercialization of energy-efficient lighting and daylighting technologies in partnership with utilities, manufacturers, occupants, builders, designers, researchers, academicians, and governmental agencies.

Mission-driven Activities

- Research & Development
- Demonstration & Outreach
- Education & Training

CLTC Founders



California Energy Commission

University of California, Davis

National Electrical Manufacturers Association

US Department of Energy

FOUNDING ORGANIZATIONS

AFFILIATES

- UC DAVIS – University of California
- pier – Public Interest Energy Research – "Research Powers the Future"
- NEMA
- Department of Energy – United States of America

UTILITIES

- PG&E – Pacific Gas and Electric Company
- Southern California Edison – An Edison International Company
- SDG&E – Southern California Gas Company – Sempra Energy utilities
- SMUD
- City of Roseville California – Roseville Electric
- Silicon Valley Power – City of Santa Clara
- BC hydro

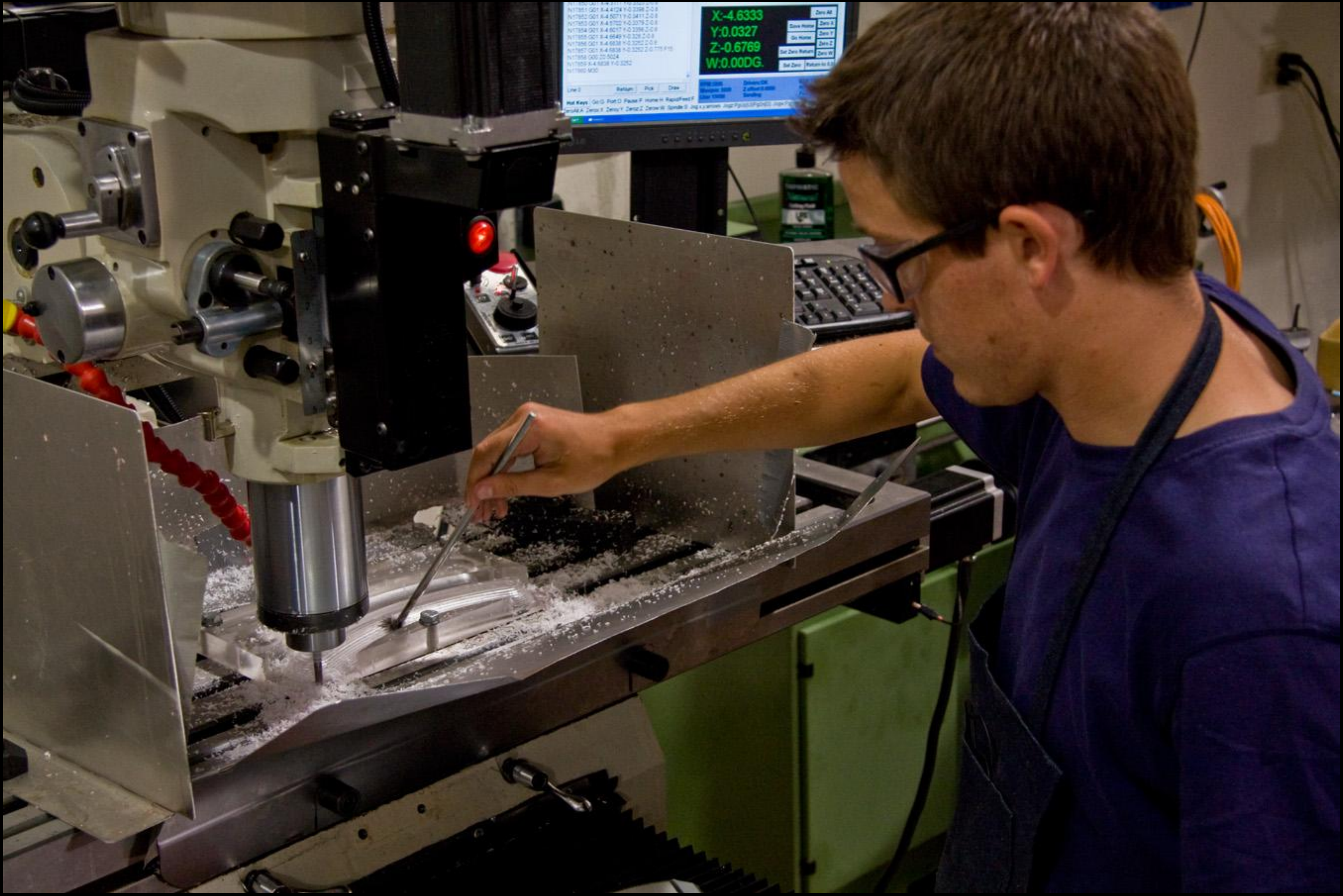
MANUFACTURERS

- 3M
- Acuity Brands
- ADURA Technologies
- AECOM
- B-K Lighting / TEKA Illumination
- Chevron
- CO ARCHITECTS
- Convergence Wireless
- CONVIA – A Herman Miller Company
- CREE
- ECHELON
- ENCELIUM – Lighting Control for the Smart Building
- EDL | Energy Dynamics Laboratory
- enlighted
- Merge Alliance
- ESKATON – Senior Residences and Services
- evluma
- FINELITE
- full spectrum solutions
- EVERLAST Lighting
- GE Lighting
- FOCAL POINT
- illuminer
- InteLED
- Intematix
- Intermatic – Providing a brighter solution
- IREC – Catalonia Institute for Energy Research
- LED ERA, Inc.
- LIGHTECH
- Lighting Science
- Lumetric
- LUTRON
- LUXIM
- redwoodsystems
- OPTO electronix
- ORION – Light Years Ahead
- OSRAM SYLVANIA
- Progress Lighting
- RUUD LIGHTING
- SHARP
- Sol – Reliable. Renewable. Remarkable.
- sun
- SWITCH
- PHILIPS
- Philips ALKCO
- CANLYTE
- Philips Color Kinetics
- Philips Day-Brite
- Philips GARDCO
- GUTH – Lighting for Demanding Environments
- Philips HADCO
- Philips LEDALITE
- Philips LIGHTOLIER
- Philips LUMILEDS – sense and simplicity
- Philips SPORTLITE
- WideLite
- tambient – Green in any color
- TE connectivity
- Topanga
- VU1
- WILLDAN Energy Solutions
- XERALUX
- 1923

LARGE END-USERS

- DGS – Department of General Services – Building Green • Buying Green • Working Green
- The University of California 1868
- CSU – The California State University – Working for California
- LACCD
- National Park Service
- Forest Service – U.S. Department of Agriculture
- Walmart – Save money. Live better.


TESTING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Z:-0.6769
W:0.00DG.





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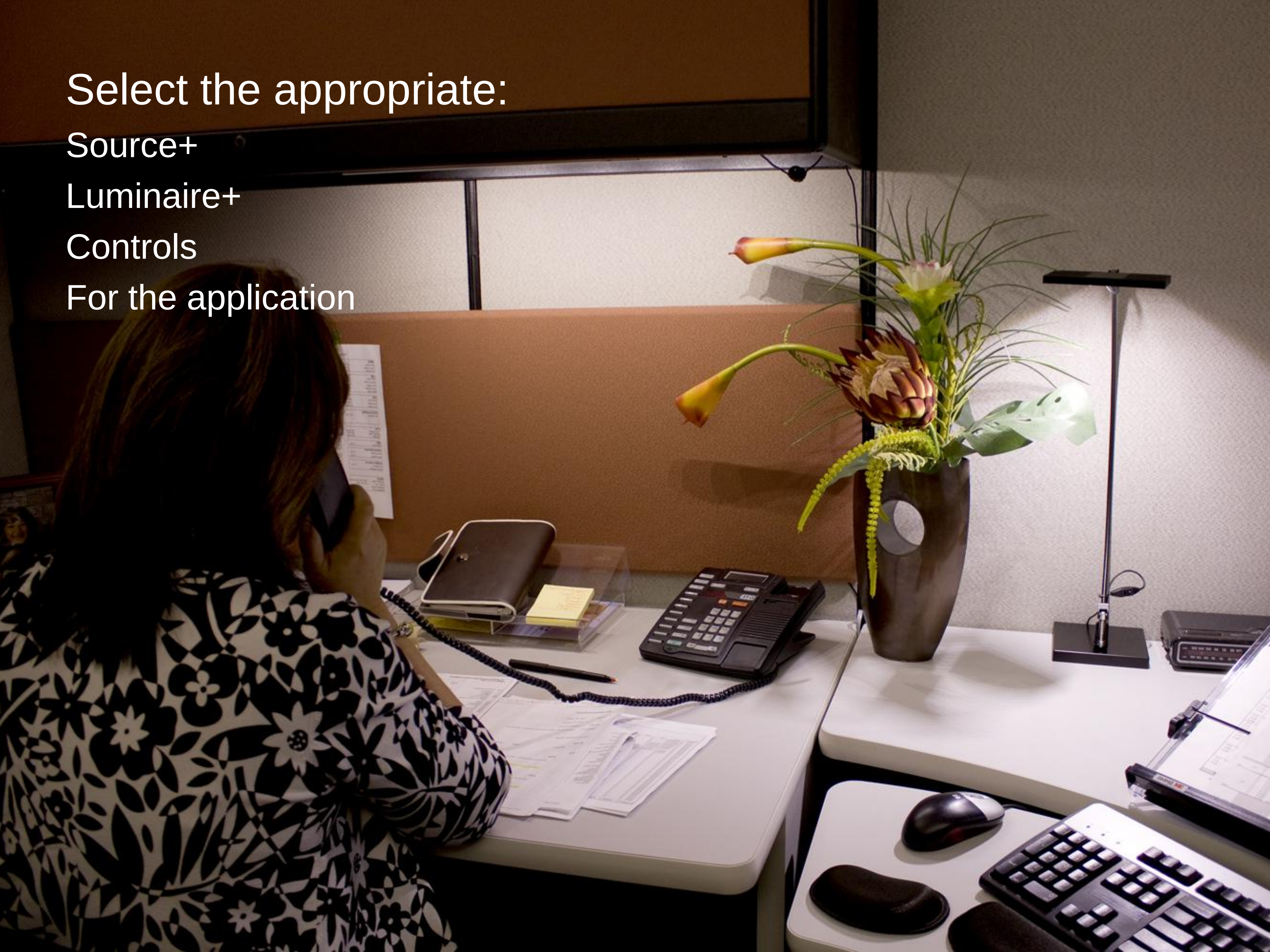
Select the appropriate:
Source+
Luminaire+
Controls
For the application

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Lutron Lighting Control Specialist
Yusen Associates
207-939-9710
dengelhardt@yusen.com

Adaptive Lighting Inside & Out

Lighting & Energy Efficiency

Luminous Efficacy

- **One time, long duration change**
- **Reduction of base line**
  - Light Source Efficacy
  - Luminaire Efficacy
  - Application Efficacy

Lighting Controls

- **Continuous, real-time change**
- **Fluctuations from base line**
  - Occupancy / Vacancy
  - Daylighting
  - Demand Response
  - Tuning
  - Personal Control

Adaptive Lighting Systems…

automatically adjust their light output…

- Total Luminous Flux
- Spectral Power Distribution
- Candle Power Distribution

based on sensory input from the space they serve…

- Occupancy / Vacancy
- Daylight
- DR Signals

to optimize space and building performance.

- Comfort
- Energy Savings
- Peak Demand Reduction


A66

Overall Integrated Control Strategy

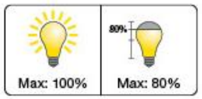
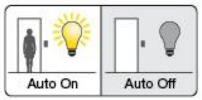
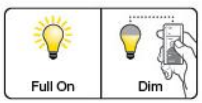
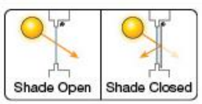
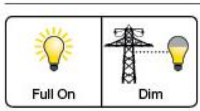
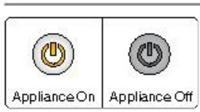
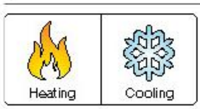
During **Occupancy** Focus on **Comfort**

- **Adjust fenestration for daylight penetration**
- **Adjust electric lighting for daylight contribution**
- **Adjust electric lighting for demand response signal**
- **Adjust HVAC**

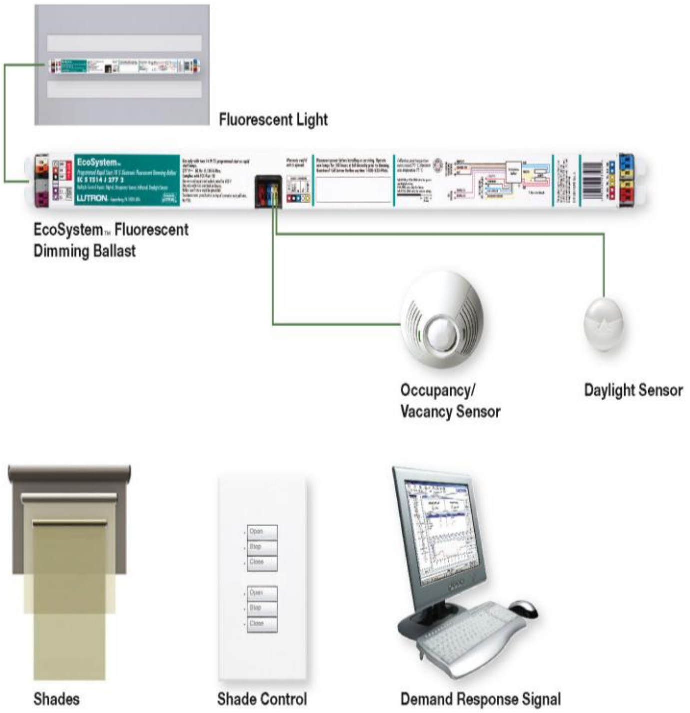
During **Vacancy** Focus on **Energy Efficiency**

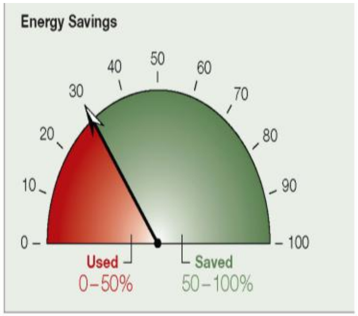
- **Adjust fenestration for cooling/heating loads**
- **Turn electric lighting off or dim down**
- **Adjust electric lighting for demand response signal**
- **Adjust HVAC**

