Arnold Schwarzenegger
Governor

LIGHTING RESEARCH PROGRAM BROCHURES

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California Energy Commission
Public Interest Energy Research Program

Prepared By:
Architectural Energy Corporation

PIER FINAL PROJECT REPORT

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Preface

The Public Interest Energy Research (PIER) Program supports public interest energy research and development that will help improve the quality of life in California by bringing environmentally safe, affordable, and reliable energy services and products to the marketplace.

The PIER Program, managed by the California Energy Commission (Energy Commission), annually awards up to $62 million to conduct the most promising public interest energy research by partnering with Research, Development, and Demonstration (RD&D) organizations, including individuals, businesses, utilities, and public or private research institutions.

PIER funding efforts are focused on the following RD&D program areas:

- Buildings End-Use Energy Efficiency
- Energy-Related Environmental Research
- Energy Systems Integration
- Environmentally Preferred Advanced Generation
- Industrial/Agricultural/Water End-Use Energy Efficiency
- Renewable Energy Technologies

What follows is an appendix to the final report for the PIER Lighting Research Program, contract #500-01-041, conducted by the Architectural Energy Corporation. The appendix is entitled *Lighting Research Program Project Brochures.* This project contributes to the Building End-Use Energy Efficiency program.

For more information on the PIER Program, please visit the Energy Commission's website www.energy.ca.gov/pier/ or contract the Energy Commission at (916) 654-5164.

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Abstract

This report contains brochures created for various lighting products developed under the *Lighting Research Program.* This program supported the creation of new lighting technologies and products that can save energy, cut peak demand, and reduce air pollution for the citizens of California. It comprised 15 research projects conducted in four research elements described below and three market connection projects, and encompassed both residential and commercial sectors, as well as outdoor lighting associated with buildings.

The *Advanced Lighting Technologies* research element consisted of three projects that developed LED products and evaluated LED performance and costs. *Demand Responsive Lighting Systems* comprised three projects that developed advanced lighting control systems to reduce peak electric load by responding to electric system demand needs and/or daylighting availability. *Advanced Lighting Luminaries and Systems* consisted of four projects focused on integrating various components into single lighting and control systems, which cut complexity and costs while improving performance. *Lighting Performance Metrics, Codes, and Standards* included four projects that filled energy efficiency gaps in the market by capturing energy savings related to specific technologies and applications. Finally, *Market Connection* included three projects focused on an innovative centralized program-wide approach to improve the market impact of this Program's activities.

Keywords: Lighting, LED, demand response, photosensor, daylighting, load shedding, energy efficiency, ENERGY STAR®, CFL, classroom, stairwell, office, electronic ballast, DALI, SPOT, Title 24 energy code

Executive Summary

Introduction

The Lighting Research Program (LRP) supported the creation of new lighting technologies and products that can save energy, reduce peak demand, and reduce air pollution for the citizens of California. Work under the Lighting Research Program was performed between October 2002 and January 2005, and was supported by the California Energy Commission's (Energy Commission's) Public Interest Energy Research (PIER) Program.

In addition to a Program Management Element (Element 1) led by Judie Porter of the Architectural Energy Corporation (AEC), the program consisted of four research elements and one market connection element:

- Element 2: Advanced Lighting Technologies, led by Steve Johnson, Lawrence Berkeley National Laboratory (LBNL)
- Element 3: Demand Responsive Lighting Systems, led by George Loisos, Loisos+Ubbelohde
- Element 4: Advanced Lighting Luminaries and Systems, led by John Kesselring
- Element 5: Lighting Performance Metrics, Codes, and Standards, led by Jeff Johnson, New Buildings Institute
- Element 6: Market Connection, led by Bob Knight, Bevilacqua-Knight, Inc.

Project Brochures

This report contains electronic versions of brochures created to promote various technologies developed under the LRP. These brochures were part of a larger effort, conduced under Program Element 6, to ensure that the program's research and development (R&D) activity maintained a focus on real market needs. Too often, R&D projects succeed technically but fail to reach the market or find commercial success. The LRP's innovative centralized marketing approach was aimed at increasing the ultimate commercial viability of LRP's technology products. This Market Connection program element primarily served to support the LRP's technology R&D projects by improving the overall quality and consistency of technology transfer activities. It also served an important R&D purpose on its own, by providing a new model for conducting effective technology transfer and market entry efforts within PIER, as well as for other major R&D programs in all energy-related fields.

The goal of this project was to improve the market focus of all the LRP R&D projects, thereby increasing the ultimate commercial viability of the program's technology products. This was both an economic and a social goal, intended to lead to an increase in public benefits of PIER's investment in the program's products. The project systematically created a commercialization infrastructure of alliances with key efficiency advocates and regulatory agencies. The project also provided market-based reviews and

refinements of each product's market approach, for both professional and consumer audiences, and communications via web and print to more specifically aid products that became ready for commercialization during the program term.

Results

Each of the brochures presented here were created as part of a process that included determining the cost-effectiveness of the various LRP products, identifying market readiness activities for the products, and gaining insights from industry representatives. The completed brochures were widely distributed to a number of audiences and are available on the Internet at www.archenergy.com/lrp.

Benefits to California

Along with other facets of the market connection program element, these brochures are expected to accelerate the acceptance and adoption of the LRP technologies and products. Market penetration estimates for the California marketplace have been set at 1 percent for all the LRP projects. However, some products may see up to 5 percent market penetration due to the quality of economic analysis and code and standards research, market tools developed, and outreach activities completed under the individual research and the three Market Connection projects.

Note to Readers:

The brochures compiled in this document were originally produced as stand-alone tri-fold documents printed back-to-back. They are displayed in this report as unfolded documents, ready for printing, which entails showing the second page of each brochure first.

1.0 LED Hybrid Outdoor Fixture Brochure

Incandescent Lamps Have High Energy Use and Short Life

Many exterior entry and walkway lights in residential and commercial applications use incandescent lamps because they are small and inexpensive. However, they are inefficient and burn out quickly—typically four times per year if operating all night—causing high operating costs and security concerns. Fixtures can also use compact fluorescent lamps (CFLs), typically last two to four years but are expensive and can be difficult to fit into existing fixtures. Additionally, replacing burned-out pin-based CFLs can be difficult since retail stocking is inconsistent.

The Light-Emitting Diode (LED) Hybrid Outdoor Fixture combines cutting-edge LED technology with an occupancy sensor and incandescent lighting to reduce operating costs below those of incandescent lamps and CFL fixtures.

The low wattage LED light turns on at dusk and operates through the night.

LED Hybrid Outdoor Fixture

A photocell controls a 5-watt amber LED array for continuous nighttime operation, providing pleasant, low-level ambient light. An occupancy sensor turns on the incandescent lamp when motion is detected, flooding the area with bright light. After a few minutes, the occupancy sensor turns off the incandescent lamp while the LED array continues to illuminate the area.

The technology is available as an entry or porch fixture suitable for commercial, institutional, or residential applications.

The California Lighting Technology Center worked with manufacturers to develop various concepts for LED exterior fixtures.

Environmentally Sound and Energy Efficient

This fixture is expected to cut operating costs 50–90 percent, depending on occupancy, while giving building owners and occupants peace of mind that the long-life LEDs will provide illumination for years to come. The LEDs meet the California Energy Commission's 2005 Title 24 Building Efficiency Standards requirement of 40 lumens/watt.

LED Outdoor Hybrid Fixture display at the California Lighting Technology Center

Benefits

- The combination of LED, incandescent, and occupancy sensor uses less energy than CFLs alone.
- Continuous LED lighting eliminates dark spots commonly associated with motion sensor systems.
- With a life of 10–15 years, LEDs provide light when incandescent lamps burn out.

INTERESTED?

Hotel/motel staff, apartment managers, university housing staff, lighting manufacturers and specifiers, code developers, contractors, and utility staff can use the information on this system.

Key next steps include:

- *Building Owners/Managers and Lighting Specifiers*—Specify the LED Hybrid Outdoor Fixture.
- *Utility Staff*—Educate audiences on the technology's benefits and offer incentives for this product category.
- *Code Developers/Implementers*—Accept the technology within new and existing codes.
- *Manufacturers*—Develop similar fixtures for mass-market use.

This product is available from Shaper Lighting by special order (www.shaperlighting.com).

The Watt Stopper Inc. is developing a similar unit—a security light using two flood lamps, an occupancy sensor, and an LED that operates all night long (www.thewattstopper.com).

Hunter Lighting Group is preparing a fixture of this type for the residential consumer market (http://www.hunterkenroy.com/).

This project was part of the PIER Lighting Research Program. To view the project results, as well as other current research activities, visit www.energy.ca.gov/pier.

Additional information about this technology can be found on the following websites:

- PIER contractor site: www.archenergy.com/lrp/products/ledhybrid.htm
- PIER researcher site: www.cltc.ucdavis.edu (under projects)

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LED HYBRID OUTDOOR FIXTURE

PROVIDING SECURITY AND ENERGY EFFICIENCY TO OUTDOOR LIGHTING

STATE OF CALIFORNIA
ENERGY COMMISSION

Public Interest
Energy Research

2.0 LED Hybrid Security Fixture Brochure

Occupancy Sensor Security Lamps Can Be Off When Needed

Many exterior entry lights in residential and commercial applications use two-lamp incandescent flood lamps with occupancy sensors because they are small and inexpensive. However, they don't provide continuous illumination, causing some people to opt for continuous operating fixtures.

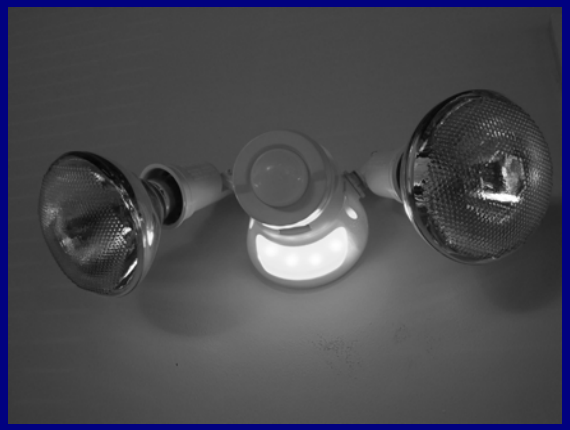
Operating incandescent lamps continuously is expensive and requires frequent lamp replacement. Alternatively, compact fluorescent lamps (CFLs) have lower operating cost than incandescents but are more expensive to install, and replacement CFLs are not widely stocked.

