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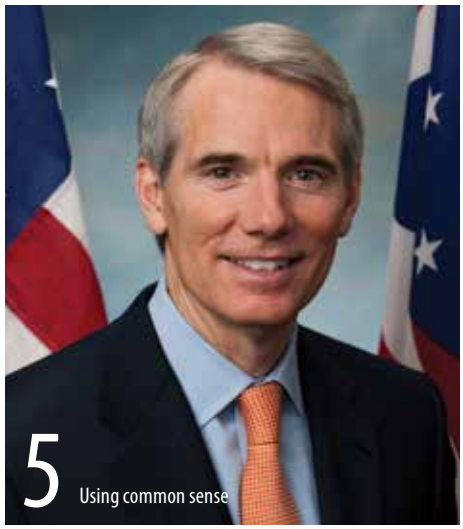

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Editor in Chief | Pat Walsh
Editor | Christine Coogle
Contributing Editors | Ann Brandstadter, William E. Green III
Art Director | Jennifer Tillmann
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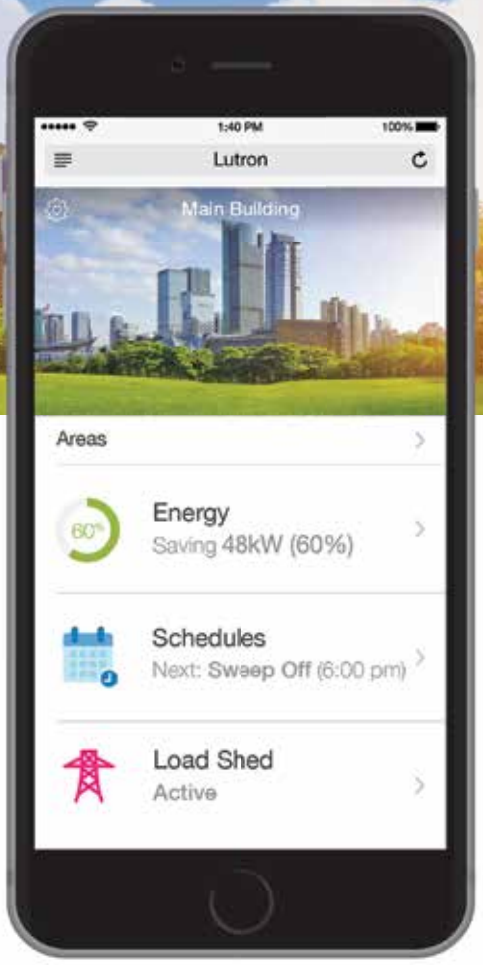

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FROM THE **CHAIRMAN**

As we strive to enhance NEMA's advocacy efforts in 2017, an important part of our mandate is working together to shape and advance better electrical and energy policies, regulations, codes, and standards. NEMA's role continues to expand, touching other markets and more broadly influencing the rapidly changing electrical and medical imaging manufacturing industries to best serve NEMA members and their customers.

In the lighting industry, for example, in just the past few years we have seen a move beyond individual components to systems that provide integrated control of lights, window shades, HVAC, and other building systems that save energy and improve commercial and residential environments. This integration serves as the catalyst for improved data collection, allowing building owners, facility managers, and homeowners to analyze and fine tune their environments to enhance their lives.

In order to provide the best products, all individual parts should work together to deliver reliable, simple-to-use solutions manufactured with the end user in mind. System components should comply with sound technical and safety standards, offer intuitive operation, and integrate seamlessly to eliminate customer confusion or misunderstanding.

NEMA is committed to strong industry coalitions that maintain high standards, promote progress, and ensure that end products meet customer expectations and preserve consumer choice. Our strategic initiatives for 2017 are focused on preparing for a connected future, one that closely ties into the evolution of many parts of the electrical and medical imaging industries from components to systems.

NEMA membership covers the majority of those industries, giving us an opportunity to speak in a unified voice that garners respect from lawmakers, government agencies, and energy advocates alike. We have a responsibility to maintain collaborative relationships and continue to drive issues that affect our business and our economy and improve our customers' lives.

As I commence my tenure as chairman of the NEMA Board of Governors, I'd like to thank Maryrose Sylvester for all her contributions as chairwoman last year. I look forward to working with the NEMA board members and the entire NEMA team to continue to serve our industry and all its constituents.

This is also an opportunity to renew our commitment to the industry. Each of us should actively contribute to and stay engaged with NEMA and all its member companies. To achieve the most positive results, we must remember that we only get out of our association what we put into it.

Michael W. Pessina
Co-Chief Executive Officer and President, Lutron Electronics

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Setting New Standards for a Transforming Industry

Never has there been a more exciting time to be part of the lighting industry. Although we have witnessed many technological shifts, none has been quite as disruptive as the industry's emerging digital transformation. The introduction of light-emitting diodes (LEDs) provided an efficient way to save energy, but the real value is realized when connected technology like sensors, networks, and software are added to LED infrastructure.

Since lighting is everywhere—in streets, public spaces, offices, and homes—connected lighting systems may serve as an information pathway capable of sending and receiving data through each connected point of light. This presents an opportunity to introduce data-enabled services.

A new class of standards is vital to this evolution. Now we must collaborate, embrace, and support standards that address the future of the lighting industry. Three key areas must be addressed: data sharing, data security, and privacy.

DATA SHARING

Every light within a connected lighting system can be an input point for information, giving us the opportunity to deliver far more customer value than just the lighting for which the infrastructure was initially deployed. Data can include everything from air quality and security risks to energy consumption and productivity. We need to address the question of whether we should, or can, provide open access to this data within the constraints of policies and regulations. One solution includes the development of an industry-standard data export interface, which would allow other companies to cost-effectively use gathered data for complementary customer applications. As an industry we determine our role and responsibility in sharing this important information.

SECURITY

Cyberattacks on internet-enabled devices continue to spotlight network and data security. As lighting plays a bigger role in this area, data security standards for connected lighting systems are fast becoming imperative to the Internet of Things (IoT) vision. While there are already general data security standards in place, the industry needs to improve them. This has heightened our resolve within NEMA to ensure that connected lighting systems are protected from cyberattacks. We need to evolve to one common framework, with security standards tuned to the specific needs and vulnerabilities of IoT devices and a compliance or certification scheme that provides a recognized, cross-industry level of protection.

PRIVACY

A sound privacy policy and practice is the third leg of this triad. Privacy regulations often vary by global region, country, or even state. With lighting's growing role in the IoT, we need to be a trusted steward for the data collected and retained by connected lighting networks. It will be crucial for industry to work with regulatory agencies to implement sound data governance practices central to information-centric value generated by connected lighting networks.

A new class of standards, drawn from the IT industry and tuned to the unique attributes of sensor-enabled, data-driven lighting applications, will lower risk and development cost while introducing economies of scale that benefit customers and the industry as a whole. As an industry, we must seize this opportunity.

Senator Rob Portman
(R-OH)

Bright Idea: Use Common Sense

Nobody can out-innovate the American worker. Americans like the Wright Brothers of Dayton, Ohio, Thomas Edison of Milan, Ohio, and Cleveland's Lew Urry—inventor of the alkaline battery—have changed the world and made all of our daily lives better.

The United States is the world leader in energy production and in science and technology. With our highly skilled workforce, we have every reason to believe that we will stay at the leading edge. But we have to ensure that regulations are helping—not hurting—the workers who make us the best. The federal government ought to be a partner with them, not a taskmaster.

There are numerous examples of regulations that make it harder for workers to continue innovating and give an unfair advantage to our competitors overseas. The electrical manufacturing industry knows this all too well: a prime example is the Department of Energy's (DOE) energy efficiency rules for certain power supplies.

Energy efficiency is critical to our economy, and I'm a big supporter of legislative efforts to help American manufacturers use energy more wisely. I authored the Energy Efficiency Improvement Act of 2015, which President Obama signed into law.

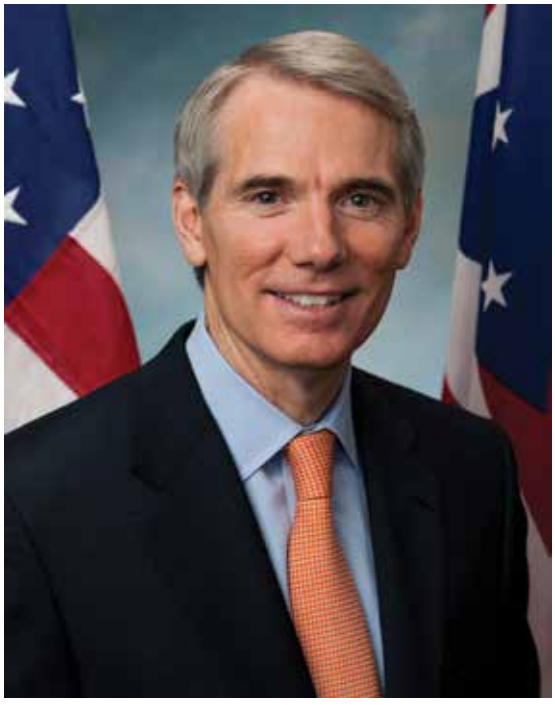
UPDATING OUTDATED REGULATIONS

I believe that we should be making more energy and using less—those ideas go hand in hand. But we must promote energy efficiency in a way that doesn't get in the way of job creation. So while I agree with the goals of these regulations, I think they were written in a sloppy way that makes them hard to comply with.

Here's what happened. In 2005, Congress told the DOE to set energy use standards for external power supplies, i.e., those that plug an appliance into a wall outlet. The goal was to focus on products, such as laptops and smartphones, that use household electric current.

After that law was passed, the industry continued innovating and developed light-emitting diodes (LEDs), which produce light but do not get hot as incandescent bulbs do. Meanwhile, the ceiling fan industry began producing fans powered by motors that used a different kind of current than is commonly used in external power supplies.

The DOE's regulations—issued in 2014—treat power supplies for LEDs and ceiling fans the same way they treat power supplies for laptops and smartphones, even though they are different and Congress could not have had them in mind when writing the law. Now manufacturers of LEDs and ceiling fans spend time and resources complying with or appealing these regulations, rather than hiring new workers or investing in making their products better.



Senator Portman is a member of the Energy and Natural Resources Committee, Finance Committee, Committee on Homeland Security and Governmental Affairs, and Committee on the Budget. He chairs the Permanent Subcommittee on Investigations.

The DOE should use common sense when writing these regulations and let these American manufacturers get back to doing what they do best: creating jobs and building things.

Congress can fix this problem by passing legislation I've introduced with Democratic Senators Jeanne Shaheen and Maria Cantwell to make that commonsense but critical distinction between LEDs and power ceiling fans and devices using exterior power supplies. We still want strong energy efficiency regulations; we just want the DOE to come up with separate regulations for these new technologies.

The Senate passed our bill last year, but it did not make it to the president's desk before the end of the year. I'm hopeful that, with a new Congress and a new president, we will get this legislation over the finish line and into law so that we can create more and better manufacturing jobs in the United States. That would be a bright idea.

James Brodrick
U.S. Department of Energy

Keeping Our Foot on the Efficacy Accelerator

Although the impressive efficacy gains made by light-emitting diode (LED) products over the last few years fall well short of the U.S. Department of Energy's (DOE) ultimate targets, they've already surpassed the limits of conventional lighting in nearly all applications—which might prompt some people to say "good enough" and question the value of further improvements.