7 Strategies of Light Control (+2)

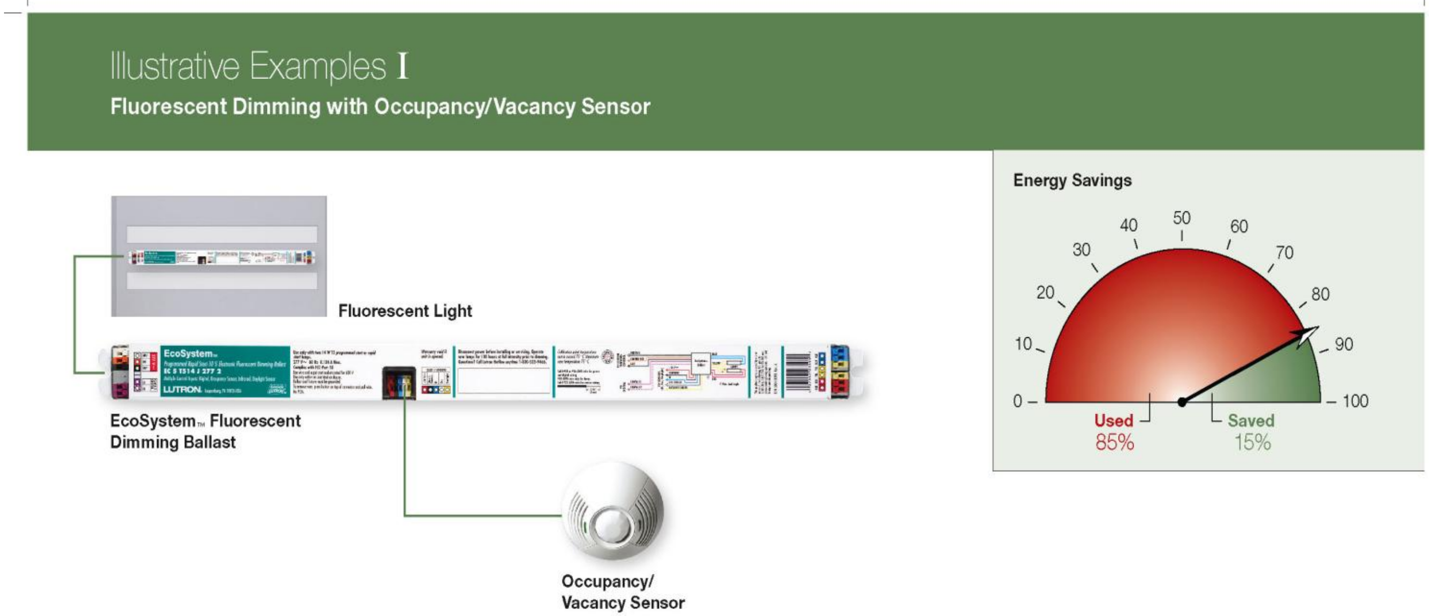
Strategy		Potential savings
	**High-end trim** sets the maximum light level based on customer requirements in each space.	10-20% Lighting[7]
	**Occupancy/vacancy sensing** turns lights on when occupants are in a space and off when they vacate the space.	20-60% Lighting[8]
	**Daylight harvesting** dims electric lights when daylight is available to light the space.	25-60% Lighting[9]
	**Personal dimming control** gives occupants the ability to set the light level.	10-20% Lighting[10]
	**Controllable window shading** moves shades to reduce glare and solar heat gain.	10-20% Cooling[11]
	**Scheduling** provides scheduled changes in light levels based on time of day.	10-20% Lighting[12]
	**Demand response** automatically reduces lighting loads during peak electricity usage times.	30-50% Peak Lighting[13]
	**Plug load control** automatically turns off loads after occupants leave a space.	15-40% Non-Electronic[14]
	**HVAC integration** control heating, ventilation and air conditioning systems through contact closure, or BACnet integration.	5-15% HVAC[15]

5 Easy Steps to 60% Lighting Energy Savings

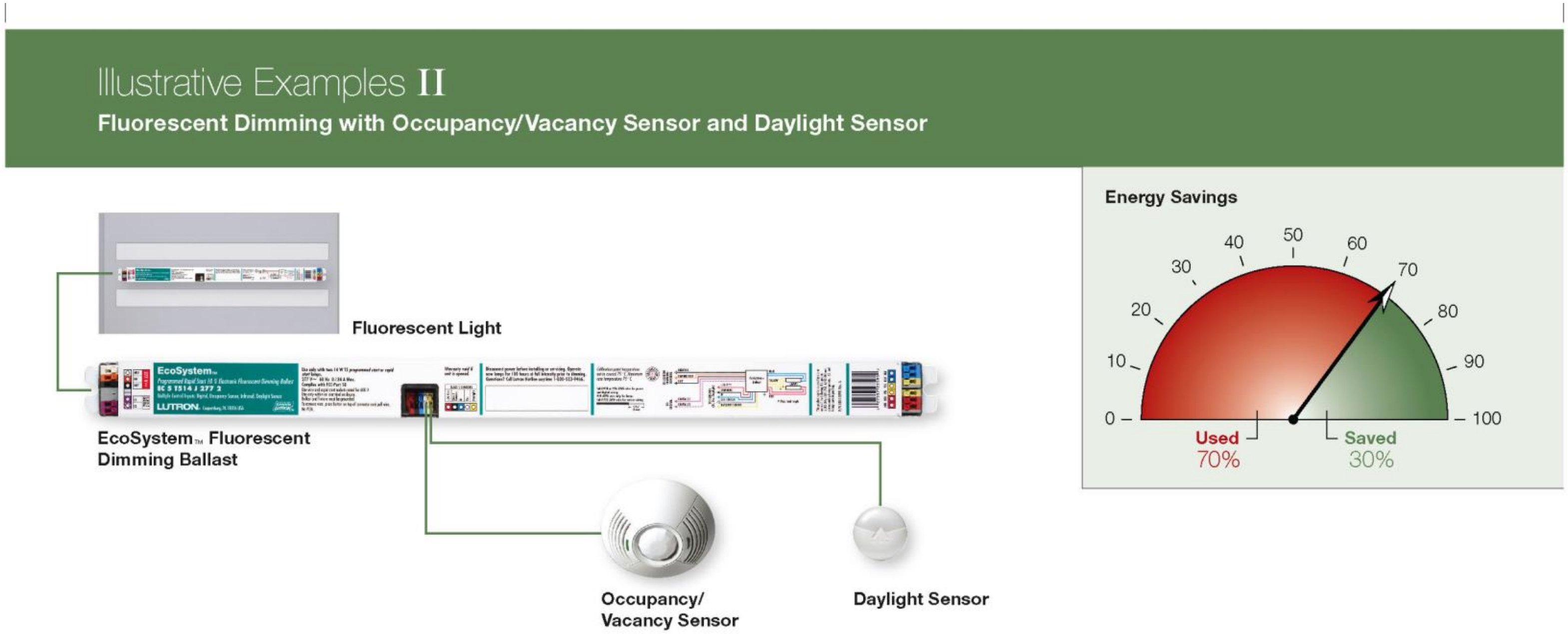




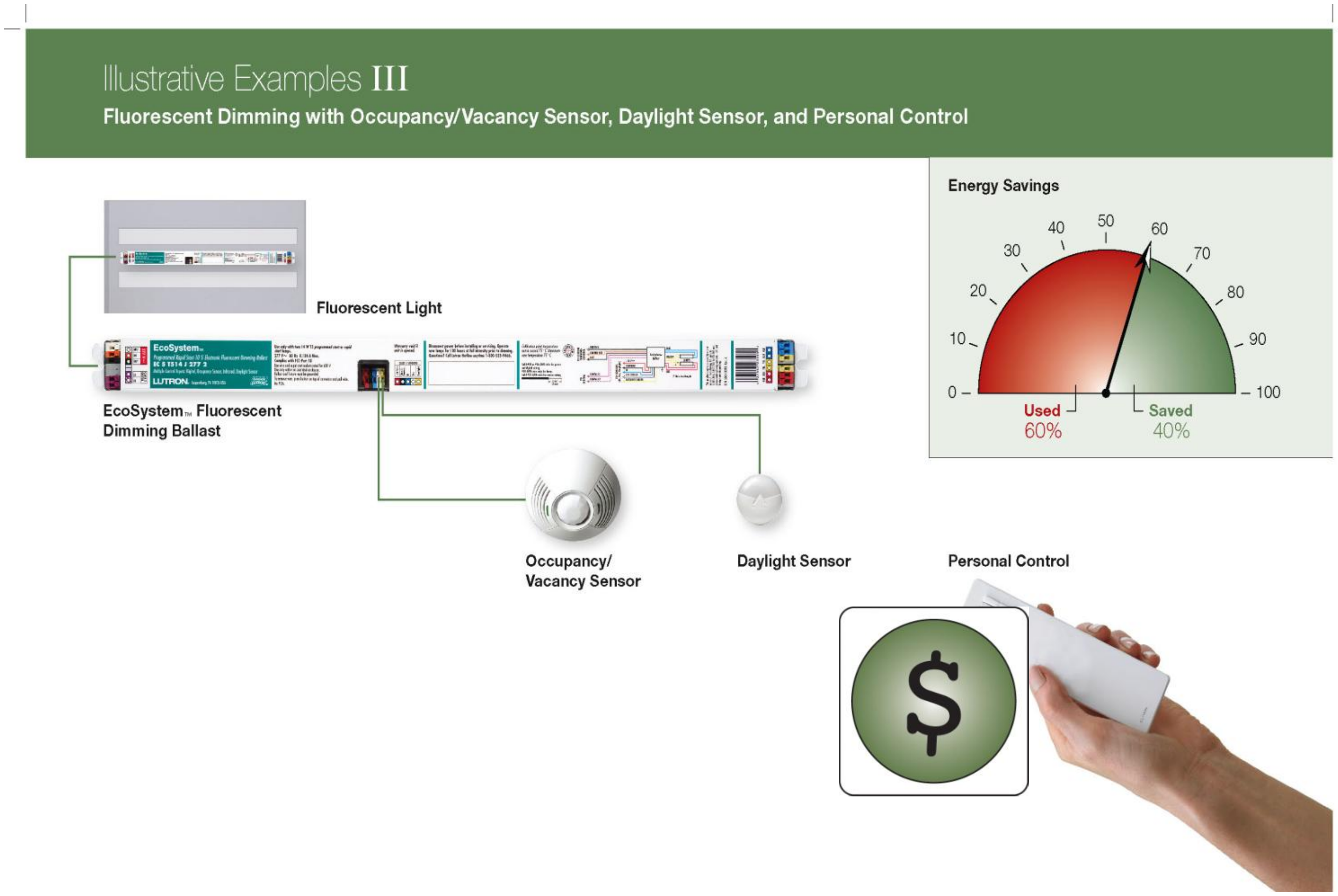
EcoSystem
Vacancy Sensor Control



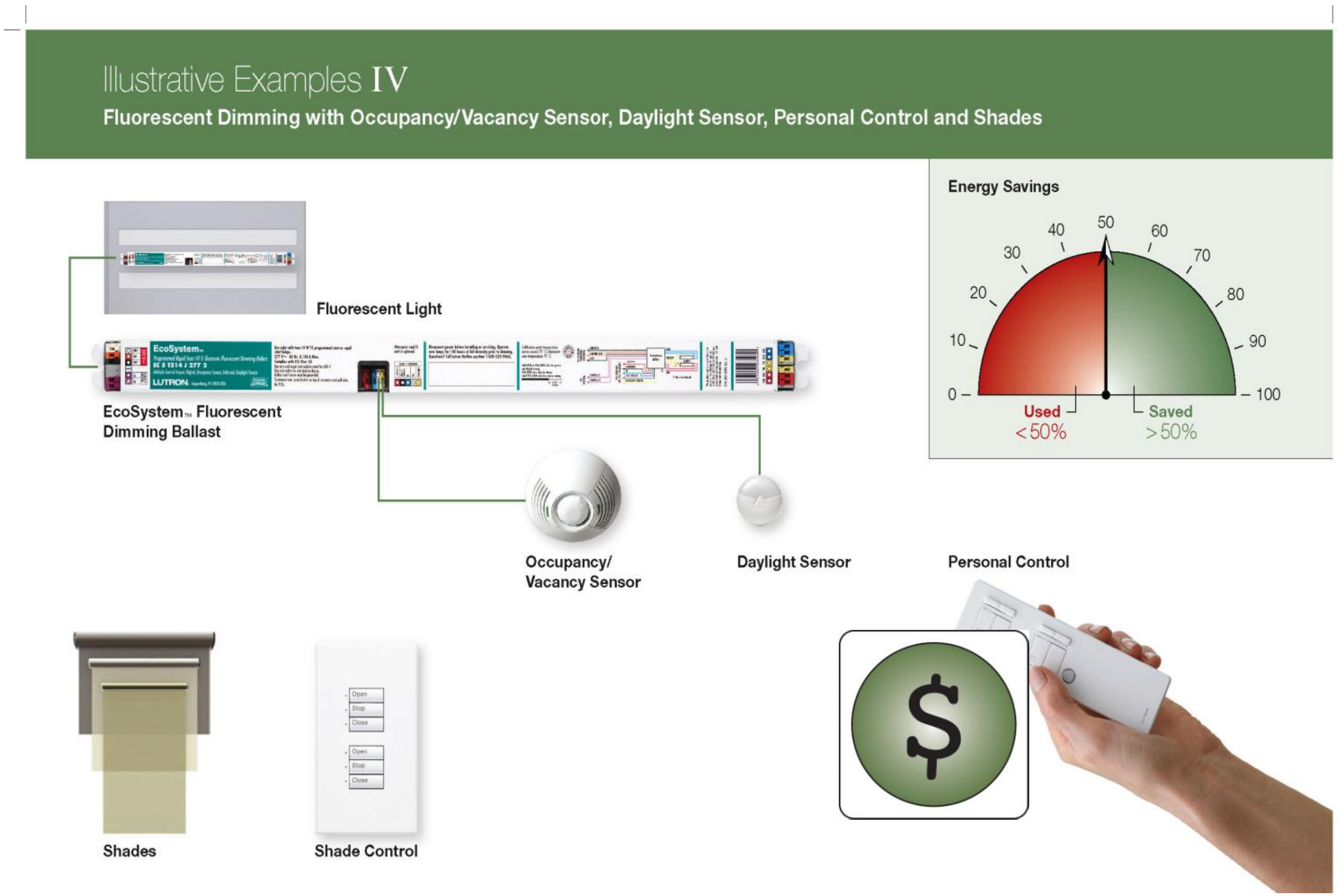
EcoSystem
Daylight Harvesting



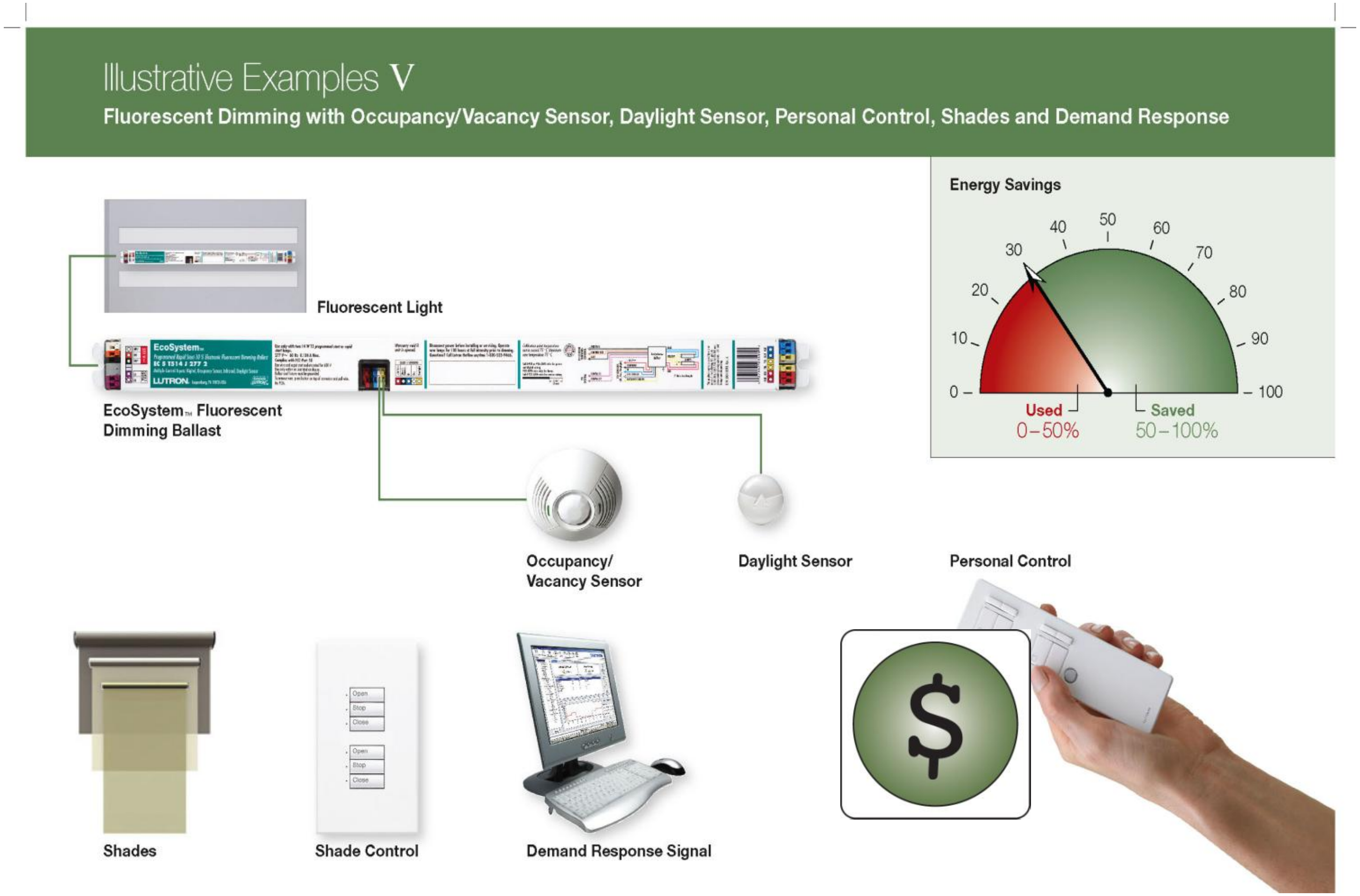
EcoSystem
Personal Control



QS & Quantum
Shade Control



QS & Quantum Demand Response



EcoSystems

- ***Current digital dimming ballasts are as efficient price-wise as non-dim ballasts that provide only on (full) and off.***

