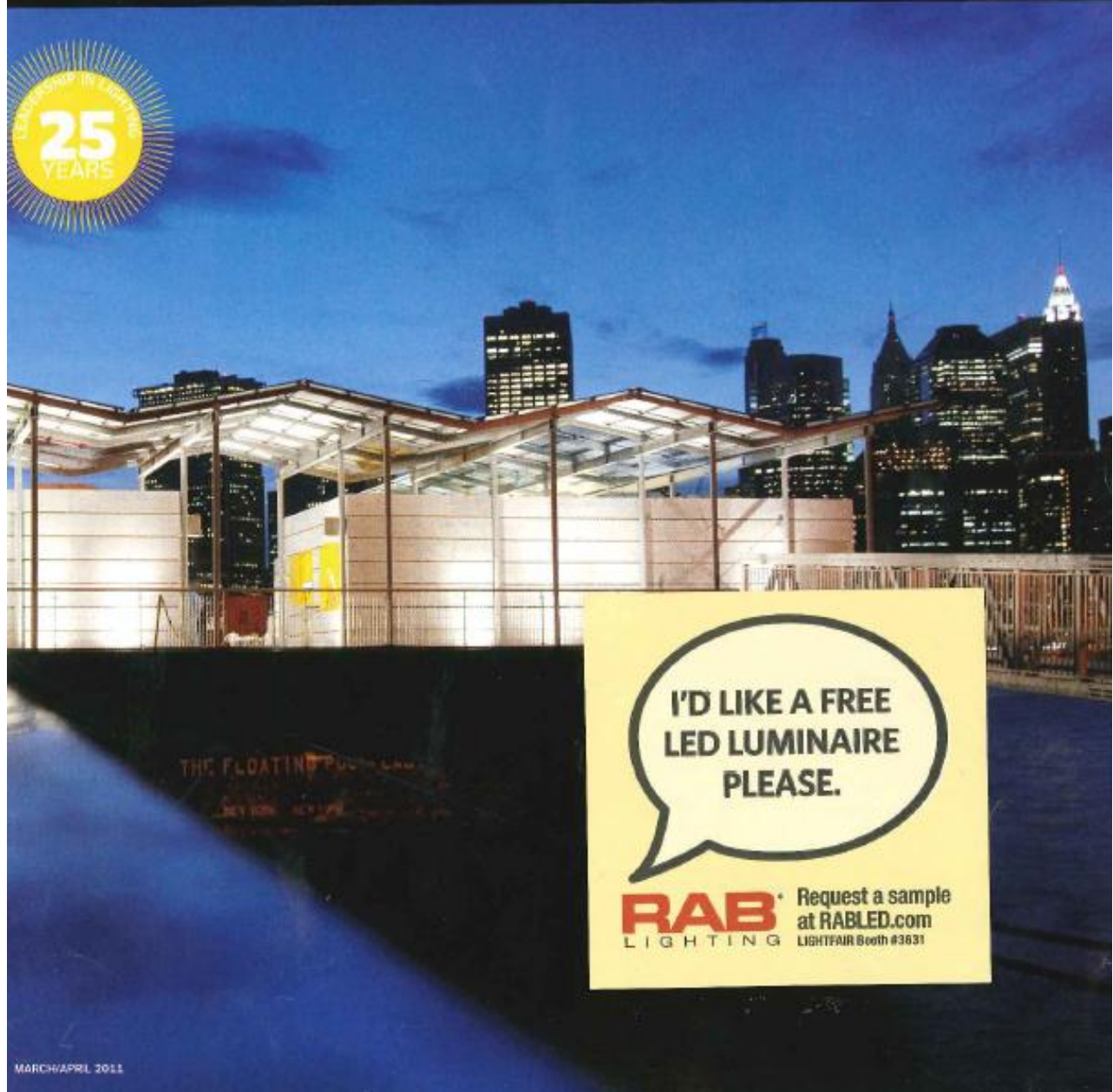


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# • TECHNOLOGY

## SMART BUILDINGS, SMART GRID

*Energy-efficient lighting is an indispensable feature of the office of the future.*

text by Gregg D. Ander

Courtesy The Lighting Quotient

Glumac Engineering's Irvine, Calif., office is one of the facilities participating in the Office of the Future initiative (above).

Whether they are typing away in their cubicles, attending lengthy meetings, or snacking in the cafeteria, office workers don't generally wonder how the lights above their heads could save their organization money. Energy-efficient lighting is, however, an indispensable feature of the office of the future. Through careful design and with the integration of high-efficacy lamps, ballasts, and controls, office spaces can achieve a vastly superior luminous environment while saving substantial money and resources.

