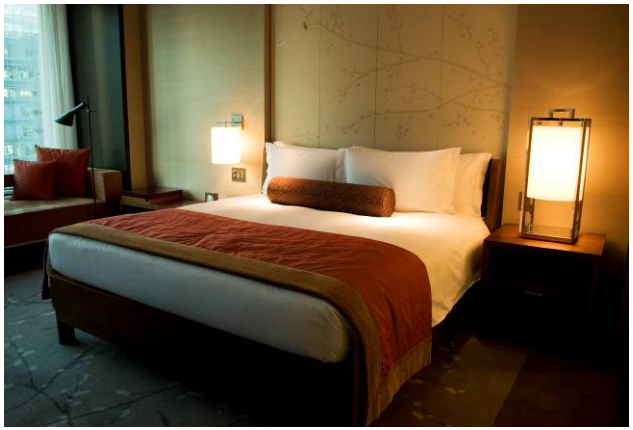


Opportunities for Adaptive Lighting

(Bi-level Lighting)

Dr. Michael Siminovitch
Professor, University of California, Davis
Director, California Lighting Technology Center
Associate Director, Energy Efficiency Center

WASHINGTON STATE UNIVERSITY
EXTENSION ENERGY PROGRAM

UCDAVIS
UNIVERSITY OF CALIFORNIA

Adaptive Lighting Design

(50-60% savings in most buildings)

1. Vacancy occupancy
2. Demand respond
3. Daylighting

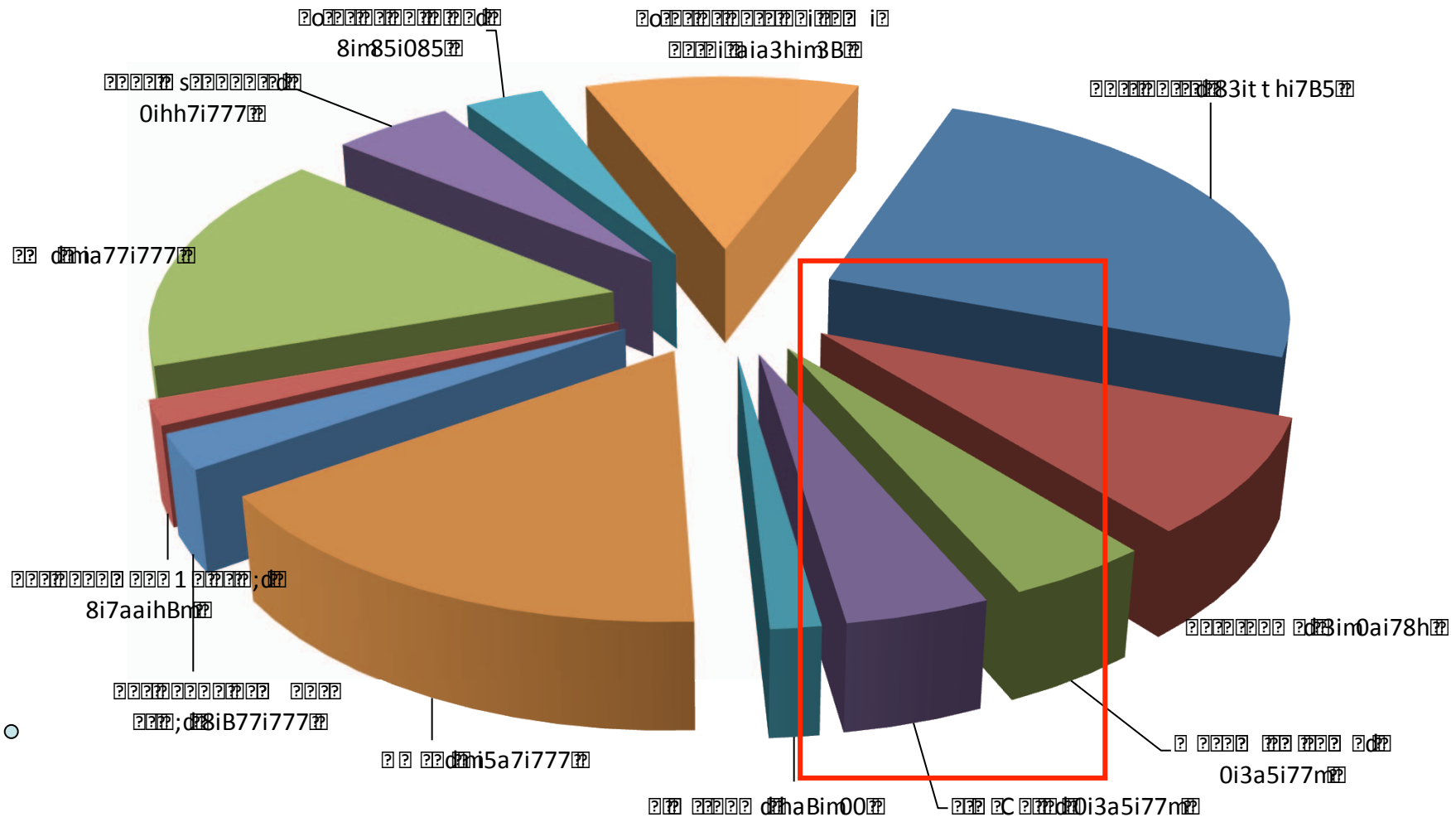
Adaptive Lighting Design: Lighting Responds to Need

(50-60% savings in most buildings)

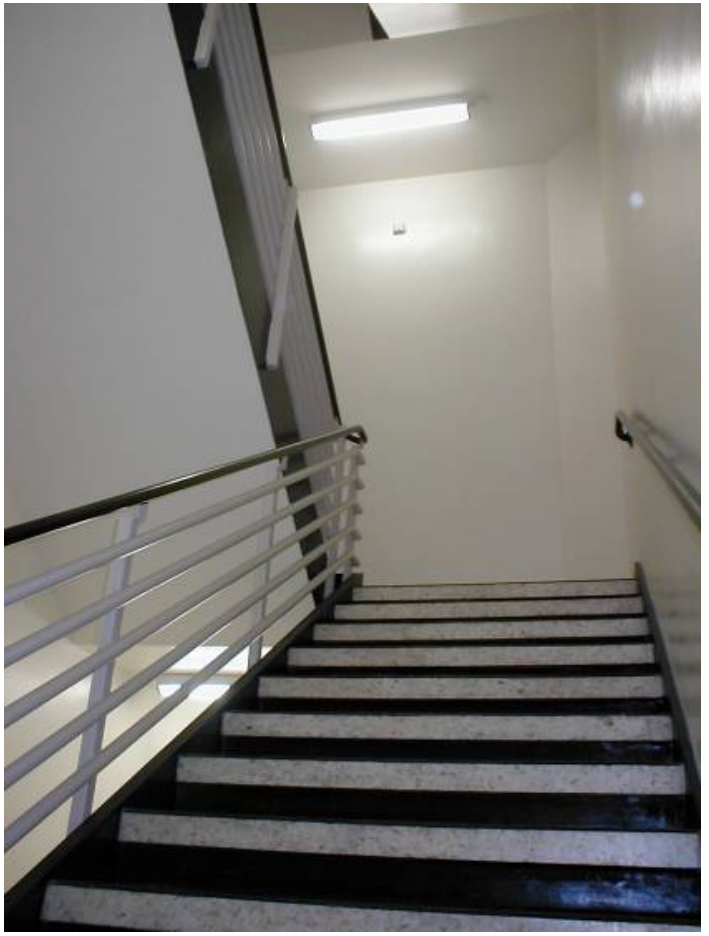
- Corridors
- Offices
- Stairwells
- Mechanical spaces
- Exterior


EMPTY CYLINDERS
EMPTY CYLINDERS
EMPTY

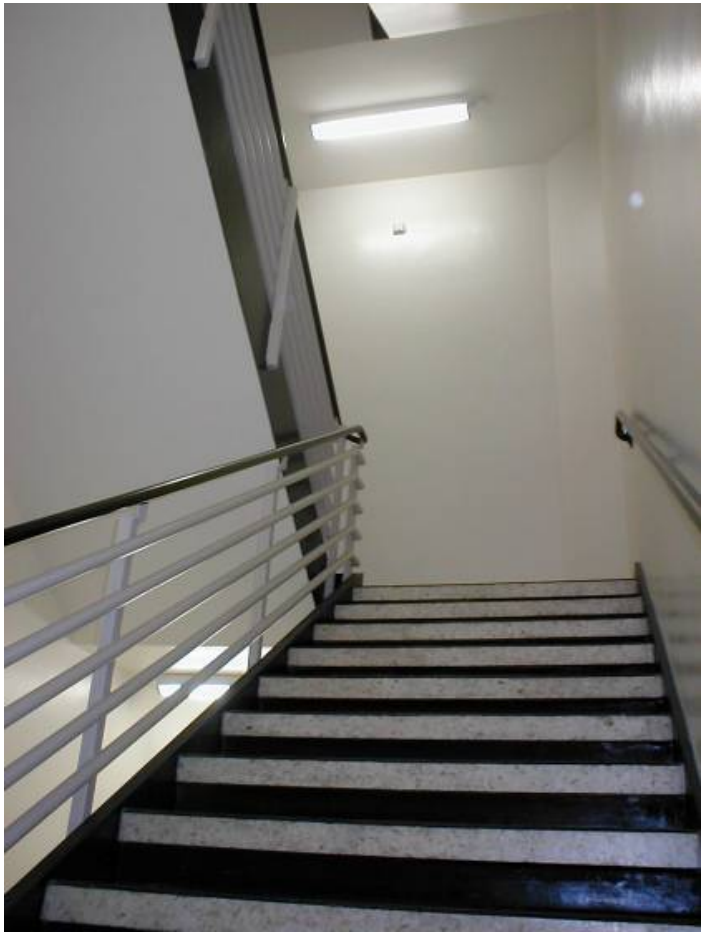
Typical Commercial Building Lighting Energy Use (Campus)