The Light-Emitting Diode (LED) Hybrid Security Fixture combines cutting-edge LED technology with an occupancy sensor and incandescent flood lamps to reduce operating costs below those of continuously operating incandescent lamps and CFL fixtures.

Standard flood lamps are dark until motion is detected.

LED Hybrid Security Fixture

A photocell controls a 5-watt amber LED array for continuous nighttime operation, providing pleasant, low-level ambient light. An occupancy sensor turns on the incandescent flood lamps when motion is detected, flooding the area with bright light. After a few minutes the occupancy sensor turns off the incandescent lamp while the LED array continues to illuminate the area.



The 5-watt LED array provides continuous illumination.

Environmentally Sound and Energy Efficient

This fixture is expected to cut operating costs 50–90 percent compared to fixtures operating continuously, depending on occupancy. Equally important, the fixture gives building owners and occupants peace of mind that the long-life LEDs will provide illumination all night long for years to come.

Motion sensor activates flood lamps.

Benefits

- Continuous LED lighting offers low-level illumination compared with standard security fixtures that are dark unless motion is detected.
- The unit is only slightly more expensive than standard units.
- The combined use of LED lighting with incandescent flood lamps controlled by an occupancy sensor consumes less energy than continuously operating incandescents or CFLs.
- LEDs with 10–15 year life provide light when incandescent lamps burn out.
- The LEDs meet the California Title 24 Building Efficiency Standards requirement for 40 lumens/watt.

INTERESTED?

Hotel/motel staff, apartment managers, lighting specifiers, code developers, contractors, and utility staff can use the information on this system.

Key next steps include:

- *Building Owners/Managers and Lighting Specifiers*—Specify the LED Hybrid Security Fixture.
- *Utility Staff*—Educate audiences on the technology's benefits and offer incentives for this product category.
- *Code Developers/Implementers*—Accept the technology within new and existing codes.

Contact The Watt Stopper for information on this product (www.wattstopper.com).

Shaper Lighting developed a similar unit. It is available on special order (www.shaperlighting.com).

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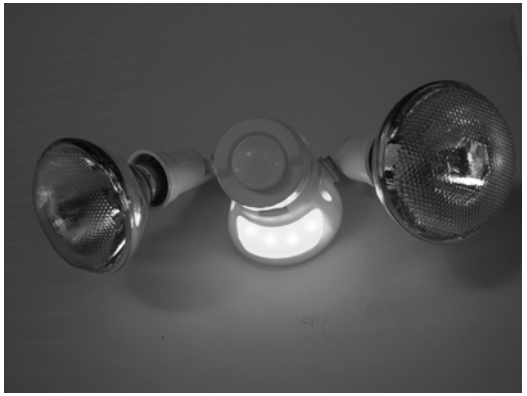
LED HYBRID SECURITY FIXTURE



PROVIDING SECURITY AND ENERGY EFFICIENCY TO OUTDOOR LIGHTING

STATE OF CALIFORNIA
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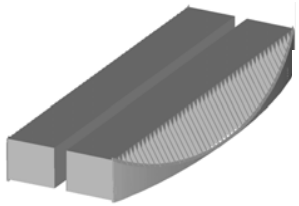
3.0 LED Task Light Brochure

LED Lighting: Promising But Challenging

Task lights, commonly used in offices, homes, and dormitories, often use incandescent lamps because they are inexpensive and offer good optical properties. However, incandescents have high energy use and are often hot to the touch. Compact fluorescent lamps (CFLs) are sometimes used, but they are bulky, requiring large fixtures and posing difficulties in focusing the light.

Light-emitting diode (LED) lighting, a fairly new solid-state source, shows promise because of its small size and energy efficiency potential. However, as an emerging technology, LEDs have not yet been widely used for general lighting purposes.

Because of their potential benefits, LEDs are a viable consideration for task lighting. Researchers from Lawrence Berkeley National Laboratory (LBNL) developed a high-performance prototype LED task light using state-of-the-art technology. The 11.5-watt unit uses two rows of 1-watt LEDs to provide lighting coverage equivalent to that of a 40-watt incandescent or 18-watt CFL task lamp.



Cooling fins enhance LED operation.

LED Task Light Using New Materials to Improve Performance

LBNL researchers developed an LED task light using high brightness LEDs, an advanced optical design, and new materials to reduce thermal stress. The advanced optics allow the LED system to use 70 percent less energy than a comparable incandescnt unit, even though the two light sources have similar energy efficiency.

In addition, the fixture uses a consumer-friendly design to speed market acceptance.

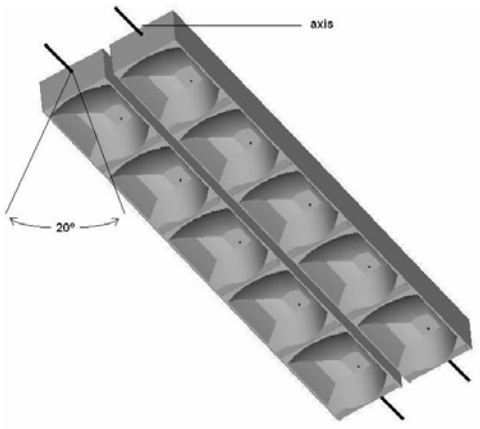
Prototype LED task light

LBNL's project team included four manufacturers:

- Permlight for thermal management
- Advanced Transformer for the ballast with variable intensity
- Cree Lighting for the LEDs
- Luxo for the luminaire

LED Matches CFL Performance While Cutting Energy Use

The prototype LED task light promises to provide high-quality lighting while cutting energy use, all in a sleek luminaire.



Three-dimensional simulation of the lamp reflector looking up into the reflector cups

Benefits

- Cuts energy use by 70 percent compared to incandescent lamps and 40 percent compared to CFL task lights
- 50,000 hour LED life expected, far exceeding 750 hours for incandescent and 10,000 for fluorescent
- Specialized optics provide proper light distribution on the workplane
- New assembly board and unique cooling fin design improves thermal management, giving long LED life and high light output

INTERESTED?

LED task lights are ideally suited for office buildings, single- and multi-family dwellings, dormitories, and, hotels. Building managers and owners, along with individuals, may all benefit from LED task lighting.

Key next steps include:

- Develop a next-generation prototype with lighting colors appropriate for a range of applications.
- Demonstrate the LED task light in various applications.
- Develop a commercial product.
- Educate building owners, home owners/renters, university dorm officials, and utilities about product availability and benefits.
- Work with retail outlets to stock the units after they are commercially available.

Luxo Corporation intends to market a new product, the Esol task light, based on this prototype. For information, contact Luxo (www.luxous.com).

This project was part of the PIER Lighting Research Program. To view the project results, as well as other current research activities, visit www.energy.ca.gov/pier.

Additional information about this technology can be found on the following web sites:

- PIER contractor site: www.archenergy.com/lrp/advlight_tech/project_2_2.htm
- PIER researcher site: http://lighting.lbl.gov/l_sources.html

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LED TASK LIGHT

A NOVEL AND ENERGY EFFICIENT APPROACH TO DESK LIGHTING

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4.0 LED Low-Profile Elevator Fixture Brochure

Expanding the Use of LEDs

The light-emitting diode (LED) is an fairly new kind of light source found currently in only a few applications, such as traffic lights and exit signs. As a relatively untested technology, luminaire manufacturers have been apprehensive about developing LED fixtures without a complete understanding of the technology and its performance.

The smaller size, cooler operation, and potentially longer life of LEDs makes this technology an ideal replacement for less efficient incandescent light sources, particularly in applications that require small or low-profile fixtures.

The Lighting Research Center (LRC), with co-funding from Westinghouse Lighting Corporation, developed and evaluated a prototype LED luminaire for elevators.

LED elevator lighting has the potential to achieve 25 percent greater efficiency than current incandescent elevator lights.

Low-Profile LED Elevator Lighting

The Lighting Research Center installed prototype LED elevator downlights that provided illumination levels similar to those of incandescent fixtures while cutting energy use 45 percent. Elevator passengers found the lighting attractive, stylish, bright, modern, comfortable, and clean-looking.

Field study site: Empire State Hall at Rensselaer Polytechnic Institute

The elevator selected for the field study used six LED downlights, each built with six white Luxeon 3-watt high-power LEDs and a custom-designed reflector. The LED downlights used 165 watts in total, compared to 300 watts for six incandescent downlights.

Reduce Maintenance and Energy Costs

LED Elevator Downlight

Benefits

- **Reduced maintenance**
  - Longer life of up to 40,000 hours
  - Rugged design resistant to elevator cabin vibration
- **Lower energy consumption compared to incandescent sources**
  - 45 percent savings compared to existing incandescent system
  - Efficacy of at least 18 lumens per watt
  - 28 GWh per year potential savings for California
  - Ability to work with on-demand dimming and motion-sensing lighting controls
- **Lower elevator manufacturing costs**
  - Low-profile fixtures can shorten the cabin height, reducing the amount of material needed to build the elevator shell
  - Smaller cabins mean smaller motors, a potential source of energy savings
- **Visual aesthetics**
  - Many color options
  - Potential for color-changing effects

INTERESTED?

Elevator manufacturers and cabin designers, building owners/managers, contractors, design engineers, code developers, and utility staff can use the information on LED elevator lighting.

Key next steps include:

- Work with Westinghouse Lighting Corporation to refine the design and select appropriate manufacturing processes.
- Educate elevator manufacturers and elevator cabin designers about the advantages of LED elevator lighting.
- Conduct additional field demonstrations with next-generation LED elevator fixtures.
- Consider the impact of LED low-profile lighting on future codes and standards.
- Evaluate other LED low-profile lighting applications.

This project is part of the PIER Lighting Research Program. For more information about PIER and its research activities, visit http://www.energy.ca.gov/pier.