In response, the DOE has published *LED Efficacy: What America Stands to Gain*,[1] a white paper that gives five compelling reasons to continue improving the efficacy of LED lighting:

- **Better lighting:** With higher LED efficacy, more light can be produced with less power at lower operating temperatures, allowing manufacturers and designers to reduce the source size, the number of LEDs, the power input, and the amount of heat generated, as well as to increase the light output for a given source size. This paves the way for improved lighting performance (including color quality, beam control, glare reduction, and lifetime), lowered costs, and the addition of new services through integration of controls and intelligence.
- **Lower initial costs:** LED lighting products have the lowest lifecycle costs in most applications, but their initial costs are still higher than those of competing technologies. Continued R&D will make many LED products less expensive than their conventional counterparts on a first-cost basis and give them an even better lifecycle cost value. The key is efficacy, which manufacturers estimate has been responsible for one-third of the cost reductions achieved in LED lighting so far. Decreasing the number of LED packages needed to deliver a given light output reduces the cost of the power supply by enabling lower input power, minimizes the amount of heatsinking needed, and allows for simplification of the optical system.
- **Broad-based scientific and technological advances:** Research into ways to improve LED efficacy has already led to breakthroughs in such areas as materials science, semiconductor physics, quantum dots, and optics and is likely to have significant crossover into still other applications. For example, gallium nitride (GaN) electronic devices, which were an offshoot of efforts related to improving the efficacy of LEDs, are emerging as high-efficiency power converters for large-scale photovoltaic and wind-power-generation facilities and will probably also be used in most hybrid and electric vehicles.
- **Stronger U.S. manufacturing:** Efficacy R&D could improve the competitiveness of U.S. manufacturers, who have focused on producing high-value, high-brightness LEDs. The lower-cost, mid-power LEDs produced by Asian manufacturers suffer more from efficiency droop at higher current densities and thus require more LEDs to achieve typical lighting levels than do high-brightness LEDs. R&D to mitigate droop would enable high-brightness LED packages to run at even higher flux levels, reducing their cost per lumen and altering the cost-performance tradeoffs between high- and mid-power LEDs.
- **Huge energy savings:** Without a concerted effort to boost efficacy, market pressures would likely halt performance gains for decades. But if the DOE's LED efficacy targets of 250 lm/W for devices and 200 lm/W for luminaires are reached, the country will achieve annual savings of 5.1 quads of primary energy by 2035, yielding an astounding $50 billion in annual cost savings in today's dollars.

Realizing the full energy-savings potential of LED lighting will require not just a continued focus on efficacy but also an emphasis on high-quality, cost-competitive products that gain wide market acceptance. The marketplace has embraced LED lighting products for applications where they offer performance and long-term cost advantages over conventional technologies.

But the value proposition needs to be made even more compelling, so that—as has been the case with smartphones—early adopters will want to upgrade to products that have enhanced performance. Making LEDs more efficacious will provide the headroom for manufacturers to do just that.

[1] www.energy.gov/eere/ssl/downloads/led-efficacy-what-america-stands-gain

Washington Watch: What Lies Ahead

Kyle Pitsor, Vice President, Government Relations, NEMA

With the inauguration of Donald J. Trump as the 45th President of the United States last month, the new administration and a Republican-controlled Congress began work on a number of key issues relevant to the electroindustry. Tax reform, repeal of the Patient Protection and Affordable Care Act (ACA), and infrastructure investment are three priorities that the White House and Congress are taking up in 2017.

REPEAL OF THE AFFORDABLE CARE ACT

Immediately upon convening in January, the 115th Congress moved to repeal ACA through budget reconciliation, a process by which certain budget and tax measures can be expedited. Since reconciliation bills are not subject to filibuster in the Senate, repeal of the ACA can pass with a simple majority vote in both chambers. Final action is expected before March. A replacement for the ACA is in development for congressional approval later in the year.

Concurrent with ACA repeal is pending legislation to repeal the medical device excise tax of 2.3 percent, which was enacted as part of the ACA in 2010. NEMA supports full repeal of the medical device tax.

TAX REFORM

President Trump and congressional Republicans, led by Speaker of the House Paul Ryan (R-WI), have championed the simplification of the U.S. tax code through comprehensive reform. Last year, Speaker Ryan released a tax reform blueprint, which is serving as a basis for discussion. Tax reform—similar to repeal of the ACA—is likely to be passed using by means of a budget resolution.

Key themes of the GOP plan include reducing the statutory corporate rate from 35 to 20 percent; providing for immediate expensing of investments (both tangible and intangible); preserving the last-in, first-out (LIFO) method of accounting; providing a research and development tax credit; eliminating various deductions and credits (in favor of the 20 percent tax rate); moving to a territorial tax system like other developed countries; and moving to a cash-flow tax approach for businesses, which reflects a consumption-based tax providing for border adjustments that exempt exports and tax imports. Some observers expect action by the August recess.

NEMA supports tax reform that encourages work, investment, research and development, and job creation.

INFRASTRUCTURE INVESTMENT

An oft-repeated campaign promise of President Trump was to "transform America's crumbling infrastructure" through a $1 trillion program that "supports investments in transportation, clean water, a modern and reliable electricity grid, telecommunications, security infrastructure, and other pressing domestic infrastructure needs."[1]

Details of what an infrastructure package might include or how it would be funded are still emerging. The Trump campaign website listed the use of tax credits to spur private investments in infrastructure as an option. Using revenues from tax reform (e.g., a tax on repatriated foreign earnings of U.S. companies) to fund infrastructure investment has been floated as a potential option since at least 2014; however, any use of tax revenue for purposes other than lowering the overall tax rate will face opposition.

NEMA members can access Washington Watch, providing up-to-date information about policy issues, as well as biographies and key information on select cabinet members, through the NEMA portal at www.nema.org/washingtonwatch.

Congressional leaders expect the Trump administration to spell out the shape, scope, and funding sources for infrastructure investment. The American Society of Civil Engineers estimated in 2016 that $3.3 trillion in infrastructure investment is needed through 2025, including $2 trillion in surface transportation, over $900 billion for electricity generation, transmission, and distribution, $157 billion for airports, $150 billion for water and wastewater, and $37 billion for inland waterways and ports.

Visit www.nema.org/policy to learn more about NEMA's priorities.

[1] https://www.donaldjtrump.com/policies/an-americas-infrastructure-first-plan

MITA Eyes 2017 as Pivotal for Medical Imaging

Joe Robinson, Senior Vice President of Health Systems Solutions, Philips Healthcare, and Chairman, MITA Board of Directors

The Medical Imaging & Technology Alliance (MITA) is well-positioned to lead efforts that will leave a positive and lasting impact on the medical imaging technology industry. MITA's 2017 strategic priorities reflect these opportunities:

PERMANENTLY REPEAL MEDICAL DEVICE TAX

The medical device tax imposes a $29 billion excise tax on companies producing innovative medical devices crucial to effective and efficient patient healthcare. This tax stifles innovation through research and development and costs thousands of jobs. MITA supports permanent repeal through legislation and will continue to support policies to invest in innovation and create jobs.

ADOPT UNIFORM STANDARDS FOR MEDICAL IMAGING SERVICE PROVIDERS

In January, Joe Robinson met with Congresswoman Suzan DelBene (D-WA), a proponent of repealing the medical device tax. Photo by Andy Dhokai

Surprisingly, only medical device service activities performed by medical device manufacturers are regulated by the Food and Drug Administration (FDA). Non-manufacturer service activities do not have the same oversight and are not held to the same quality, safety, and regulatory requirements. This has resulted in serious patient safety and device performance issues. MITA pursues opportunities to standardize best practices and urges the FDA to apply existing servicing standards to all providers who service medical devices.

ENSURE PATIENT ACCESS TO MEDICAL IMAGING

Ultrasound, computed tomography (CT), magnetic resonance imaging (MRI), positron emission tomography (PET), positron emission tomography/computerized tomography (PET/CT), and single photon emission computed tomography (SPECT) are invaluable technologies used in cancer screening, diagnosis, staging, surveillance, and therapy monitoring. Reimbursement for these services has come under intense pressure. MITA seeks to work with public and private payers for broad coverage and reimbursement to ensure that patients get access to the right scan at the right time.

PROMOTE CYBERSECURITY FOR MEDICAL IMAGING

Medical imaging devices are subject to increased threats to software, hardware, and data security. As devices become increasingly connected to networks, security risks move beyond the system to intrusions across digital networks. Advancing cybersecurity measures within healthcare relies on a whole community approach, requiring manufacturers, installers, service staff, and healthcare providers to accept shared ownership and responsibility. MITA seeks to foster collaboration with all stakeholders through best practices and standards development such that current and emerging threats can be appropriately addressed across the life cycle of imaging devices—from design to installation through end of life.

DEVELOP STANDARDS THAT ENSURE PATIENT SAFETY AND TIMELY ACCESS TO MARKET

Standards ensure the safety of patients and equipment operators, as well as efficient and timely market access for products. MITA continues to be the "gold standard" in standards development for the medical imaging industry. MITA will pursue opportunities to promote standards that improve patient safety and play a vital part in the design, production, and distribution of products destined for both national and international commerce.

IMPROVE THE REGULATORY ENVIRONMENT TO PROMOTE GROWTH AND INNOVATION

Because all MITA member products are either approved or cleared by the FDA, it is important to engage with FDA officials and provide constructive feedback on regulatory proposals. MITA's goal is to support a fair and equitable regulatory environment that ensures growth and innovation in medical imaging.

REMOVE BARRIERS AND REDUCE COSTS IN OVERSEAS MARKETS

MITA members are global in scope, and their products are highly regulated at each stage of the product lifecycle. This makes engagement in global activities critical for success. MITA works with high-level U.S. government officials to obtain favorable trade policy and international agreements; takes a leadership role in the Global Diagnostic Imaging, Healthcare ICT, and Radiation Therapy Trade Association (DITTA) to tackle global regulatory issues; and showcases the value of medical imaging to the non-government organization community.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Ceiling lighting using downlight and LED RGB color

Jes Munk Hansen, CEO, LEDVANCE, formerly known as OSRAM SYLVANIA

Mr. Hansen is a member of the NEMA Board of Governors.

Technological and business innovations are transforming what lighting can do, as well as the industry that delivers it. The primary change agent is solid-state lighting, notably the white-light properties of the light-emitting diode (LED).

While still a relatively young technology, LED lighting has already proven superior to conventional light sources in almost every respect. Initially, energy efficiency and long life drove demand. As the technology matures, however, the industry is focused on performance and extended capabilities, including the three dimensions of controllability, communications, and color.

CONTROLLABILITY

The majority of LED products offer dimming as a standard feature or option. The light source itself is easily controllable, with smooth dimming available across a potentially wide dimming range. Frequent dimming may even extend product life. Further, LEDs are instant-on devices. Frequent switching has a negligible effect on service life, making them ideally suited to occupancy-sensing control.

These capabilities extend dimming across general lighting, enabling more cost-effective implementation of strategies such as daylight response, occupancy sensing, and task tuning. For example, an outdoor parking area luminaire could be dimmed automatically at a certain time after business hours, with light levels raised and lowered after that point using an occupancy sensor. Indoors, occupancy sensors could be designed with much shorter time delays than would be cost-effective with fluorescent. Occupancy sensors in an open office could dim to a lower level or turn off to avoid the visual disruption of lights switching. LEDs are well suited to a much deeper level of control, which in turn extends energy cost savings and flexibility.

One of the most exciting aspects of LED control is the adoption of networked intelligent lighting control. As digital devices, LEDs are inherently compatible with digital control. Controllers can be assigned a unique address within a lighting network. This allows for the programming of lighting system behavior globally, in groups, or at the individual luminaire level. Because the miniaturization of controllers and sensors allows for their installation within each luminaire instead of remotely, manufacturers may offer light sources and control packages that are easy to install and come out of the box energy-code compliant.

The rapid development of wireless communication enables control signal communications in buildings and outdoor installations where luminaires are spaced at a significant distance apart. With intelligent lighting, system operators can program and manage their lighting systems to optimize performance, energy savings, maintenance, and information.

COMMUNICATION

Networked digital wired and wireless communication is typically two-way, enabling operators to talk to devices, devices to talk to each other, and devices to talk back. Measuring and monitoring capabilities offer intriguing application possibilities for energy analysis and maintenance. For example, with a roadway lighting system, operators could identify failures instantly from a remote location, improving service and maintenance efficiency.