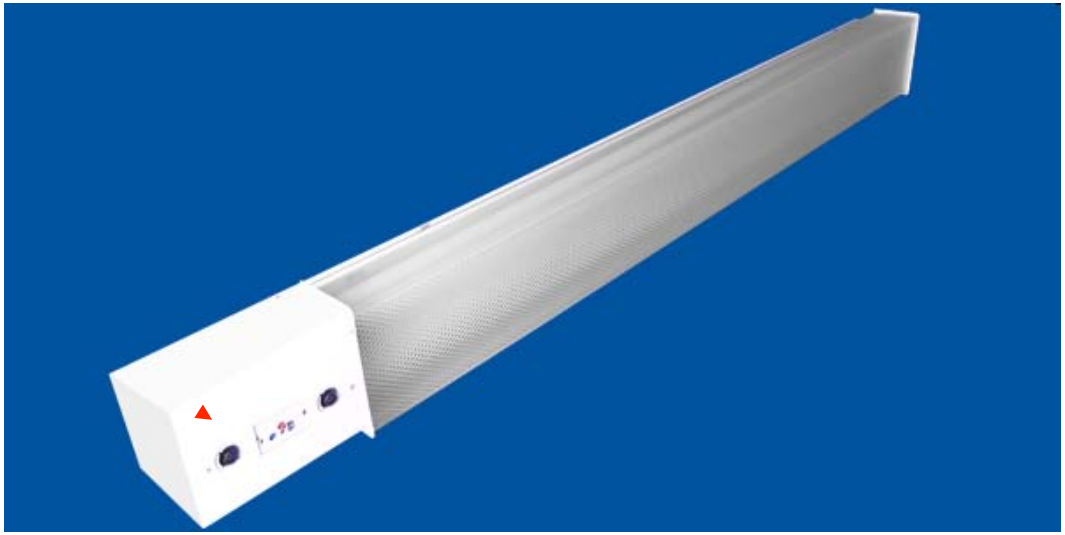


Bi-level Stairwells in State Buildings

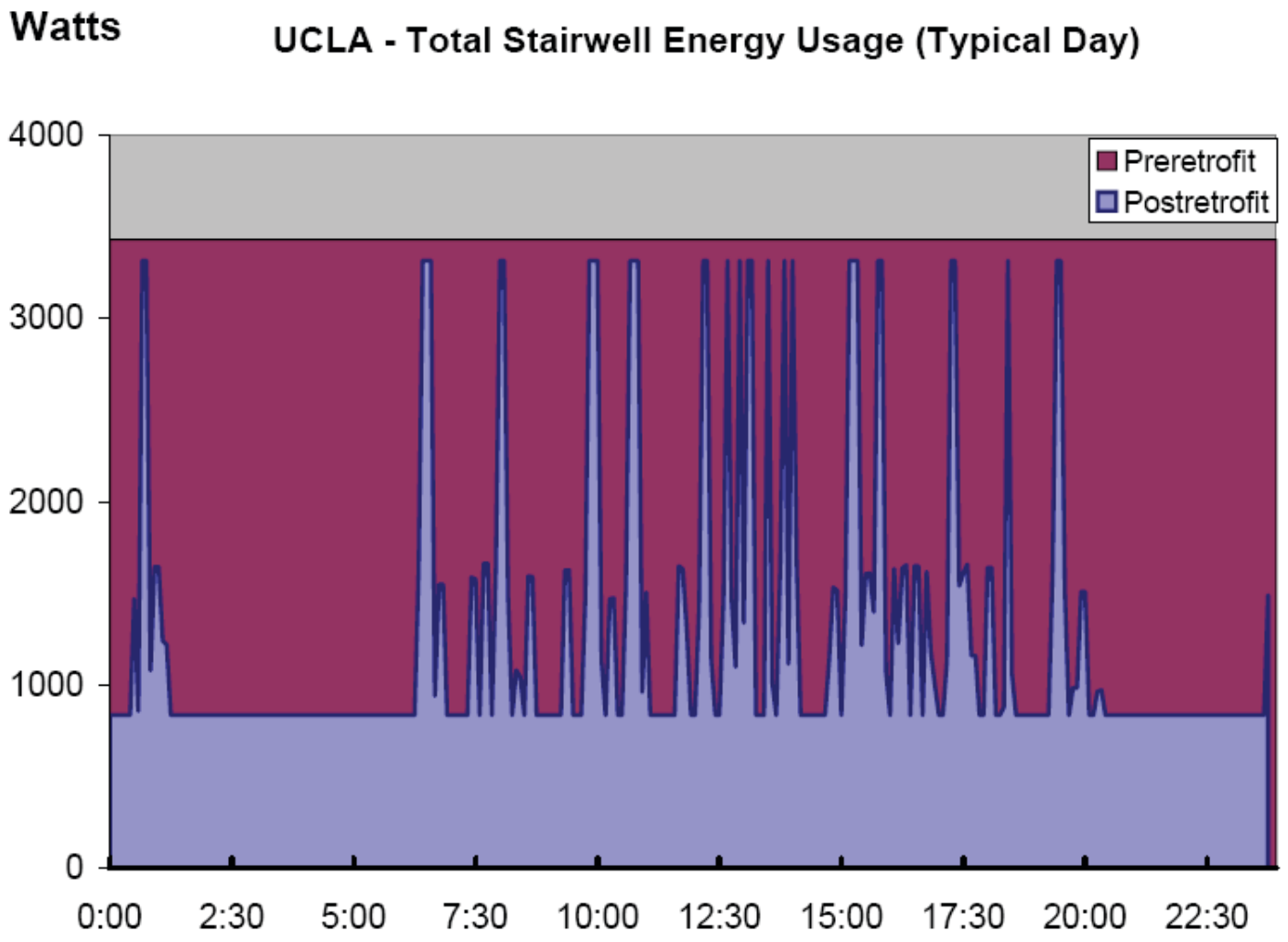


Bi-level Stairwells in State Buildings





50% Savings:
Large Purchase Programs Initiated



Bi-level Stairwells for all State Buildings

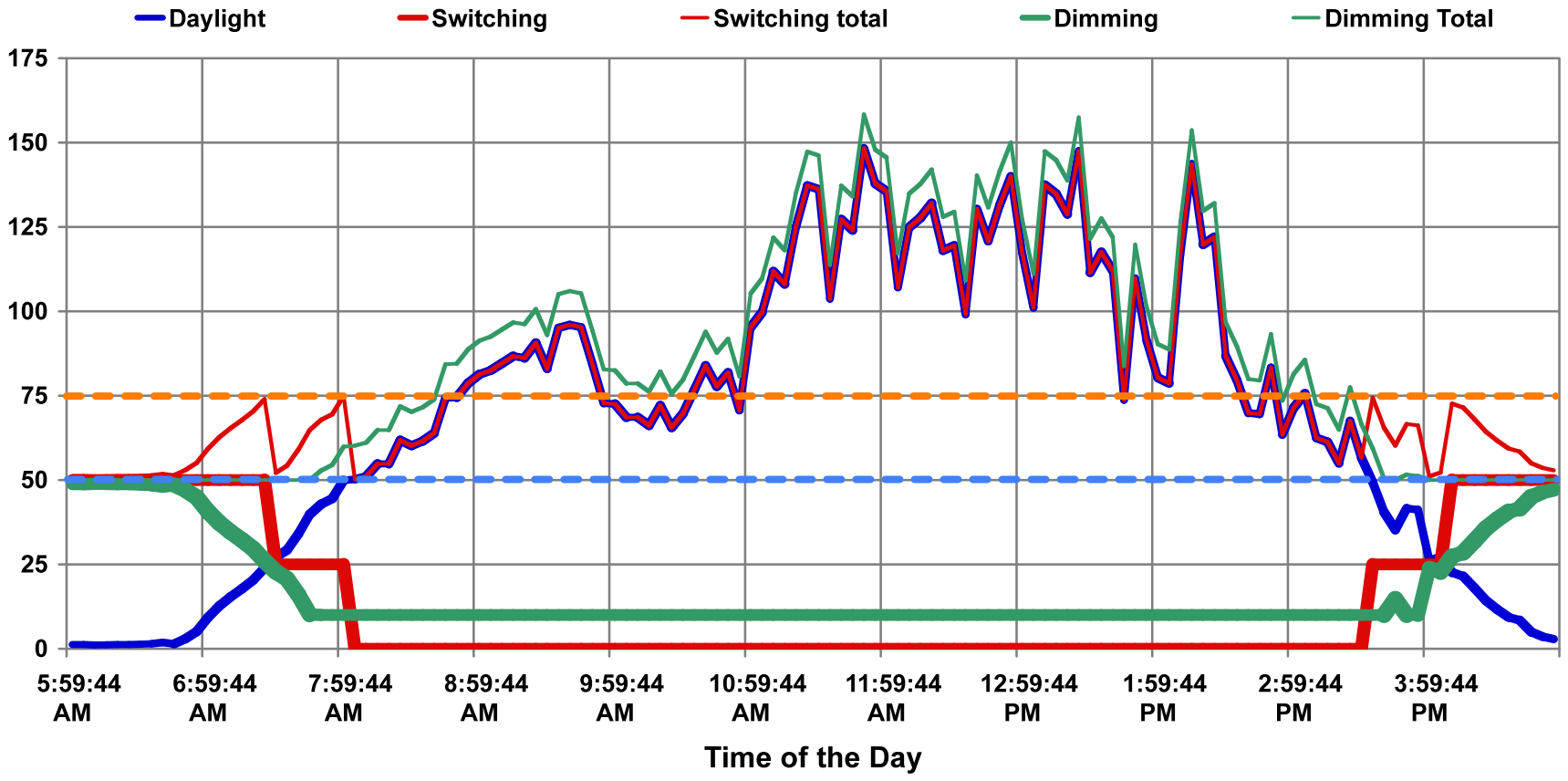
- Objective/directive to relight all government and state buildings by 2015
- Agreements with DGS
- Purchase program now developing