Project results can be found on the following web sites:

- PIER contractor site: www.archenergy.com/lrp/products/elevator.htm
  www.archenergy.com/lrp/advlight_tech/project_2_3.htm
- Researcher project site: www.lrc.rpi.edu/programs/solidstate/

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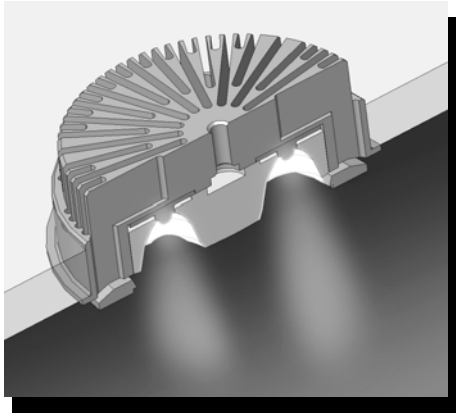
LED LOW-PROFILE ELEVATOR FIXTURE



AN INNOVATIVE APPLICATION FOR LED LIGHTING

Public Interest
Energy Research

5.0 Wireless Fluorescent Dimming with Integrated Lighting Controls Brochure

Wiring Costs Limit Dimming Applications

Combining daylighting, personal controls, and load shedding offers enormous potential for reducing energy consumption from lighting in commercial buildings. At the same time, integrated lighting control systems can enhance occupant comfort and improve organizational productivity.

However, even with advances in digital lighting technology, the benefits of integrated lighting controls have been largely limited to newly constructed buildings. A huge untapped reservoir of energy savings lies in the 4.6 billion square feet of commercial building floor space in California. Until now, installing advanced lighting controls into existing buildings required additional control wiring, which is cost-prohibitive because of the labor required.

To tackle this problem, a proof-of-concept dimmable lighting control system was created that does not require additional control wiring in the ceiling. The system uses a new power line control communication technology, called the Phase Cut Carrier (PCC), to transmit digital commands over existing lighting power circuits.

The PCC reliably sends control signals from a junction box–mounted encoder to dimming ballasts embedded with decoders. The PCC controls all ballasts on a lighting switch-leg without adding additional ceiling wires.

Fluorescent Dimming with Integrated Lighting Controls

The Lawrence Berkeley National Laboratory (LBNL) research team created a proof-of-concept dimmable lighting control system that does not require additional control wiring in the ceiling. LBNL is communicating with various manufacturing partners about producing system components.

System components

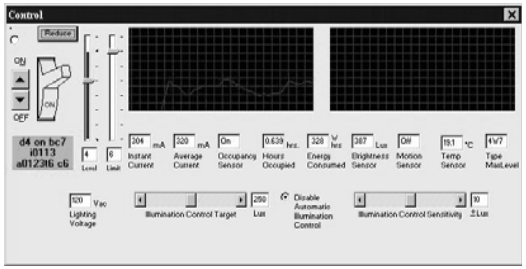
The proof-of-concept system integrates:

- Dimming ballast with decoder
- Ceiling-mounted occupancy sensor
- PCC encoder
- Occupant control switch
- Environmental sensor
- Computer control panel
- Bluetooth wireless technology

Wireless Controls Offer Installation Cost Savings

Benefits

- Less expensive to install in existing buildings than conventional dimming systems
- Enables lighting system to respond to available daylight and demand response control
- Allows building occupants to control their local lighting systems
- Allows organizations to set overhead light levels according to workgroup preferences
- Integrates dimming control with occupancy control
- Does not compromise the electrical distribution system with additional undesirable current harmonics
- Favorable signal-to-noise ratio compared to conventional Power Line Carrier (PLC) techniques
- Eliminates the possibility of interfering with other upstream building equipment



From this computer desktop control panel, the user can monitor and control all aspects of system operation and log the workplane illluminance and power consumed by the overhead lighting system.

INTERESTED?

Building owners/managers, lighting designers and specifiers, lighting equipment manufacturers, code developers, contractors, and utility staff can use the information about this proof-of-concept system.

Key next steps include:

- *Controls, Ballast, and Sensor Manufacturers*—License the PCC technology to move the proof-of-concept system towards prototype development and product commercialization.
- *Lighting Industry and Utility Staff*—Educate potential user groups on dimming benefits
- *Code Developers*—Consider the improved cost-effectiveness of wireless dimming to promote daylighting controls and load-shedding

This project was part of the PIER Lighting Research Program. To view the project results, as well as other current research activities, visit www.energy.ca.gov/pier.

Additional information about this technology can be found on the following websites:

- PIER contractor site: www.archenergy.com/lrp/products/controls.htm
- PIER researcher site: http://lighting.lbl.gov/l_controls.html

This project was also supported by the Assistant Secretary for Energy Efficiency and Renewable Energy, Office of Building Technology, Building Technologies Program, of the U.S. Department of Energy under Contract No. DE-AC03-76SF00098.

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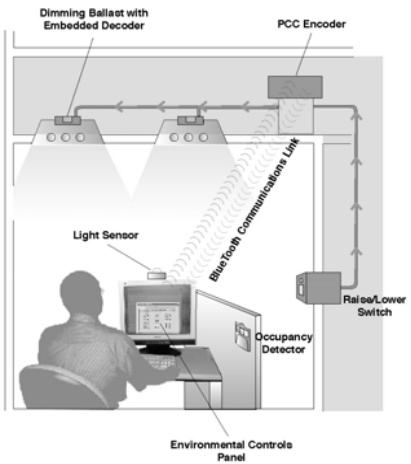
WIRELESS FLUORESCENT DIMMING WITH INTEGRATED LIGHTING CONTROLS



A SMART AND ENERGY EFFICIENT LIGHTING CONTROL SYSTEM

Public Interest
Energy Research

6.0 Load-Shedding Ballast Brochure

Will My Lights Go Out This Summer?

On hot summer days, businesses and consumers may worry about whether there will be enough electricity to go around. These periods of peak electric load can pose a real threat if the demand for electricity exceeds the supply; resulting blackouts can cripple regions within a city or state.

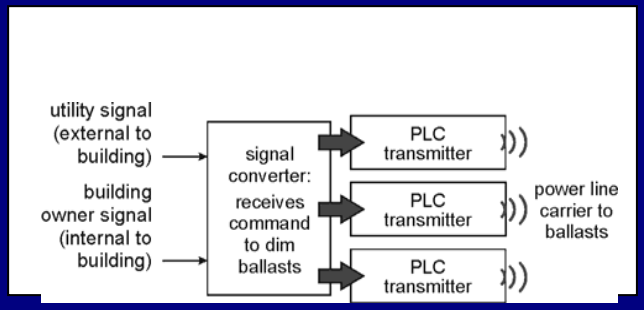
Building new power plants is an expensive approach to handling rising loads. Demand management, a broad topic that includes many methods for reducing peak-period electricity usage, is an economical alternative for controlling peak loads. Lighting control, in particular, is a very effective demand management strategy:

- Shedding lighting load is repeatable, predictable, and immediate.
- Dimming electric lighting by up to 40 percent for brief periods is acceptable to occupants in an office setting.
- Dimming, as opposed to switching, maintains a lights-on appearance.

Because few off-the-shelf technologies exist to implement demand management, PIER researchers developed a low-cost load-shed ballast that trims lighting power and lighting levels by 33 percent.

Load-Shedding Ballast Development

The Lighting Research Center (LRC) developed a prototype load-shedding ballast. This highly efficient instant-start unit includes step dimming and a built-in power line carrier (PLC) signal receiver for automated dimming response. The research team is working with a major ballast manufacturer, a PLC manufacturer, and an electric utility to commercialize the technology and conduct a field test. Appearance, installation, and wiring are identical to standard instant-start ballasts.



Load-shedding ballast technology

Until now, controlling fluorescent lighting loads required customized solutions with expensive hardware and installation. The load-shedding ballast avoids the cost and complexity associated with traditional dimming methods.

Limited Dimming Is Widely Accepted

Building owners and utilities alike will benefit from electric grid stability by avoiding costly peak power and blackouts. Tests show that building occupants accept and hardly notice when lighting is dimmed by 33 percent, and installing the load shed ballast offers about 30 percent demand savings off the connected fixture lighting load. Demand reductions within California from this technology could grow to 1.2 megawatts per year.

Benefits

- Cost effective installation, with $9 per ballast additional cost expected.
- Simple payback in 3–6 years for new installation or retrofit projects, assuming current California rates and 100 hours in load-shed mode.
- Limited dimming is preferred to switching off lighting to maintain occupant productivity and satisfaction and does not reduce lamp life.
- High efficiency operation, losing only 1 percent efficiency in load-shed mode.
- Instant-start lamp operation for reliable, high efficacy lighting, enabling parallel lamp operation and easy wiring.
- Universal input voltage (120 or 277 volt) minimizes stocking.
- High power factor (>0.9) and low total harmonic distortion (<10 percent) minimize utility impacts.
- Unique simplified PLC signaling system provides response time in less than two minutes.
- Flexible transmitter design accepts load-shedding signal from many different communication systems.

INTERESTED?

Building owners/managers, utility staff, contractors, design engineers, building owners/managers, and code developers can use the information on the load-shedding lighting technology.

Key next steps include:

- Complete demonstration of 200 load-shedding ballasts and utility-to-ballast signaling system planned for a New York office building.
- Commercialize the technology (in progress with a major ballast manufacturer and a PLC company).
- Publicize product availability and benefits after it becomes available.
- Develop electric rates to promote the use of load shedding ballasts.
- Consider code changes to require load shedding ballasts in new buildings.
- After they become available, include load-shedding ballasts in new construction and retrofit projects.

This project was part of the PIER Lighting Research Program. To view the project results, as well as other current research activities, visit www.energy.ca.gov/pier.

Additional information about this technology can be found at:

- PIER contractor site: www.archenergy.com/lrp/demandresp_lighting/project_3_2.htm
- PIER researcher site: www.lrc.rpi.edu/ResearchTopics/ReducingBarriers/LoadManagementSolutions.asp

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LOAD-SHEDDING BALLAST

COST-EFFECTIVELY REDUCING PEAK ELECTRIC DEMAND

Public Interest
Energy Research

7.0 Classroom Photosensor and Control System Brochure

High Commissioning Costs Limit Dimming Applications

Photosensors and associated control systems can dim or raise fluorescent lighting systems to decrease or increase the electrical lighting used as the amount of daylight changes during the day. However, such daylighting control systems may require extensive and costly set-up (commissioning) to ensure proper operation, and they do not always provide consistent, accurate light levels.

These issues make daylight dimming systems expensive while providing inconsistent operation, thereby limiting user acceptance.