A related capability is the notion of using LEDs as infrastructure for delivery of additional sensors, forming an Industrial Internet of Things (IIoT)

strategy. For example, sensors connected to an outdoor LED luminaire could measure relative humidity, temperature, air quality, smoke, radiation, and noises such as gunshots. While the IIoT is still developing, its potential is transformative.

COLOR

The controllability and diminutive size of LEDs allows them to be separately controlled, which enables color output tuning, including full-color tuning to produce virtually any color, premium dimming operation to imitate the very warm light of incandescent dimming, and tunable-white lighting.

This emerging capability is opening new applications. Designers can realize an ideal appearance for a space or objects, mimic the color of traditional sources, or create entirely new sources. They can use light to communicate and create dynamic and attention-grabbing displays and environments. They can calibrate color quality across luminaires, blend electric lighting with daylighting, and adjust color output to support changing space uses, displays, and finishes. Color tuning is also expected to play a role in circadian lighting, in which light level and color output are controlled to support circadian health.

These exciting features of controllability, communication, and color will be delivered—thanks to LEDs—in sleek and novel ways that meet the needs of future applications.

Managing Change and Challenges

LED lighting, intelligent control, and network communication optimize familiar applications while creating new ones that were previously impractical. For lighting owners, these trends offer incredible ways to use lighting as an asset. For the electrical industry, however, they challenge business as usual by introducing a much stronger element of risk.

Designers, installers, and distributors must educate themselves about new technology while vetting new products. Everything is becoming more complex, from lighting and controls to metrics and energy codes. New issues are being introduced to lighting, such as network security and integration with IT. Shorter product cycles, lack of standards, variable and uncertain product quality, and the entrance of many new suppliers are all adding risk.

To address this risk, practitioners are encouraged to stay informed, vet new products, and choose their partners carefully. Being informed means staying on top of the enormous number of new products introduced and removed each year; gaining and vetting samples to confirm quality prior to commitment; and keeping abreast of new metrics, energy codes, control capabilities, and changes in best practices. Education is key to remaining competitive.

As new manufacturers enter the industry, they contribute not only innovation and competition but also more risk. Companies that did not exist only a few years ago are offering products supported by long warranties. A large volume of products introduced each year still show a marked variation in quality. Compressed product cycles and the lack of standards means that if a product or supplier fails, it is difficult to replace. Practitioners should research manufacturers with whom they want to do business and vet their products and sales claims, while ensuring that they provide strong training, customer service, and support.

Lighting manufacturers have their own share of challenges with product cycles shortening from years to months. They are taking a more collaborative approach with quality, R&D, and product development teams working simultaneously on projects, and with even more collaboration across regions. Today's successful manufacturers foster cultures of efficiency, innovation, and agility to address the unique opportunities and threats of the LED era. Lighting has become a fast-moving technology that has more in common with mobile phones than traditional lighting.

Supply chains must efficiently deliver more products that will be available for a shorter period. No longer can manufacturers effectively plan five to 10 years out. Successful manufacturers will continually develop relevant competencies and maintain flexibility in processes and people to be ready for anything. They will not only look forward; using acute peripheral vision they will discover opportunities and threats in areas outside lighting. The traditional model of vertical integration to serve a specific market is eroding into a more transparent, open-source model with innovation fueled by collaboration and people accustomed to change and bringing outside knowledge into the industry. The value chain is expanding into other areas such as software, analytics, and security.

The LED revolution offers dramatic potential for buildings and spaces while creating new opportunities and challenges for the electrical industry. The most successful players will embrace a culture of agility to thrive in the LED era.

Daylight Management

Opens the Window to Comfort and Energy Efficiency

Daylight management is an emerging term referring to strategies and technologies for controlling daylight penetration in interior spaces through windows, clerestories, skylights, tubular daylighting devices, and building core sun-lighting systems to maximize daylight benefits. This article presents key performance aspects affected by daylight penetration in interior spaces, along with strategies and technologies used to effectively manage its dispersion to address the daily and seasonal changes in outdoor and indoor conditions.

Daylight Benefits

The daily and seasonal variation of solar radiation has shaped life on earth over millions of years. Our vision and circadian rhythms have been shaped by the variations of the spectral power distribution and intensity of daylight. As we increasingly spend more time indoors during daytime, it is important to bring daylight indoors to satisfy significant psychological and biological needs.

The most important psychological benefit of daylight penetration in interior spaces is the information it provides about outdoor conditions, such as the

The CLTC Daylight Harvesting Optimization laboratory showing the interior façade and the installation of the electrochromic glazings and the openable window with the roll-down shade, the venting skylight with the solar shade, and the HVAC system. The vertical façade and the skylight are illuminated with controllable electric lighting that is used to simulate daylight changes, such as sunrises, sunsets, partly cloudy skies and uneven distribution of daylight on the façade that can be caused by outdoor obstructions. Photo courtesy of the CLTC

time of the day, weather conditions, and the state of our surrounding world. Windows provide the most informative view and thus the greatest psychological benefits. Clerestories and skylights also provide some connection to the outdoors, especially when they provide view of the sky. Tubular daylighting devices and building core sun-lighting systems, which are designed to transfer daylight and sunlight deep into building core spaces, do not provide view but still provide some information about time of day and weather conditions.

The most important biological benefits of daylight penetration in interior spaces are related to vision and circadian rhythms. Daylight is an excellent source of illumination for visual activities and has been a common standard for the evaluation of color rendering fidelity of electric lighting sources. The circadian benefits were discovered about fifteen years ago, through the realization of the function of certain ganglion cells in the retina, referred to as ipRGCs (intrinsically photosensitive retinal ganglion cells). With peak sensitivity in the blue part of the visible spectrum, ipRGCs send messages to our brains that adjust our biological clock to maintain healthy circadian rhythms, i.e., excretion of hormones that strongly affect our sleep-wake patterns, body temperature, metabolic activity, alertness, etc., all of which are critical for health and wellbeing.

Konstantinos Papamichael, PhD, Professor, Department of Design and Co-Director, California Lighting Technology Center, University of California, Davis

Dr. Papamichael chairs the Daylighting Committee of the Illuminating Engineering Society of North America (IESNA).

A third important benefit of daylight is its potential contribution to sustainability through energy efficiency. Using daylight to satisfy interior illumination needs reduces electric lighting loads. The term "daylight harvesting" initially referred to the practice of saving electric lighting energy in commercial spaces by adjusting the output of electric lighting systems based on interior daylight levels. Various strategies and technologies have emerged over the past several decades, continually improving reliability in determining interior daylight levels through use of photo sensors. Moreover, controlling electric lighting through switching and dimming has now been mostly resolved with solid-state lighting. Traditionally, daylight management at the window level is provided mostly for luminous comfort, view and privacy, through use of window attachments such as Venetian blinds, vertical louvers, roll down shades, and screens, controlled manually by occupants.

Daylight Challenges & Opportunities

While daylight offers significant benefits, it can also produce uncomfortable conditions. Direct solar exposure can produce discomfort through glare and heat, especially during the cooling season. Unless the sun paths to the window are blocked by external obstructions, such as trees or other buildings, most window orientations require some form of static or dynamic glazing or window attachment to control direct solar penetration.

Space occupants are very good in manually operating dynamic daylighting systems for view, privacy, and glare. However, most fall short in operating for energy efficiency, as studies have shown that most people respond to nuisances, especially from direct solar penetration, but not to opportunities, such as reducing energy requirements.

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Continued from page 13

Operation of dynamic daylighting systems for energy efficiency is also required when there are no occupants in the space. Manually adjusted systems are often left in "shading" mode, resulting in reduced interior daylight levels and missed opportunities to save electric lighting energy. The benefits of daylight harvesting can only be realized through automated operation of dynamic daylighting systems and prioritizing among multiple performance aspects, such as comfort and energy efficiency.

Automated performance of dynamic glazings and window attachments can maximize opportunities to reduce electric lighting based on available daylight, while eliminating or reducing glare from direct solar penetration. Moreover, automatic operation can expand energy savings beyond electric lighting, by operating the dynamic daylighting systems in ways that reduce HVAC loads for heating, cooling, and ventilation, especially when spaces are vacant.

Some of the work presented in this article is supported by Southern California Edison, the California Energy Commission, and the University of California, Davis. It is also supported through in-kind contributions by several manufacturing partners, including Finelite, Winco, WattStopper, Velux, and Sage Glass.

Some static daylighting systems can satisfy specific performance aspects for specific applications, such as preventing glare from direct sun penetration by blocking targeted directions of incoming solar radiation or dramatically reducing daylight penetration through use of low-transmittance glazings, which supports view but eliminates most other daylight benefits. While such static systems certainly manage daylight penetration, daylight management refers mostly to automated operation of dynamic daylighting systems, aiming at optimizing multiple performance aspects under varying indoor and outdoor conditions.

Strategies & Technologies

Today's glazing and window attachment strategies and technologies offer a wide range of options for balancing the often-competing performance aspects affected by daylighting.

One of the most promising strategies for addressing competing needs for comfort and illumination is to split windows horizontally into two sections, which are treated differently in terms of glazing and window attachments. The lower section, e.g., below 7 feet, is focused on view (view window), and the upper section, e.g., above 7 feet, is focused on providing daylight for illumination purposes (daylight window).

Daylight management through automated operation of dynamic glazings and window attachments requires process controllers that continuously receive and process input about outdoor and indoor conditions and send commands to actuators that adjust the dynamic window components for visible and solar transmittance to maximize multiple performance aspects, such as comfort and energy efficiency.

Many high-performance buildings use automated daylighting systems, often implemented as double facades for buildings with curtain walls, with excellent performance in terms of providing comfort and energy savings, extending beyond direct daylight benefits to include natural cooling and ventilation. This practice, however, is not spread in ordinary buildings, mainly

due to economic constraints. The technologies to implement the required integrated automation are available today and as the cost of related processors, sensors, and communications decreases, it is a matter of time before automated daylight management becomes common practice.

Daylight Management R&D

Most of today's R&D efforts in daylight management are focused strategies and technologies to improve on three main challenges:

- Reliability of sensing indoor and outdoor conditions (e.g., occupancy and light levels)
- Algorithms that process outdoor and indoor conditions to determine the desired state of dynamic daylighting systems
- Integration of automatic operation with manual operation by occupants, which is most important for acceptance of automated operation

The California Lighting Technology Center (CLTC) has developed a unique experimental laboratory that includes an internal vertical facade and one skylight, both illuminated by electric lighting that simulates daylight changes, such as sunrises, sunsets, partly cloudy skies, and facades of the same space that are partially blocked by external obstructions, resulting in uneven distribution of indoor daylight levels. The CLTC laboratory also includes dimmable light-emitting diode (LED) lighting, a dedicated HVAC system, and sensors for occupancy, indoor, and outdoor light levels. Current work is focused on the development of control algorithms to automatically operate the electric lighting and HVAC along with several dynamic daylighting systems, including an operable venting skylight with operable solar shade, a window with two electrochromic panels that can be operated separately, and an openable window with an operable perforated shade.

The development of the integrated control algorithms is based on a simple control strategy that shifts priorities between comfort and energy efficiency based on occupancy. When the space is occupied, all systems (daylighting, electric lighting, and HVAC) are adjusted for comfort. When the space is unoccupied, all systems are adjusted for energy efficiency. Daylight management is based on occupancy, the state of the electric lighting and HVAC systems, and the potential for daylight glare, determined through photo sensors measuring incident radiation on the facade and the skylight.