- ***The ability to couple control strategies such as vacancy sensor control, daylight harvesting, personal control, shade control and demand response with these ballasts has lead to significant energy savings above and beyond simply installing high-efficiency lighting.***

EcoSystems

- ***Manages both electric light and daylight response dimming through automatic and manual control of lights***
- ***Allows building operations to manage light from a single system at the local level***
- ***Saves energy by maximizing use of daylight and minimizing waste***
- ***Improves comfort and productivity by setting the required light for any task***

EcoSystems

Advantages of EcoSystems:

- *Lower Cost System*
- *Scalability*
  "Building Block Approach"
- *Improved Maintenance*
  - *Lamp and Ballast Failure reporting with Quantum*
  - *Ballast Failure replacement without reprogramming*
- *Personal Control/Daylighting/Occupant Sensing/Manual Control*
- *No power packs or interfaces*
- *Infinite flexibility with Class 2 & wireless sensors*

EcoSystems

Wired or Wireless Controls

- ***Wired sensors connect directly to ballasts***
  - ***No power packs required***
- ***Wireless sensors and controls reduce wiring, installation time and cost***
  - ***Use reliable Clear Connect RF technology***

Ballasts
EcoSystems vs. H-Series

EcoSystem Ballasts

- ***Dimming to 10%***
- ***EcoSystem and 3-wire***
- ***Sensor connections allow wired sensors to connect directly to the ballast***

EcoSystem H-Series Ballasts

- ***Dimming to 1%***
- ***EcoSystem only***
- ***Use ESN and/or QSM to connect wired or wireless sensors***

Ballasts
EcoSystems H-Series

1% Dimming is available for any budget

- *Low-cost dimming*
  - ***$79 list price, published in advertisements***
  - ***$67 suggest contractor price, published online***
- *100% to 1% dimming range*
- *EcoSystem control ONLY*

Models Available:

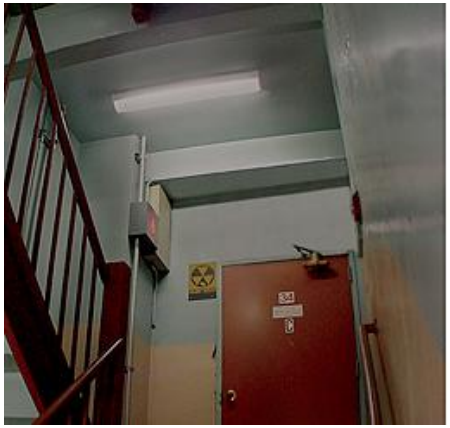
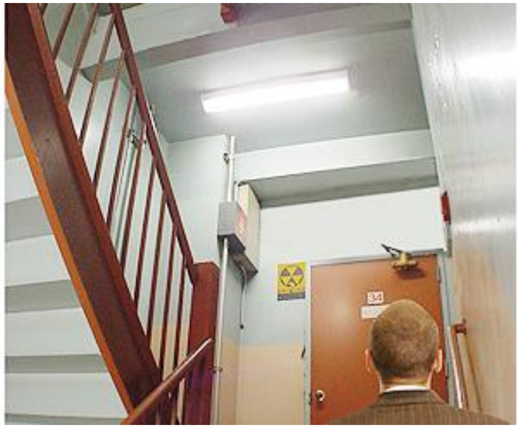
- *1 and 2 lamp for T8 17W, 25W, & 32W*
- *3 lamp for T8 32W*
- *1 and 2 lamp for T5 14W, 21W, 28W, & 54W*
- *1 and 2 lamp for T5HO 39W & 24W,*

Adaptive Corridors and Stairwells

Are not this…

2007: Adaptive Stairwells in UC/CSU campuses

Demonstration Location	Pre			Post				Savings			
	# Fixtures	Fixture Wattage	Annual Energy Consumption (kWh)	Fixture Wattage (High)	Fixture Wattage (Low)	Annual Energy Consumption (kWh)	Stairwell Occupancy Rate	Demand Savings (kWh)	Demand Savings (Percentage)	Savings From Occupancy (kWh)	Occupancy Savings (Percentage)
UCOP	32	53.6	15025.15	66.7	20.3	18697.34	3%	0.00	0.0%	8944.45	59.5%
UCLA Cogen	48	53.2	22369.54	68	16.43	28592.64	12%	0.00	0.0%	12858.95	57.5%
UCLA Buenche	50	68.6	30046.80	66.3	16.73	29039.40	9%	1007.40	3.4%	19757.61	65.8%
UC Riverside	38	150	49932.00	38	8.5	12649.44	1%	37282.56	74.7%	9721.76	19.5%
UC Santa Barbera	10	52.7	4616.52	71.1	17.8	6228.36	6%	0.00	0.0%	2777.10	60.2%
UC Irvine	37	55	17826.60	66.5	17.5	21553.98	29%	0.00	0.0%	7548.75	42.3%
Sonoma State	27	54.4	12866.69	67.3	16.8	15917.80	23%	0.00	0.0%	6145.97	47.8%
San Diego State	29	57.8	14683.51	70.1	17.8	17808.20	27%	0.00	0.0%	6574.30	44.8%
CSU Northridge	32	54	15137.28	67.7	20.5	18977.66	7%	0.00	0.0%	8464.54	55.9%

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9 University of California / California State University campuses
303 bi-level fluorescent luminaires

average **13%** occupancy rate
average **50%** savings from addition of occ sensor / bi-level feature

UC DAVIS
UNIVERSITY OF CALIFORNIA

Smart Lighting Initiative:

Lighting the Way to a Sustainable 2nd Century

Sid England
Assistant Vice Chancellor
Director of the Office of Environmental Stewardship and Sustainability
http://sustainability.ucdavis.edu
http://sli.ucdavis.edu

UC Davis: Adaptive Stairwells

UC Davis installed 999 LED units

Assumed 20% occupancy rate

22W high / 5W low

PIR sensor times out after 5 min

Expected energy use reduction: **85%**

7,008 hours in standby mode

1,752 hours in active mode

UC Davis: Adaptive Stairwells

Incumbent technology:

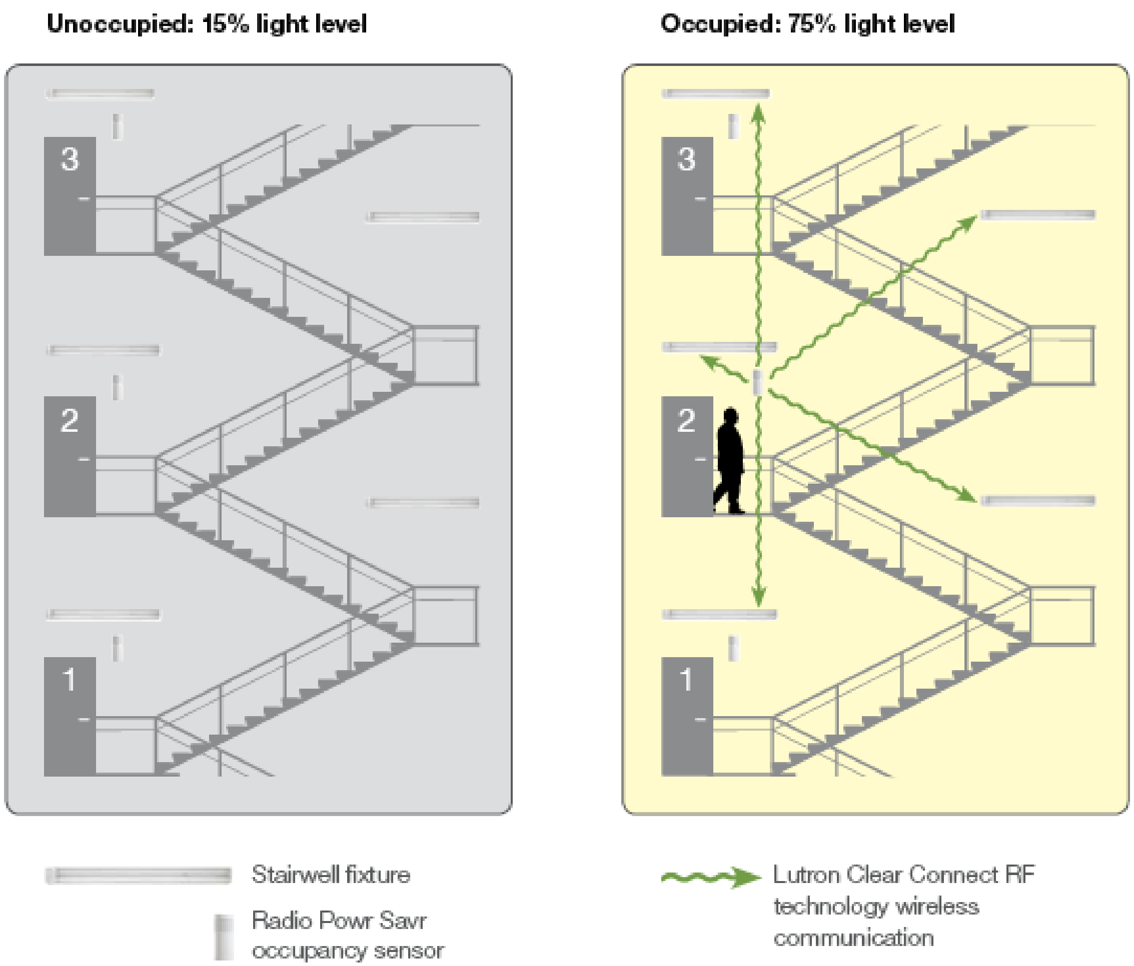
Lamp Type	Quantity	Lamp Power (W)	Average Lifetime (Hours)
CFL 13w	143	13	10,000
CFL 20w	2	20	10,000
CFL 26w	39	26	10,000
CFL 28w	10	28	10,000
CFL 32w	69	32	10,000
CFL 42w	39	42	10,000
F17T8	70	17	20,000
F25T8	3	25	20,000
F32T8	598	32	20,000
F54 -T5 HO	32	54	20,000
FO35T8	4	35	20,000
HPS 50w	4	50	24,000
MH 175w	8	175	12,000

1,021 incumbent = 496,600 kWh

999 replacement = 73,510 kWh

~$31,731 per year

Single fixtures vs. network



Energy savings – ability to save over 80% of lighting energy usage

- high-end trim reduces light levels when occupied
- occupancy sensing lowers light levels when unoccupied

Simple installation – wireless communication between devices allows the occupancy sensor(s) to be mounted in the location that provides the maximum area of coverage with no need for additional wiring

Payback of 1-3 years

Flexible – group multiple fixtures to a single occupancy sensor and/or multiple occupancy sensors to a single fixture

Single fixtures vs. network

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University of Vermont

Adaptive Corridors

Typically illuminated continuously

Intermittent occupancy

Occupancy-based control

- 100% during occupancy
- 50% or less during vacancy
- 40-80% savings

CLTC case studies to date

- Commercial
- Education

Possible CLTC future work

- Hospitality
- Healthcare (being implemented by others, right now!)

Case Study: Latham Square, Oakland CA

Commercial office building in downtown Oakland

14 Stories and 130,000 sq ft

Case study install on 12 floors

Corridor occupancy rate: 8%

175 luminaires replaced in corridors

86% reduction in energy use

- 113,724 kWh annually
- $23,803 in energy and maintenance costs over the life of the fixtures

Case Study: Latham Square, Oakland CA

Fixtures: UA Retrofit Shielding Kit
by A.L.P. Lighting Components

- 86 W 3-lamp T8 fluorescent fixtures replaced with 64W 2-lamp T8

Controls: Energi TriPak system by Lutron

- Lutron EcoSystem H-Series ballasts,
  Radio Powr Savr occupancy/vacancy sensors,
  wireless PowPak dimming modules, and wireless controls

Payback w/ Oakland Shines + PG&E rebate:
6 months

Payback w/ PG&E rebate only:
3 years 4 months

Technology	System Size (Nominal W)	Annual Energy Consumption (kWh)	Annual Energy Cost	Annual Maintenance Cost	Total Annual Cost	Life-Cycle Energy Cost	Life-Cycle Maintenance Cost	Total Life Cycle Cost	Total Life-Cycle Cost for All Fixtures
Incumbent	86	752	$105	$5	$110	$503	$24	$528	$92,338
Lutron Controls	7 (low) 68 (high)	561	$78	$3	$375	$375	$16	$392	$68,535
Savings		191	$27	$2	$28	$128	$8	$136	$28,803

Laney College, Oakland, CA

40 classrooms

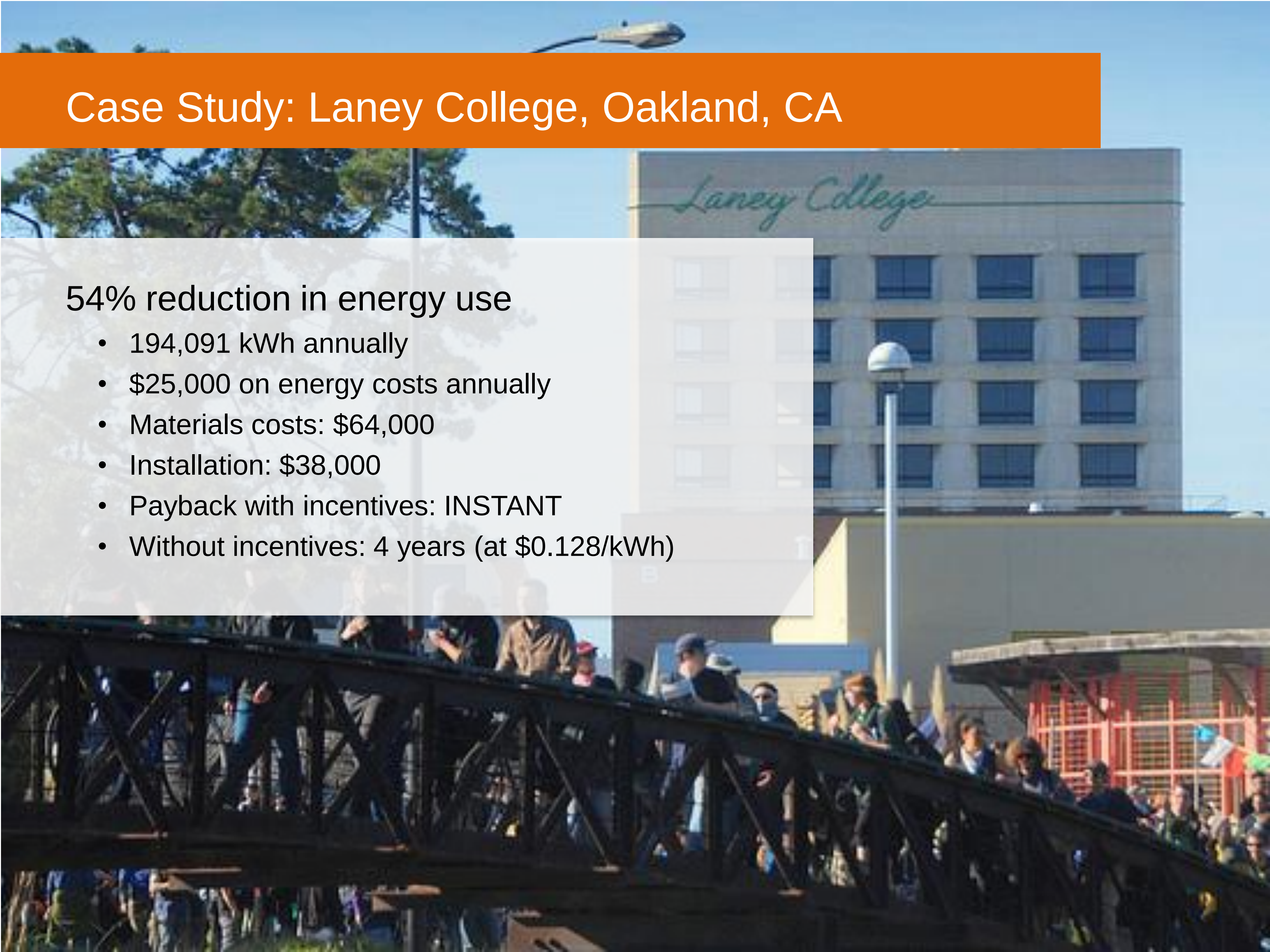
Lamp-and-ballast retrofit with added controls