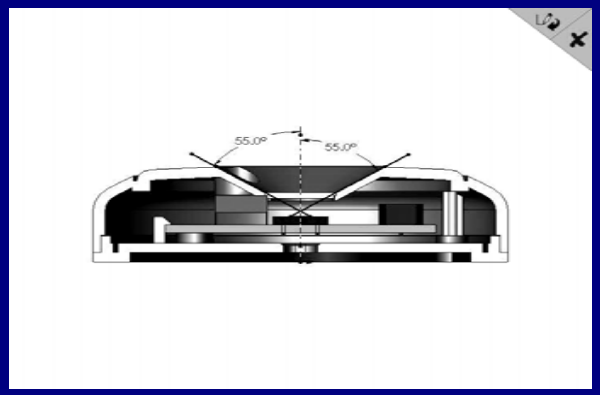
A new photosensor has been developed to achieve the following objectives:

- Provide accurate control of the electric lights in response to changes in the available daylight by maintaining the target setpoint
- Make the setup and adjustment of the control system fast and repeatable

The new system allows the user to quickly commission the photosensor and calibrate light levels using a remote hand-held tool. The control system has the potential to reduce lighting energy use in classrooms by 60 percent, reduce lighting demand in controlled spaces by 40 percent during peak periods, and reduce the commissioning time of installing and setting up photosensor control.

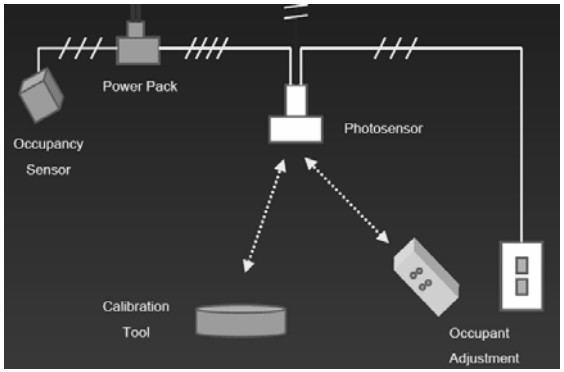
Self-Commissioning Classroom Photosensor and Control System

PIER RESEARCHERS DEVELOPED A NEW PHOTOSENSOR AND LIGHTING CONTROL SYSTEM THAT OPTIMIZES THE INTERACTION BETWEEN COMMON CLASSROOM ELECTRIC LIGHTING SYSTEMS AND DAYLIGHTING. THE SYSTEM HANDLES SEVERAL DAYLIGHTING CONFIGURATIONS: SIDE-LIGHTING ONLY, TOP-LIGHTING ONLY, AND SIDE- AND TOP-LIGHTING COMBINED. SIMPLE AND EASY TO COMMISSION, THE SYSTEM EFFECTIVELY OPERATES WITH MANUAL CONTROLS AND OCCUPANCY SENSORS.



Cross-section of the new photosensor prototype

Cut Installation cost and improve user satisfaction



The classroom photocell and control system

Benefits

- Self-commissioning desktop tool significantly cuts commissioning and calibration time.
- Advanced photosensor design accurately senses daylight availability, cutting electric light usage 40–60 percent or more depending on space design.
- Control system automatically tunes the electric lighting to the desired light levels.
- System may include a wall switch to let occupants turn lights on and off, or raise and lower the target light level.
- Integrated power pack, photosensor, commissioning tool, and occupant adjustment control speeds installation.
- Low-voltage wiring simplifies installation.
- Design is optimized for classrooms and other instructional spaces, but is also appropriate for standard offices.

INTERESTED?

School and university facility managers, contractors, lighting designers and specifiers, engineers, code developers, and utility staff can use the information on the classroom photosensor and control system.

Key next steps include:

- Complete development of system components.
- Commercialize the system.
- Conduct demonstrations in well daylit classroom/instructional spaces.
- Document energy savings and teacher/student acceptance.
- Educate school and university facility managers on system benefits and availability.
- Educate system designers on the benefits compared with standard technologies.

This project was part of the PIER Lighting Research Program. To view the project results, as well as other current research activities, visit www.energy.ca.gov/pier.

Additional information about this technology can be found on the following web sites:

- PIER contractor site: www.archenergy.com/lrp/demand resp_lighting/project_3_3.htm
- PIER researcher site: http://lighting.lbl.gov/ l_controls.html

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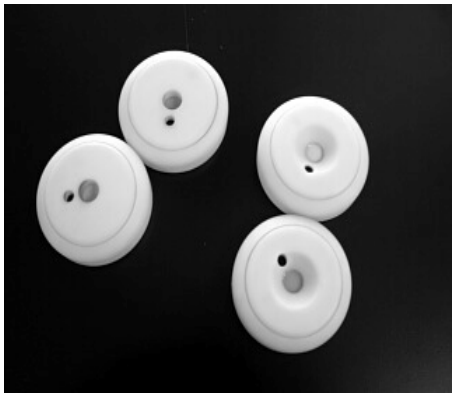
CLASSROOM PHOTOSENSOR AND CONTROL SYSTEM



SELF COMMISSIONING CUTS INSTALLATION COSTS

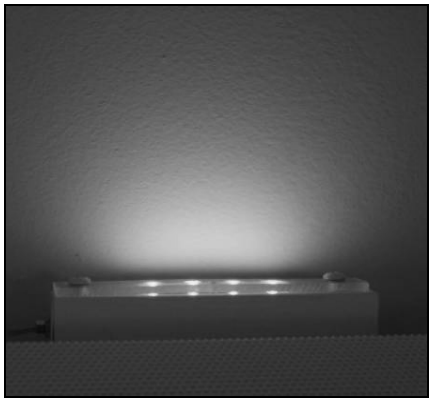
Public Interest
Energy Research

8.0 Hotel Guestroom Bathroom Lighting Brochure

Hotel Bathroom Lights Consume the Most Electricity

Bathroom lights generally operate between five to eight hours per occupied day in hotels. Sometimes people leave the bathroom light on at night as a guide. Additionally, people often don't turn off the bathroom light when they leave the room and it is left on until the maid service arrives. However, hotel managers are typically reluctant to install occupancy sensors in these spaces due to concerns of accidental light shut-off while the bathroom is occupied.

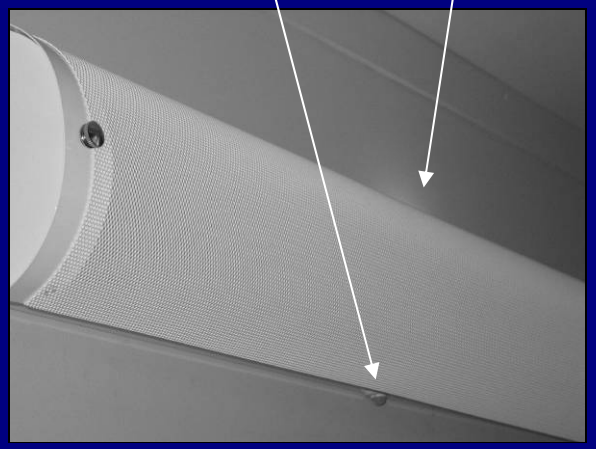
The California Lighting Technology Center (CLTC) partnered with a fixture manufacturer, a utility, and a hotel to develop an energy-saving, hotel-specific luminaire that integrates a low-wattage light-emitting diode (LED) nightlight and an occupancy sensor that saves energy while improving occupant satisfaction.



The LED nightlight provides enough illumination for night time visibility.

High Performance Hotel Guestroom Bathroom Luminaire

Researchers developed a new energy efficient luminaire specifically designed for hotel guestroom bathrooms. This luminaire includes an integrated occupancy sensor and LED nightlight to maximize energy savings for hotel owners, while providing unique features and amenities for hotel guests. The fixutre also includes a battery backup to ensure emergency lighting during power outages.



A Unique Lighting Solution for Hotel Bathrooms

CLTC staff worked closely with the Sacramento Municipal Utility District, SpecLight, and hospitality partners to develop a novel luminaire that cuts energy use by about 50 percent while improving occupant satisfaction. Payback is expected to be 2-6 years, depending on application.

The luminaire is being installed and tested in hotels and assisted-living facilities.

Benefits

- T8 lamp with an electronic ballast provides efficient operation during occupancy.
- 1-2att LED nightlight system supplies low-energy illumination during the night and during unoccupied periods.
- Integrated occupancy sensor on one-hour time-out minimizes "false-offs."
- The occupancy sensor in "auto-off, manual-on" mode maximizes energy savings and avoids blinding guests who walk into the bathroom at night.
- Safety-mode feature automatically runs LED nightlight on backup battery during power outages.

INTERESTED?

Hotel and institutional owners/managers, contractors, design engineers, code developers, and utility staff can use the information on high-performance hotel bathroom lighting systems.

Key next steps include:

- Conduct field demonstrations in hotel and assisted-living applications.
- Educate hotel and institutional owners/managers about energy and maintenance savings opportunities.
- Identify buildings with high-wattage fixtures that would be ideal early adopters of this technology.
- Identify a manufacturer that will produce the system in high volumes at a competitive price.

To participate in field demonstrations or to get more information on this technology, contact Erik Page at CLTC (epage@ucdavis.edu).

This project was part of the PIER Lighting Research Program. To view the project results, as well as other current research activities, visit www.energy.ca.gov/pier.

Additional information about this technology can be found on the following web sites:

- PIER contractor site: www.archenergy.com/lrp/advlight_luminaires/project_4_1.htm
- Researcher project site: www.cltc.ucdavis.edu (under projects)

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HOTEL GUESTROOM BATHROOM LIGHTING

REDUCING ENERGY USE WHILE IMPROVING OCCUPANT SATISFACTION

Public Interest
Energy Research

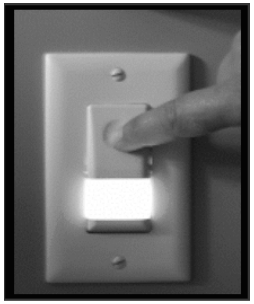
9.0 Motion Sensor Nigthlight Brochure

Hotel Bathroom Lights Consume the Most Electricity

Typically, hotel bathroom lights are left on between five to eight hours per occupied day. Sometimes people leave the bathroom light on at night as a guide. Sometimes people don't turn off the bathroom light when they leave the room, and it stays on until maid service arrives.

The WN-100 Motion Sensor Nightlight from The Watt Stopper is a motion sensing wall switch and nightlight that controls lighting based on occupancy. Designed for installation in hotel rooms, and institutional and other semi-public spaces, the energy efficient, super bright light-emitting diode (LED) nightlight remains on whenever lights are off, providing constant illumination in the space and energy savings through reduced use of overhead lighting.

This pilot project stimulated development of the Motion Sensor Nightlight and demonstrated it in at the DoubleTree Hotel in Sacramento.