During vacancy, the electric lighting is off, and the daylighting system is adjusted to either minimize solar heat gain during cooling periods or maximize solar heat gain during heating periods. During occupancy, the daylighting system is adjusted based on the state of the electric lighting and the potential for daylight glare. Daylight penetration is increased if there is no potential for glare, until the electric lighting is reduced to a minimum or turned off. Daylight penetration is then adjusted based on the status of the HVAC system and the potential for glare. If the HVAC system is in cooling mode, then the daylighting system is adjusted to maintain the same interior light levels at which the electric lighting reached its minimum or was turned off. If the HVAC system is in heating mode, then the daylighting penetration is increased if there is no potential for glare.

Conclusion

Automated daylight management is key to realizing daylight benefits by maximizing comfort and energy efficiency. Today's commercial technologies can certainly meet the needs of the required integration of daylighting, electric lighting, and HAVC controls, which can be brought together through appropriate communications and control algorithms. The ultimate vision for the future is the development of smart luminaires, windows, and skylights, which carry their own sensors to sense various environmental conditions—such as occupancy, light levels, temperature, and humidity—and communicate with each other and the electric lighting and HVAC systems for effective individual operation.

What the industry is saying: **Lighting for Health**

An experiment is underway to regulate the circadian rhythms on astronauts on the International Space Station (ISS) with light. Since the cycle of sunlight and darkness occurs every hour on the ISS, it is difficult to use daylight light for regulation of melatonin. A team of researchers have developed a dynamic spectrum lighting system that changes the color of light to help the astronauts fall sleep in their sleeping compartments. Instead of using medications to go to sleep, light that is void of short wavelengths is used.

National Academies of Sciences, Engineering, and Medicine. 2016. *Assessment of Advanced Solid-State Lighting, Phase 2*. Washington, DC: The National Academies Press. doi: 10.17226/24619

CASE **STUDY**

LIGHTING DESIGN REFLECTS

Unique Culture of State-of-the-Art San Francisco Office

In designing the interior of its new San Francisco office, Perkins+Will, a global leader in architecture and design, did not get every single item on its wish list. As so often happens, external factors tamed early expectations.

You would never know that when touring the office today. A visitor is easily wowed by the gracious, sunlit space, with its open plan, high-performance features, and striking views of the San Francisco Bay. One key to the space's success, and to the wellbeing of its employees, is an impressive, interoperable lighting system.

Photos courtesy of Acuity Brands

Solutions for Wide Open Spaces

In seeking to demonstrate its commitment to environmental stewardship while also creating a corporate showplace for clients, the internationally renowned firm selected a 21,000-square-foot space at 2 Bryant on the Embarcadero—prime real estate just beneath the Bay Bridge.

Open floor plans are hot in corporate environments, and Perkins+Will's office shows why. Still, while open space is alluring, it represents a challenge for lighting designers. With few physical features to delineate workspaces, light fixtures must help define each area, highlight task areas, and direct traffic, all while being unobtrusive and easily managed.

Larry French, MIES, LC, FIALD, of Auerbach Glasow French, has been in the lighting design business for more than 30 years. He was able to provide lighting solutions for Perkins+Will in collaboration with sales agents at sixteen5hundred, a representative for architectural, commercial, institutional, industrial, and residential lighting and lighting controls manufacturers.

Mr. French required fixtures with integrated controls that were beautiful; easy to map, install, and use; and, particularly crucial in California, energy-efficient. He specified a mix of LED luminaires and controls from Acuity Brands.

"We proposed fixtures to meet the design intent of the project team," said Heather Mabley, a controls specialist at sixteen5hundred.

Integrated LED Versatility

In planning for open space, lighting designers consider the contribution of daylight and balancing low-energy solutions with uniformity of artificial light across the space. The best plans apply controls for lighting in zones, allowing for flexibility when office space needs to be reconfigured. The use of sensors allows electric lighting to respond to stimuli such as natural light levels and occupancy.

The design laid out four primary areas for deploying the fixtures: an open office where the designers work; meeting spaces; a high-profile entry lobby; and several back-of-house rooms for copy, mail, supply, and storage.

The office has immense windows overlooking the water creating enormous daylight potential, yet it still required a high number of fixtures, making price and flexibility especially important. A crucial decision was whether to use LED lighting.

"Until very recently, LED products did not do all they were touted to do," Mr. French explained. "Companies would cram the light source into existing fixtures. It's been challenging to find product that really does work universally and does a better job than its predecessor. It's the wild, wild West out there."

Ultimately, the design team chose high-performing LED luminaires, with an integrated digital lighting control system that uses time, daylight, sensors, and manual input for maximum flexibility. When the California sun is shining and the shades are up, the lights dim or turn off completely. When the San Francisco fog rolls in, lighting turns up. The LED fixtures feature drivers that fully dim with no flicker.

> Good design has the ability to disappear.

The suspended and wall luminaires produce comfortable, glare-free illumination with built-in controls that allow for good output variation. They throw the light wide and far, allowing designers to space the fixtures out without jeopardizing uniformity. At the core of the office, the fixtures had to stretch through three programming and zoning areas—including across partitions set for breakout meetings—yet still function as a single unit. Controls help delineate the spaces and determine lighting across zones.

The lobby features recessed downlights. The third-floor reception area, a focal point of the office, combines LEDs and a unique pendant. Storage areas were treated with brushed-aluminum pendants and ceiling-mounted LED luminaires, as well as edge-lit exit signs with LED lamps for emergency.

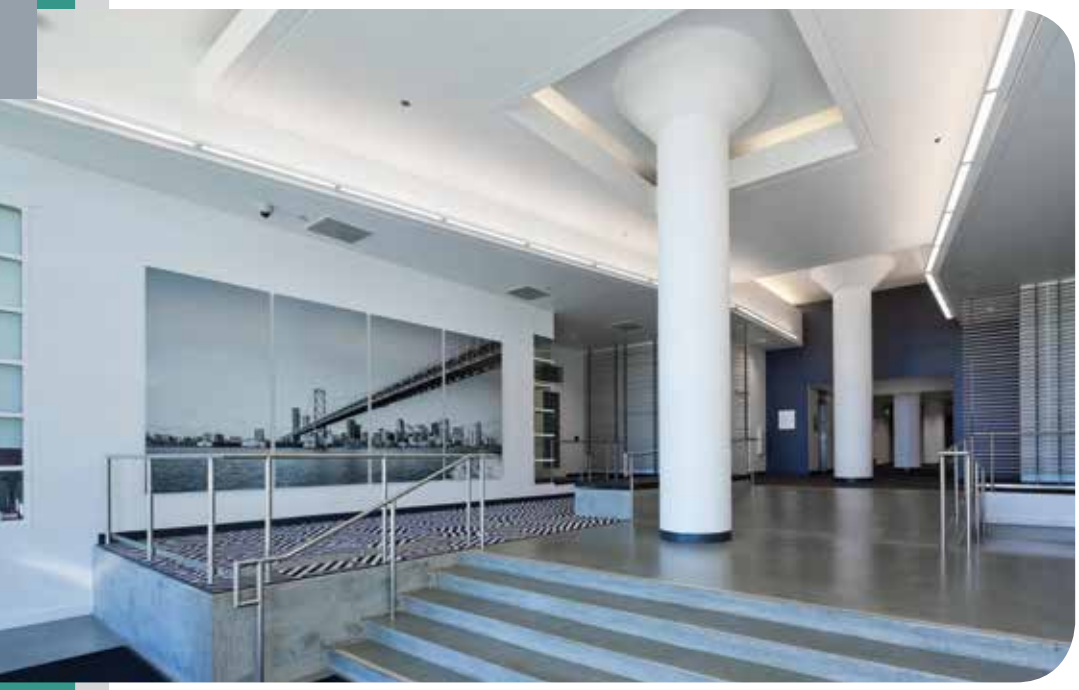
Making an Impression

Drake Hawthorne and Reinhardt Muir of Perkins+Will say the Acuity fixtures and systems are meeting high expectations. "The lighting is amazing. We are very impressed with the occupancy and daylighting system," said Muir.

Perkins+Will's staff give clients tours through the office regularly and the lighting is part of the narrative. For staff members, the new space's clean look came with some variability that presented an adjustment period—some lights are on, some are off, and some are dimmed.

"If I stop by on a Saturday night and I walk to my desk, it's like a movie—the lights turn on rapid-fire.

Continued on page 18



Continued from page 17

Or, if you pull down a shade, the light at the window turns on gradually," said Mr. Hawthorne. "The beauty is that the lighting doesn't bring attention to itself. Good design has the ability to disappear."

Since the original move-in, the firm has already reshuffled the office floorplan. "We were able to readjust everything without having to interrupt the lighting. This lighting is very uniform, and not having to change it was quite a benefit," said Mr. Muir.

Going Green and Fast

In the Golden State, Title 24, which governs construction, can create challenges for commercial builders. Regulations limit watts per square foot of energy consumption and require a minimum lumen output per watt. The code also requires commercial buildings to use lighting with dimming capability and photocell control. Builders who choose to add dimming ballasts to existing fluorescent fixtures do not reap all of the benefits of LED.

"LEDs are meant to be systems, not components, which provide durable, energy-efficient lighting without flicker or glare. If they are not designed as a system, buyers beware," said Mr. French.

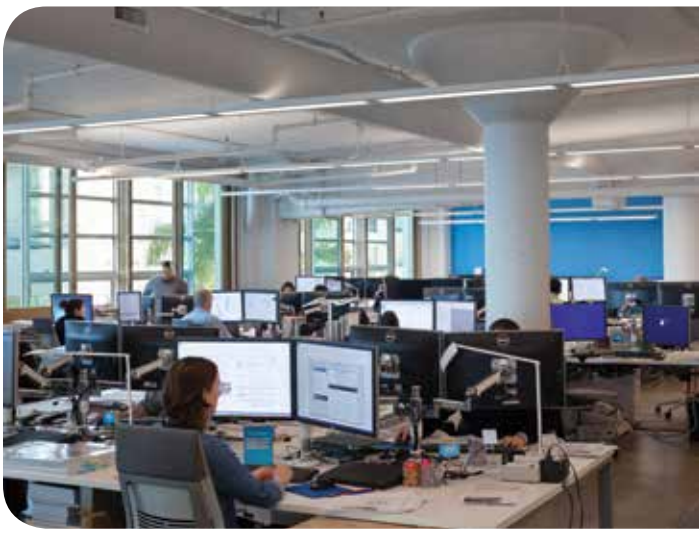
Perkins+Will was running a tight schedule. Mr. French said, "We often tell clients a minimum of 12 weeks. I think this project came in at about six weeks. It was fast and all pretty cutting-edge."

The complete system of lighting and controls is helping Perkins+Will achieve LEED Platinum certification for the space. "Perkins+Will wanted to be as far into the future as they could be. We were fortunate to be partnered with Acuity for that extra support," said Ms. Mabley.

Acuity fixtures and systems work together properly, optimizing for the LED source in uniformity and interoperability. Light monitors patterns of use and occupancy, providing meaningful green value through energy savings and user configurability.

Hitting the Mark

As workers and visitors would affirm, 2 Bryant represents another win for Perkins+Will. Its flexible, beautiful, and energy-efficient lighting system is a model for next-generation workplaces.



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CASE **STUDY**

Illuminating Symbolism

at the Lincoln Square Synagogue

Sohana Arni, LC, Marketing Manager, Architectural Products Group, Eaton's Lighting Division

The Jewish faith emphasizes symbolism in architecture, and the Lincoln Square Synagogue in New York, New York, honors Jewish history and tradition.

Needing a larger synagogue and expanded facilities, the synagogue called on Tillotson Design Associates and Eaton's Lighting Division to amplify the architectural vision with lighting design. With a focus on illuminating the elements and materials that made the building project special, Ellen Sears, principal designer for Tillotson Design Associates, ensured that the lighting was integral to the overall design.