Daylighting Design

Simplified Daylighting Technology

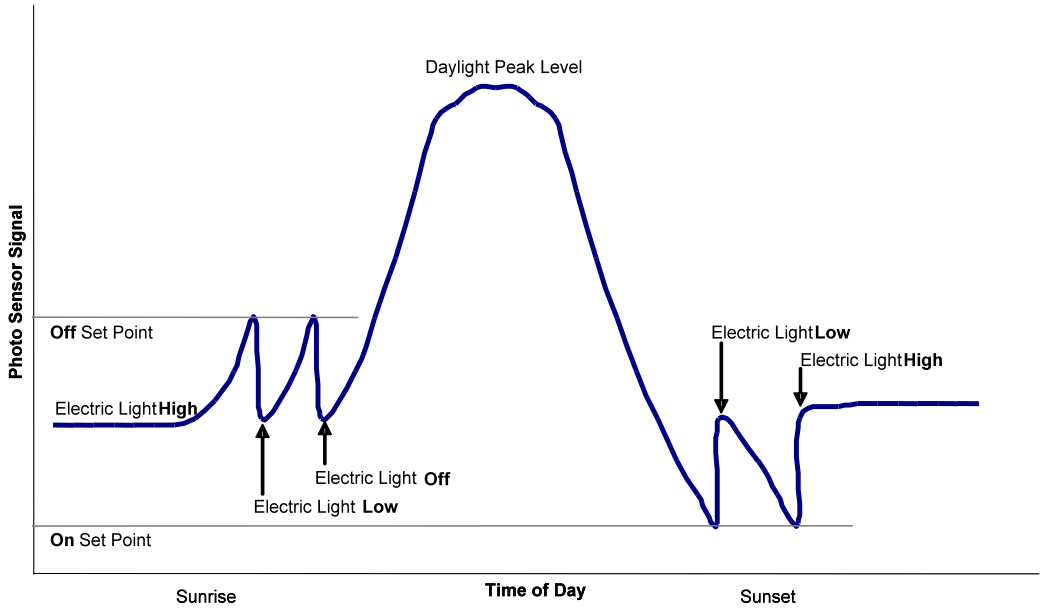
Simulated Switching & Dimming

Target Illuminance at 50 fc - Switching Set Point at 75 fc



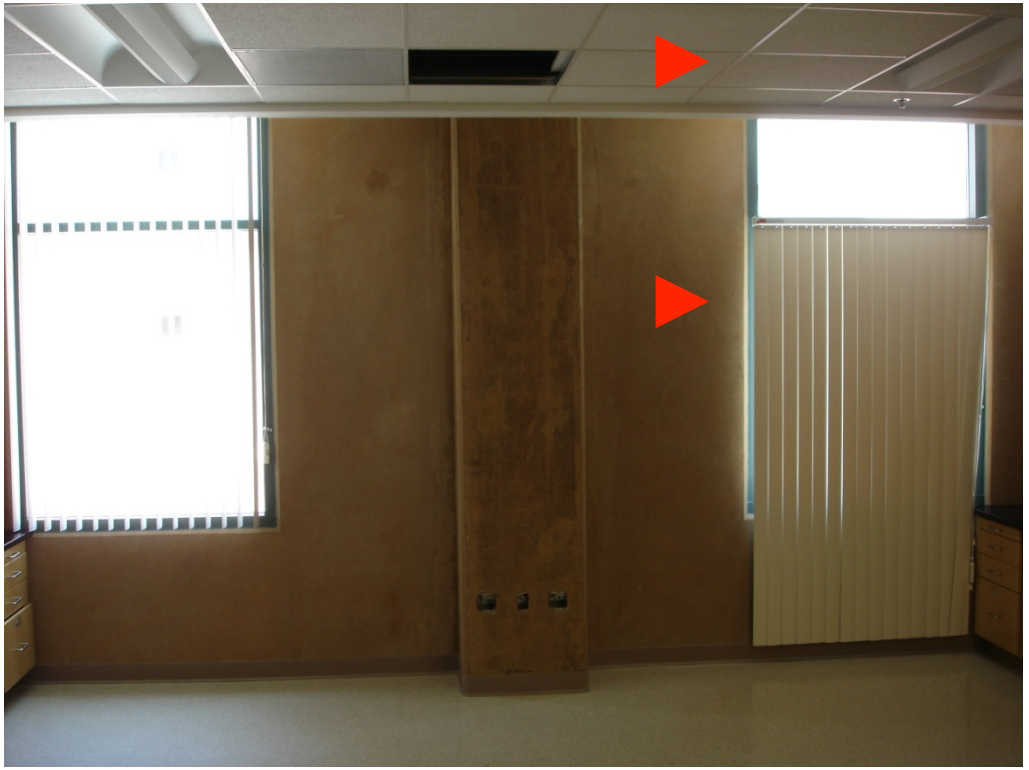
North-facing window at Davis, CA, on November 17, 2004

By 2020, Daylighting will be used in all new and existing offices and commercial spaces