The nightlight has the potential to save from 45 to 75 percent of the total energy used by bathroom light fixtures.

Motion Sensor Nightlight Study

Researchers installed a motion sensing wall switch and nightlight in more than 400 hotel bathrooms. Their study showed that the nightlight provided 46 percent energy savings and received positive comments from customers staying at the hotel.

The Motion Sensor Nightlight helps save energy and provides security benefits.

The Motion Sensor Nightlight can cut lighting operation by six or more hours per occupied day. For hotels and institutional spaces where the main bathroom lights are connected to high-wattage fixtures, the payback for the technology can be as short as one year.

Cut Operating Cost and Increase Safety

The Motion Sensor Nightlight

Benefits

By installing the Motion Sensor Nightlight, facility managers and property owners can cut bathroom lighting energy use about 50 percent. The simple payback is 2.5 years for new projects and 5.5 years for retrofits.

Other benefits include:

- Built-in LED nightlight illuminates room whenever overhead lights are off.
- Reduced lamp operation lengthens lamp-changing cycle and reduces maintenance cost.
- Impact resistant hard lens offers long life.
- Adjustable time delay from 15 minutes to 2 hours meets varying needs.
- 180 degree coverage, maximum of 300 square feet fits most bathroom applications.
- Manual-ON or Auto-ON provides operational flexibility.

INTERESTED?

Hotel and institutional owners/managers, contractors, design engineers, building scientists, code developers, and utility staff should be interested in this information on improved lighting controls in hotel bathrooms.

Key next steps include:

- Educate hotel and institutional owners/managers about energy and maintenance savings opportunities.
- Identify buildings with high-wattage fixtures that would be ideal early adopters of this technology.
- Characterize bathroom lighting usage patterns in different types of hotels and other institutional facilities.

For more information, visit The Watt Stopper website (www.wattstopper.com). Rebates may be available from the manufacturer or local utility company.

This project was part of the PIER Lighting Research Program. To view the project results, as well as other current research activities, visit www.energy.ca.gov/pier.

Additional information about this technology can be found on the following web sites:

- PIER project site: http://www.energy.ca.gov/pier/buildings/projects/500-01-041-0-4-4_1.html
- PIER contractor site: http://www.archenergy.com/lrp/advlight_luminaires/project_4_1.htm
- PIER researcher site: http://cltc.ucdavis.edu/

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MOTION SENSOR NIGHTLIGHT

A SMART AND ENERGY EFFICIENT NIGHTLIGHT

Public Interest
Energy Research

10.0 Portable Residential Light Fixtures Brochure

Few ENERGY STAR® Table Lamps Exist

Few homeowners have bought table lamps with compact fluorescent lamps (CFLs) because many CFLs have poor performance (e.g., flicker starting, slow warm up, poor color, etc.). ENERGY STAR®–rated products provide assurance of reliable product performance, and most consumers recognize the ENERGY STAR logo. However, few ENERGY STAR rated portable table lamps exist.

Based on data gathered at a series of U.S.EPA workshops, the PIER Lighting Research Program selected four fixture manufacturers and supported development of mid- to high-end portable indoor fixtures that use pin-based CFLs rather than screw-in lamps and qualify for the ENERGY STAR label.

Plans called for making the fixtures from the four manufacturers available in the California marketplace by early 2006. The products target various markets, including residential, assisted living, and the hospitality markets.

Pricing for each product varies greatly by manufacturer and depends on the specific market targeted.

High Performance Task Light by MaxLite

Developing Energy Efficient Residential Light Fixtures

Each product from the four participating manufacturers is unique.

American Fluorescent – The Halifax Task Lamp uses an electronic ballast with programmed start, 40-watt circular CFL, and does not have a dimmer.

Fire & Water - The Fibonacci Series Table Lamp uses an electronic ballast and a 26-watt CFL. A dimmable version is planned.

MaxLite - This High Performance Task Lamp uses an electronic ballast, an 18-watt CFL, and does not have a dimmer.

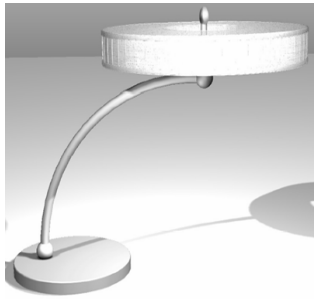
PowerLux - The LaVista Task Lamp features an electronic ballast and three lamps: a 57-watt CFL, a 55-watt circline, and an LED. Switching provides uplight, downlight, and night light modes.

LaVista Task Lamp by PowerLux

Energy Efficient with Longer Lamp Life

Fibonacci Series Table Lamp by Fire & Water Lighting

For a typical high use fixture, replacing a 120-watt incandescent fixture with a 30-watt ENERGY STAR fixture saves approximately $11.33 per year and $113.30 over the proposed life of the fixture. If the projected 20,000 fixtures enter the market in the first year, California residents would realize electric savings of over $226,000 in the first year and have quality lighting with longer lamp life.



Halifax Task Lamp by American Fluorescent

INTERESTED?

owners/managers, homeowners, code developers, and utility staff can use the information on the ENERGY STAR Portable Residential Fixture Project.

Key next steps include:

- Educate homeowners and building owners/managers in the target markets.
- Find buildings with high quantities of portable incandescent fixtures that would be ideal adopters.
- Work with utilities and manufacturers to identify incentive opportunities.

To obtain more information about these products, visit the manufacturer websites:

- American Fluorescent: www.americanfluorescent.com (products HAD2054SNE9 and HAD2054SNE9CD)
- Fire and Water: www.cyberg.com
- MaxLite: www.maxlite.com
- PowerLux: www.powerlux.com

This project was part of the PIER Lighting Research Program. To view the project reports, as well as other current research activities, visit www.energy.ca.gov/pier.

Additional information about this technology can be found on this PIER Contractor site: www.archenergy.com/lrp/products/energystar.htm

Information about another effort to develop new ENERGY STAR fixtures may be found at: www.LightingForTomorrow.com.

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PORTABLE RESIDENTIAL LIGHT FIXTURES

ENERGY STAR®
CERTIFIED FIXTURES ENSURE PERFORMANCE

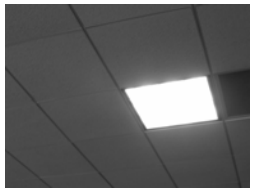
Public Interest
Energy Research

11.0 CFL Recessed Downlights for Commercial Buildings Brochure

Commercial Downlights Are Expensive To Install

Most new recessed downlights in the commercial sector use compact fluorescent lamps (CFLs), but a large stock of incandescent downlights remains in operation. Replacing these incandescents with CFLs would cut energy use by about 75 percent, but the CFL fixtures are often too expensive to justify the investment.

In addition, most "small" fluorescent fixtures in hallways, lobbies, and conference rooms use full-size T-8 or T-12 lamps in a relatively large (2-foot square) fixture. Such fluorescent fixtures with full-size lamps are often considered less aesthetically pleasing compared to recessed downlights, which produce less glare and have a cleaner look. However, CFL downlights are relatively expensive to install because more fixtures are required to maintain illumination levels.

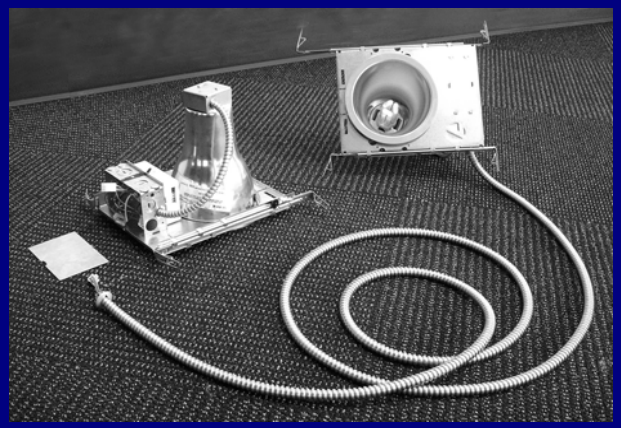


Typical "small" fixture using full-size fluorescent lamps

Researchers from the California Lighting Technology Center (CLTC) developed two prototype CFL downlight systems—one each for commercial and residential markets—that reduce both energy and installation costs while improving lighting quality.

Master-Remote CFL Downlights

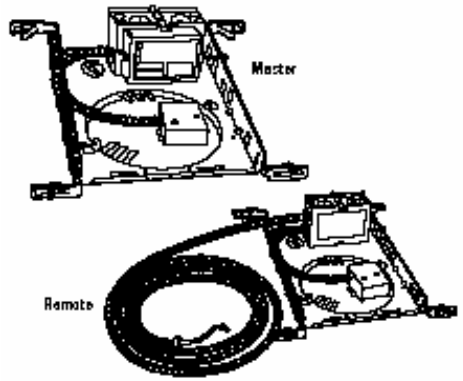
Building on a previous PIER project that developed a family of CFL downlights for residential new construction—Lithonia model CKP62—CLTC researchers worked with Lithonia Lighting to develop a new family of downlights for commercial new construction and renovation projects. The new series, comprising models CCR62 and CCR82, employs just one ballast to operate two lamps using a plug-and-play wiring system. This system cuts equipment and installation costs while reducing energy use. The research team also developed a prototype residential retrofit kit that promises to allow cost-effective replacement of incandescents.



The master-remote CFL downlighting system uses only one ballast to operate two lamps.

One Ballast Operates Two Lamps

CFL downlights have a clean look desired by many building owners and lighting designers. The new Lithonia CCR series lets building owners and lighting designers more easily install CFL downlights at a lower cost than for standard CFL downlighting systems.



Lithonia model CCR62 uses a plug-and-play wiring system to cut installation costs.

Benefits

- Cuts energy use compared to standard systems:
  - 6 percent versus standard CFL downlights
  - 15 percent versus T-12 fluorescent
  - 75 percent versus incandescent downlights
- Plug-and-play installation cuts labor cost by about 20 percent.
- Single ballast operates two lamps, reducing equipment cost.
- Thermally-enhanced ballast configuration ensures long lamp life.

INTERESTED?

Office building owners, lighting designers and specifiers, lighting equipment manufacturers, code developers, contractors, and utility staff can use the information on the CFL downlight system.