Every architectural element in the building is inspired by the Jewish faith. The front wall design of the glass façade, divided into five undulating glass ribbons, represents a Torah Scroll. The light comes from within the Torah as a guiding symbolic reference; as such, the illumination of the entire façade alludes to this reference. Linear LEDs incorporated into the bottom and top of each glass facet illuminate a sheer, bronze-colored, fabric interlayer, as well as a white translucent pattern on the interior. During the day, the fabric layer sparkles in the sun; at night, the translucent pattern and lighting help create a soft glow.

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© Emile Dubuisson, Studio Dubuisson

choose the right product and figure out much of the wiring for the project.

Together, the design team helped create a striking space at the Lincoln Square Synagogue, which has been embraced by the community. Tillotson Design Associates has received several awards for the project, including the 2016 International Association of Lighting Designers Radiance Award, 2016 Illumination Engineering Society (IES) Illumination Award of Merit, 2016 IESNYC Lumen Award of Excellence, and the 2015 Architectural Lighting Outstanding Achievement Award.

Inside, the sanctuary's 613 1¾-inch diameter recessed LED downlights, set in a moderate convex ceiling with brilliant acoustical properties, equal the number of commandments in the Torah and are meant to symbolize the stars in the desert sky. To maintain the star symbolism, the downlights needed to be small, but designers that they wouldn't give off enough light. Fortunately, LED technology advanced so rapidly after the project started in 2007 that in the end, the team was extremely confident about the light levels in the sanctuary. These lights were also positioned using a formula to show that God's plan is always at work, even if it is not always visible. Finally, the ceiling had to be plastered due to the synagogue's acoustical system, creating a need for small flanges and access to the drivers through the actual fixtures. The interior walls have soft lighting that emphasizes the angled facets of the acoustical wall panels, creating a tent-like feeling. The sanctuary's "in-the-round" seating also represents the nomadic history of the early Jewish people.

The Lincoln Square Synagogue marked one of Tillotson Design Associates' first projects that called for the illumination of an entire façade with LED fixtures, and the interior design was multifaceted as well. In total, the design called for about 500 individual fixtures, each of which was about 12 inches long, and 50 remote drivers. The design team needed a product that could handle the design's complexity yet create something beautiful, and turned to the team at Eaton to help

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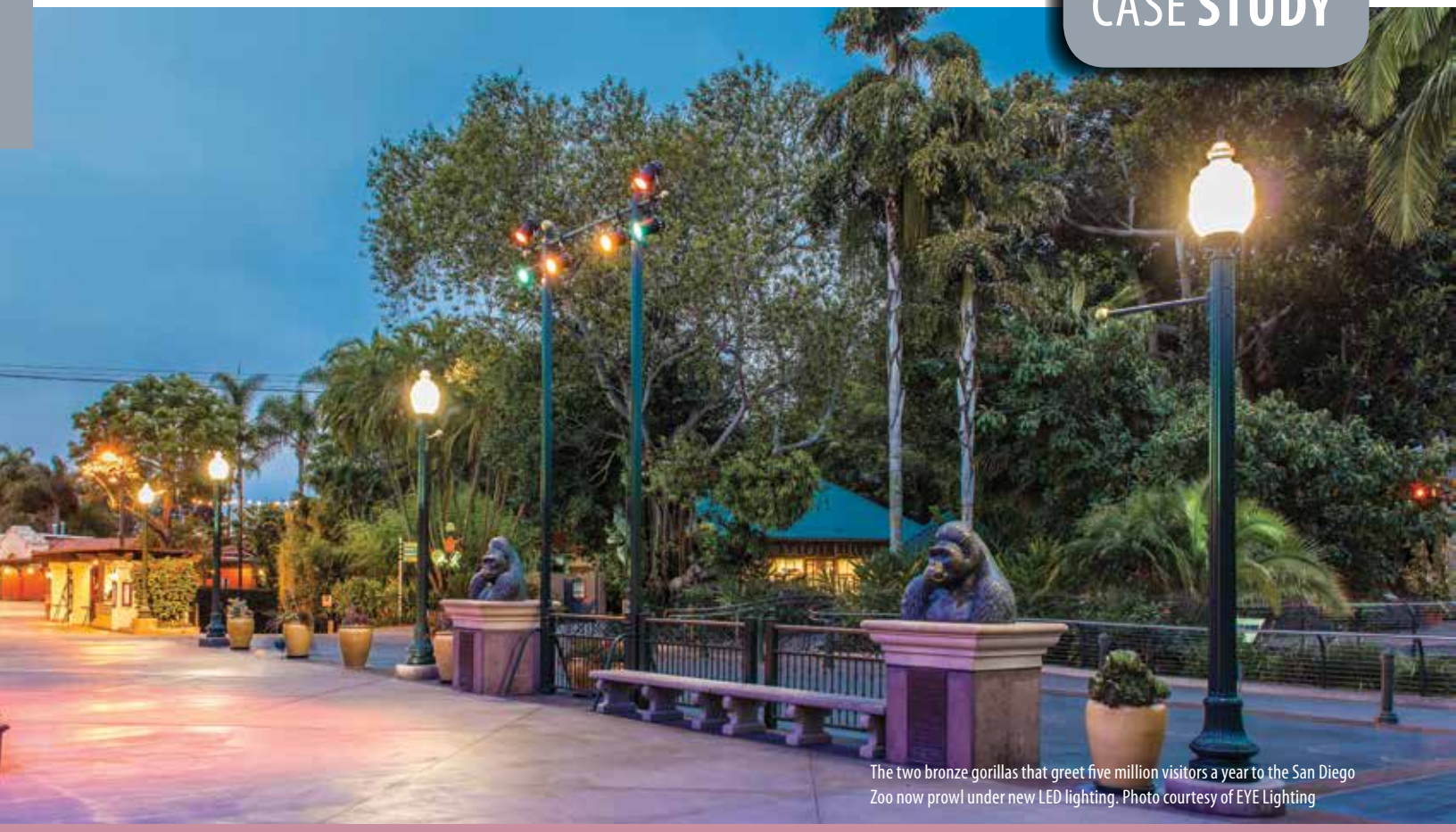
CASE STUDY



The two bronze gorillas that greet five million visitors a year to the San Diego Zoo now prowl under new LED lighting. Photo courtesy of EYE Lighting

A Zoo and a College Campus: Different Venues, Same Outdoor Lighting Goals

Two Institutions Reduce Energy Use by 85% with LED Retrofits

Tom Salpietra, President and COO, EYE Lighting International

Mr. Salpietra serves on the NEMA Lighting Division Board, and is a member of the Industry Advisory Committee of the Design Lights Consortium.

Sleek, modern designs, as well as historically-styled outdoor lighting fixtures have been growing in popularity over the last few decades as cities, municipalities, and educational institutions make significant investments in lighting infrastructure, especially outdoor applications. These investments squared off with the light-emitting diode (LED) revolution as it became clear that reductions in energy and maintenance costs could be achieved, while improvements were made to the quality of the lighting from old sources such as sodium and metal halide. Customers began to demand that lighting retrofits be aesthetically pleasing, fit the architectural design of the area, and provide safety and security while reducing energy consumption.

Budgets for capital equipment or expenses, however, weren't generous enough to warrant a complete change-out of lighting poles and fixtures. This was an engineering challenge because initially LED light sources could not be screwed into existing light sockets. But leading manufacturers stepped up to the challenge and provided a solution that worked for almost any post top application.

Here's how two applications by different organizations solved unrelated problems with similar technology. In a world where quality outdoor lighting represents a hard-sought ideal, these customers could not afford a wholesale change-out. In one instance, a world-class institution enhanced its global brand and created a

nighttime environment suitable for families. In the other, a preeminent research university's city campus is now brighter and safer.

San Diego Zoo

For nearly 100 years, two bronze have gorillas adorned the front gates of the San Diego Zoo and greeted five million visitors each year. With guest hours that now extend into the evening, the lighting of the entrance plaza and the two famous simians was an important earmarked project. Edward Newell, head of design and specification for RTM Lighting & Electronics, led the design. Replacing the old 250 watt light sources saved 85 percent in energy."

> "The zoo needed to increase light levels, improve the quality of light, reduce energy use, and lower maintenance costs."

"I saw this project as a classic solid-state lighting upgrade," he said. "The zoo needed to increase light levels, improve the quality of light, reduce energy use, and lower maintenance costs. As it turned out, the existing poles were made by three different manufacturers, so the challenge was to find a single lighting solution that was flexible enough to accommodate the different fixtures, and at the same time deliver consistent quality light."

Kevin Haupt, director of facilities operations for the San Diego Zoo, was pleased with the result.

"Everything under the newly retrofitted poles looks brighter and more vibrant, and we are convinced our guests will enjoy the park even more. As a global leader in conservation and sustainability, the zoo is constantly searching for new ways to reduce our overall resource consumption."

University of Louisville

Three time zones away, the University of Louisville in Kentucky was nearing its final step in upgrading the major thoroughfare leading into the institution. It was part of a campus-wide lighting retrofit, replacing Eastern Parkway's 82 existing 250 watt high-pressure sodium luminaires with energy-saving LED technology. The decision was easy, but the cost to implement was the problem. The poles along the road dotted the landscape nicely, but it was not in the budget to replace them. The university needed a retrofit solution that delivered quality lighting, reduced energy, and could be economically installed by facility maintenance personnel. Several months of searching revealed no product that fit the specification, until the maintenance personnel discovered an LED post top solution.

The primary goal for the Eastern Parkway retrofit was lighting quality. Louisville needed to ensure a superior visual environment for both pedestrian and vehicular traffic. Photo courtesy of EYE Lighting

"A primary goal for the Eastern Parkway retrofit was lighting quality; we needed to ensure a superior visual environment for both pedestrian and vehicular traffic," said Matt Minard, the project leader for Eco Engineering, the university's project partner.

> "Louisville's goal for the Eastern Parkway retrofit was lighting quality; we needed to assure a superior visual environment for both pedestrian and vehicular traffic."

The cost of operating the Eastern Parkway luminaires was reduced by more than 85 percent, with kilowatt hours dropping from more than 100,000 to 12,000 per year. Kilowatt demand went from 23.7 kW to 2.7 kW. The goal of good lighting quality along with security and safety was met.

CASE **STUDY**

Sweat Equity:
Lighting Retrofit Enhances Workouts

Terralux recently completed a retrofit lighting project at MBS CrossFit in Arvada, Colorado, allowing the club members to benefit from pumping iron in a well-lit, internet-connected facility.

Opened in 2008 by CrossFit Games competitor Patrick Burke, MBS expanded its Arvada location at a converted warehouse facility. While members had more room to work out in the new facility, the gym inherited a lighting problem.

Photos courtesy of Terralux

The warehouse had several light fixtures that had stopped functioning and others flickered continually, creating a less-than-desirable atmosphere for intense concentration and hardcore workout sessions. The 175-watt mercury vapor surface mounted luminaires were so outdated that replacement parts to repair the broken lights could not be ordered. Furthermore, MBS wanted to upgrade without creating the unnecessary waste of trashing the fixtures altogether.

Terralux provided an ideal solution with the ability to convert the existing fixtures to more energy-efficient light-emitting diode (LED) lamps. During the retrofit, lamps and ballasts were removed and existing wires were reconnected to the retrofit kit, which was enhanced with technology for wireless lighting configuration and control. In addition, wireless occupancy and daylight sensors were added to provide additional energy savings during vacancy and afternoon sunlight.

While maintenance to replace lamps, ballasts, and sockets on the existing lights previously took one hour per fixture, these kits only took 10 minutes per fixture, and are guaranteed to be maintenance-free for seven years.

"We are happy to be able to enjoy our new facilities with our members minus the flickering and oddly colored lighting that we inherited from the previous occupants," said Mr. Burke. "Not only did we eliminate a time-consuming maintenance task, we are also benefiting from more energy efficient and controllable lighting."

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Opportunities and Challenges in Modern Lighting: *A Designer's Perspective*

David Ghatan, President, CM Kling + Associates Inc.