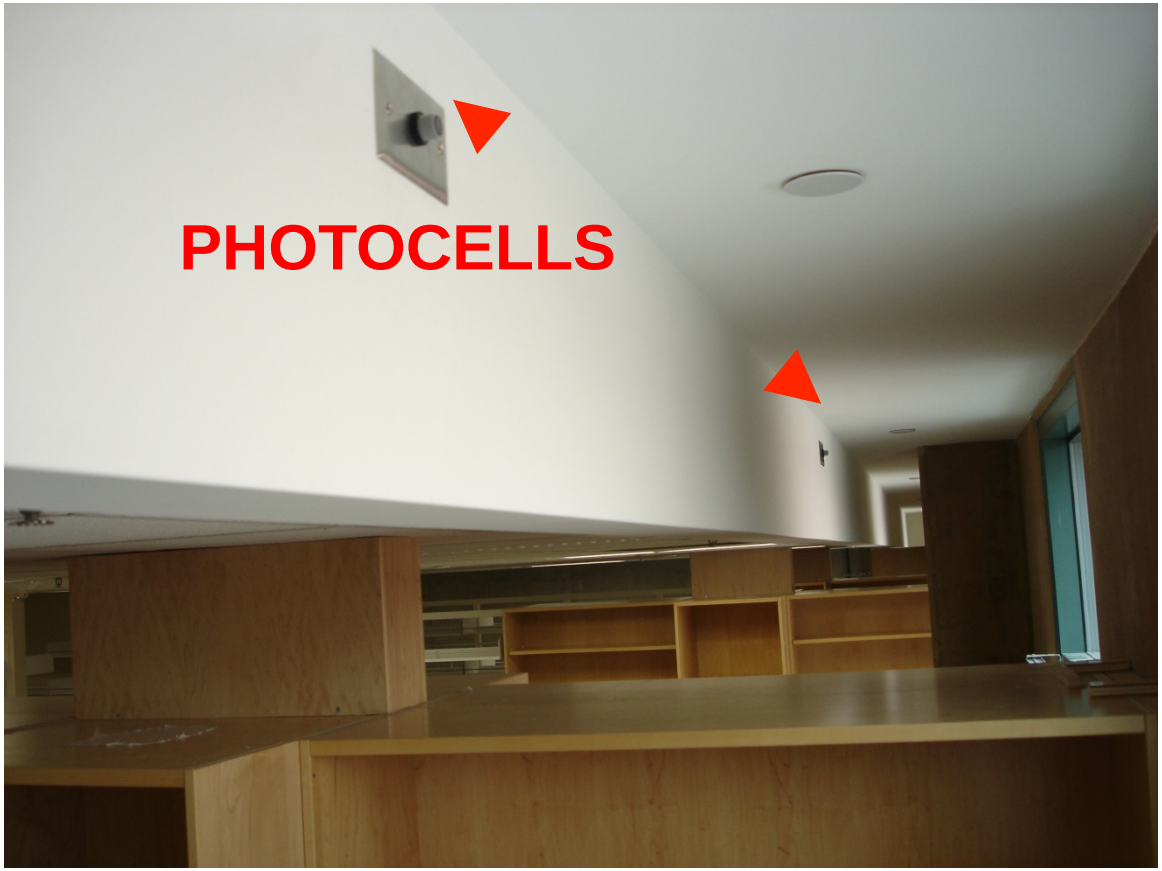


Laboratory Daylighting University of California, Irvine

- UC Irvine
- 50% savings
- Design standard

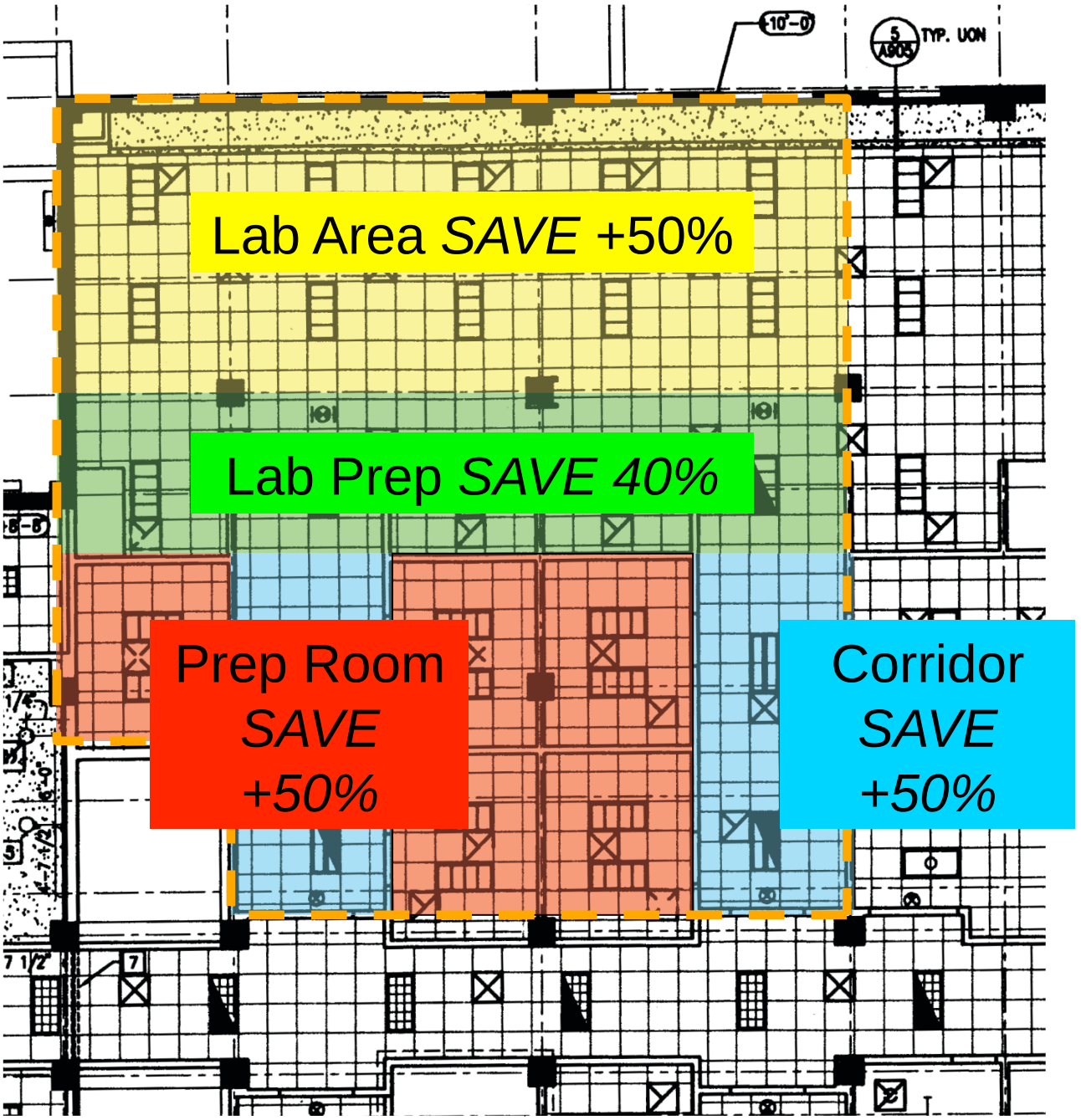


Photocell to control window row fixtures



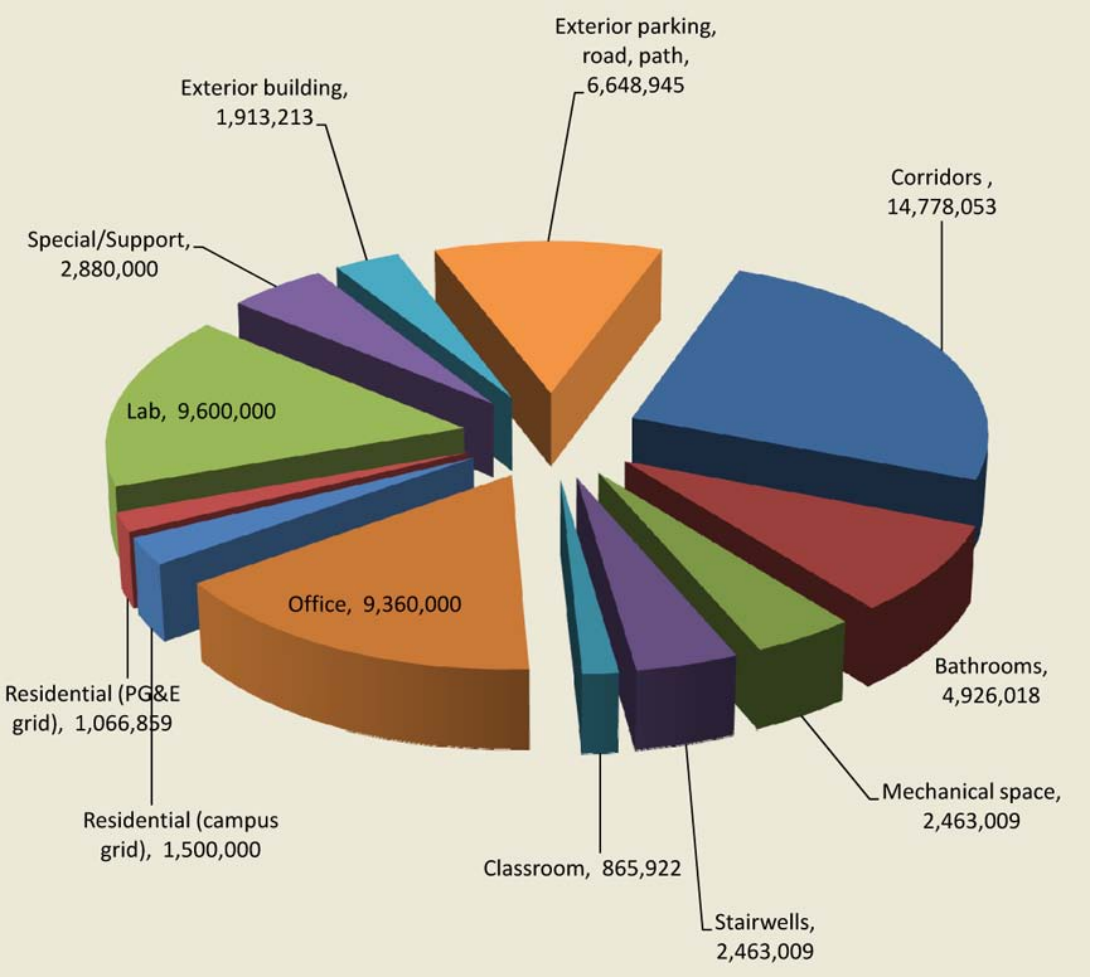
Fixture row closest to the window is controlled OFF (50% saving in labs)

AFTER


10'-0"
5
A505
TYP. UON
Lab Area *SAVE* +50%
Lab Prep *SAVE 40%*
Prep Room
SAVE
+50%
Corridor
SAVE
+50%

Bi-level Corridor Lighting

- New study underway at UC Davis indicates corridors account for **25%** of the annual campus lighting electricity use



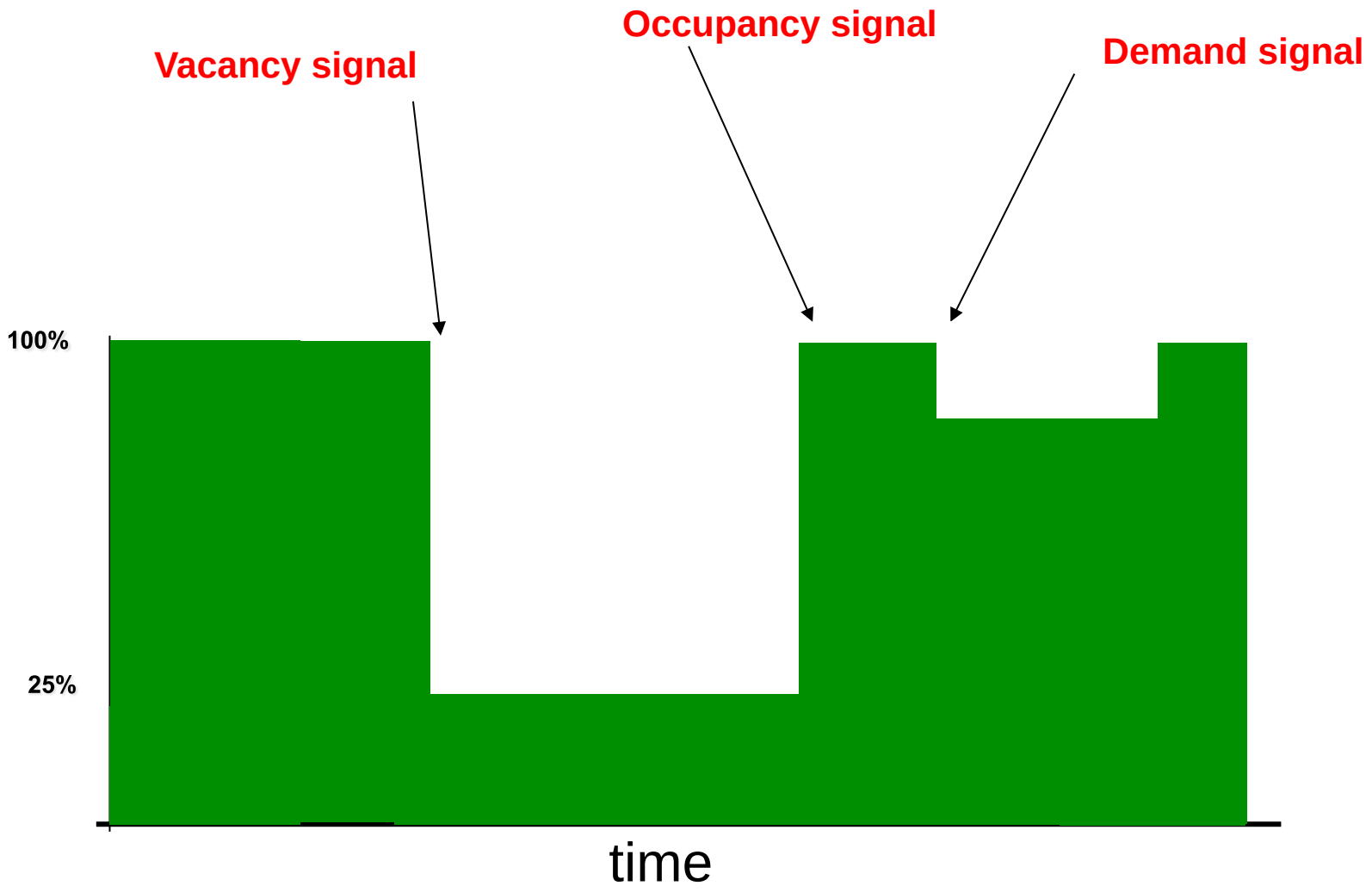
Total Campus Lighting:	58,465,028 kWh
Total Campus Electricity Use:	250,000,000 kWh

Adaptive Lighting: Smart Corridors

Bi-level Corridors: Institutional

- Low level: 30-50%
- Maintains aesthetics
- Safety security
- Energy savings
- Demand response

Smart Corridors: EE & DR



Institutional

Commercial Office

Hotel Corridors

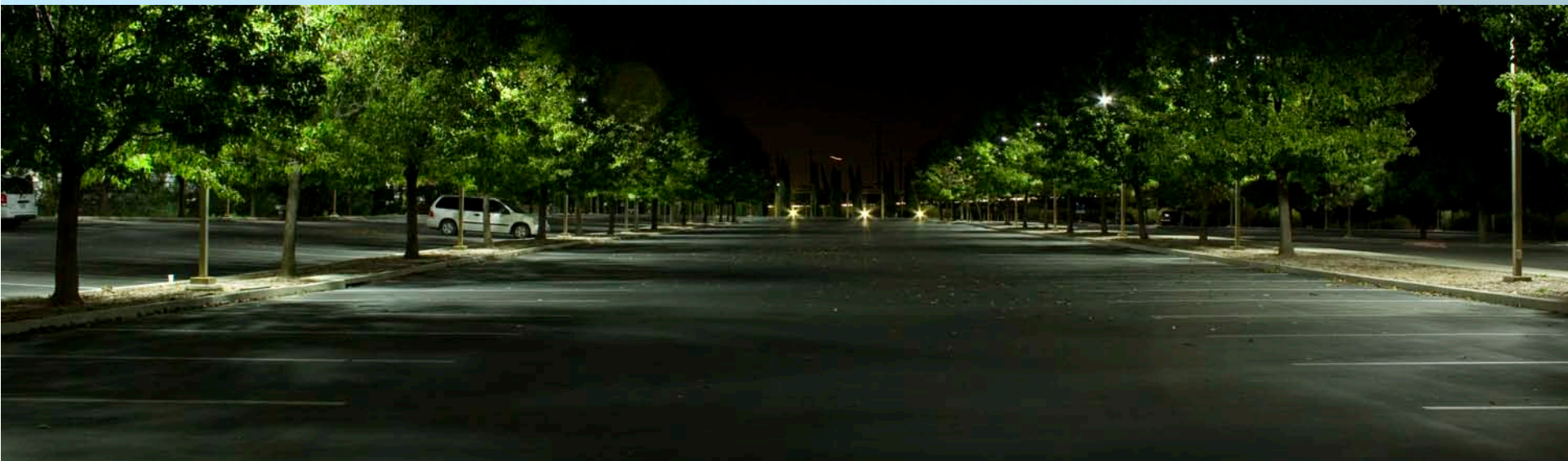
(40-50% savings opportunity)

Testing Lab

- Dimming and switching
- Addressing functions
- Retrofit systems
- Human factors

UC Davis:
Smart Exterior Lighting Initiative

All exterior light points will reduce automatically to 50% or less power upon vacancy and increase automatically to 100% upon occupancy.



Exterior Lighting:

Significant opportunities to save energy through adaptive bi-level controls.