Occupancy, daylighting, and dimming

Case Study: Laney College, Oakland, CA

54% reduction in energy use

- 194,091 kWh annually
- $25,000 on energy costs annually
- Materials costs: $64,000
- Installation: $38,000
- Payback with incentives: INSTANT
- Without incentives: 4 years (at $0.128/kWh)



Dartmouth

Adaptive Campus Control System:
Street, Pathway & Wall packs

UCDAVIS
UNIVERSITY OF CALIFORNIA

UC Davis LED Networked Outdoor Lighting

1600+ connected points of exterior lighting

Direct monitoring and control of individual luminaires

Automatic adaptation to environmental changes

- Daylight levels
- Occupancy / vacancy
- Direction of travel
- Street surface reflectance
- Fixture case temperature

Multiple exterior applications

- Street
- Pathway
- Post top
- Wall packs

UC Davis responds to legislation, guidance, codes & standards

California's Long Term Energy Efficiency Strategic Plan

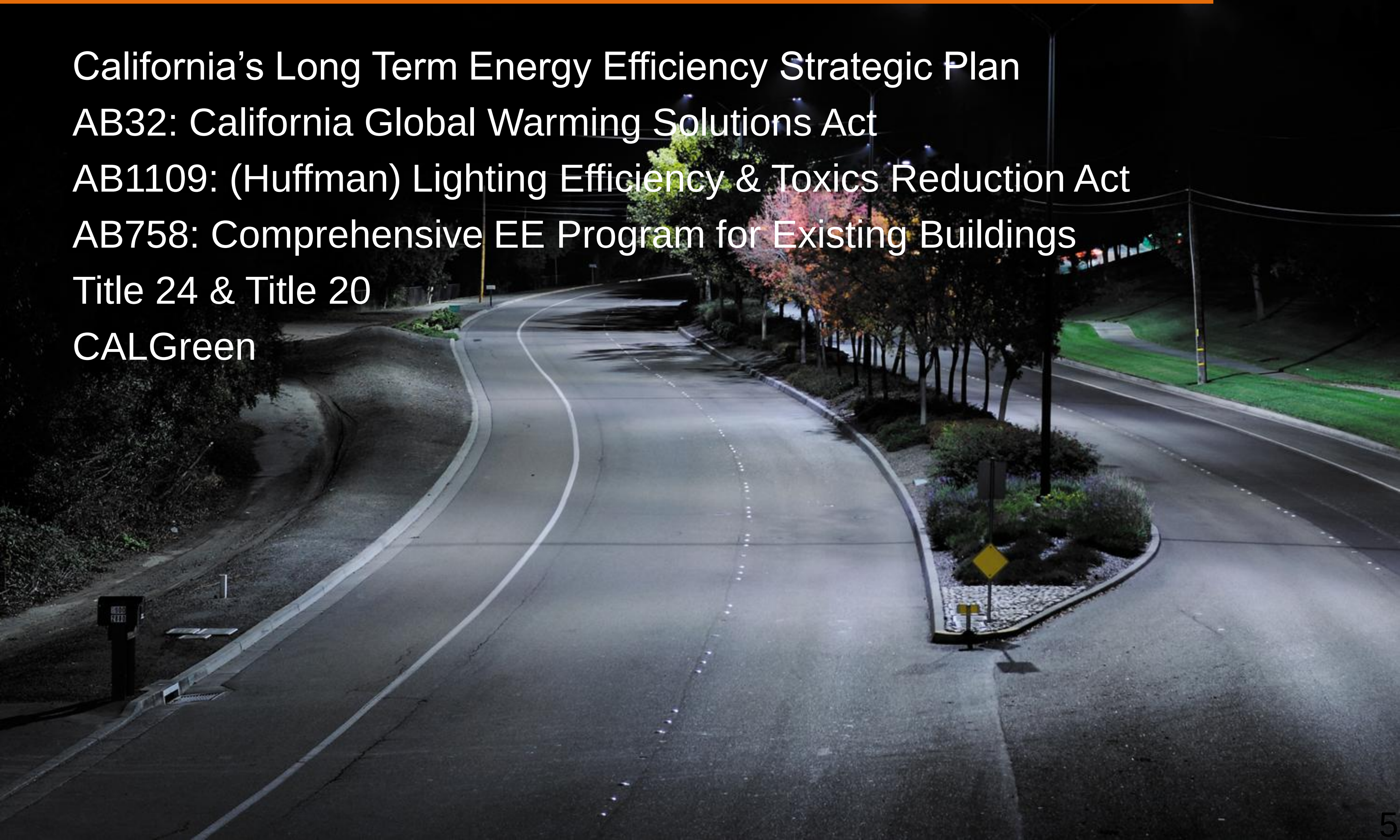
AB32: California Global Warming Solutions Act

AB1109: (Huffman) Lighting Efficiency & Toxics Reduction Act

AB758: Comprehensive EE Program for Existing Buildings

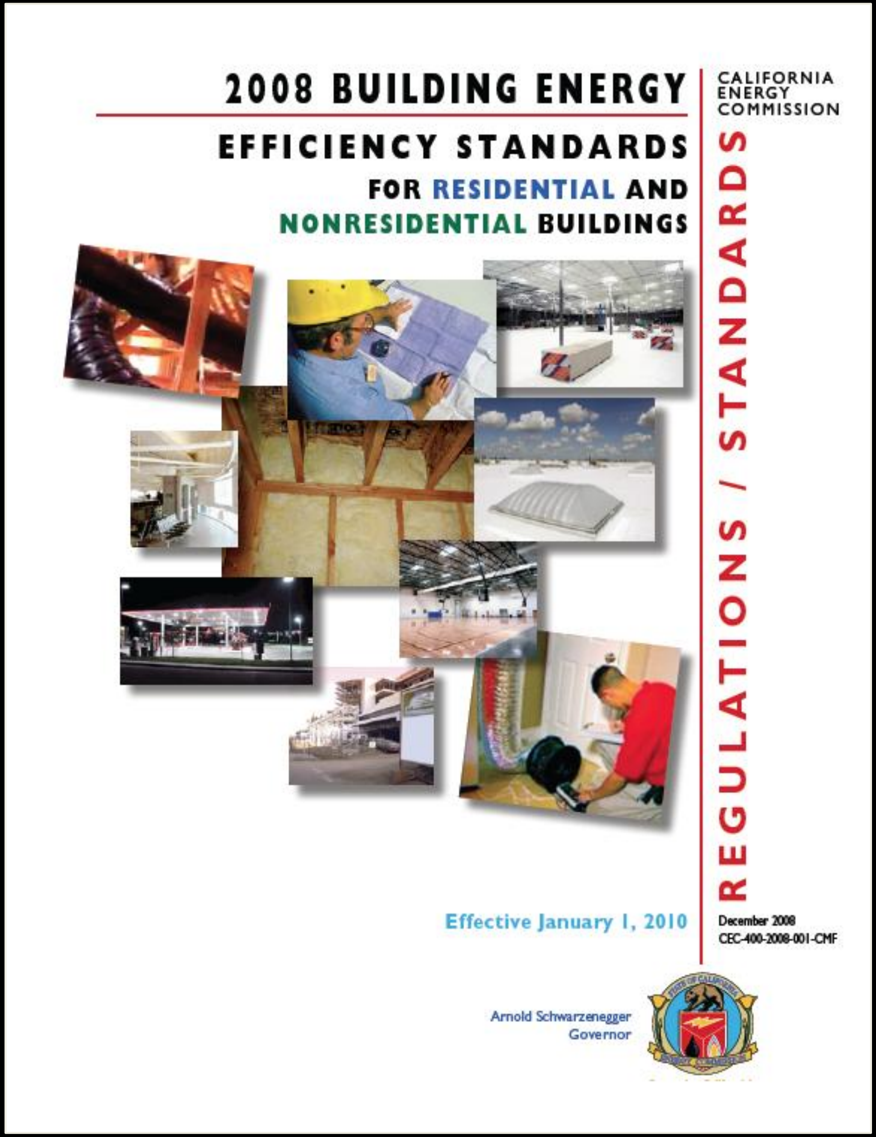
Title 24 & Title 20

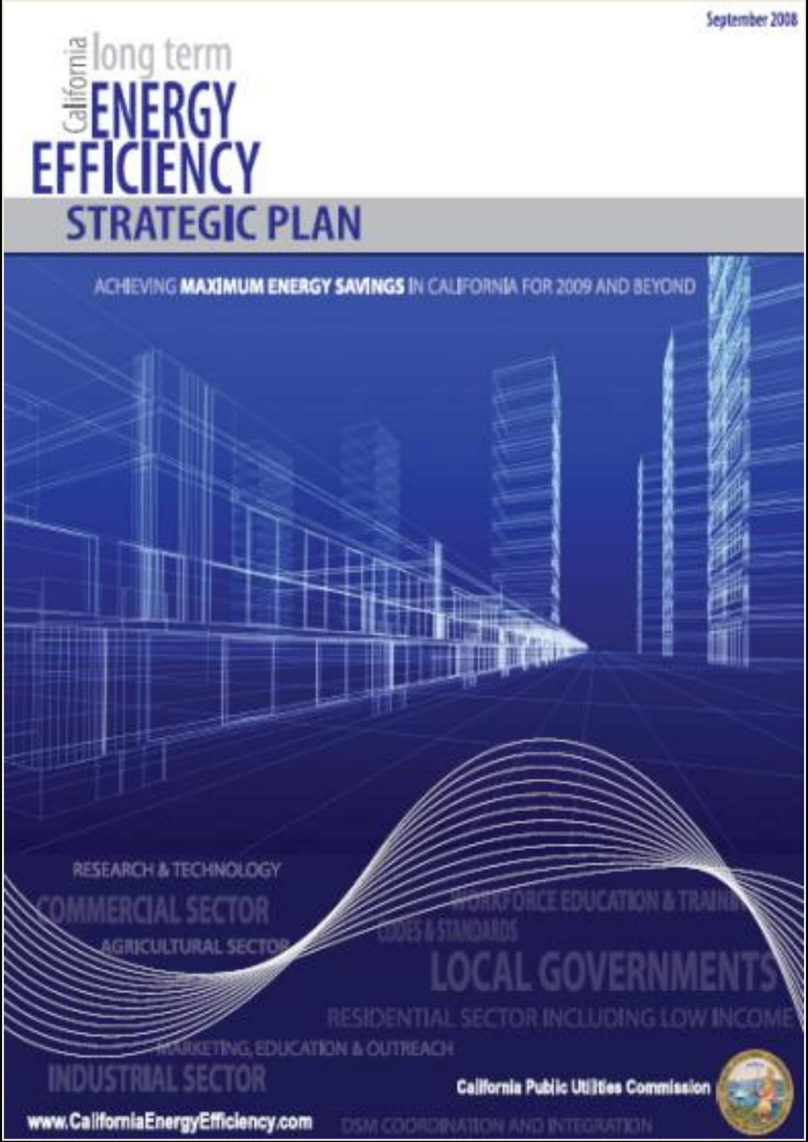
CALGreen



Standard Practice

Best Practice





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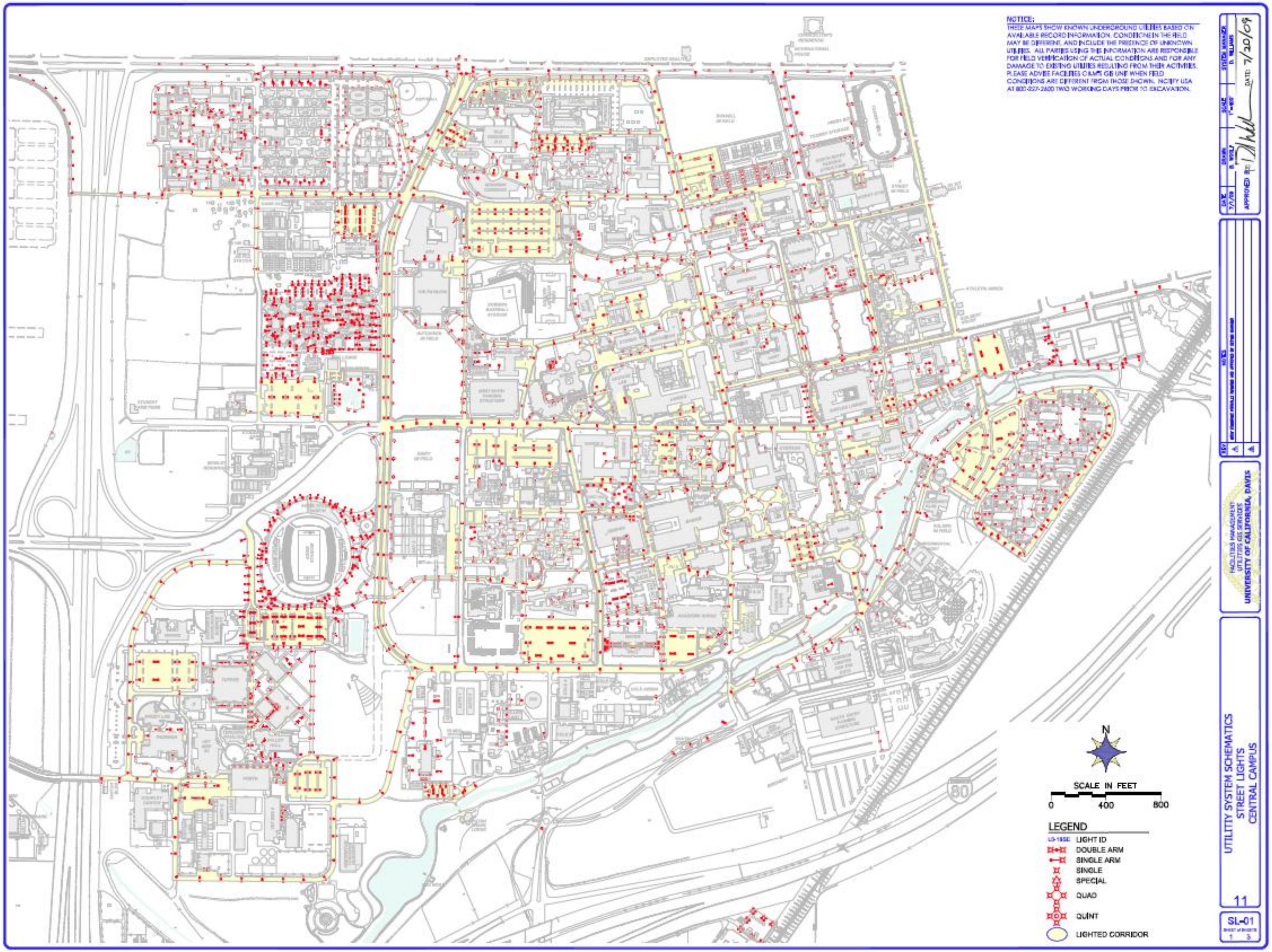
http://sustainability.ucdavis.edu
http://sli.ucdavis.edu

First: Bi-level parking structures in 2010

All TAPS parking structures and lots were converted to bi-level induction (and some LED) saving 60–80%.