Mr. Ghatan is a recipient of the Illuminating Engineer Society's Edwin F. Guth Memorial Award for Interior Lighting Design.

The lighting systems market holds opportunities and barriers for designers, as systems integrate and communicate more comprehensively than ever. Without standard protocols and hardware, however, they're hard to understand, specify, and maintain, and they don't always work as intended.

Lighting designers troubleshoot solutions and patchwork communications to achieve desired results. The time required to understand the systems is significant and often beyond the normal scope of a design contract. With increasingly complicated system options, pairing clients with a lighting system that fits their needs and abilities is time-consuming. The design role has changed within the last few years, and firms are stretched to do more on shorter deadlines. While incredible tools are available to designers, the expertise required to work with those tools is considerably greater and more nuanced.

Lighting control systems are more robust, offer a multitude of integration options (e.g., receiving signals from the building management systems), and may use a building's Wi-Fi for a master controller. These systems can provide significant user data feedback on space usage, occupancy settings, and other systems. The difficulty lies in who manages and aggregates the data once it's collected by the systems.

Obstacles include working with systems and protocols that cannot control the lights because of a lack of information or standards. Each project becomes a custom fit. Integrating lighting systems is complicated, with multiple system languages for controls protocols and, separately, the system itself. Once the system is in place, it is challenging to get everything to work the way it has been planned due to complicated programming. Too often, "working" is a moving target, and designers spend valuable time determining realistic expectations.

Even within the lighting system, commissioning systems doesn't always work as planned. Drivers don't always dim consistently across multiple luminaires, even when the specs and wiring are identical; for example, 0–10 V protocols offer stated dimming ranges from 0.1 percent to 30 percent low-end dimming. But it is not always clear what those dimming percentages mean when applied to specific products and whether the dimming system itself can be programmed to handle an analog dimming signal below 1.

Designers address challenges by dedicating time to understanding the systems and working closely with commissioning. An industry standard can help when applied to wiring and compatibility. In other areas of the system, an industry standard would stifle innovation and lead us toward a one-size-fits-all solution. That won't work. There is no one-size-fits-all solution.

Three recently completed projects demonstrate how light-emitting diode (LED) lighting systems work with lighting controls systems to produce dazzling results.

Boston Park Plaza

Boston Park Plaza Lobby, Boston, Massachusetts

Photographer: Colin Miller

Renovations to the Boston Park Plaza incorporate a modern feel into a traditional landmark. Lighting in the lobby and bar shifts throughout the day, from bright morning to dusky evening to moody nighttime. The historic charm feels fresh and new with airy, modern, geometric chandeliers to anchor the high ceilings. The open, luminous bars are a modern take on a historic idea, creating sparkle and grandeur. Two-story curtains in the lobby create intimate spaces and, depending on the time of day, moods.

Original millwork behind the bar was rediscovered during construction. The lighting draws attention to the architectural details, and a custom-made backlit clock pays homage to the original design. The lighting systems in the hotel are preset so that daily transitions happen without any effort from hotel staff. It was important to work with high-quality, low-end dimming drivers to achieve the smooth diming and dramatic transition of the space.

Newport Marriott

Newport Marriott Hotel Bar, Newport, RI

Photographer: Roberto Farren Photography

The waterfront Marriott Hotel in Newport, Rhode Island, has a fresh and modern nautical-themed look, following an ambitious renovation project. The primary focus was finding an efficient lighting system that was powerful yet subtle, to create a dramatic effect and fit with the overall architecture.

The lighting system provides a broad dimming range and a hint of color. In the hotel's atrium—an impressively tall space—cove fixtures are installed in the wave-like undulating niche in the wall. RGBW fixtures (i.e., those with red, green, blue, and white LEDs) are programmed with a variety of presets, including watercolor hues for most days and red and rich amber hues during the sunset hour. Incorporating the color-changing lights into the architecture helped bring the lighting down and create an experience on a human scale.

Lighting plays a key role in the transformation of the space. All the elements come alive after dark, and the magic of the new lighting shines, resulting in a modern elegance, while remaining faithful to the city's seaside character.

Sands Capitol, Custom Chandelier

Sands Capital Offices, Washington, D.C.

Photographer: Eric Laignel

The Washington, D.C., office of Sands Capital features a custom-made chandelier. The designer worked closely with the manufacturer to drape in the stairwell at a height equivalent to four floors. This chandelier required more than 600 diodes with identical output and appearance. Each custom-made LED chip is mounted behind a specially made crystal in the bespoke chandelier. The controls required special DMX interfaces to allow for the proper power and dimming. These added layers of integration, which necessitated the design team, contractor team, and manufacturer to be in sync.

CONNECTING YOUR BRIGHT IDEAS

BOOK 18
COMMUNICATION
MODULE

TE Connectivity (TE) is transforming technology and helping to inspire new designs in LED street lighting systems by enabling connected lighting. These “plug-and-play” lighting solutions allow creative designers to take advantage of increased functionality, modularity and efficiency to design lighting systems that offer faster installation, reduced costs and flexibility. TE works with designers, engineers and manufacturers on connectivity solutions for products used in innovative, efficient and more intelligent buildings.

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TE connectivity

Illustration courtesy of GE Lighting

Intelligent Energy:

How the Industrial Internet is Making Lighting Systems Smart

Joseph Howley, Manager, Industry Relations, Current, powered by GE

Mr. Howley is chairman of the NEMA Light Sources Section, past chairman of the NEMA Lighting Division and a recipient of NEMA's Kite and Key Award.

It wasn't long ago that the Internet of Things (IoT) completely changed the consumer technology landscape. From phones and televisions to appliances and light bulbs, everyday products are suddenly "smart" and helping people complete tasks, find information, and interact more efficiently–accurately and in real time. Now, the same is true for businesses as the Industrial IoT (IIoT) emerges.

The IIoT is benefiting businesses in three ways: energy efficiency, system maintenance, and productivity. Along with sensors and software, the IIoT is transforming energy systems—such as lighting—into a digital infrastructure that provides detailed energy and maintenance analytics, while offering environmental insights, improving employee productivity, and even driving new revenue streams. Smarter energy means smarter business.

Energy Optimization

It's estimated that the average commercial building can improve its energy efficiency by more than 30 percent, and with 5.6 million such buildings in the United States alone, there is a huge savings opportunity. More efficient solutions and controls are becoming more prevalent and improving the way businesses consume energy, but connecting those systems to the IIoT unlocks an entirely new realm of energy management.

New software and hardware tools are transforming the way customers monitor and optimize energy use. By integrating sensors and software, customers can now see exactly when, where, and how their lighting systems are consuming energy across different buildings, even if they are located on different sites.

multiple buildings —sometimes dozens or hundreds— across their enterprises. These new tools offer both a holistic energy view across sites and the details of each, while powerful software enables not only historic but also predictive and prescriptive analytics.

Overall, customers are expected to save up to 20 percent of their monthly energy use by using intelligent management tools. Add this to the immediate savings offered by an LED lighting system upgrade (sometimes up to 50 percent) and lighting controls, and customers are seeing significant monthly cost savings and improving their overall bottom lines.

Business Optimization

By collecting data through sensors and software, intelligent systems harness the power of the IIoT to not only offer invaluable operational insights but also enable new methods of interaction and information. From heat maps that optimize office layouts and mobile coupons based on shoppers' precise locations to analytics for employee optimization, there are huge possibilities for a custom, digital business.

By embracing the IIoT, businesses are finding new and better outcomes through their lighting systems that ensure they stay competitive from both an energy and operational view. Bringing buildings from idle to intelligent, today's lighting systems go beyond illumination.

Energy is a large overhead cost to any business, and customers are looking for holistic, simple ways to manage energy more intelligently. As the lighting industry integrates sensors and software across systems, business operations can transform the way they see and optimize not only their energy use but also their operational productivity.

Increasingly, entities are seeing the benefits of building automation and are seeking out connectivity. The lighting industry is integrating intelligence through infrastructure such as new LED luminaires, and new software applications harness the power of data beyond energy savings. Customers across a variety of commercial building types are realizing the energy-saving potential of intelligent software applications, with pilot installations already underway.

The IIoT is already being used by national customers including McDonald's and Simon Property Group.

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What the industry is saying: Smart Lighting

Smart lighting can deliver traditional illumination and provide new functionality. The Internet of Things, connected lighting, and smart lighting are terms commonly used in the lighting industry today. In the initial period of solid state lighting advancement, light-emitting diode (LED) sources succeeded in saving energy in most lighting applications. Now, with better lighting controls and connectivity to a network, LED lighting is evolving to provide greater value to end users.

To address security concerns and bandwidth limitations of communications systems, communication using visible light is being considered and studied. This is called visual light communication (VLC) and has been given the name Li-Fi (Light Fidelity) by the IEEE standardization committee whose scope covers this technology.

Li-Fi systems are networked two-way data communication systems that use visible light by switching the current to the LEDs on and off at high temporal frequencies, beyond the flicker fusion frequency of the human visual system.

Li-Fi has potential to be very high speed, perhaps as much as 100 times faster than Wi-Fi, with demonstrations claiming to have achieved data transmission rates from 500 mega-bits per second to nine gigabits per second (Gbps), and up to 200 Gbps.

Because communication uses visible light, it is limited to a line-of-sight, meaning that it cannot be used to communicate through walls or other such opaque obstacles. This limits the communication range compared to radio transmission, but has the benefit of not being detectable outside enclosed walls and is not easily subject to eavesdropping.

National Academies of Sciences, Engineering, and Medicine. 2016. *Assessment of Advanced Solid-State Lighting, Phase 2.* Washington, DC: The National Academies Press. doi: *10.17226/24619*

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From lighting to HVAC systems, restaurants, retailers, warehouses, and commercial businesses can use the IIoT to see exactly where and when energy is being used in real time, while powerful software enables thorough analytics.

"At McDonald's, we aspire to deliver exceptional service for both our internal and external customers. We are always interested in technologies that can improve our capabilities and operational KPIs while enhancing the customer experience," said James Floyd, vice president of U.S. operations for McDonald's Corporation.

"New EMS tools provide actionable analytics around energy use and offer insights into additional dimensions that enhance our customers' experience. This intelligence provides infinite possibilities that include optimizing labor, reducing operational tension and improving overall efficiencies and effectiveness at the restaurants, all while creating sustainable, profitable growth," he said.

New energy management software is also being piloted with Simon Property Group, a global leader in retail real estate ownership, management and development for shopping malls retail properties across the United States.

"This connected, real-time view of how, when, and where energy is being used enables our site managers to take actions to reduce and shift energy away from the grid during peak periods, saving significant monthly costs," said Michael Romstad, executive vice president of property management for Simon Property Group.

"We've already installed efficient solutions such as LEDs at several Simon properties, which are providing significant energy savings and better lighting levels," he continued. "We estimate the energy management solution will help us reduce consumption across the board at The Westchester mall [in White Plains, New York] by about 20 percent."

Connecting new commercial LED lighting systems to the IIoT is quickly moving from concept to reality, with benefits for all.

GALLOPING THROUGH THE WILD WEST OF LIGHTING PROTOCOLS

Over the past 20 years or more, several control protocols have become popular for indoor and outdoor lighting systems. In North America, only a few "open" basic dimming protocols have been favored within the general lighting industry; the more complex digital communications have been handled by proprietary digital protocols developed by the United States–based control manufacturers.

Robert Hick, Vice President of Engineering, Lighting, and Energy Solutions, Leviton Manufacturing Company

Times are changing, with the advent of flexible light-emitting diode (LED) and high-tech initiatives such as the Internet of Things and networked lighting controls. Just as a pioneering spirit characterized the 19th-century, a new manifest destiny has emerged as many organizations and consortiums have staked their claims in the new Wild West of lighting protocols. The protocols fall nicely into categories I call the pioneers, early prospectors, and gold rushers

Pioneers

The first settlers arrived in the half of the last century and ran the town until LEDs showed up.

