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
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
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

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

Vacancy signal

Occupancy signal

Demand signal

100%

25%

time
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
“Smart” Bi-level

- Makes LED cost effective
- Extends life
- Enhances security
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

68 % SAVINGS
By 2020, all exterior lighting will use adaptive controls
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

<table>
<thead>
<tr>
<th>Office 1</th>
<th>Office 2</th>
<th>Office 3</th>
<th>Office 4</th>
<th>Office 5</th>
<th>Office 6</th>
<th>Office 7</th>
<th>Office 8</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>53%</td>
<td>0%</td>
<td>38%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>9%</td>
<td>13%</td>
</tr>
</tbody>
</table>

- **100% Light (Switch 1 and 2)**: 4%, 0%, 3%, 0%, 2%, 2%, 3%, 17%
- **50% Light (Switch 1 or 2)**: 99%, 99%, 59%, 77%, 99%, 98%, 89%, 94%
- **0% Light (Off)**: 0%, 1%, 0%, 1%, 2%, 2%, 3%, 70%
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