Adaptive Induction Parking Structure Luminaires, North Entry Parking Structure, UC Davis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N
SCALE IN FEET
0
400
800
LEGEND
LIGHT ID
DOUBLE ARM
SINGLE ARM
SINGLE
SPECIAL
QUAD
QUINT
LIGHTED CORRIDOR
80
DATE 7/1/09
DRAWN B. WOLF
SCALE 1"=400'
SYSTEM MANAGER D. WILLIAMS
APPROVED BY:
DATE: 7/20/09
REV
NOTES
FACILITIES MANAGEMENT
UTILITIES GIS SERVICES
UNIVERSITY OF CALIFORNIA, DAVIS
UTILITY SYSTEM SCHEMATICS
STREET LIGHTS
CENTRAL CAMPUS
11
SL-01
1 3

Technology Package: RF Control Network

Profiles & interfaces
- Power to fixture on/off
- Bi-level with OFF
- 0-10V (sink) dimming control with 0V turning fixture power Off
- Dimming control in 5% increments

Events & schedules
- Weekday & weekend schedules
- Special event schedule
- Schedule up to 9 control events/day
- Scheduled events based on time of day and/or astronomical time
- Schedule use of motion sensors and photocell
- Real-time commands and overrides

Power metering (Revenue Grade)

Data logging

Failure detection and reporting

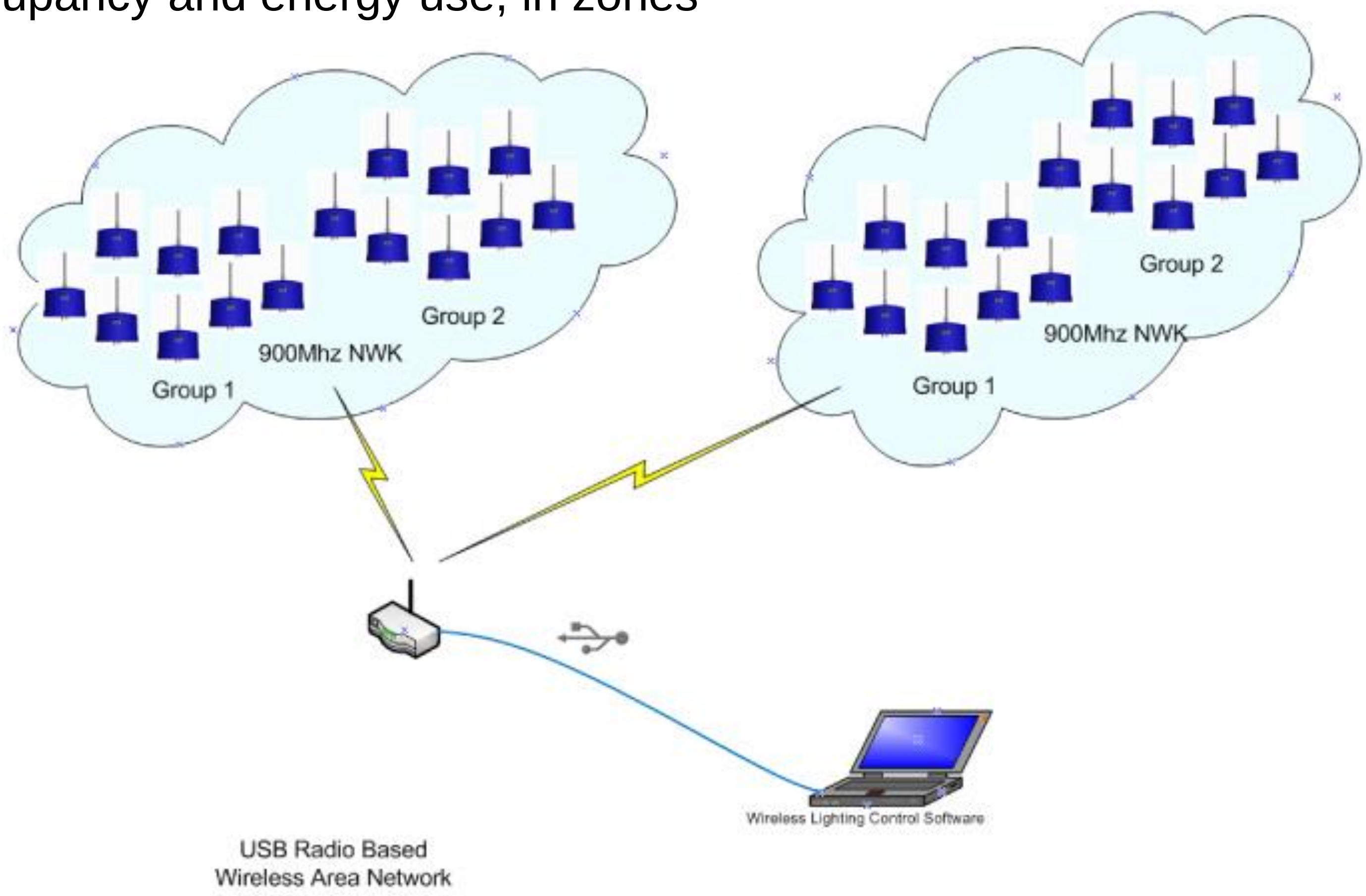
Occupancy sensor input

Emergency call button input

Over-the-air flashing (program updates)

RF Control Network

One gateway and one centralized antenna
Gateway <--> Node = ~5 miles LOS (line of sight)
Node <--> Node = ~2 miles LOS (if mounted to 25' pole)
Monitoring of occupancy and energy use, in zones



Results: Wall packs

Tech specs:

- 101 42W 0-10V dimming LED wall packs with wireless controllers and PIR sensors
- High mode: 42W, Low mode: 14.8W

Energy savings: 85%

Annual energy consumption: 9,302 kWh (before 62,115 kWh)

Average occupancy rate: 28%

Results: Post top

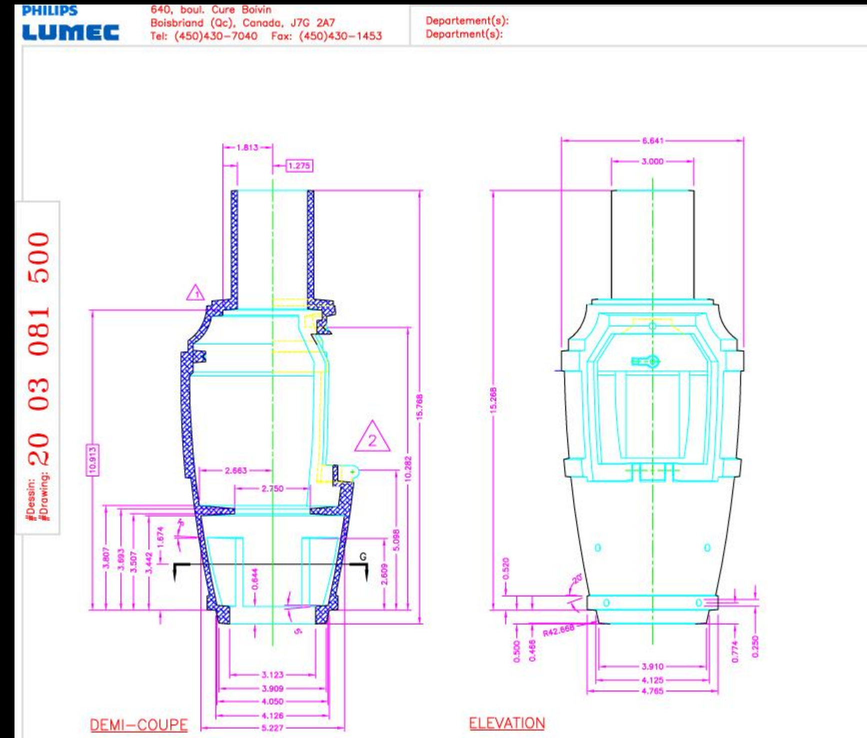
Tech specs:

- 45W LED engines with 0-10V multi-level, wireless controllers and PIR sensors in a collar on each unit
- High mode: 45W
- Low mode: 15W

86 installed

Average occupancy rate: 40%

Energy savings: 87%


PHILIPS
LUMEC
640, boul. Cure Boivin
Boisbriand (Qc), Canada, J7G 2A7
Tel: (450)430-7040 Fax: (450)430-1453
Departement(s):
Department(s):
#Dessin:
#Drawing:
20 03 081 500
DEMI-COUPE
ELEVATION

Results: Pathway

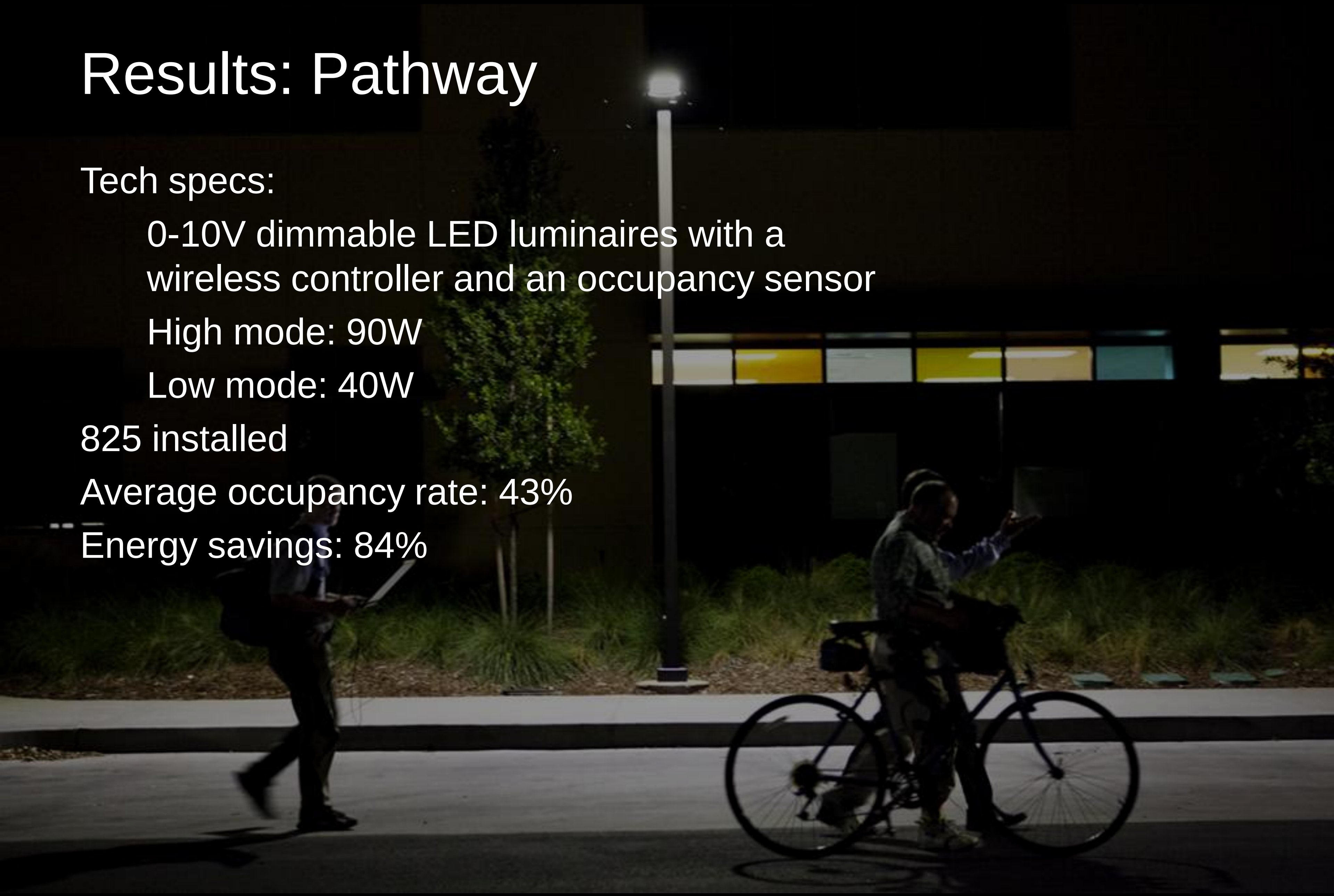
Tech specs:

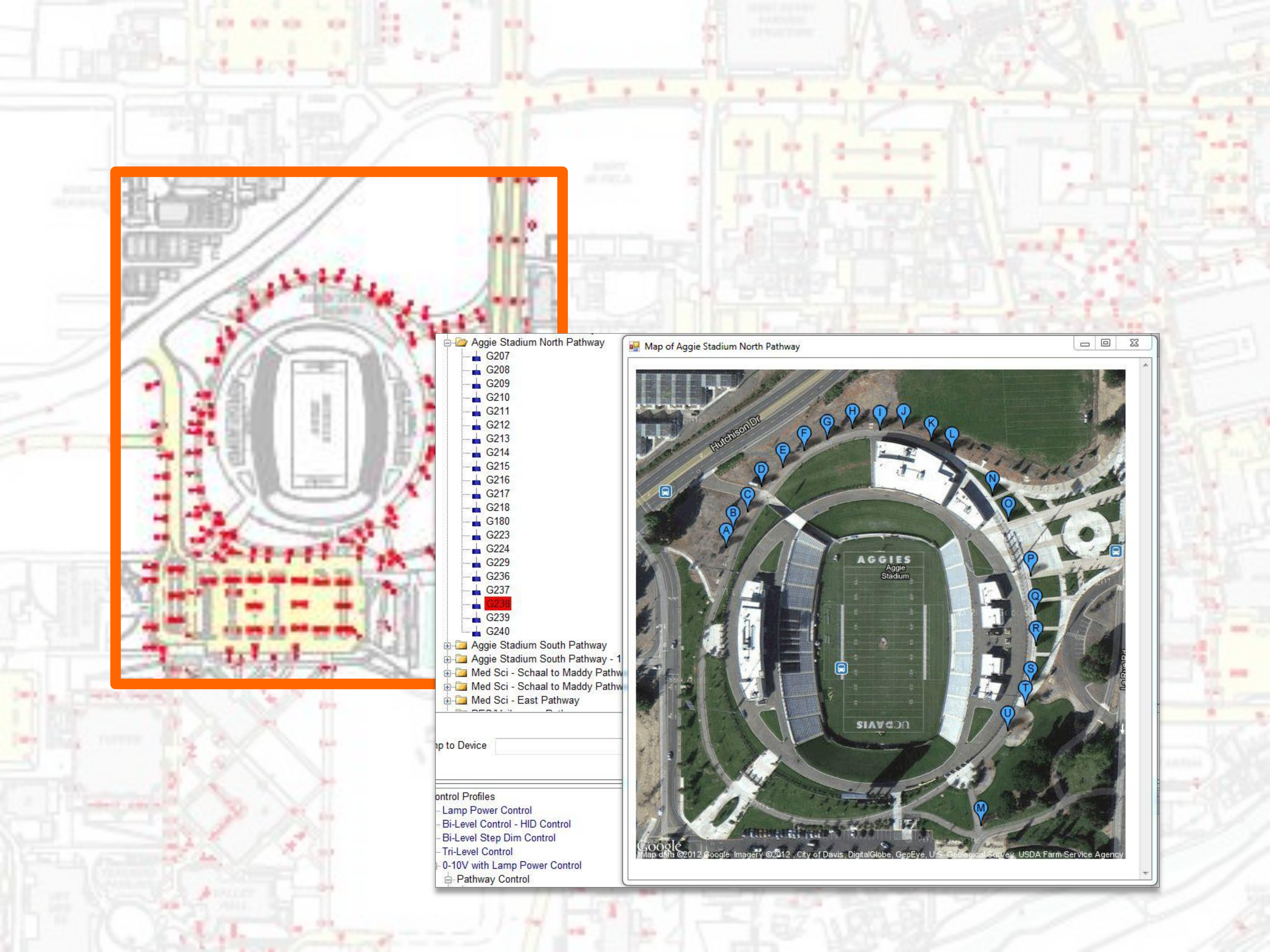
- 0-10V dimmable LED luminaires with a wireless controller and an occupancy sensor
- High mode: 90W
- Low mode: 40W