Key next steps include:

- *Building owners*—Consider replacing incandescent downlights and T-12 fluorescents with CFL downlights.
- *Utility staff*—Work with CLTC to identify and support field demonstrations.
- *Luminaire manufacturers*—Consider manufacturing plug-and-play downlight systems and commercializing the residential retrofit prototype.
- *Code Developers*—Consider the impact of CFL downlights in residential applications.
- *Lighting Designers*—Consider CFL downlights in applications where full-size fluorescent lamps are typically used but a cleaner look is desired.

This project was part of the PIER Lighting Research Program. To participate in field demonstrations or to get more information on this technology, contact Erik Page at CLTC (epage@ucdavis.edu).

Additional information about this technology can be found on the following websites:

- PIER project site: www.energy.ca.gov/pier/buildings/projects/500-01-041-0-4-4_3.html
- PIER contractor site: www.archenergy.com/lrp/products/downlight.htm
- PIER researcher site: www.cltc.ucdavis.edu (under projects)

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ARCHITECTURAL ENERGY CORPORATION
Integrated Engineered Solutions

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CALIFORNIA LIGHTING TECHNOLOGY CENTER

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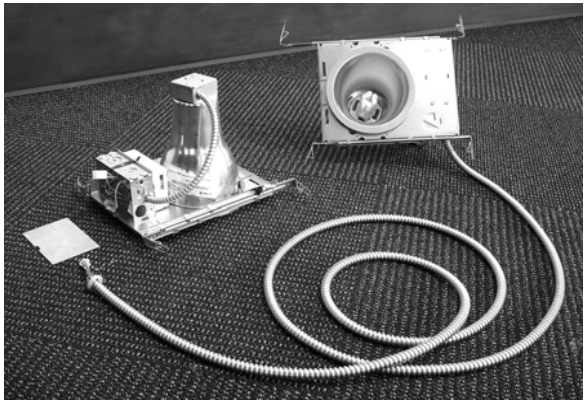
CFL RECESSED DOWNLIGHTS FOR COMMERCIAL BUILDINGS



EASY INSTALLATION CUTS COST

Public Interest
Energy Research

12.0 Portable Office Luminaire Brochure

Standard Lighting is "Everything for Everybody"

Office spaces typically rely on a uniform layout of ceiling mounted luminaires to evenly illuminate the space—lighting "everything for everyone" since user requirements may change over time.

Such lighting systems, illuminated to the highest levels that the lighting designer feels will be needed, are inefficient and inflexible.

The Portable Office Luminaire provides both ambient and task lighting and reduces lighting energy costs by 30–50 percent compared to conventional office applications.

Combined with low-level ambient lighting, the Portable Office Luminaire maximizes energy efficiency while improving lighting quality.

Portable Office Luminaire

The Portable Office Luminaire provides office workers with a unique combination of flexibility, energy efficiency, and control. The floor lamp, with its state-of-the-art high-output compact fluorescent lamp (CFL), integrated occupancy sensor, and low-glare direct/indirect design, is specifically designed to be used as the primary light source in an office.

Portable Office Luminaire prototype developed under this PIER LRP project

Researchers from Finelite and the California Lighting Technology Center (CLTC) developed a prototype portable luminaire designed to be the primary source of illumination in office environments.

Flexible, Energy Efficient Office Lighting

Portable office lighting systems offer more flexibility and control than do standard ceiling systems while also providing better quality, glare-free direct/indirect lighting.

These systems use the same energy efficient lighting components as ceiling mounted systems. They can be placed strategically in offices to provide high or low levels of illumination where needed and easily adapt to changing office layouts or tasks.

In a 150-square-foot (ft^2)private office, a state-of-the-art super T8 system uses 0.83 watts/ft^2 while the Portable Office Luminaire requires only 0.53 watts/ft^2.

Dual lamps and a perforated fixture provide glare-free direct and indirect light.

Benefits

- Cuts energy use 30–50 percent compared to ceiling-mounted systems.
- The 80W CFL with electronic ballast provides high light output and increased energy efficiency.
- A low-glare direct/indirect design delivers superior light quality.
- An integrated occupancy sensor reduces energy use during unoccupied times.

INTERESTED?

Office building owners/managers, small home/office users, lighting designers and specifiers, lighting equipment manufacturers, code developers, contractors, and utility staff can use the information on the prototype portable office luminaire.

Key next steps include:

- *Utility staff*—Work with CLTC to identify and support field demonstrations.
- *Luminaire manufacturers*— Consider manufacturing the portable office luminaire.
- *Code Developers*—Bear in mind the impact of task-ambient lighting systems when considering code changes.
- *Lighting Designers*—Adopt task-ambient lighting designs using the Portable Office Luminaire.

To participate in field demonstrations or to get more information on this technology, contact Erik Page at CLTC (epage@ucdavis.edu).

This project was part of the PIER Lighting Research Program. To view the project results, as well as other current research activities, visit www.energy.ca.gov/pier.

Additional information about this technology can be found on the following websites:

- PIER contractor site: www.archenergy.com/lrp/products/portable.htm
- PIER researcher site: www.cltc.ucdavis.edu (under projects)

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PORTABLE OFFICE LUMINAIRE

PROVIDING LIGHT WHEN AND WHERE USERS NEED IT

STATE OF CALIFORNIA
ENERGY COMMISSION

Public Interest
Energy Research

13.0 Integrated Classroom Lighting System Brochure

Component Approach Limits Advanced Controls

Many classroom lighting systems provide mediocre lighting quality and have high energy costs. Although new high-efficiency systems are available, they must be built piecemeal approach when including automatic controls for occupancy and dimming. Specifying control components individually greatly increases design time and cost. Additionally, each component carries an individual warranty, causing confusion if performance problems occur.

The Integrated Classroom Lighting System (ICLS) combines high quality lighting, increased flexibility, daylighting, and energy efficiency into an affordable, easy to use, and easy to maintain single-source solution.

The ICLS standard package includes:

- Direct/indirect fixtures
- Two rows of fixtures for maximum savings
- Teacher control center located at the front of the room
- Manually switched rows for daylighting control
- Automated dual-technology occupancy sensor
- One source for layout, pricing, and warranty
- 3500k XPS T8 lamps and instant-start ballasts
- Five-year system warranty includes ballasts, sensors, and controls

Options include daylight dimming and a third row of fixtures for better uniformity.

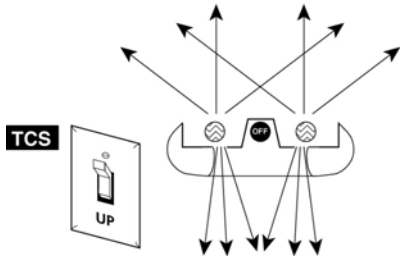
Integrated Classroom Lighting System

PIER RESEARCHERS DEVELOPED AN INTEGRATED, PLUG-AND-PLAY CLASSROOM LIGHTING SYSTEM WITH FULLY INTEGRATED CONTROLS. THE SYSTEM INCLUDES A SINGLE-SOURCE FOR LAYOUT, PRICING, TRAINING, COMMISSIONING, AND WARRANTY. THE TEAM INSTALLED THE SYSTEM IN 19 CALIFORNIA CLASSROOMS AND CONFIRMED SYSTEM PERFORMANCE AND OCCUPANT SATISFACTION.

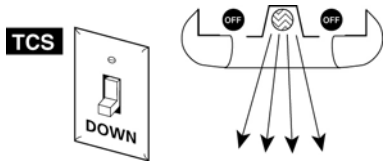
THE SYSTEM PROVIDES DIRECT/INDIRECT LIGHTING WITH OPTIONAL DIMMING CONTROLS. ENERGY USE IS APPROXIMATELY 50 PERCENT OF TYPICAL CLASSROOM LIGHTING, AND TEACHERS ARE ENCOURAGED BY THE CALMING EFFECT ON THE STUDENTS.

Heritage Oak School - Roseville, CA
One of 19 classrooms involved in the study

Equally Effective In New and Retrofit Construction



Full Illumination



Light directed downward only

(TCS: teacher control switch)

Benefits

- High-quality, glare-free lighting ensures occupant satisfaction
- Teacher controls enhance the learning environment
- 0.95 watts/sq-ft energy use compared to 1.2–1.7 watts/sq-ft for new and older systems
- Immediate to nine-year simple payback for new installations depending on selected options
- 96 percent reflective paint reduces number of fixtures and energy use
- Plug and play components minimize design, installation, and commissioning time
- Innovative 24-volt surface mount control system cuts installation costs in retrofit spaces with limited ceiling or wall access

INTERESTED?

School boards, superintendents, principals, architects, lighting designers, utility staff, and code officials can use information on the Integrated Classroom Lighting System in planning for new school construction or classroom renovations.

Key next steps include:

- Publicize the success of the demonstration projects.
- Inform the lighting community and school officials about the system's availability.
- Document system performance and occupant acceptance at future sites.
- Work with interested parties to incorporate the concepts into new construction designs and Title 24 energy conservation standards.

To purchase or learn more about the system, look for the Integrated Classroom Lighting System on the Finelite web site (www.finelite.com).

This project was part of the PIER Lighting Research Program. To view the study results, as well as other current research activities, visit www.energy.ca.gov/pier.

Additional information about this technology can be found on the following websites:

- PIER contractor site: www.archenergy.com/lrp/advlight_luminaires/project_4_5.htm
- PIER researcher site: www.finelite.com/prodinfo/icls/icls_frmset.htm

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Better Lighting For A Better Workplace

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INTEGRATED CLASSROOM LIGHTING SYSTEM

SUPERIOR LIGHTING QUALITY WITH OPTIMIZED CONTROLS

Public Interest
Energy Research

14.0 Bi-Level Stairwell Fixture Brochure

Stairwell Lighting Operates Needlessly

Stairwells are lit 24 hours per day regardless of occupancy. In stairwells with high-wattage light fixtures (T12s or T8s), 24-hour use can lead to a significant and unnecessary waste of electricity.

Although occupancy sensors are widely available to switch off stairwell lighting during unoccupied periods, they require custom installations and do not provide illumination during unoccupied periods, as required by code.