- Parking lots
- Parking garages
- Path way
- Building illumination
- Signage

Midnight: Six Cars in Structure

Exterior Lighting Systems

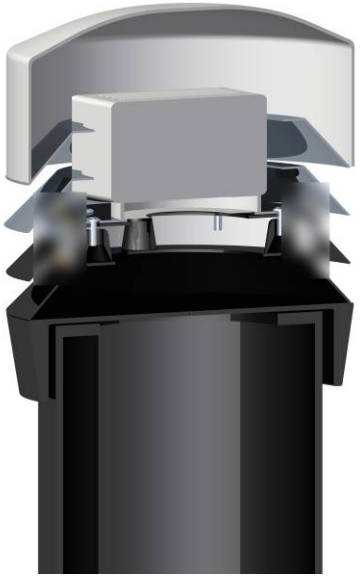
Controls and Smart Systems

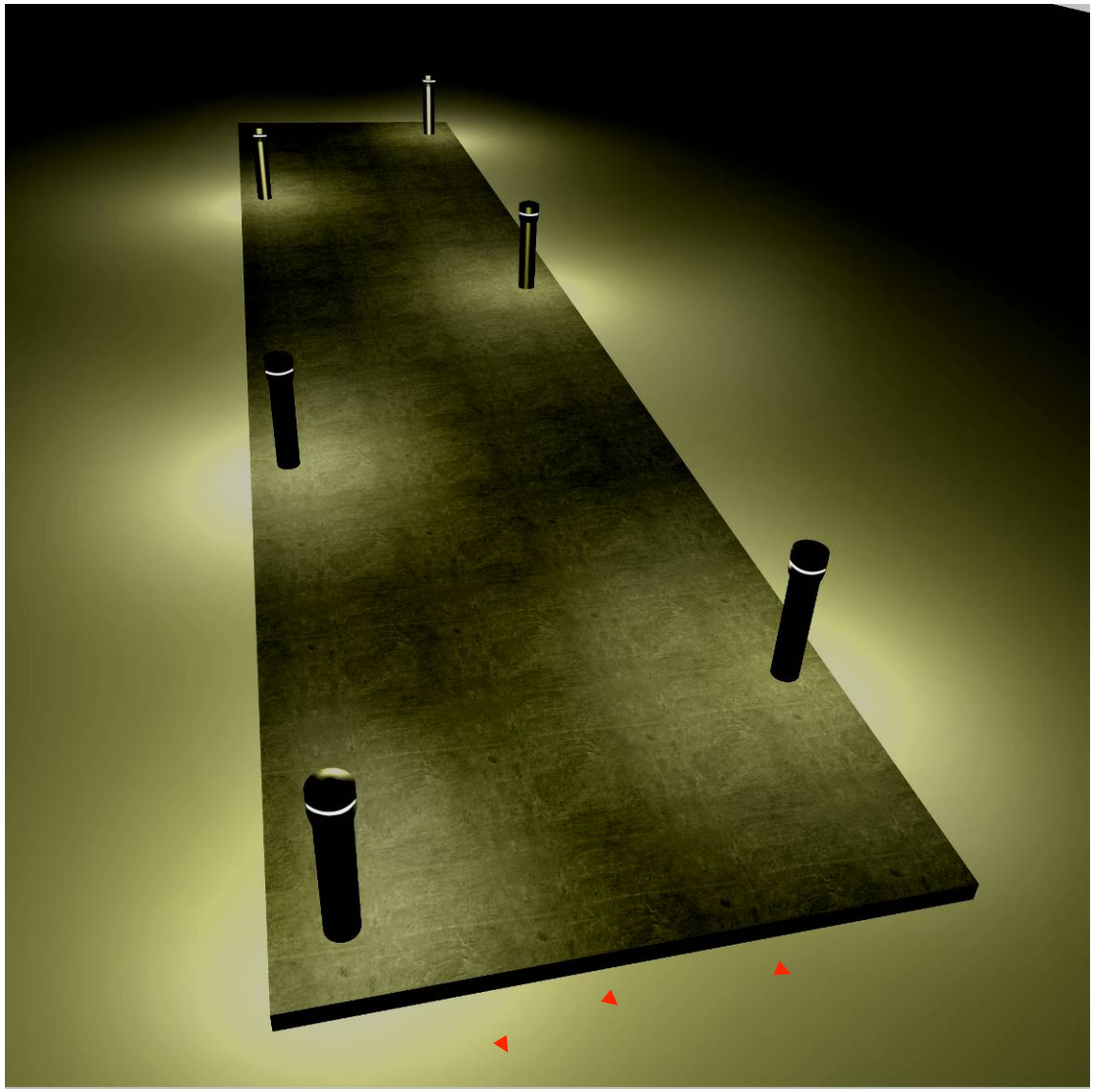
- Security
- Optics
- Color
- Maintenance

Next Generation Optics (directed flux, dark sky, fixture efficiency)

Bi-level Optic with Controls

- RF/PLC sensor
- Security
- Efficiency

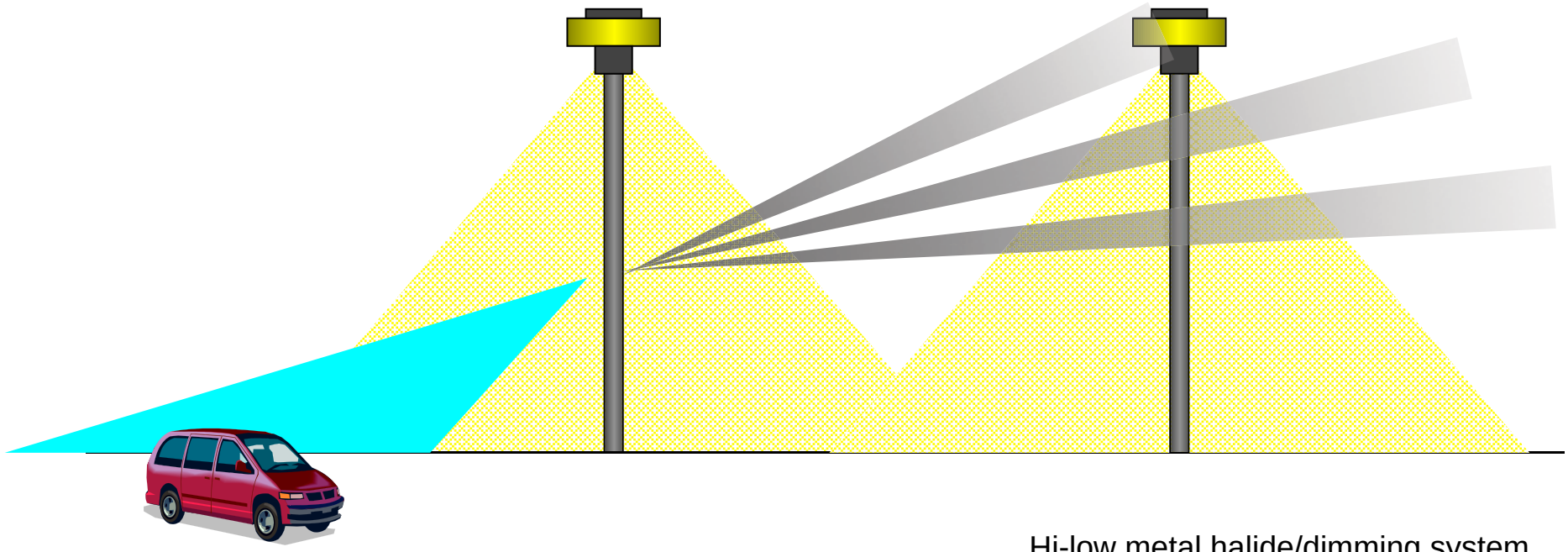




Demonstrations Update: Arcade Creek Park & California Department of Public Health receive Bi-level Bollards

California Department of Public Health in Richmond. At the park, the bollard operated in low mode 85% of the time, and at the CDPH, the bollards consumed **78% less energy than the original luminaires.**