Phase-cut: While some may not call it a true protocol, phase-cut dimming was the first practical, commonly used method of controlling general lighting. Phase-cut dimming became popular in the 1960s and most homes in the United States continue to use it. Phase-cut dimming works by chopping each cycle of the alternating current (AC) line voltage waveform.

There are two basic types of phase-cut protocols. The original and most popular in the U.S. is the leading edge (forward phase) dimmer, also known as a triac dimmer, which turns on the current to the light load for a variable amount of time during each AC cycle. The other is the trailing edge (reverse phase) dimmer that turns off the current for a time during each cycle. Trailing edge became popular for general use in Europe and elsewhere. In the U.S., these were called electronic low voltage (ELV) dimmers and only used for dimming special types of low voltage lighting.

Life was grand when phase-cut dimmers were used with incandescent lamps. Since incandescent lamps all had the same basic electrical characteristics, standardization was not necessary and manufacturers invented many variations of dimmers that are fully compatible with the venerable lamp.

Fluorescent lamps, however, presented challenges, but since there was a limited group of ballast manufacturers, solutions were generally available. Trouble arrived with the light-emitting diode (LED) revolution. New manufactures of LED lamps and drivers appeared overnight with no standardization. Incompatibility and mayhem reigned until 2013 when NEMA rode into town with SSL 7A Phase-Cut Dimming for Solid State Lighting—Basic Compatibility, which is bringing order to this ruckus.

0–10 V Dimming: The 0–10 V (also known as 1–10 V) dimming protocol showed up around 1990 as a way to control electronic ballasts. This protocol was standardized first in IEC 60929 AC and/or DC-supplied electronic control gear for tubular fluorescent lamp—Performance requirements and then in ANSI C82.11 *American National Standard for Lamp Ballasts—High-Frequency Fluorescent Lamp Ballasts.* Both standards have minimal performance requirements.

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At the same time, a fundamentally different version of a 0-10 V protocol became popular in the theatrical industry.

The IEC 60929 and ANSI C82.11 standards do not specify such details as the direct current (DC) control voltage-to-light level curve. Initially, this was not a big problem since the number of electronic ballast manufacturers was small and variations were not significant.

Again, the LED revolution brought trouble, with confusion between the very different theatrical and ballast versions of 0–10 V protocol and very different dimming curves causing incompatibility and unexpected performance. NEMA supports a proposal for ANSI C137.1 0–10V Dimming Interface for LED Drivers, Fluorescent Ballasts, and Controls, which ropes in the performance of 0–10 V LED drivers and controls.

DMX: DMX-512 was the first popular digital control protocol for lighting, standardized in 1990 by the United States Institute of Theatrical Technology. By today's standards, it is a very simple serial protocol that involves repeatedly sending data over a special type of twisted pair wire at 250,000 bits per second. Since the data rate is relatively high, the wiring type is very specific and must be wired in a daisy-chain fashion. The data consisted of a start byte, followed by up to 512 bytes, called channels, representing lighting levels for a number of electronic dimmers controlling the lighting fixtures.

As moving and color-changing fixtures became popular, DMX channels controlled the position and color attributes of these fixtures in a non-standardized manner that was casually shared between control and fixture manufactures. Although DMX was mostly used in the theatrical industry, it still provides basic control for many general lighting products including many LED systems worldwide.

DALI: DALI, which stands for digital addressable lighting interface, was standardized in 2002 by the IEC as an annex to the IEC 60929 electronic ballast standard. Later it was separated into its own standard, IEC 62386 DALI Part 101: General requirements—System components. It has grown significantly, with many new parts added to keep up with new lighting technology, including LEDs. DALI uses a pair of wires to send two-way digital communications from control devices to the ballasts and drivers. Since the data rate for DALI is 1200 bits per second, the wire type is very flexible, with wiring varying from 18 AWG to 12 AWG standard building wire.

DALI's compatibility is due to maturity, a high level of standardization, an extensive set of lighting commands, and continuous evolution. It is widely accepted for lighting controls in most parts of the world, except North America. Its growth in the U.S. has been slow but expected to improve as manufacturers rely more on open protocols versus proprietary protocols. Last year, DALI version 2 was published, adding specifications for control devices and multi-master capability. New standardization projects are underway for wireless DALI and extensions such as demand response and energy measurement.

Early Prospectors

The Wild West of lighting protocols heated up when the original wireless bunch came to town. Z-Wave, ZigBee, EnOcean, and a few proprietary cowboys shook things up.

Z-Wave: This was one of the first technologies to enable simple mesh networking in early 2000 and resulted in a spurt of wireless lighting products for the early days of smart homes. The protocol was widely compatible, due not to standardization but to a special Z-Wave chip that was required in all products. Z-Wave was used primarily in homes and did not gain much commercial usage.

ZigBee: This mesh network had a slow start in lighting control, as it took many years to work out an open standard that could provide most of the needs for automation and lighting markets. As ZigBee matured, it was adopted in both residential and commercial markets. ZigBee, like DALI, is constantly evolving and is becoming a mature and proven protocol.

EnOcean: EnOcean started in Germany as a solution for a very low-power wireless protocol that can be used with energy harvesting controls. EnOcean is a simple protocol that sends a very small data packet, only when needed, using very little energy. It is mainly used for commercial lighting control endpoints, including wireless occupancy sensors, photo sensors, and switches using energy harvesting such, as solar cells for power or very long-life batteries.

EnOcean protocol's low-power and non-mesh architecture limit its range. ZigBee Green Power and other new wireless protocols are reaching very low power levels and may be a challenger for the energy-harvesting powered devices.

Proprietary wireless: Several manufacturers have developed proprietary wireless protocols, some modifying IEEE 802.15 (a communication specification) radios similar to ZigBee, while others have fully proprietary radios and protocols. Some have been very successful; others may ride into the sunset as open wireless protocols become more capable and mature.

Gold Rushers

The arrival of the Internet of Things (IoT) created a gold rush, and a frenzy of prospectors now seeks to make it big in all sectors of the high tech industry. New protocol consortiums are springing up like boom towns and shooting it out in the smart home frontier. The Design Lights Consortium specification for networked lighting controls has been successful in bringing this gunfight to commercial lighting lands as manufacturers look for solutions.

This following list is not complete, as protocols are popping up and disappearing as fast as prairie dogs.

Bluetooth/Bluetooth mesh: Bluetooth wireless protocol's inclusion on almost every smart phone gives the protocol a natural key position for control and configuration of lighting systems. The original Bluetooth protocol is mature, easy to use, and can establish a point-to-point connection. Coupled with a smartphone app, it provides a powerful and ubiquitous tool to make residential and commercial lighting systems easier to set up and operate. A standard for a mesh version of Bluetooth will be released soon, and proprietary versions of Bluetooth mesh are already showing up in commercial lighting systems.

Thread: Thread is a wireless protocol proposed by Thread Group (composed of Nest/Google, Samsung, and others) that uses a protocol known as 6LoWPAN, which is easily addressable by computer systems. It is a similar radio to the ZigBee protocol. ZigBee Alliance and Thread Group have recently announced that they have demonstrated interoperability.

AllJoyn: AllSeen Alliance is a consortium of Qualcomm, LG, Sharp, and others that is promoting the AllJoyn Framework as a contender for appliance control protocol and have also developed models for basic lighting control. AllJoyn primarily uses TCP/IP Ethernet and Wi-Fi for communication transport but also claims wireless and power line carrier transports.

HAP: Apple's HomeKit Accessory Protocol uses Bluetooth LE or TCP/IP (Wi-Fi) for transport. Of course, lighting is a big part of HomeKit. The details of the protocol are only shared with partners.

EchoNet: This protocol was originally designed for home audio/visual and appliance control. A consortium of Japan-based manufacturers is promoting this IEC standardized protocol for residential and commercial lighting control. Transports include TCP/IP Ethernet and Wi-Fi, infrared, and power line carrier.

CoAP: The Constrained Application Protocol (CoAP) is promoted by Cisco and others for power over Ethernet (PoE) lighting applications. This, of course, runs on Ethernet, and its simplicity and security make it a contender for the wired Ethernet and Wi-Fi space.

LoRaWan and Sigfox: Long-range and low-power 900 MHz protocols for city coverage may be used for outdoor lighting such as LoRaWan and Sigfox.

Cellular: LTE, 3G, and GPRS protocols are being promoted for outdoor lighting control.

Proprietary Modules: Several manufacturers now package proprietary wireless protocols into modules used by lighting partners as a cohesive but proprietary platform.

Taming the Frontier

The Wild West was a place of opportunity for the exploration of untamed territories. Rules were few and conflicts abounded. With the disruption caused by LED lighting, new wireless technology, and the IoT, lighting has become a new Wild West. As winners emerge and the promises of IoT take shape, this new frontier remains exciting.

Craig DiLouie, LC, CLCP
Lighting Industry Journalist, Analyst, and Marketing Consultant

Lighting Controls Education: Just a Click Away

The rapid adoption of lighting controls necessitates an educated workforce that can properly design, install, and commission lighting systems. The majority of energy codes require a broad range of controls in new commercial buildings, and the development of wireless control signal communication is now accelerating adoption in existing buildings as part of light-emitting diode (LED) upgrades.

To address these needs, the Lighting Controls Association, administered by NEMA, developed the Education Express online education system. Education Express consists of more than 30 courses covering the gamut of lighting control strategies, technology, application, design, commissioning, and energy codes. Recent additions include courses on ASHRAE/IES 90.1-2013/IECC 2015, tunable white lighting, centralized intelligent lighting control systems, and an update to the LED control course.

Users can earn education credits at any time and at their own pace.

Courses are registered with the National Council for Qualification of the Lighting Professions, awarding education units toward maintenance of the lighting certification. Courses are also registered for health, safety, and welfare learning units with the American Institute of Architects Continuing Education System. Five courses are recognized as prerequisites for California/National Advanced Lighting Controls Training Program training and certification. The entire curriculum serves as the basis for earning the Certified Lighting Controls Professional certification administered by the interNational Association of Lighting Management Companies.

Since the program launched in 2006, some 27,000 students have completed 215,000 courses and taken 150,000 tests for credit. Registration is quick and provides access to all courses. Visit lightingcontrolsassociation.org and click the Education Express box.

Alex Boesenberg
Manager, Government Relations, NEMA

Regulatory Update and 2017 Outlook

In the closing weeks of the previous administration, the Department of Energy pushed numerous rules to completion in an effort to finalize as many regulatory actions as possible.

POWER ELECTRONICS

Originally part of the rulemaking for battery chargers and external power supplies, uninterruptible power supply (UPS) technology was carved out in 2015 for an attempted rulemaking in the computer systems category, only to find that rule abandoned and UPS brought back into the battery charger regulation scope. The U.S. Department of Energy (DOE) then resumed work on the previously stalled battery charger rulemaking, updating the test procedures and then adding standards for UPS.

NEMA continues to oppose the energy standards as written (now in pre-publication final status), having voiced several concerns with the test procedures, proposed energy standards, and evidenced success of the existing ENERGY STAR® UPS program with respect to market transformation.

ELECTRIC MOTORS

Energy conservation standards were finalized for commercial and industrial (C&I) pumps through a negotiated rulemaking. The test procedures and standards for this rulemaking focused on the efficiency of the pump system and, as a result, included the performance of the electric motor and the drive and transmission, if installed at the time of manufacture.

Rulemakings for C&I compressors and C&I fans also regulate the system instead of individual components. The systems approach is in line with NEMA positions. We have long argued that installation and operation matter more than simple component efficiency. However, concerns exist that a rulemaking for a system might become a backdoor regulation for individual components.

Due in part to NEMA involvement, thus far all these systems rules (which the DOE calls "extended product regulations") evaluate each system as a whole, without individual component performance mandates. This means the pump system must meet a certain efficiency, which may be reached by all manner of solutions, as opposed to individually mandated pump, motor, and drive efficiencies, for example. Since many or most electric motors are already regulated, concern was higher in the variable speed drive sector, a product section also represented by NEMA. There are currently no backdoor regulations in sight for NEMA products.