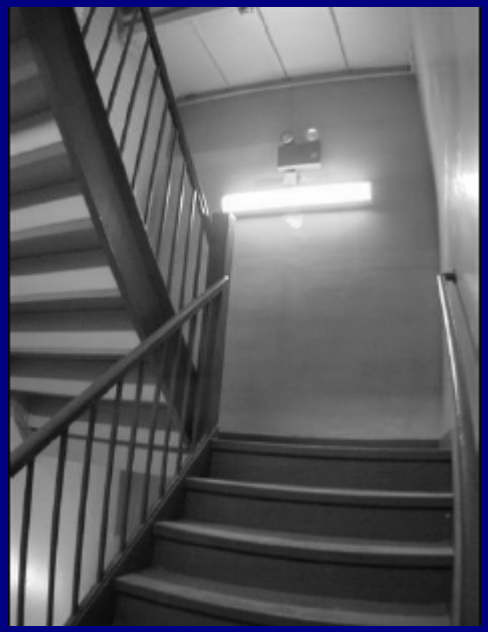
In contrast, a new bi-level stairwell fixture with integrated occupancy sensors are easy to install and even easier to operate—they're automatic! The system is designed to provide safe, reliable, and efficient lighting with high illumination during occupied periods and reduced illumination when stairwells are vacant. However, building owners and code officials have had little exposure to these emerging fixtures.

PIER researchers installed bi-level fixtures from LaMar Lighting in four buildings, ranging from a 5-story commercial office to a 10-story university classroom/office. The team monitored occupancy schedules and energy use and experienced no code issues.

The bi-level fixture has no special installation requirements and has standby wattage consumption as low as 8 watts using a one-lamp 25-watt T8 fixture.

Bi-level Stairwell Fixture Research Study

Working with the International Facility Management Association (IFMA), Researchers monitored bi-level fixtures in four California sites, measuring occupancy use patterns, energy savings, and installation cost. Results indicate standby operation 15 to 40 percent of the time for lower floors and 60 to 90 percent for upper floors, varying between weekdays and weekends. Energy savings totaled 40 to 60 percent.



Bi-level stairwell fixture

Cut Energy Use While Providing Continuous Lighting

Bi-level stairwell fixture technology provides peace of mind by offering standby lighting levels for safety and security when the space is unoccupied, and full light output when the space is occupied.

Benefits

- Standby operation meets code minimum illumination requirements
- Typical 40–60 percent energy savings provides 3–8 year simple payback depending on existing lighting and new versus retrofit applications
- Various models are available to meet most applications:
- One- or two-lamp fixtures
- 120-volt or 277-volt models
- Bi-level, step-down ballasts to 5, 10, or 33 percent of full light output (i.e., two 4-ft T8s with step down to 10 percent reduces power from 62 watts at full output to 13 watts at standby)
- Integrated ultra-sonic motion sensor simplifies design, purchase, and installation
- 100-hour lamp conditioning circuit assures long lamp life
- Adjustable time in full output operation ranges from 15 seconds to 30 minutes
- Emergency operations options available
- Five-year factory warranty on all ballasts and sensor components.

INTERESTED?

Building owners, facility managers, contractors, design engineers, building code developers, and utility staff can leverage the bi-level stairwell lighting study results in their future efforts.

Key next steps include:

- Identify buildings with stairwells that are overlit or using high-wattage fixtures
- Identify utility financial incentives to offset initial cost and publicize availability to lighting designers and contractors
- Publicize energy savings and cost-effectiveness results to building owners, lighting designers, and contractors
- Standardize this technology for use in new stairwells
- Inform code officials about successful applications and acceptance in numerous code jurisdictions

To learn more about the system, visit www.occusmart.com.

This project was part of the PIER Lighting Research Program. To view the project results, as well as other current research activities, visit www.energy.ca.gov/pier.

Additional information about this technology can be found on the following websites:

- PIER contractor site: www.archenergy.com/lrp/lightingperf_standards/project_5_1_impacts.htm
- PIER researcher site: http://lighting.lbl.gov/l_controls.html

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BI-LEVEL STAIRWELL FIXTURE

THE RIGHT STAIRWELL LIGHT LEVEL WHEN NEEDED

Public Interest Energy Research

15.0 Low-Glare Wall Sconce Brochure

Reduced Glare and Reduced Energy Use

Wallpack luminaires are commonly used on buildings of all types. However, they are notorious for poor control of light output, which contributes to “sky glow” and light trespass problems. Because of the poor optical design, conventional wallpacks have an effective light projection of only 30 feet at 15-foot mounting heights.

The new low-glare wall sconce prototype from Gardco Lighting, addressed the shortcomings of the conventional wall-pack. This luminaire effectively projects light up to 45 feet from the base of the building at 15-foot mounting heights. The improved optics give better illumination and reduce light “pollution.”

The prototype featured a ceramic metal halide lamp and a semi-cutoff tilted lens. With the higher optical efficiency, designers can specify 33 percent fewer luminaires per installation, reducing both installed and operating costs.

Gardco also applied the wall sconce’s optics into a pole-mounted perimeter light that can reduce light trespass from parking areas into adjacent spaces. Gardco plans to introduce a commercial product based on these designs in 2006, intended for a 70 watt lamp as a replacement for a standard 175 watt fixture.

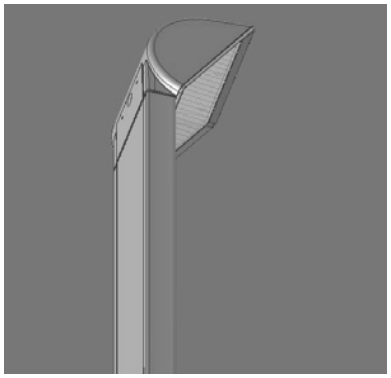
Low-Glare Outdoor Luminaire

Lawrence Berkeley National Laboratory (LBNL) worked with Gardco Lighting to model advanced optic designs that provide higher average illumination within the lighted zone while reducing light pollution beyond the lighted area.

The results are two prototypes—a wall sconce and a pole-mounted fixture—that offer up to 30 percent energy savings for new or retrofit applications.

The new luminaire could help save energy and provide safety benefits for commercial building owners.

Improve Outdoor Lighting Performance



The Gardco Forward Form Perimeter Light Prototype

Benefits

Gardco’s prototypes using either 100- or 150-watt ceramic metal halide lamps with electronic ballasts provide numerous benefits compared to standard wallpacks with 150-watt high- pressure sodium lamps:

- 30 percent energy savings in new or retrofit applications with the 100-watt unit
- 33 percent fewer fixtures and 50 percent more coverage in new installations
- Improved optics using a semi-cutoff design that reduces light pollution
- Whiter light with higher color quality
- Comparable lamp life—20,000 hours
- Potential for significant annual energy savings in California

Building owners will receive more uniform, better quality lighting with less light pollution and reduced energy costs.

INTERESTED?

Commercial and institutional building owners/managers, contractors, and designers, as well as code developers and utility staff, will benefit from learning about the new low-glare outdoor luminaires.

Key next steps include:

- Demonstrate the new fixture at different types of buildings.
- Consider code changes to stimulate use of low-glare luminaires.
- Disseminate product information to lighting designers and contractors.
- Educate building managers about low-glare, high-efficiency lighting that can reduce night sky pollution.
- Stimulate other manufacturers to produce similar products.

A product based on these design improvements is expected to be commercially available soon.

This project was part of the PIER Lighting Research Program. To view the project results, as well as other current research activities, visit www.energy.ca.gov/pier.

For more information, visit the following websites:

- PIER contractor site: www.archenergy.com/lrp/lightingperf_standards/project_5_3.htm
- PIER researcher site: http://lighting.lbl.gov/l_distribution.html

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Gardco Lighting
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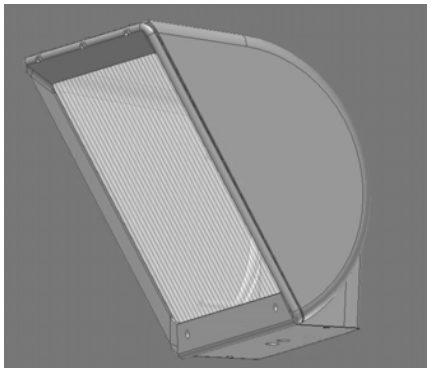
LOW-GLARE WALL SCONCE



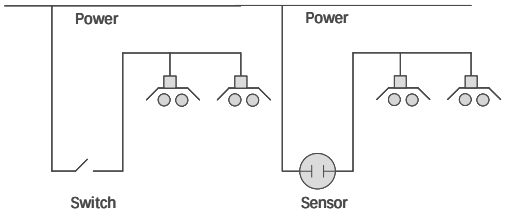
INCREASED COVERAGE, LOWER ENERGY USE, BETTER CONTROL OF LIGHT POLLUTION

Public Interest
Energy Research

16.0 Enhancing the DALI Lighting Controls Protocol Brochure

Lighting Controls: Some Successes Still Awaiting

Lighting is often the largest electrical load in a typical office, school, or store. However, the cost of lighting energy pales when compared to the cost of the employees using the space. Occupancy sensors and time-based controls are effective at saving energy, yet neither provides a direct benefit to the occupant. Potential energy savings and occupant satisfaction increase dramatically if users can *control* the lighting level, not simply turn it on or off.



Digital ballast technology promises reliable and cost-competitive fluorescent dimming that can improve energy savings, occupant satisfaction, and building operation. Using the non-proprietary Digital Addressable Lighting Interface (DALI) protocol, contractors can install lighting networks with interoperable components from various manufacturers.

The current DALI protocol applies only to ballasts and not to associated control components, such as sensors and controllers. This project developed a draft protocol for these additional control components that will allow designers, contractors, and manufacturers to install fully interoperable DALI systems.

Enhanced DALI Control Standard

PIER RESEARCHERS WORKED WITH THE NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA) TO DEVELOP THE DRAFT ENHANCED DALI LIGHTING CONTROLS PROTOCOL. THE DRAFT STANDARD INCLUDES INPUT FROM MAJOR MANUFACTURERS, DESIGNERS, AND END-USER GROUPS AND HAS BEEN SUCCESSFULLY DEMONSTRATED IN TWO FACILITIES. THE FINAL STANDARD IS EXPECTED TO RECEIVE IEC APPROVAL IN LATE 2005.

DALI allows for different preset "scenes," as shown in these photos.

Expanded Use of Powerful Controls

The enhanced DALI protocol will provide orderly communications between all of the devices on the network.

Equally important, designers can easily specify control devices for each space. This capability eases the installation of dimmable systems and supports individual occupant preferences while maximizing energy savings and controlling demand.