Utilities in the 21st century face significant challenges. Integrated systems and controls must be in place to deliver highly reliable service with quality results. Energy-efficient office spaces need to be reasonably priced to attract business owners. It's also important to question how a lighting design will affect the environmental quality of office buildings.

Policy makers recognize that greenhouse gases in the atmosphere—caused in part by

heavy reliance on fossil fuels—will have major long-term global impacts, including rising sea levels, lowering air quality, and increasing ecological damage. Federal and state regulators who are aggressively promoting climate and energy policies recognize that smart buildings, when plugged into a sophisticated electricity grid, help reduce greenhouse gas emissions.

Energy-efficiency programs in the U.S. abound. Many utility companies offer consumers incentives for an array of technologies, technical analysis, and training to help facilitate market adoption and ultimately to reduce costs. Demand response programs, specifically, allow consumers or other third parties to operate and closely monitor energy consumption using smart meters, building area networks, and dashboards that allow connectivity and other monitoring functionality.

Those meters are just one tool in the smart grid, which can deliver electricity more

## Studies have shown that employees with personal dimming controls registered higher ratings of overall satisfaction with their environment and were happier at work.

efficiently by boosting the coordination between suppliers, consumers, and networks in two-way or "N-way" digital communications. The smart grid restores the supply-and-demand balance by linking transmission lines with conventional electricity generators, rooftop solar customers, wind farms, plug-in electric vehicles, and distribution stations. Renewable-energy generation can have a significant impact on the grid's reliability, which is affected by intermittent power production or transient loads. Additionally, peak loads during the 9-to-5 workday are typically double that of off-peak loads from midnight to 6 a.m.

Zero-net-energy (ZNE) or ultralow-energy buildings also relieve the grid's load by harvesting energy on site with the goal of achieving zero- or low-carbon emissions. California's goal is to have zero-net-energy in place for new residential buildings by 2020 and for new commercial buildings by 2030. These goals may be reached through exemplary building design, highly efficient space conditioning, state-of-the-art lighting design, as well as by using solar electric or wind generation. These high-performance building features would be integrated through sophisticated controls.

### THE MARKET

Lighting is so ubiquitous that we take it for granted. According to the California Energy Commission, lighting represents 42 percent of the electrical consumption in California—more than air conditioning, refrigeration, and ventilation. More than three-quarters of the total lighting load is nonresidential space and 26 percent of that is commercial.

There is a currently a glut in office space on the commercial market. According to the Urban Land Institute, the national downtown urban market space equals 1.5 billion square feet, while the suburban market equals 3.2 billion

square feet. Less demand means rising vacancies, declining rents, and tenants who want more at less cost. Market trends in commercial real estate show little new development or money for retrofits. Instead, property management firms are increasingly specializing in niche markets such as green buildings.

According to the 2008 study "Does Green Pay Off?" by Norm Miller, Jay Spivey, and Andy Florance, LEED-certified buildings sold for 64 percent more while Energy Star-labeled buildings sold for 27 percent more. Studies have shown that employees with personal dimming controls registered higher ratings of overall satisfaction with their environment and were happier at work, according to a study by the Light Right Consortium. The general literature also suggests that green office spaces have the potential to lower worker compensation claims, increase productivity, reduce absenteeism, and lower vacancy rates. These trends make office spaces unique platforms for integrated lighting solutions.

### SOLUTIONS

The Office of the Future (OTF), a consortium founded by Southern California Edison and other utilities, promotes an integrated technology and market-driven approach to lighting design and other building systems in commercial office spaces. The OTF combines two-way connectivity, off-the-shelf solutions, and careful design. Coupled with demand response, two-way connectivity empowers businesses to intelligently manage their energy use. If there is a transmission constraint, or issues on the distribution system, this connection allows businesses or third-party aggregators to control loads and reduce operating costs.

One of the foundations of the OTF is thoughtful design. Detailed assessments of how fixtures, ballasts, lamps, and controls are utilized during the workday help

dictate which solutions should be implemented and studied. Off-the-shelf solution packages make retrofits more economical and accessible.

The involvement of prominent stakeholders demonstrates how large the market is for the OTF. The consortium includes Microsoft, IBM, Trane, Consolidated Edison, Pacific Northwest National Laboratory, NSTAR, Sempra Energy, BC Hydro, National Grid, Pacific Gas & Electric Co., Sacramento Municipal Utility District, and others.