Smart Light:
RF Bi-level Control



Hi-low metal halide/dimming system


Motion sensor

“Smart” Bi-level

- Makes LED cost effective
- Extends life
- Enhances security


"A"/"C"
VISITOR
PERMIT
LEVEL


Stairs
UCDAVIS

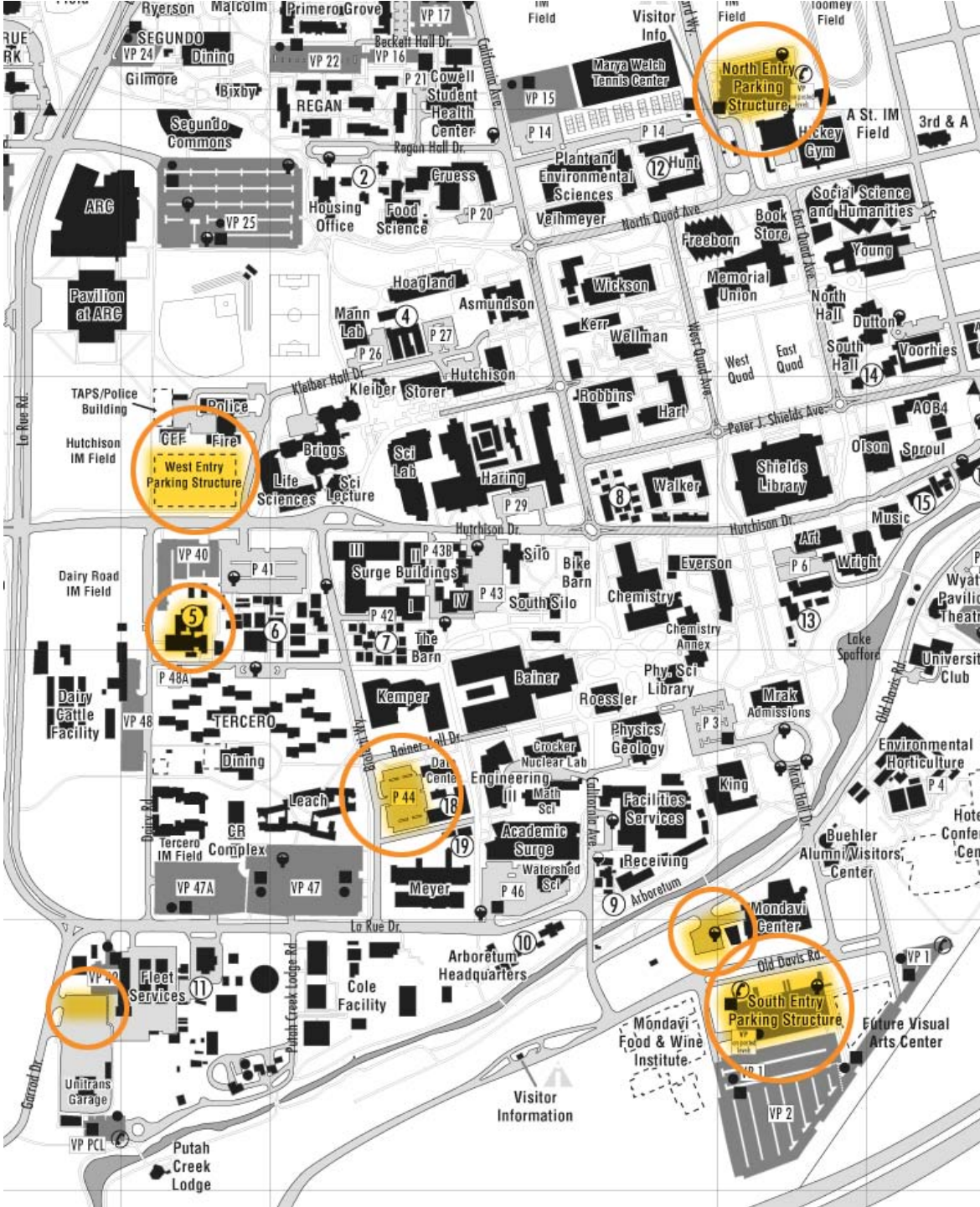
North Entry: 2/3 installed

Sacramento State

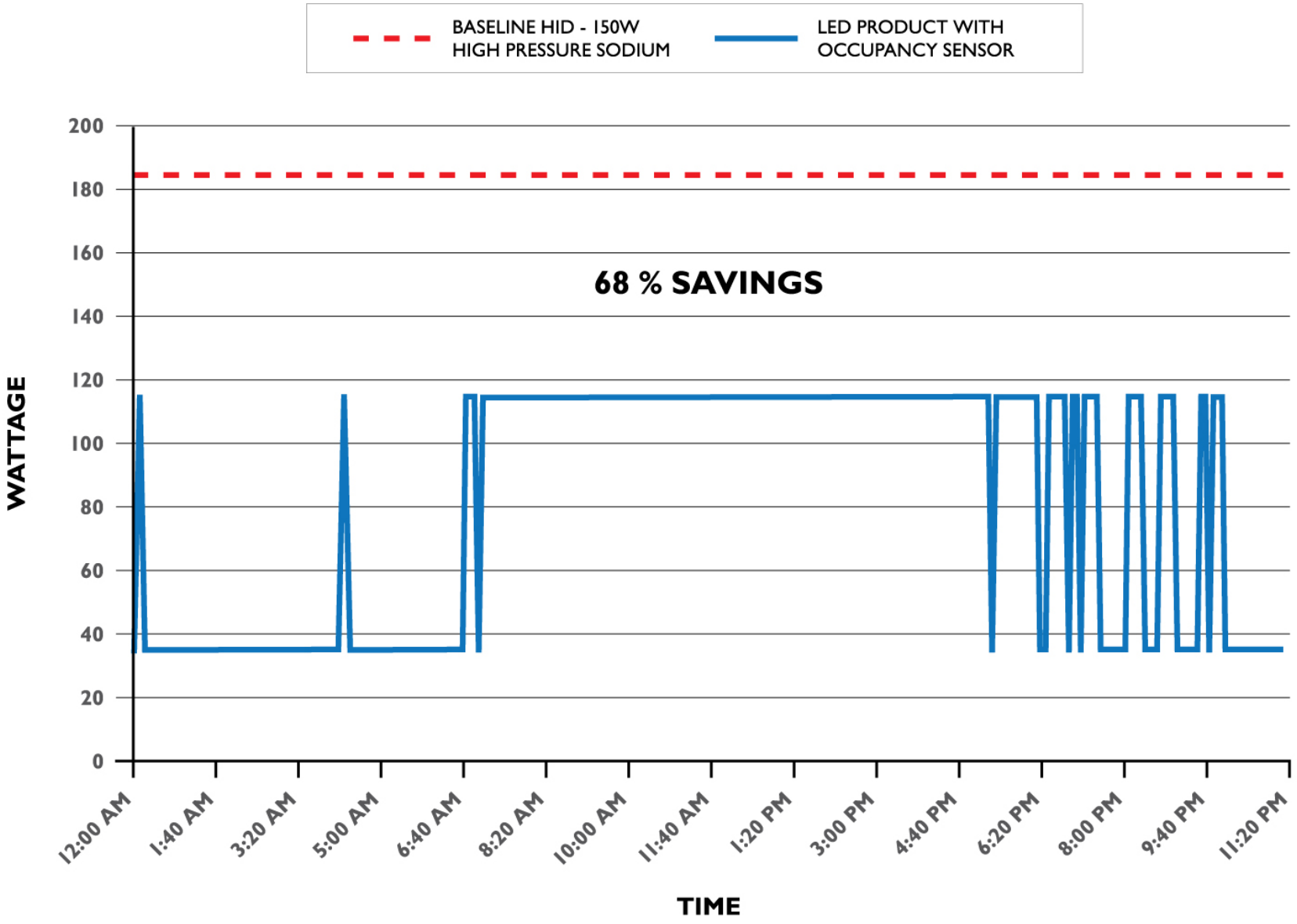
Smart Bi-level (~60% savings)

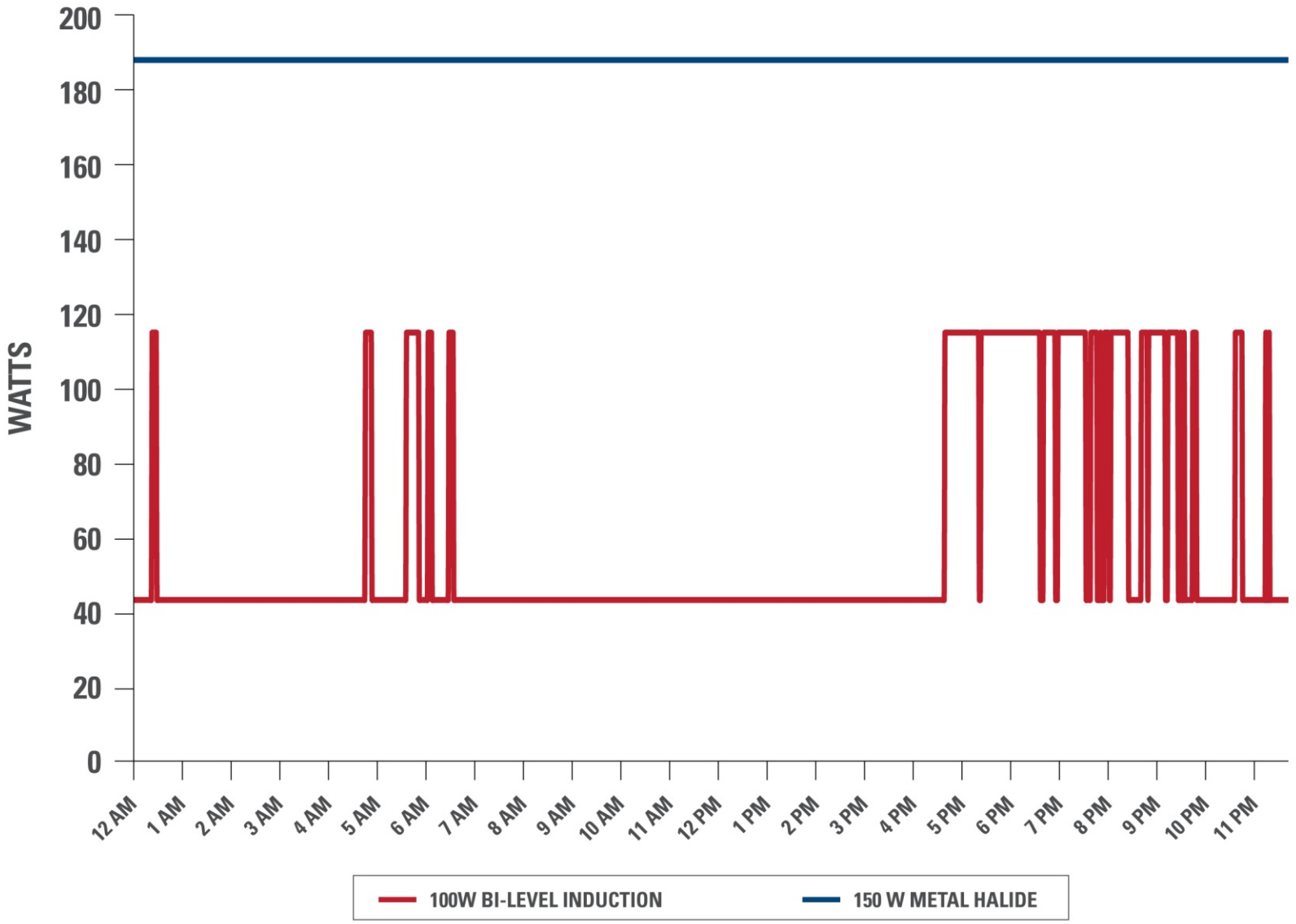
($50 added cost
<1 year payback in new construction)

Campus-wide Retrofit



LED BI-LEVEL SMART GARAGE VS. BASELINE HID TECHNOLOGY



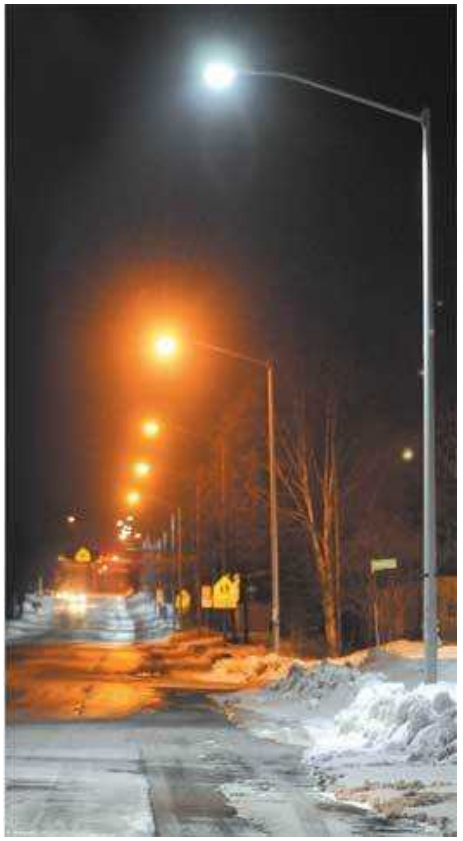

WATTS
200
180
160
140
120
100
80
60
40
20
0
12 AM
1 AM
2 AM
3 AM
4 AM
5 AM
6 AM
7 AM
8 AM
9 AM
10 AM
11 AM
12 PM
1 PM
2 PM
3 PM
4 PM
5 PM
6 PM
7 PM
8 PM
9 PM
10 PM
11 PM
100W BI-LEVEL INDUCTION
150 W METAL HALIDE