825 installed

Average occupancy rate: 43%

Energy savings: 84%





Aggie Stadium North Pathway
G207
G208
G209
G210
G211
G212
G213
G214
G215
G216
G217
G218
G180
G223
G224
G229
G236
G237
G238
G239
G240
Aggie Stadium South Pathway
Aggie Stadium South Pathway - 1
Med Sci - Schaal to Maddy Pathw
Med Sci - Schaal to Maddy Pathw
Med Sci - East Pathway
p to Device
ontrol Profiles
Lamp Power Control
Bi-Level Control - HID Control
Bi-Level Step Dim Control
Tri-Level Control
0-10V with Lamp Power Control
Pathway Control
Map of Aggie Stadium North Pathway
Hutchison Dr
AGGIES
Aggie Stadium
UC DAVIS
A
B
C
D
E
F
G
H
I
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K
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M
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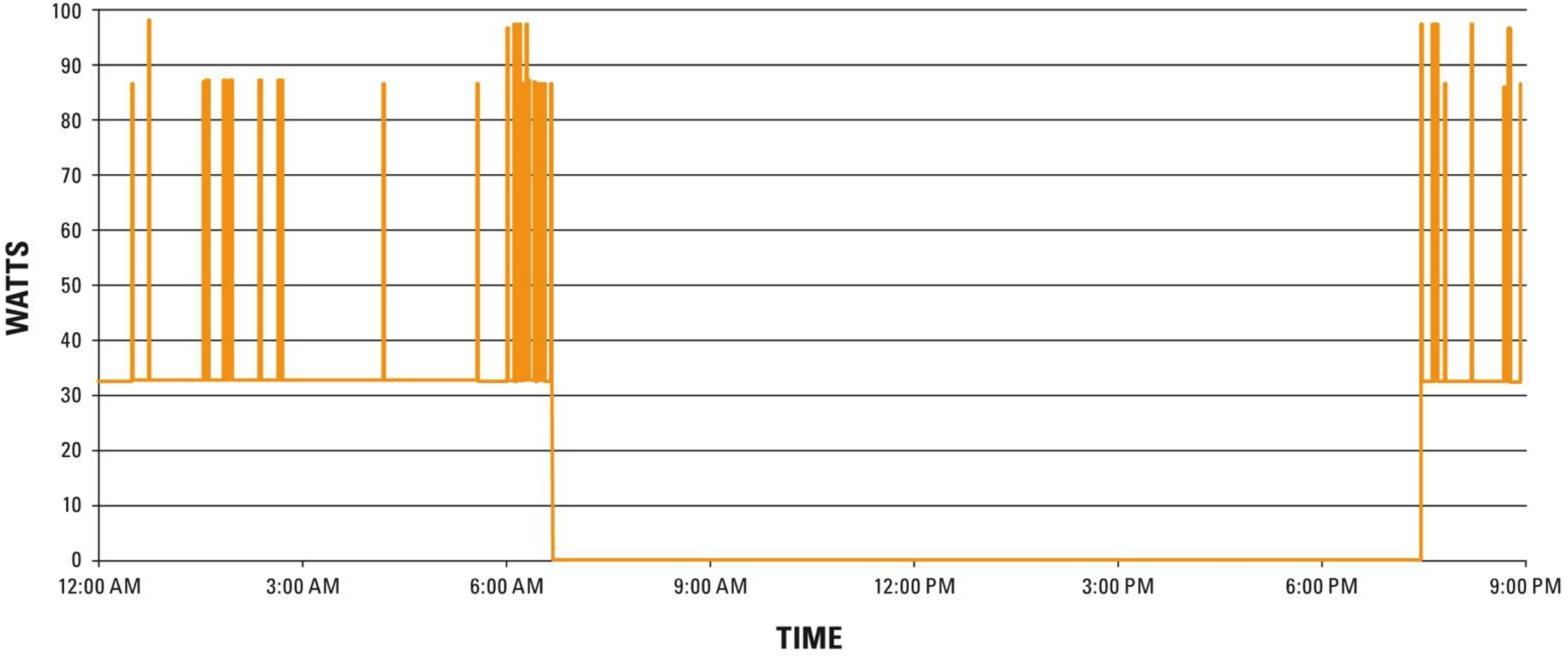
Google
Map data ©2012 Google Imagery ©2012 , City of Davis, DigitalGlobe, GeoEye, U.S. Geological Survey, USDA Farm Service Agency

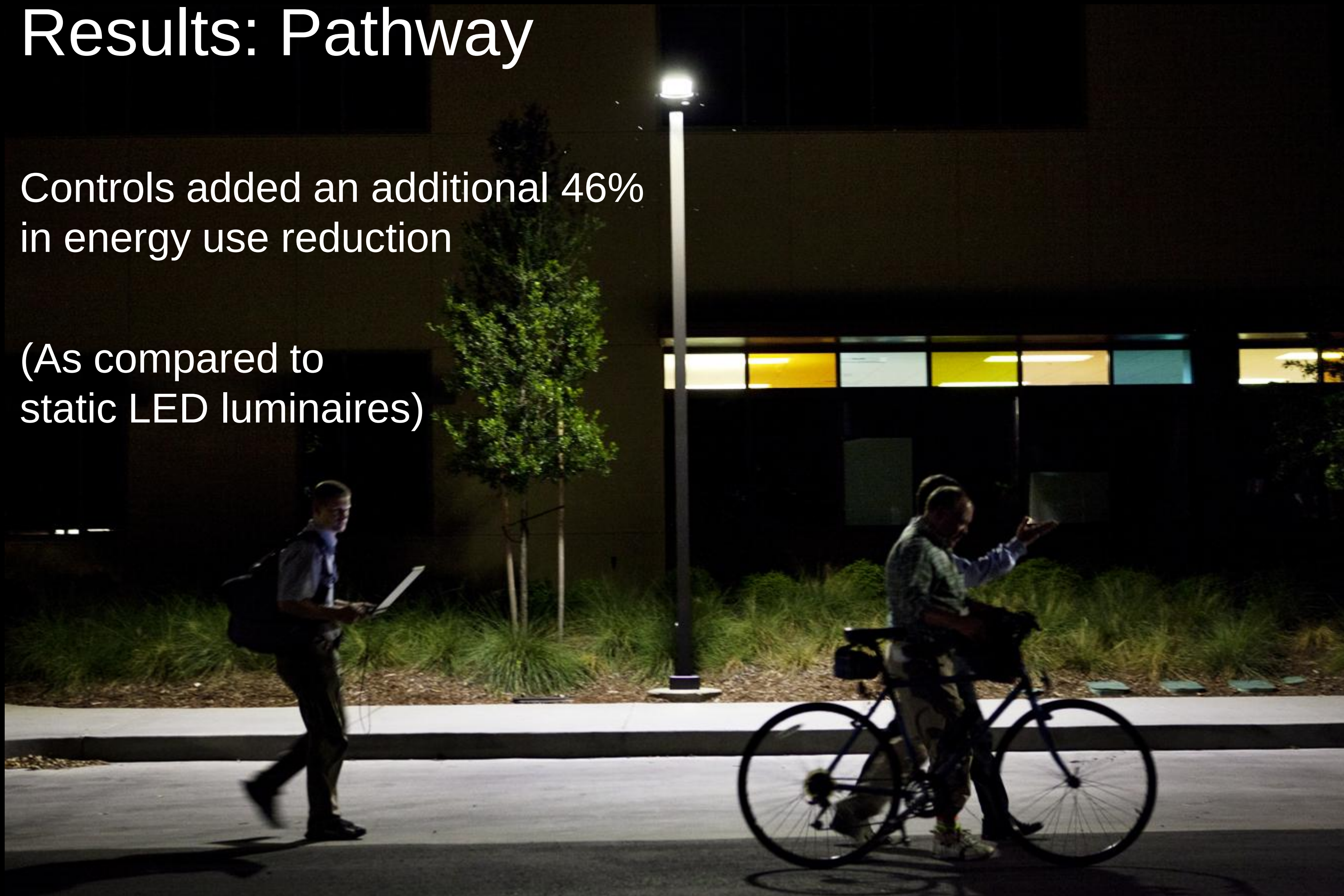


Pathway luminaires, April 24, 2012:
Preliminary data gathered from the pathway leading to the University's new Aggie Stadium reports an average energy savings of 60% as compared to a static installation of the same fixture.

Results: Pathway

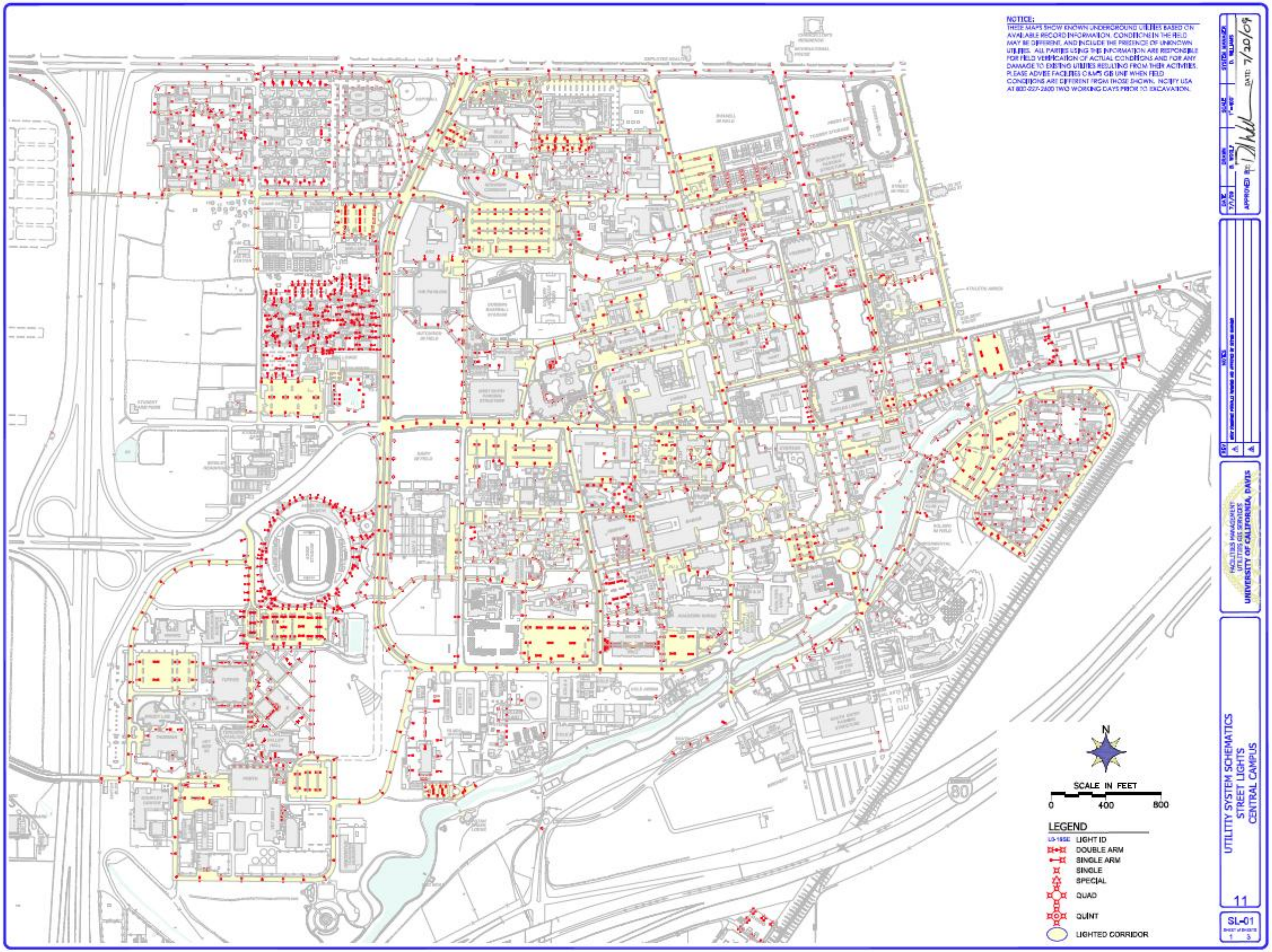
Controls added an additional 46% in energy use reduction

(As compared to static LED luminaires)




BICYCLES
AND
EMERGENCY
VEHICLES
ONLY

Young Hsll, UC Davis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What is an Energi Savr Node?

- ***Intelligent and distributed lighting control that integrates sensors and controls to adjust lights to maximize energy savings***

- ***Easily combines daylighting, occupancy/vacancy sensing, personal control, and timeclock***

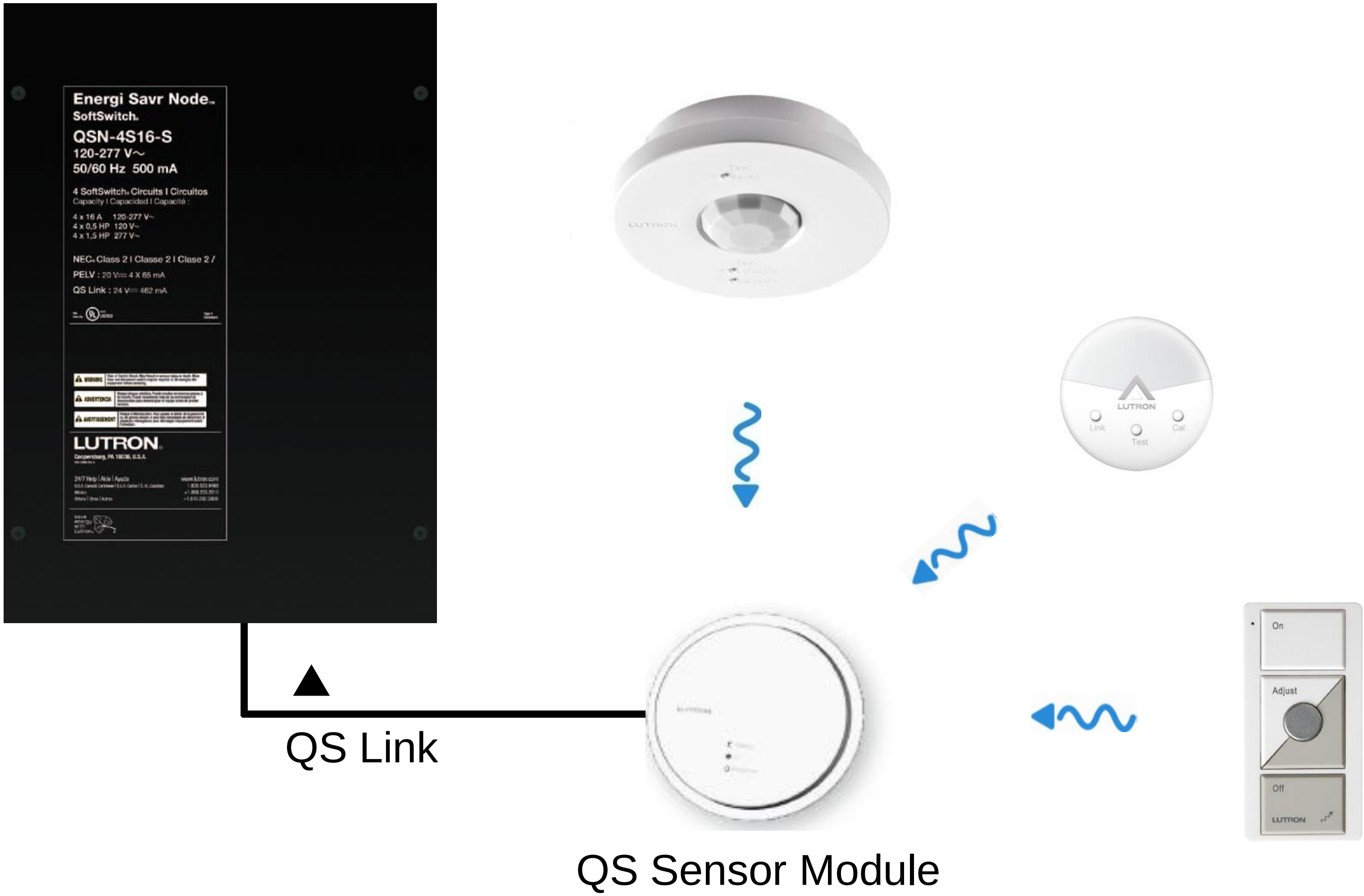
- ***Network ESN's to report back to the Centralized Lighting Control System (either BMS or Quantum)***