The consortium has already completed several successful pilots. One pilot project involved retrofitting a cube farm in an Irwindale, Calif., office building with a 1990s lighting system that used 1.2W per square foot. A suspended lighting system was installed, including dimming ballasts, Super T8 lamps, and small-zone occupancy sensing. The new system is demand responsive and set up to automatically respond to daylight. The redesign cut the watts per square foot in half and also reduced the annual energy cost by 74 percent.

Another SCE pilot project involved a redesign of executive office suites in Rosemead, Calif. The offices, which had been rebuilt in 1999, had incandescent lighting highlighting art objects, T8 U-lamps, and east-west facing windows. The beige-colored ceilings had less than 60 percent reflectance and the light levels were on average about 25 footcandles.

The office suites were outfitted with a range of design solutions including a sophisticated control system, pendant lights over desks, dimming ballasts at workstations, and daylighting controls. On-site instrumentation showed that the new designs dropped the watts per square foot from 1.84 to 0.64 while at the same time doubling the number of footcandles where needed. The instrumentation also verified a decrease in kilowatt-hours per square foot per year from 8 to 3.

As these performance results demonstrate, careful lighting designs can substantially save energy costs and environmental resources. Similar pilots are planned, over the next year, for other parts of the country through OTF partners to demonstrate technologies and expose stakeholders to these concepts.

Making smart office spaces with superior luminous environments the norm means increasing connectivity at all levels. Building owners and decision-makers who are demanding higher-performance buildings must be provided with thoughtful solutions that include two-way high-fidelity controls and connectivity. The design community must also be prepared to provide such services to building owners, real estate developers, and others who are eager to take advantage of incentives or rates that are currently available or under

development. This effort is made easier by the fact that dimmable ballast costs are dropping (in some instances by as much as \$40) and new control requirements are being introduced into energy codes

One significant challenge is that designers, contractors, engineers, and others often lack the specific, detailed training needed to install some advanced control systems. Programs have recently been rolled out by the U.S. Department of Labor, however, that will train electricians on how to install sophisticated lighting-control systems (See "How to Light

the Office of the Future," right.) With all of these efforts, high-quality, energy-efficient lighting can become a permanent fixture in every office building. •

*Gregg D. Ander, FAIA, is the chief architect at Southern California Edison. He serves on the board of directors of the Sustainable Buildings Industry Council, the New Buildings Institute, the Collaborative for Higher Performance Schools, and the California Commissioning Collaborative. He is the author of Daylighting Performance and Design (Wiley, 2003).*

### **How to Light the Office of the Future**

Advanced Lighting Control (ALC) systems are fundamental features of smart buildings. Switching off lights in unoccupied offices, conference rooms, and toilet rooms during normal business hours can yield energy savings of up to 40 percent in commercial buildings. A system of dimming ballasts, occupancy sensor photocells, and communication-based devices will reduce the lighting load and help to develop Smart Grid infrastructure.

That kind of innovative design has been stymied by the fact that installers, designers, electricians, and contractors often lack the specialized training necessary to put those systems in place. As a result, architects and engineers often steer clients away from ALC systems that can improve light quality and productivity.

A bold California initiative aims to address that challenge from within the industry. The California Advanced Lighting Controls Training Program (CALCTP) was created to promote the design, installation, and commissioning of ALC systems in commercial buildings by advancing the training and certification of contractors. The idea is based on the principle that market transformation is best achieved through industry organizations and shared standards and practices. The CALCTP team includes investor-owned and municipal utilities, the International Brotherhood of Electrical Workers, the National Electrical Contractors Association, the California Lighting Technology Center, the University of California at Davis, community colleges, manufacturers, and ICF International.

The technical and sales trainings—to be held at 30 sites in California—will include both classroom and hands-on lab training on everything from dimming ballasts to high performance TB lighting systems and Web-enabled controls. There are strong incentives for unions and businesses to go through the training. The CALCTP's partner utilities, equaling more than 90 percent of the California market, encourage contractors and electricians to be certified in ALC installations.

A rise in the number of highly skilled ALC installers promises to spur an upsurge in the supply and demand for lighting controls, while also creating new green jobs for the state. A recent summit at the University of California at Berkeley on employment in the green economy promoted such training efforts as a boon to California's economy and the environment. "Green technologies will not flourish without a well-trained technical and supporting labor force," according to the summit's website—[irla.berkeley.edu/via1](http://irla.berkeley.edu/via1). "There is potential for a 'win-win-win' strategy in this growing facet of California's economy, but it will require careful strategies, educational efforts, and coalitions."

The CALCTP's stakeholders believe their coalition is well positioned to spur that kind of market transformation and become one of the most momentous lighting initiatives in decades. —G.A.