By 2020, all exterior lighting will use adaptive controls

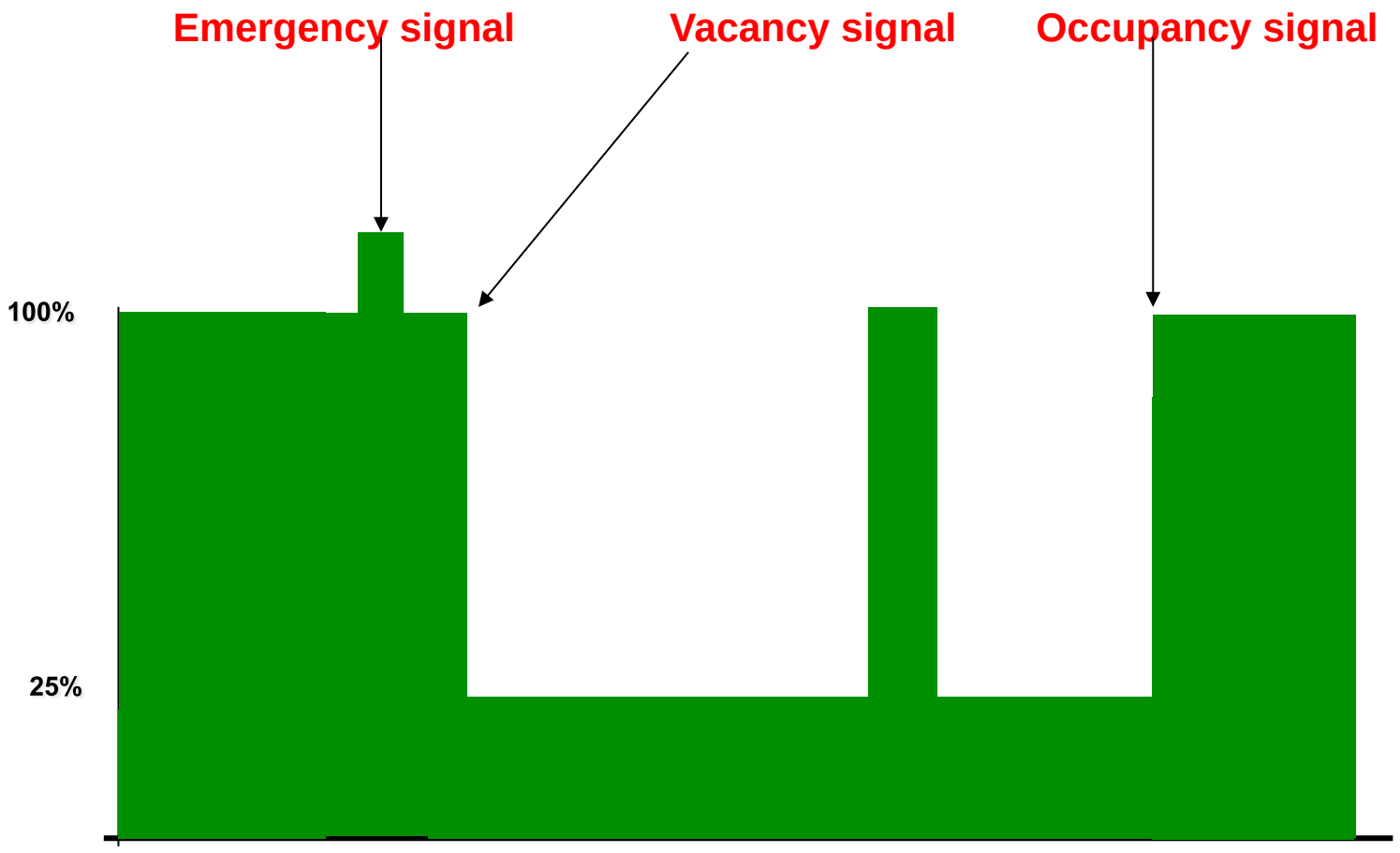
National Specification for Street Lighting

Adaptive capabilities for all exterior lighting

1. Base level power for standard illuminance
2. Low power level during vacancy
3. *High level/flashing during emergency response*
4. *Dark sky*



Adaptive Lighting: Street Lighting (40-50% savings)



Bi-level controls in Offices and Commercial spaces

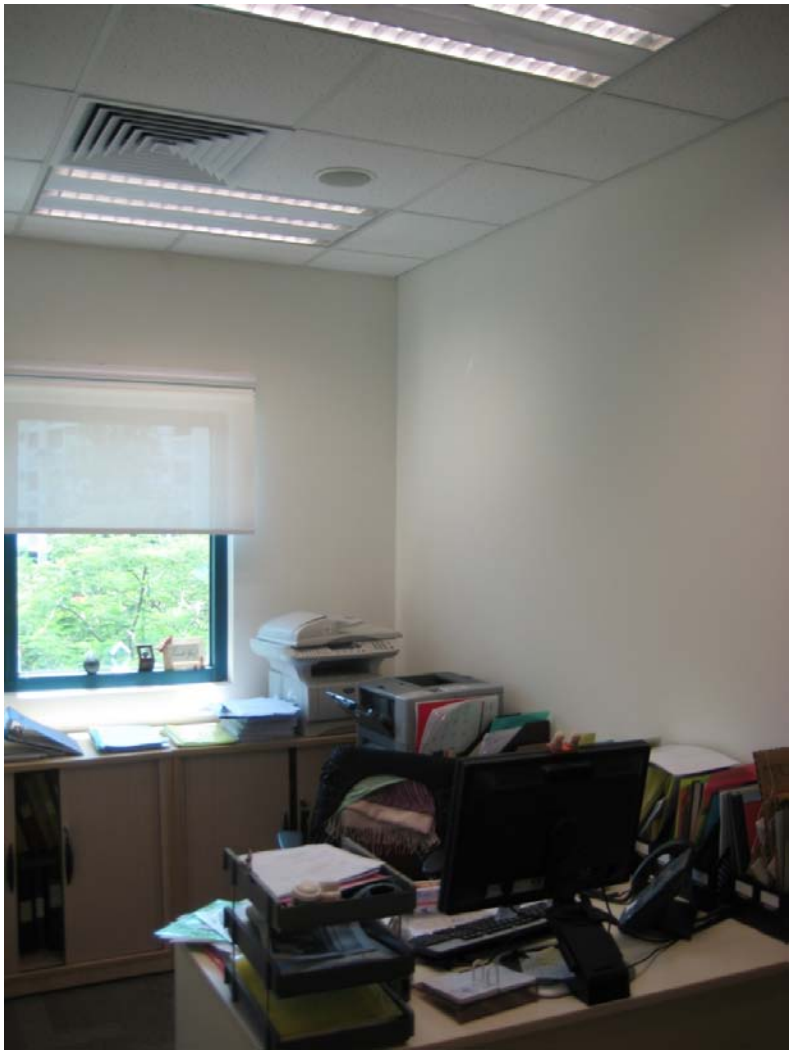
Bi-level Controls

50% over CA code

- Utility funded
- Industry partners
- 3 large demo’s
- Training guides

Lunch Time

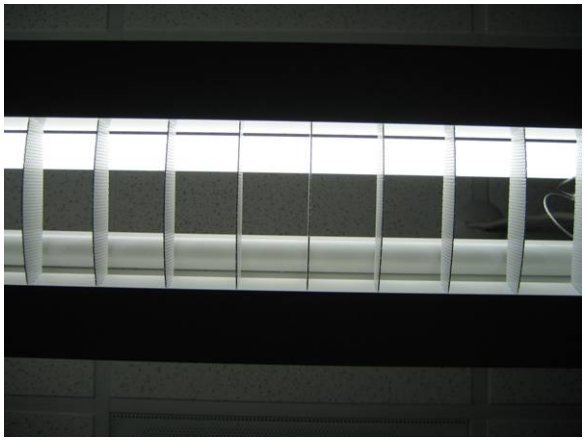
- 30% saving opportunity
  - Vacancy controls
- Daylighting
  bi-level controls
  - 50% saving



Controls Protocol

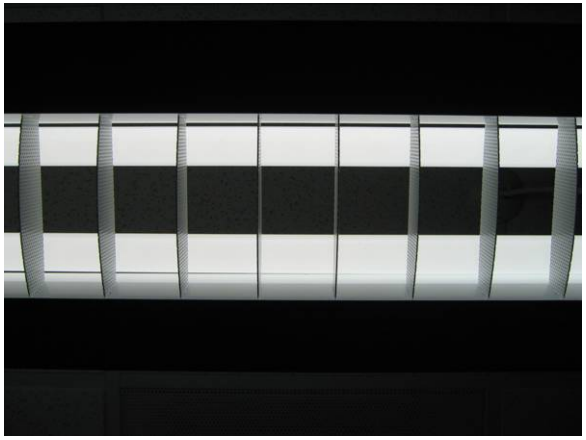
- Automatic on 50%
- Manual on 100%
- Manual off
- Automatic off