Energi Savr Node
Sensor Connections

4 x Wired Daylight Sensor connections
(all current wired sensors)

4 x Wired Occupancy Sensor connections
(1 and 4 Button)

Energi Savr Node Wireless Capabilities

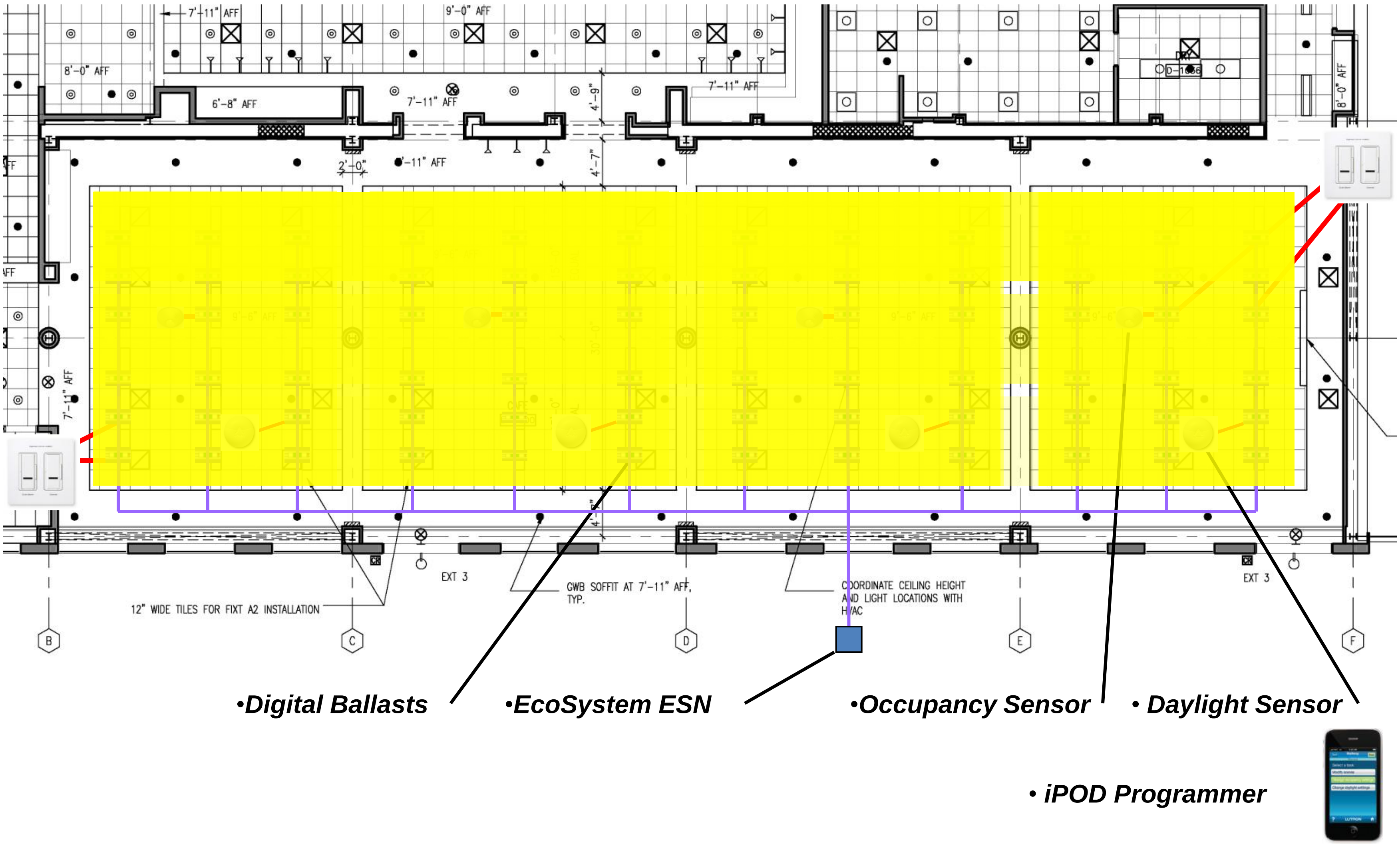


Easy Integration with other Building Systems

- ***Easy data flow between Lighting Control System and other building systems***
- ***Contact closure, RS232, Ethernet, and BACnet for integration with 3rd party equipment***
  - ***AV Systems***
  - ***BMS Systems***
  - ***Fire Alarm Systems***
  - ***Security Systems***

BACnet

EMD Millipore Cafe
EcoSystem Example



What is Quantum?

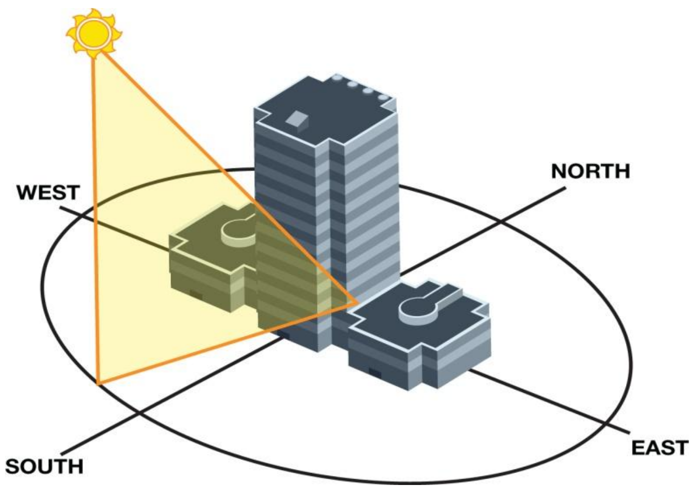
- ***Quantum manages both electric light and daylight through manual or automatic control***
- ***Quantum Manages Through Software . . .***
  - ***Digital Ballasts & Drivers***
  - ***Preset Dimming Controllers***
  - ***Motorized Shades***
  - ***Switching & Dimming Panels***

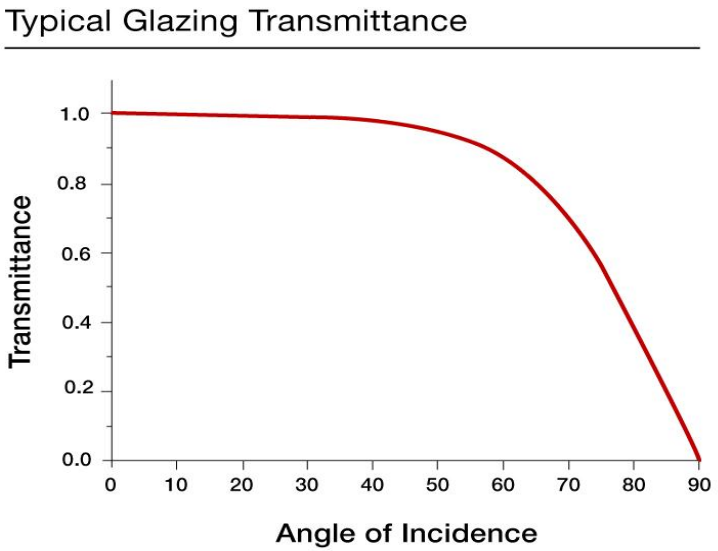
Quantum's Hyperion Software

- ***Automatically adjusts the window shades based on sun position to maximize the use of good available daylight while minimizing heat penetration***
- ***User selects***
  - ***Desired sunlight penetration***
  - ***Number of shade preset positions***
  - ***At any time user can manually override shades***
  - ***Cloudy Day Sensor is used to over-ride when the sun is not present and keep the shade open***

Quantum's Hyperion Software

- ***Comfort and productivity can be greatly effected by how hot and how glaring it is by a window. By recognizing glazing's ability to transmit* and reflect, we can adjust the shades at critical points in the day to maximize comfort and productivity***



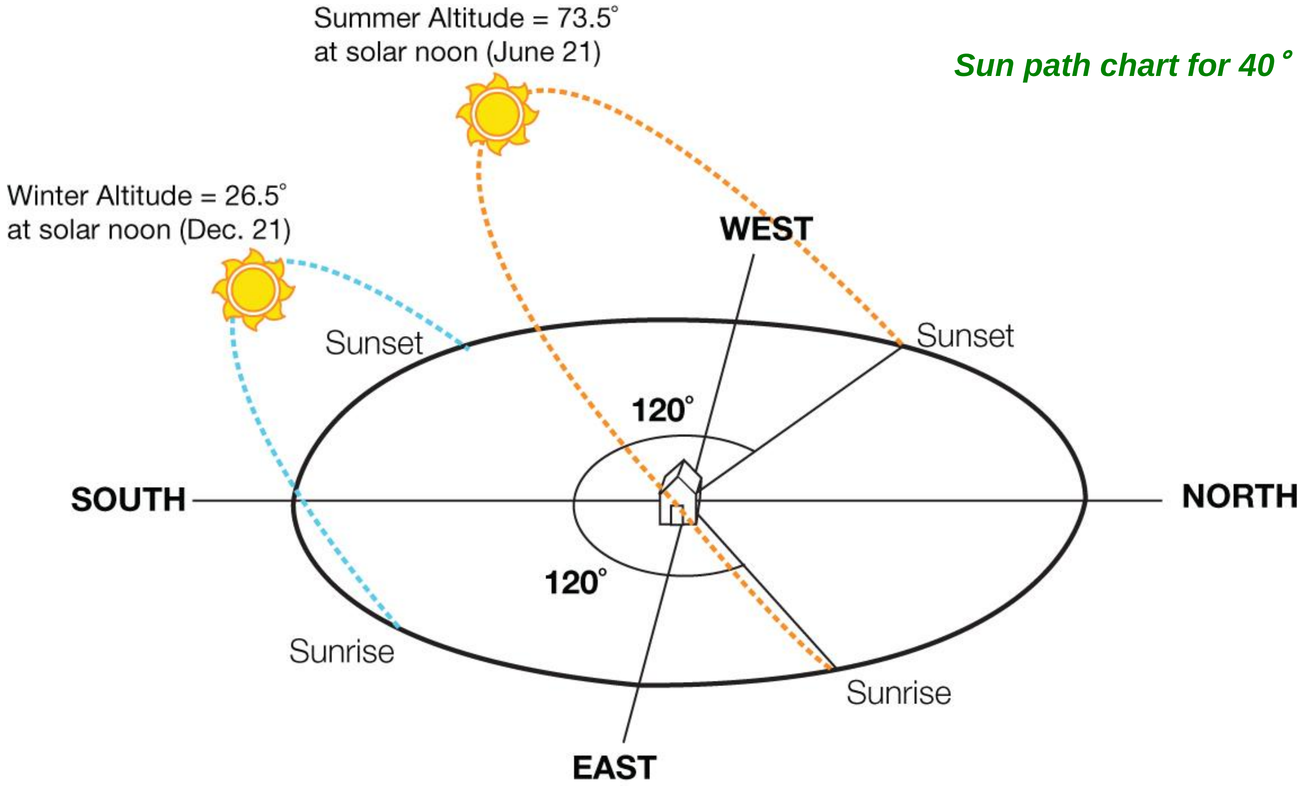


* ***Solar transmittance = The amount of solar energy (visible, infrared and ultraviolet) that passes through a glazing system, expressed as a percent.***

Quantum's Hyperion Software

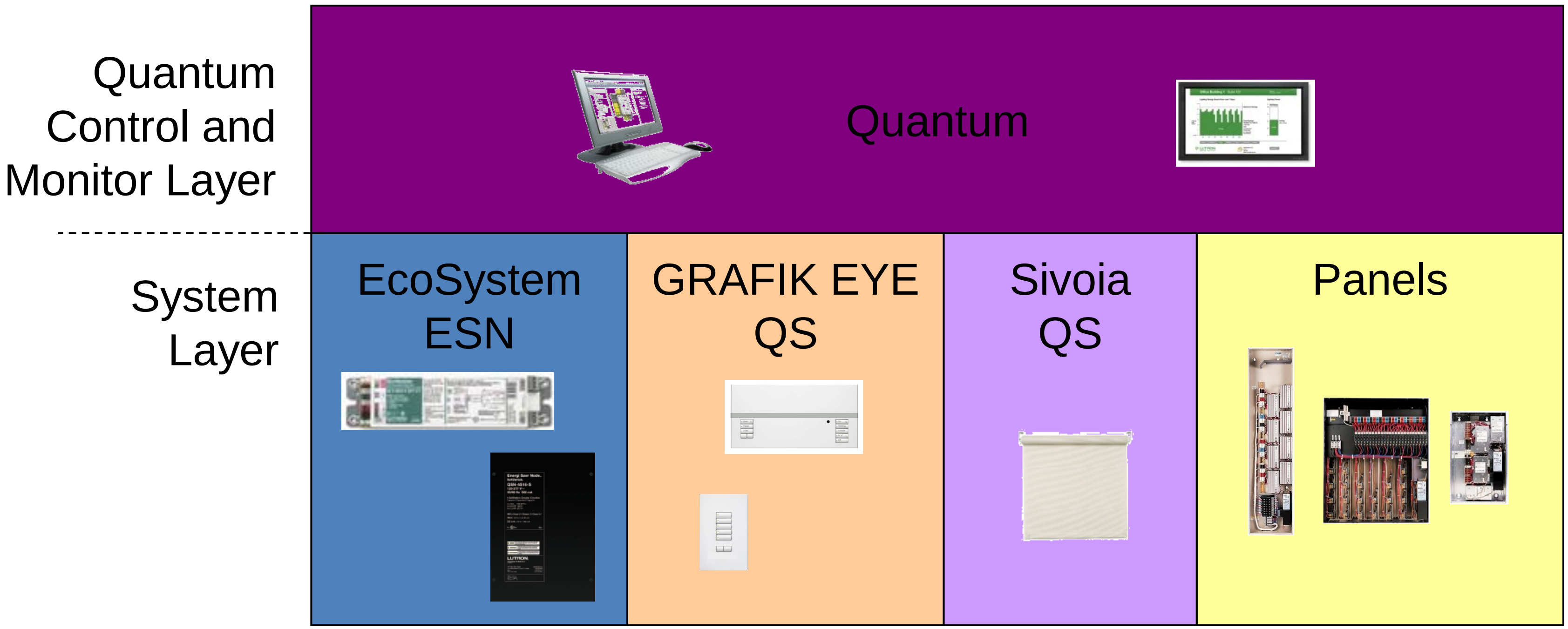
- ***Why not just use an astronomical time clock?;***
  daily solar path varies at different times of the year