Benefits

- Wiring and signal specifications guarantee messages are heard and understood by all devices
- A collision management process minimizes the possibility of data loss
- A programming and monitoring control device operates parameters from a central location to reduce operation and maintenance costs.
- The ability to easily implement flexible control scenarios according to changing building needs.
- Occupant empowerment.
- Increased occupant satisfaction and productivity, as demonstrated by the Light Right Consortium.
- Reduced energy consumption and the ability to shed lighting on demand.
- Energy analysis.
- Lamp failure reporting.
- Reduced occupant complaints of glare/headaches.

INTERESTED?

Many in the lighting and buildings sector can use these project results, including:

- Building owners/managers
- Facility managers
- Lighting designers/specifiers
- Contractors
- Commissioning agents
- Electric utility staff

Key next steps include:

- *National Electrical Manufacturers Association (NEMA) and International Electrical Commission*—Adopt the new standard.
- *NEMA and Efficiency Advocates*— Educate lighting and control manufacturers and specifiers on the benefits.
- *Building Owners*—Direct designers/specifiers to implement the new protocol.
- *Lighting Designers/Specifiers*—Implement the enhanced standard in additional buildings.

This project was part of the PIER Lighting Research Program. To view the project results, as well as other current research activities, visit www.energy.ca.gov/pier.

Additional information about this technology can be found at:

- PIER contractor site: www.archenergy.com/lrp/lightingperf_standards/project_5_4.htm
- PIER program site: http://www.energy.ca.gov/pier/buildings/projects/500-01-041-0-5-5_4.html

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Integrated Engineered Solutions

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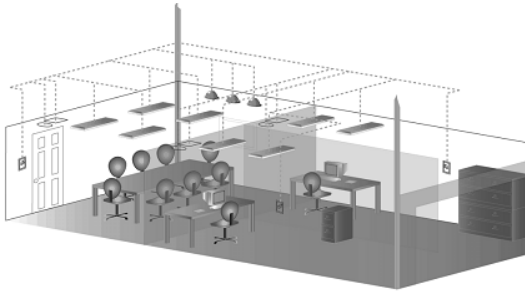
ENHANCING THE DALI LIGHTING CONTROLS PROTOCOL



IMPROVING OPEN-STANDARDS LIGHTING CONTROLS

Public Interest
Energy Research

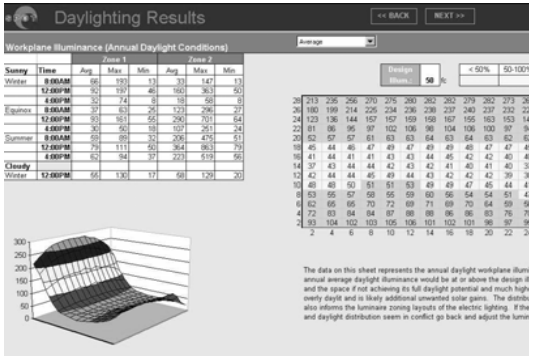
17.0 Sensor Placement and Orientation Tool (SPOT) Brochure

Sensor Challenges Hinder Daylighting and Electric Lighting Integration

Lighting professionals have long struggled with ensuring proper integration of daylighting and electric lighting while also quickly estimating energy savings from designs. Photosensor systems vary widely, greatly impacting daylighting and electric lighting performance. However, few design professionals have tools to help them account for variations.

The Sensor Placement and Orientation Tool (SPOT™) was developed to promote successful daylighting and electric lighting integration while maximizing energy savings. This free software package also helps designers establish correct photosensor placement relative to the proposed lighting design.

It analyzes overall system design performance prior to field installation and commissioning. Developed with classrooms in mind, SPOT™ may also be applied to other spaces, such as offices.



SPOT screen shot showing daylighting calculation results

SPOT Software

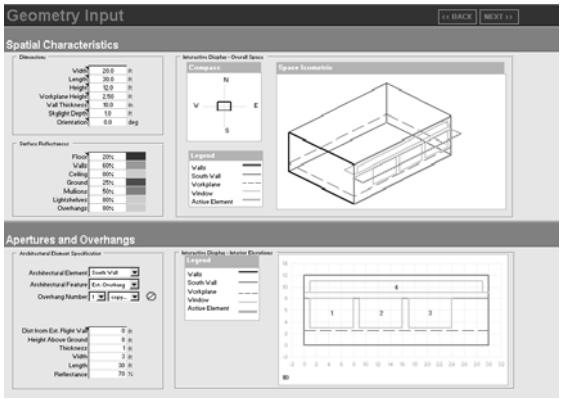
SPOT WAS CREATED TO ANALYZE PHOTOSENSOR SELECTION AND PLACEMENT IN CLASSROOM APPLICATIONS, ENSURING APPROPRIATE YEAR-ROUND LIGHTING LEVELS AND MAXIMIZING DAYLIGHTING ENERGY SAVINGS.

SPOT accounts for many variables, such as room geometry, surface reflectances, solar orientation, electric lighting layout, and window design.

SPOT consists of a Microsoft Excel interface with a mostly invisible Radiance calculation engine. Based on user inputs, the tool calculates nighttime illumination levels and the range of daylight contribution throughout the year.

It allows the user to test various photosensor placements and evaluate alternate designs. Annual illuminance averages and energy performance data allow the user to evaluate the daylighting and electric lighting design.

Design Daylighting and Electric Lighting and Analyze Results



SPOT Software Screen Shot

Lighting designers using SPOT can quickly and easily optimize photosensor placement and estimate daylighting savings, which can be 10 to 60 percent, depending on system design.

Benefits

- Simple, easy-to-use interface
- No cost to purchase
- Comprehensive inputs ensure accurate analysis
- Software based on industry-standard daylighting analysis tool (Radiance)
- Multiple libraries of default values provided for basic use
- Widespread customization available for advanced users
- Extensive analysis output: sensor placement, electric lighting and daylighting illumination levels, and annual energy performance
- Reinforces capability to provide better illumination uniformity and improve occupant satisfaction

INTERESTED?

Architects, facility managers, contractors, design engineers, building scientists, code developers, commissioning agents, and utility staff can take advantage of the SPOT software package.

Key next steps include:

- Widespread distribution of SPOT freeware
- Train user groups on SPOT operation
- Demonstrate successful application in real-world projects and validate results
- Stimulate photosensor manufacturers to provide standard performance data
- Develop an extensive database of manufacturers' photosensor performance
- Integrate SPOT usage into standard practice for lighting designers and specifiers

To obtain SPOT or learn more, visit www.archenergy.com/SPOT

This project was part of the PIER Lighting Research Program. To view other project results, visit www.energy.ca.gov/pier.

Information about other LRP technologies can be found on the following web sites:

- PIER LRP – Improved Classroom Photosensor
  www.archenergy.com/lrp/products/photosensor.htm

- PIER LRP – Integrated Classroom Lighting System
  www.archenergy.com/lrp/products/classroom.htm

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SENSOR PLACEMENT AND ORIENTATION TOOL

SPOT
SENSOR PLACEMENT + ORIENTATION TOOL

OPTIMIZE DAYLIGHTING AND ELECTRIC LIGHTING INTEGRATION

Public Interest
Energy Research

18.0 Lighting R&D and Code Connections Brochure

Why Codes and Standards Connections Matter?

The Public Interest Energy Research (PIER) Lighting Research Program (LRP) needed a solid strategy for translating its successes into workable codes and standards proposals. If an LRP product or finding is adopted into the state energy efficiency codes, the market effect will be fairly certain. The codes would then require that type of technology or process—or some strategy of equal efficiency—to be implemented in all new buildings.

The Heschong Mahone Group, Inc. (HMG) helped the LRP Project Leads:

- Evaluate all LRP research efforts and map the path from each research outcome into the codes and standards arena.
- Identify the most code-ready research outcomes and recommend steps to adoption, as well as identify outcomes that may require additional research and development (R&D) before they can enter the code process.
- Identify lighting codes and standards problems that require additional R&D, such as outdated lighting industry metrics still referenced by codes.

HMG helped identify LRP efforts likely to have the largest energy savings or demand reduction potential. They also identified additional lighting research needs that could be addressed by future PIER work.

Lighting Research Program Codes and Standards Connections

The Heschong Mahone Group collaborated with LRP project teams to identify codes and standards connections for the LRP products. This effort informed product design and development and helped with promotion through future codes and standards provisions.

Various LRP technologies were reviewed by HMG for codes and standards implications.

The standards process often serves as a catalyst to introduce energy-efficient products into the marketplace. The process also encourages utilities and other agencies to grant economic incentives through energy efficiency rebates to stimulate early adoption of technologies.

Connecting Research to Energy Efficiency Standards

The Codes and Standards Connections project provided the following support to the LRP teams:

- Lighting Standards Review: Reviewed the various lighting efficiency standards enacted across the nation, and compared them to California's lighting standards.
- Program Projects Reviews: Reviewed all LRP projects for their potential as code improvements under California's building and appliance efficiency standards.
- Complementary Lighting Research Reviews: Identified research activities that can complement LRP R&D work.
- Lighting Standards Needs Assessment: Identified problem areas in the California lighting efficiency standards that require additional R&D.

Reports for each of the categories listed below are available for review.

Benefits

- Ensure potential energy savings are valid
- Review the cost-effectiveness of the technology
- Evaluate whether the technology is commercially available from more than one manufacturer
- Review whether the technologies are feasible and compatible with current building practice

INTERESTED?

Lighting researchers, code developers, contractors, and utility staff can use the recommendations from this project.

Key next steps include:

- Enhanced support for research needs for codes and standards development in California. This includes research into:
  - Consumer or user acceptance problems with code provisions
  - Reliability or other concerns with requirements for a given technology
  - Long-term persistence of energy savings from code measures and technologies
- Increased coordination with utility emerging technology programs to develop energy efficient lighting solutions
- Support for long-term fundamental lighting research into topics such as:
  - Biological and environmental impacts of lighting technologies
  - Understanding the mechanics of human vision and the impact of various lighting frequencies and spectrum on visibility
  - Lighting needs for safety and security inside buildings and in the outdoors
  - New product development through materials research, technology specifications, and industry standards

This project was part of the PIER Lighting Research Program. To view the project results, as well as other current research activities, visit www.energy.ca.gov/pier.

Additional information can be found at:

- PIER contractor site: www.archenergy.com/lrp/products/codes.htm

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LIGHTING R&D AND CODES CONNECTIONS

MAPPING PIER LIGHTING RESEARCH PRODUCTS TO CALIFORNIA BUILDING ENERGY EFFICIENCY STANDARDS

STATE OF CALIFORNIA
ENERGY COMMISSION

Public Interest
Energy Research