Office Workplane Illuminance



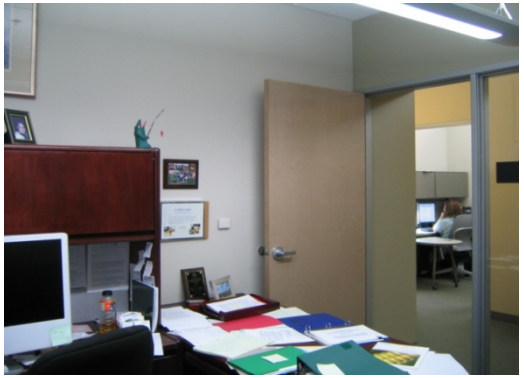
50% light level

26 fc

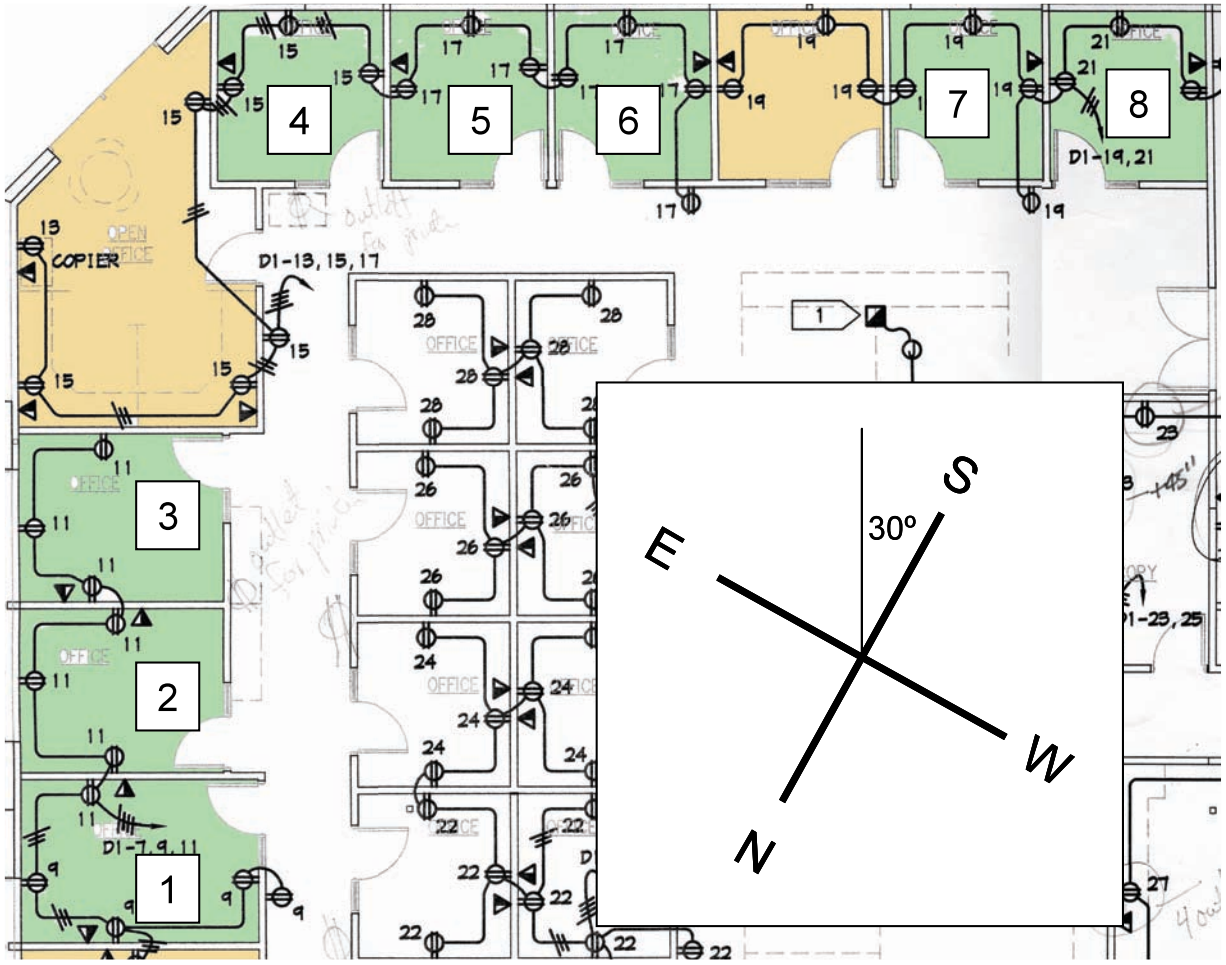


100% light level

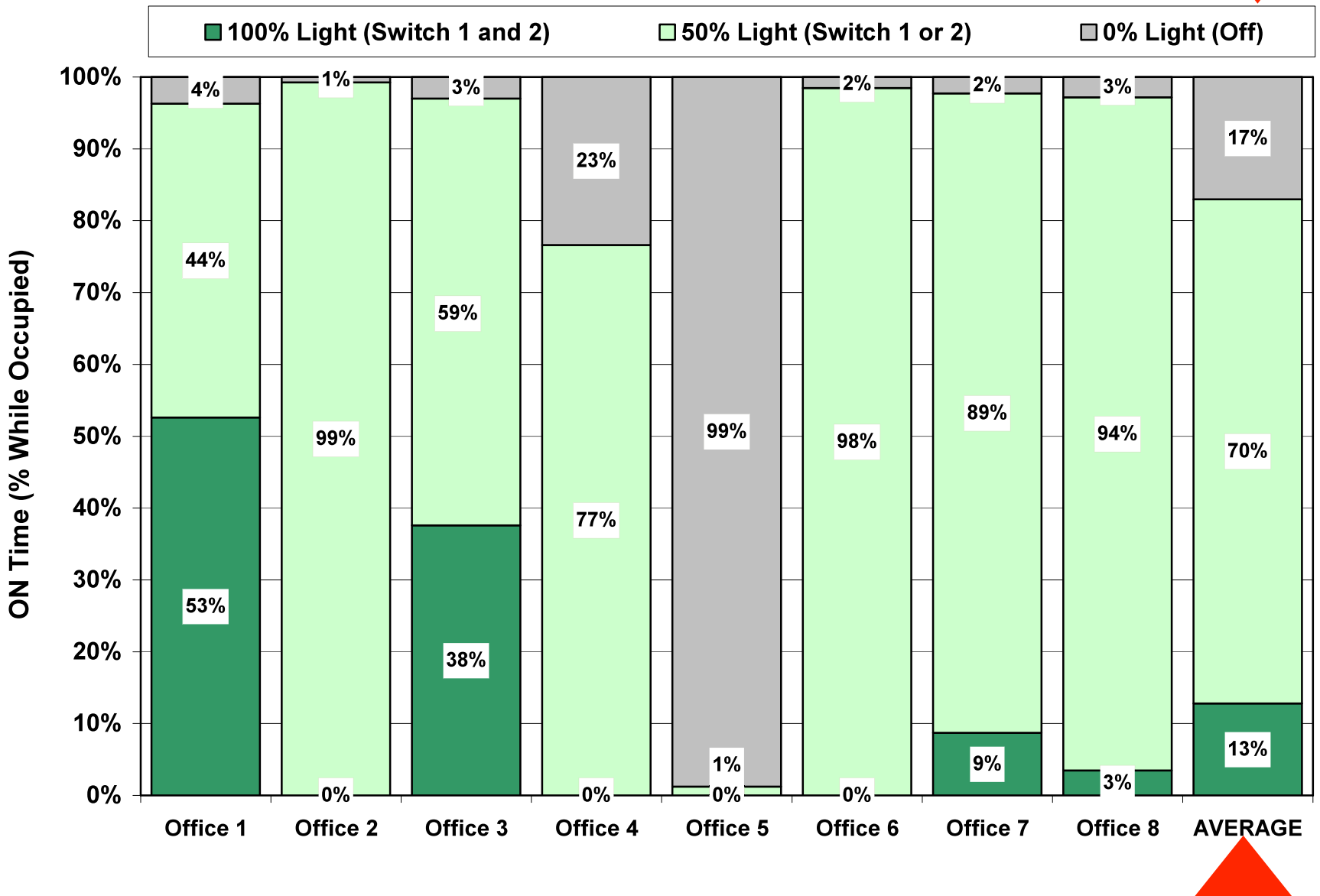
48 fc



Study Location

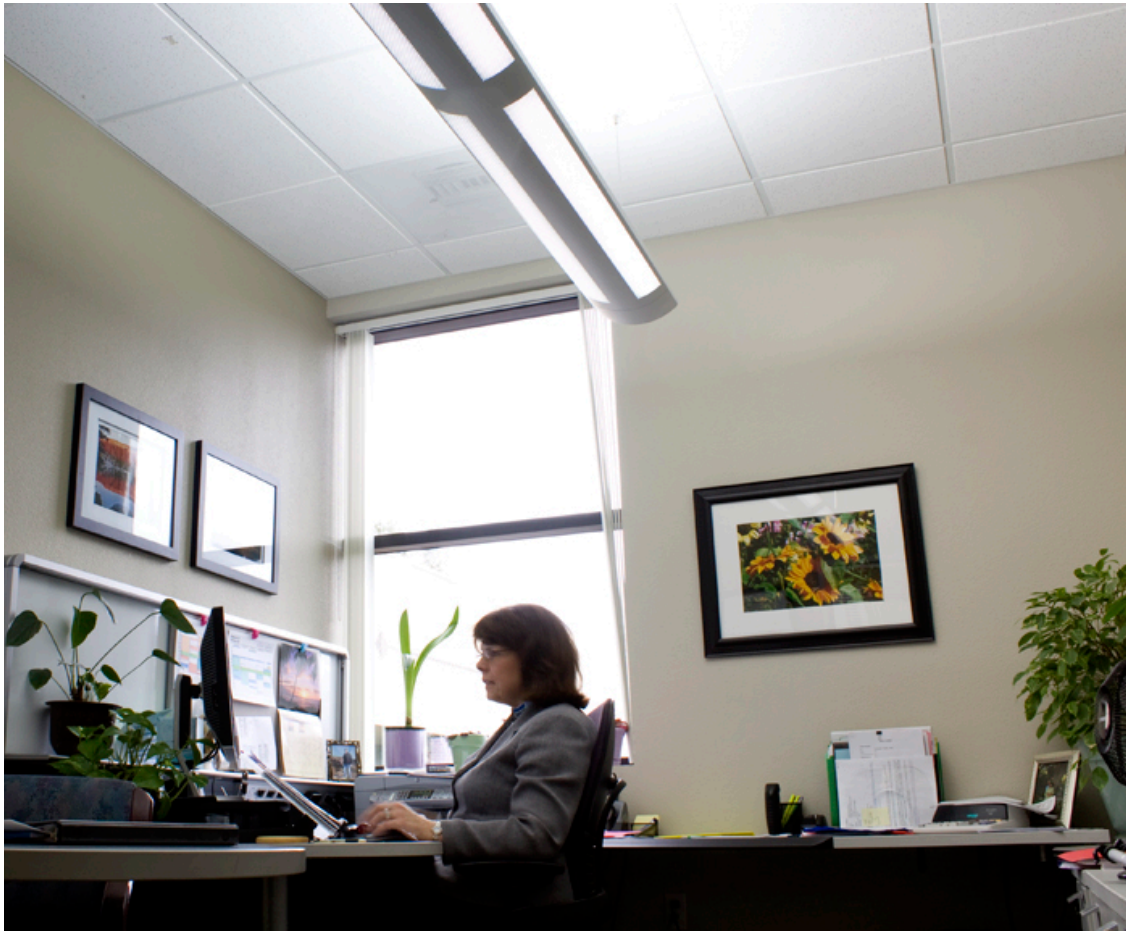


Phase 1 – 50% Auto ON



Controls Design and Integration

Bi-level controls: 2–3 year payback



Bi-level in Other Non-daylit Spaces

- Spaces where auto-off won’t work
- Safety and security
- Aesthetics and design integration

Utility spaces

- Copy rooms
- Storage spaces
- Mechanical
- Bathrooms

Copy rooms

Bi-level in larger public spaces

- More difficult
- Daylighting
- Vacancy

Lobby and Entry

Bi-level Controls

Summary of Opportunities

Bi-level Daylighting Design Retrofits

(40-50% saving opportunity)

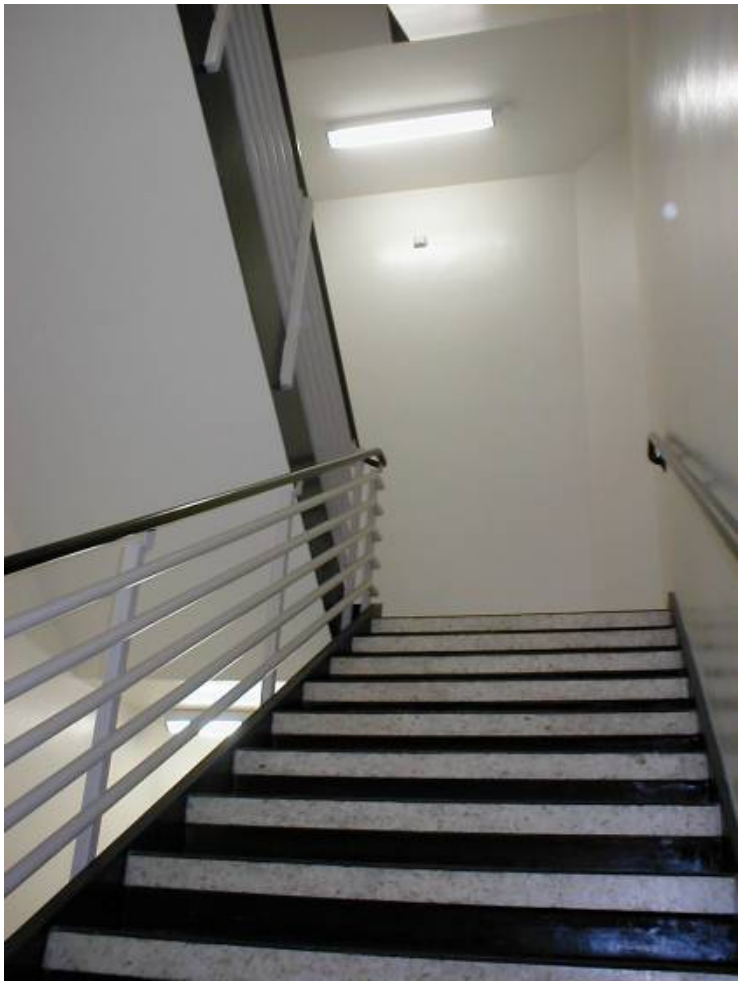
- Design/technology
- Demonstration
- guidelines

Bi-level utility spaces

(40-50% saving opportunity)

Bi-level stairwells

(40-50% saving opportunity)



Bi-level hallway Lighting

(40-50% saving opportunity)

Bi-level Lobby

Bi-level Exterior Lighting

(40-50% saving opportunity)

- Technology development
- Demonstrations
- Design guidelines

Bi-level Controls in Commercial Warehouses

- Aesthetic
- Security
- Energy