Sun path chart for 40° Latitude

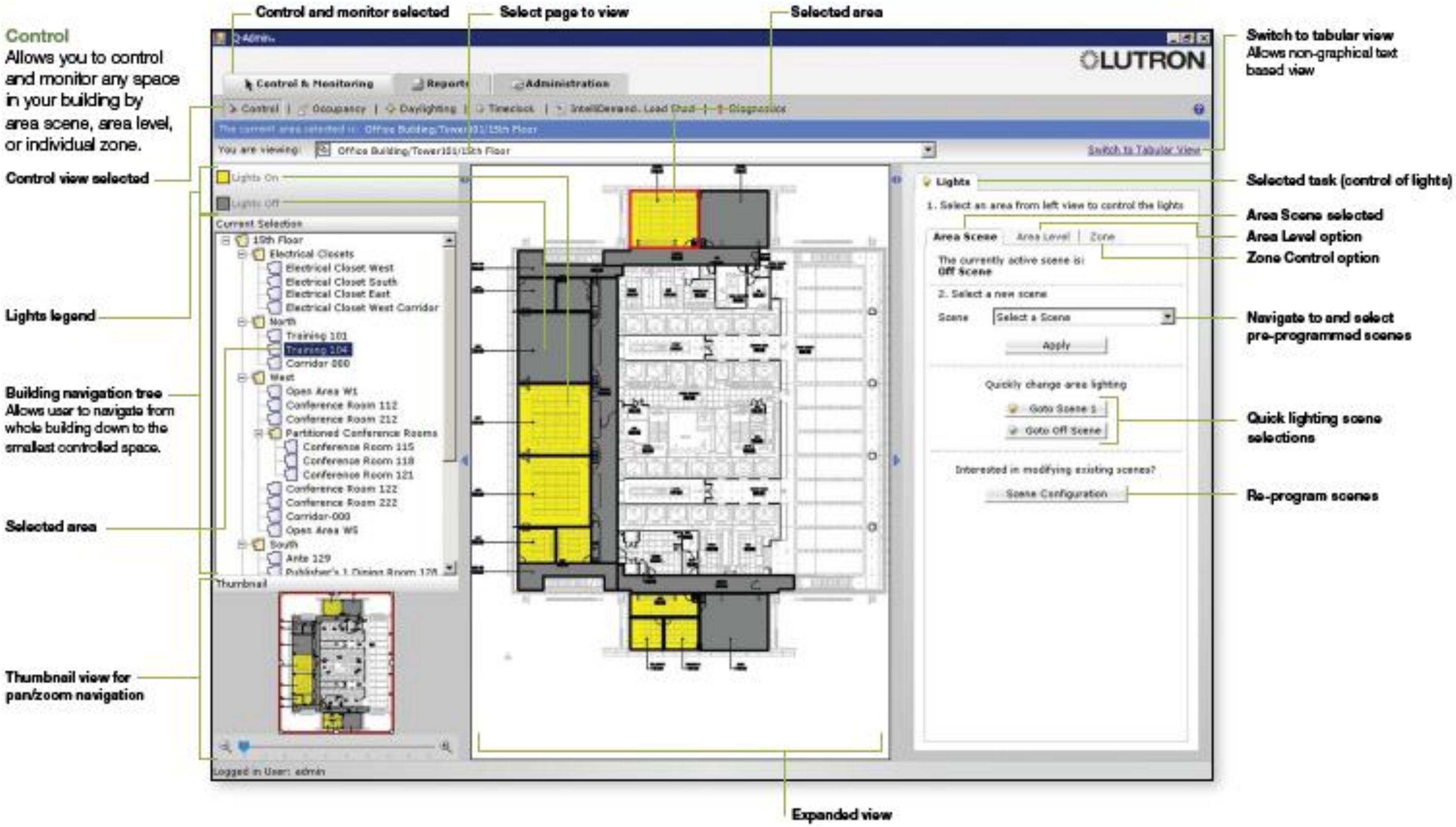


What Quantum provides . . .

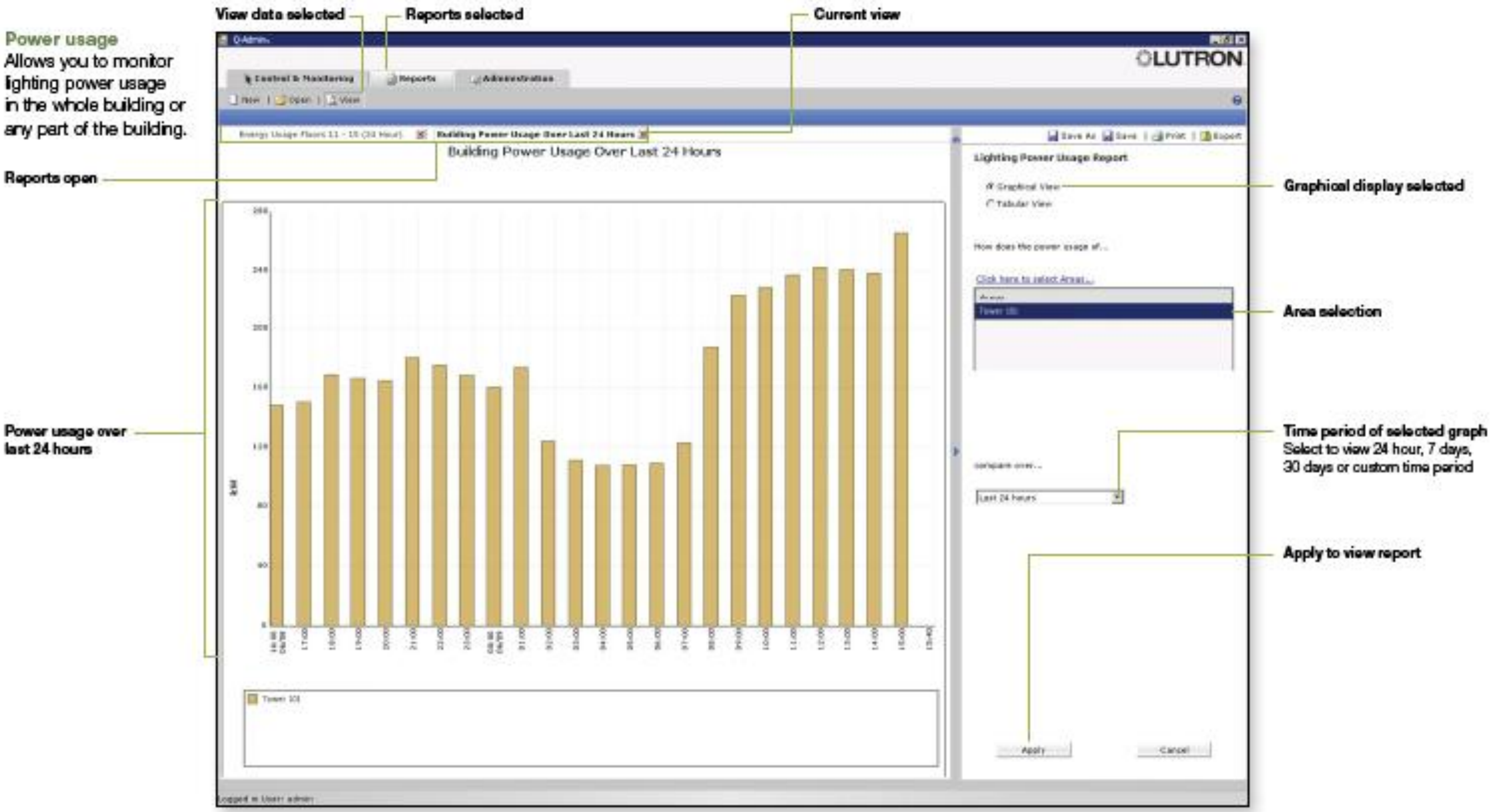
- ***Another Layer of Intelligence***
  - ***Adds additional features to independent systems***
  - ***Lets independent systems share functionality***



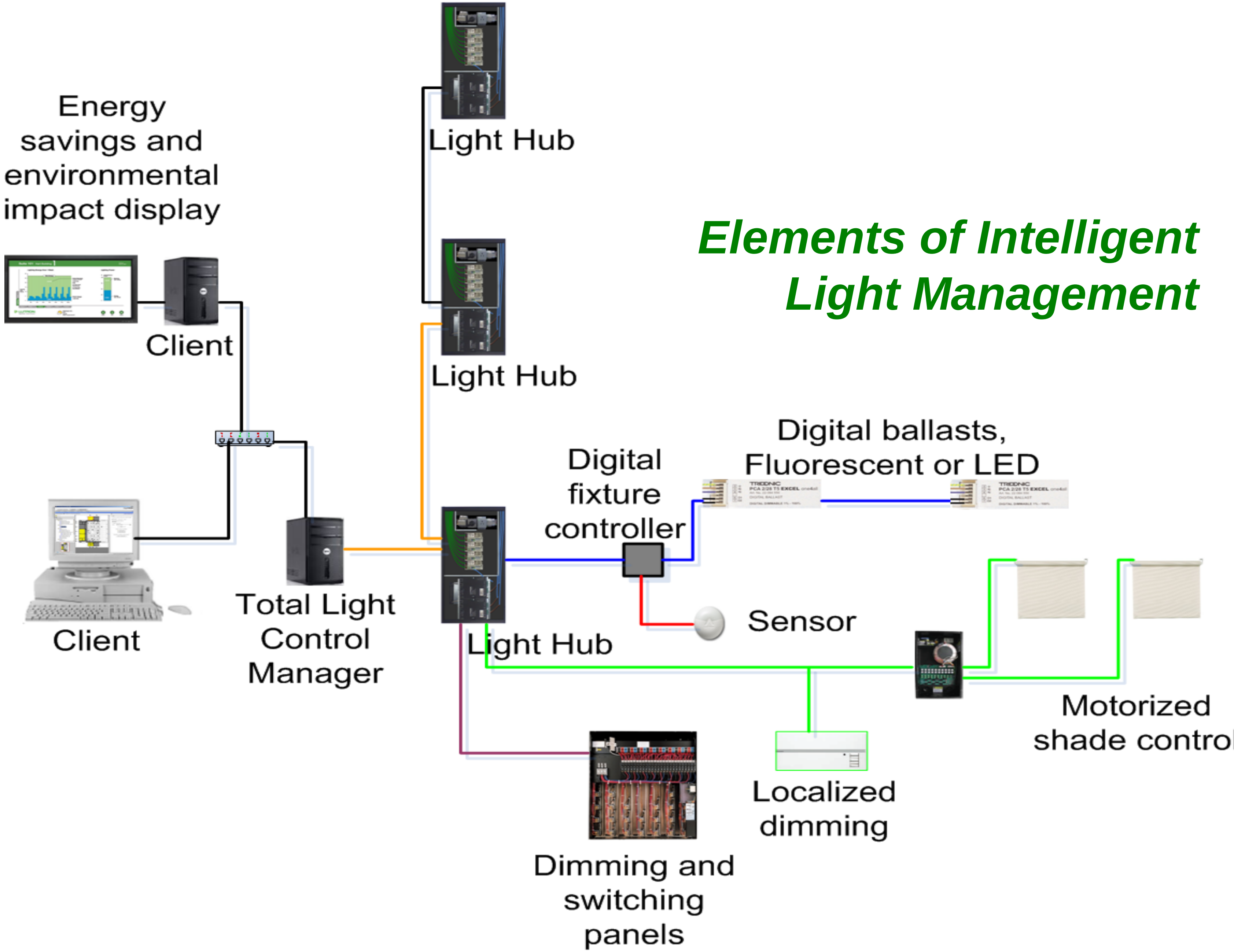
Controlling & Monitoring



Reporting


View data selected
Reports selected
Current view
Power usage
Allows you to monitor lighting power usage in the whole building or any part of the building.
Reports open
Power usage over last 24 hours
Graphical display selected
Area selection
Time period of selected graph
Select to view 24 hour, 7 days, 30 days or custom time period
Apply to view report
LUTRON
Building Power Usage Over Last 24 Hours

Elements of Intelligent Light Management



Solutions for Renovation & Retrofit

Quantum

- ***Total Light Management System for Commercial Buildings***
  - ***Though not a wireless technology itself, it ties several different pieces together including the GRAFIK Eye QS wireless - which brings the compatible wireless components into the individual rooms throughout the building***

Fairbanks Scales, Burlington, VT

Warehouse Facility

-Eco System w/ H Series Series Ballasts

-Radio Power Saver Sensors
*Occupancy Sensors
*Daylight Harvesters
*Pico Controls

	2011	2012	Actual Change		EV Projected Change	
Usage - kWh	2,190,000	1,666,590	(523,410)	-23.9%	(339,000)	-15.5%
Peak - kW	482	400	(82)	-17.0%	(75)	-15.5%

National Life – Montpelier, VT

Key Contact: Tim Shea

Office Space

-Eco System w/ H Series Series Ballasts

-Radio Power Saver Sensors
 *Occupancy Sensors
 *Daylight Harvesters
 *Pico Controls

-Stairwell Fixtures with High/Low dimming ballast set, using wireless Occ Sensors

Dartmouth College - Hanover, NH

Key Contact: Laura Black

Berry Library

-Quantum Total Light Management Server
-Eco System w/ H Series Series Ballasts
-Switching Relay Panels
-Local Switching Pow Paks

-Radio Power Saver Sensors
  *Occupancy Sensors
  *Daylight Harvesters
  *Pico Controls

Berry Library Lighting Efficiency Upgrade – Phase 1

New Linear Fluorescent Lighting in Many Spaces WIth Lutron Eco System + Controls Applied

ENERGY REDUCTION REPORT CARD

Results of Configuration, Programming and Early Tuning/Operations

Report Card

Consumption

Consumption Reduction Targets

	kWH/Yr	kWH/Wk	kWH/Day
Present Energy Usage	1,227,265	23,600	3,370
Target Savings for Phase 1	547,605	10,530	1,500
Target Energy Consumption Following Phase 1	679,660	13,070	1,870

Daily Average Target Consumption → 1,870

Actual Consumption Reduction

	kWH/Wk	kWH/Day
Prior to Project	23,600	3,370
Post Config. Saturday 1/19		1,994
Post Config. Sunday 1/20		2,078
Post Config. Monday 1/21		2,387
Post Config. Tuesday 1/22		2,501

Current project at **IDEXX Laboratories (**LEED Gold)

Westbrook, ME

New office space

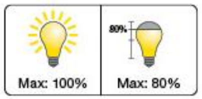
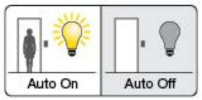
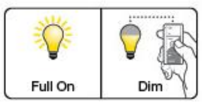
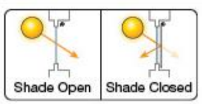
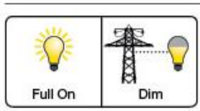
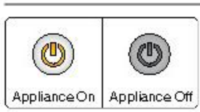
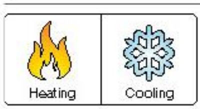
-Quantum Total Light Management Server

-Eco System w/ Cree LED Troffers w/ integral H Series Drivers

-Radio Power Saver Sensors
    *Occupancy Sensors
    *Daylight Harvesters
    *Pico Controls

-Hyperion Solar Adaptive Motorized Shading
    * Cloudy Day Sensors

7 Strategies of Light Control (+2)

Strategy		Potential savings
	**High-end trim** sets the maximum light level based on customer requirements in each space.	10-20% Lighting[7]
	**Occupancy/vacancy sensing** turns lights on when occupants are in a space and off when they vacate the space.	20-60% Lighting[8]
	**Daylight harvesting** dims electric lights when daylight is available to light the space.	25-60% Lighting[9]
	**Personal dimming control** gives occupants the ability to set the light level.	10-20% Lighting[10]
	**Controllable window shading** moves shades to reduce glare and solar heat gain.	10-20% Cooling[11]
	**Scheduling** provides scheduled changes in light levels based on time of day.	10-20% Lighting[12]
	**Demand response** automatically reduces lighting loads during peak electricity usage times.	30-50% Peak Lighting[13]
	**Plug load control** automatically turns off loads after occupants leave a space.	15-40% Non-Electronic[14]
	**HVAC integration** control heating, ventilation and air conditioning systems through contact closure, or BACnet integration.	5-15% HVAC[15]

Overall Integrated Control Strategy

During **Occupancy** Focus on **Comfort**

- **Adjust fenestration for daylight penetration**
- **Adjust electric lighting for daylight contribution**
- **Adjust electric lighting for demand response signal**
- **Adjust HVAC**

During **Vacancy** Focus on **Energy Efficiency**

- **Adjust fenestration for cooling/heating loads**
- **Turn electric lighting off or dim down**
- **Adjust electric lighting for demand response signal**
- **Adjust HVAC**

Lighting Control Strategies for Energy Efficiency and Comfort

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