In early January 2017, the DOE announced a pre-publication final rule for certification, compliance, and enforcement (CCE) regulations for electric motors. NEMA opposed the rule as proposed during the 2016 rulemaking process, citing numerous concerns for burden, especially that the rule as proposed would change how efficiency is calculated during enforcement reviews. This, we argued, was a de facto change in energy conservations standards. Since this was an enforcement rulemaking, and not an energy conservation standards rulemaking,

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mandatory cost benefit analyses were not undertaken nor was manufacturing burden assessed deeply. Now that the rule is imminent and has an implementation period of only 90 days, NEMA staff and members are discussing appropriate administrative or political actions to address continuing significant concerns.

In another action related to enforcement of DOE energy efficiency regulations, numerous industries participated in comments to a DOE-proposed rule to collect data regarding compliance with DOE energy conservation standards on products at the time of importation. This rulemaking seems stalled, owing to public comments regarding scope and feasibility.

It is critical to all industries that responsible importers and manufacturers not be burdened with complex reporting requirements while scofflaws may continue to ignore regulations due to ineffective enforcement practices. Collaboration between the DOE and Customs and Border Protection must be well scripted for importation enforcement to be undertaken effectively. NEMA continues to advocate for sensible, feasible enforcement of product standards, and we support government efforts to make improvements in this neglected area.

LAMPS AND LIGHT SOURCES

The DOE also finalized several test procedure regulations for lamps and light sources, in preparation for finalizing standards for general service lamps (GSL).

The GSL rulemaking is not complete as of publication date, and NEMA expects the new administration will turn its attention to this rulemaking. GSL includes standard light-emitting diode (LED), compactflorescent lamps (CFL), and incandescent lamps. Congress also authorized DOE to consider standards for lamps currently exempt from regulation.

This unpredictability notwithstanding, the 2017 regulatory landscape is sure to be interesting, and NEMA staff and members are prepared to react to—and, where needed, drive—these discussions and outcomes to the benefit of industry and customers.

ENERGY STAR® PROGRAMS

In contrast to the DOE's push to finalize as many rules as possible, recent work at the Environmental Protection Agency (EPA) has been slow and steady, at least with respect to ENERGY STAR programs. In December, the EPA announced that the ENERGY STAR Distribution Transformers program would launch as a pilot project, without formally finalizing the performance specification or program operating rules, in favor of a soft start using the final drafts as guidance.

NEMA Transformer Product Section members and many utility representatives continue to oppose the program.

Some routine updates and announcements for ENERGY STAR lighting programs were issued, none of which caused noticeable concern. The EPA also finalized a test procedure for electric vehicle (EV) charging systems and will start a program in 2017.

CALIFORNIA

In California, rulemaking preparations for the next cycle of revisions to the Title 24 building energy efficiency regulations continue methodically. Early proposal concepts and budding research studies have begun.

NEMA is collaborating more effectively with California Energy Commission staff and other stakeholders, having campaigned for years to be involved as early as possible and to improve the proceedings with NEMA members' technical expertise and experience. The outlook for 2017 is positive.

CANADA

The Canadian government initiated two amendments to harmonize energy conservation standards with dozens of product regulations in the United States.

NEMA supports these amendments, favoring the practice of making one product to sell in multiple markets, and submitted comments on behalf of its electric motor manufacturers to allow for sufficient phase-in time, even though compliant products already exist. This would prevent stranded inventory by allowing the sell-through of products that may already be in or en route to Canadian warehouses.

With respect to radiated and conducted emissions requirements for lighting products, NEMA and ElectroFederation Canada (EFC) continue to work with a large group of manufacturing members to maintain harmonization of these regulations in North America. At issue is the Canadian government's mandate to consider International Electrotechnical Commission (IEC) standards when adopting new regulations or updating old ones. This is problematic for NEMA products. There is no established practice of this in the U.S., and the Federal Communications Commission is not considering any sweeping changes to emissions requirements. The adoption of the IEC standard for lighting product emissions (CISPR 15) in Canada would fracture the North American market.

NEMA and the EFC will continue to identify solutions that maintain harmonization between communications systems (i.e., spectrum licensees) and lighting products. Strong technical research and data-driven assessments are at the core of these efforts.

Karen Willis

Senior Program Manager, Lighting, NEMA

NEMA Debunks Medical Association Lighting Report

The NEMA Lighting Systems Division is currently in the process of revising LSD 55 *Outdoor Lighting and Human/Animal Factors: An Industry Opinion*. This white paper includes, in part, a response to the recent American Medical Association (AMA) report "Human and Environmental Effects of Light Emitting Diode (LED) Community Lighting."[1]

The AMA report encourages minimizing blue light and recommends the use of outdoor lighting below the 3000 K level (representing a low color temperature) due to concerns about effects on circadian rhythm. NEMA's document points out that the effects on the day/night cycle in humans and animals are scientifically complex and are not yet fully understood by the scientific community.

NEMA's document opines that "technical recommendations that have the potential to impact lighting products, emerging technologies, outdoor lighting design and architectural practices, lighting codes, and legislation must be based on expert consensus and sound science after full scientific discourse and peer review."

NEMA LSD 55 indicates that an argument can also be made to use only higher color temperatures (>4000 K) in outdoor lighting for important public policy reasons. This is because the use of high color temperature sources can improve human reaction time at night and improve energy efficiency, safety, and security.

NEMA Lighting Systems Division members do not believe that enough data presently exists to recommend that outdoor lighting systems be restricted to a limited range of (correlated color temperature. A one-size-fits-all recommendation is not an appropriate solution for all lighting applications and is not supported by the current body of research.

1 www.ama-assn.org/ama/pub/news/news/2016/2016-06-14-community-guidance-street-lighting.page

Revision to Chromaticity Standard Extends Range

Michael Erbesfeld

Program Manager, Lighting Systems Standards, NEMA

ANSI C78.377-2015 *American National Standard for Electric Lamps—Specifications for the Chromaticity of Solid-State Lighting (SSL) Products* provides the range of chromaticity (color) for general SSL products. It applies to LED products (SSL that uses light-emitting diodes) for general indoor lighting applications.

The ANSI C78 committee is working on a revision that extends the chromaticity range. This change is needed to extend the chromaticity recommendations for general SSL products to specify regions below the blackbody (Planckian) locus. The extended range will enable energy-efficient LED products, which were designed to replace traditional light sources, to be considered for future ENERGY STAR® certification.

The chromaticity coordinates of light sources for lighting have been designed around the Planckian locus for decades. However, recent studies question whether light sources on the Planckian locus, particularly at correlated color temperatures (CCTs) below 4000 K, are adequate for all applications. These studies support the premise that light sources with chromaticity in the extended CCT categories are adequate for many applications.

In the C78.377 revision currently underway, extended specifications are being added as options for products designed with chromaticity points that are suitable for some lighting applications. The standard will not render a judgment on the preference or perception of white or natural light. Instead, it will simply extend the designation of chromaticity regions. The standard will specify only standardized chromaticity regions and will not relate to color quality metrics such as fidelity, chroma saturation or color discrimination. Specifications of the existing chromaticity standard remain intact without modification.

The current revision process for points below the blackbody has been underway since May 2014. The ANSI C78 Working Group 9 is currently resolving the latest round of committee comments. The committee draft for vote and corresponding public review is likely to be released in the second quarter of 2017, with a final publication date towards the end of 2017.

Karen Willis

Senior Program Manager, Lighting, NEMA

ASC C137 to Publish First Standard This Year

Since 2014, NEMA Lighting Systems Division member companies have recognized the need to address lighting industry standards from a systems perspective. ANSI Accredited Standards Committee (ASC) C137 Lighting Systems was formed in 2015. The committee initiated the ANSI process (notifying the industry of the intent to develop a standard) in 2016 for four documents and expects to publish its first standard in 2017.

The ANSI ASC C137 has 43 voting organizations with more than 100 members. Current projects include

- a zero to 10 V dimming interface for LED drivers, fluorescent ballasts, and controls standard;
- minimum requirements for installation of energy efficient power over Ethernet (PoE) lighting systems standard;
- security for parking lot lighting systems standard;
- energy measurement data use case development;
- minimum compatibility requirements for parking lot lighting systems;
- a terms and definitions document; and
- a lighting systems data model review.

ASC C137 is an active committee that meets quarterly across the United States, usually at member facilities. The committee actively seeks members in the underrepresented general interest and user categories. If interested, contact Karen Willis.

ASC C136 DEVELOPS NEW STANDARDS FOR CHANGING INDUSTRY

As the outdoor lighting industry continues its rapid acceptance of light-emitting diode (LED) luminaires, utilities, municipalities, and other end users see enormous potential. New technologies have expanded the use capabilities from distinct on/off schedules to dimming abilities, remote control of lighting, and adaptive street lighting for specific conditions and events.

In anticipation of the flexible options that LED technology allows, the ANSI Accredited Standards Committee (ASC) C136 Roadway and Area Lighting drafted two new standards to measure and report the energy consumed at each outdoor luminaire. The proposed standards, tentatively titled *Revenue Grade Energy Measurement within a Locking Type Control Device* and *LED Drivers with Integral Energy Measurement Means* will address a growing need in the industry: minimum acceptable performance criteria for energy measurement in each luminaire.

Additional proposed standards under development by ASC C136 include the following:

- C136.42 *American National Standard for Roadway and Area Lighting—SSL Cobra Head Retrofit Mechanical and Electrical Interchangeability*
- C136.48 *American National Standard for Roadway and Area Lighting—Remote Monitoring and Controls*
- C136.54 *American National Standard for Roadway and Area Lighting—Occupancy Detectors, Motion Sensors and Vacancy Detectors for Area Lighting*

ASC C136 is open to all materially affected and interested parties. To achieve and maintain balance, it actively seeks additional members in the User and General Interest categories. If interested, contact Karen Willis.

Ann Brandstadter
Manager, Standards Publications and Marketing, NEMA

Recently Published Standards

ANSI C78.21-2011 (R2016) *American National Standard for Electric Lamps—PAR and R Shapes* may be purchased in hard copy or as an electronic download for $201 on the NEMA website.

ANSI C78.40-2016 *American National Standard for Electric Lamps—Specifications for Mercury Lamps* may be purchased in hard copy or as an electronic download for $275 on the NEMA website.

ANSI C78.380-2016 *American National Standard for Electric Lamps—High-Intensity Discharge (HID)—Method of Designation* may be purchased in hard copy or as an electronic download for $80 on the NEMA website.

ANSI C78.682-1997 (R2016) *American National Standard for Electric Lamps—Standard Method of Measuring the Pinch Temperature of Quartz Tungsten-Halogen Lamps* may be purchased in hard copy or as an electronic download for $100 on the NEMA website.

ANSI C78.62035-2016 *American National Standard for Electric Lamps—Discharge Lamps (Excluding Fluorescent Lamps)—Safety Specifications* may be purchased in hard copy or as an electronic download for $50 on the NEMA website.

ANSI C82.2-2002 (R2016) *American National Standard for Lamp Ballasts—Method of Measurement of Fluorescent Lamp Ballasts* may be purchased in hard copy or as an electronic download for $147 on the NEMA website.

Bryan Holland
South Field Representative, NEMA

South Begins Adoption of the 2017 NEC

The 2017 *National Electrical Code*® (NEC), the 54th edition, supersedes all other previous editions, supplements, and printings dating back to 1897. The code by itself is not effective without timely adoption and proper enforcement. The states and local jurisdictions that adopt and enforce the most current edition of the NEC enhance public safety. Statistics from the U.S. Consumer Product Safety Commission and U.S. Fire Administration clearly show a reduction in the number of injuries, deaths, and fires from electrical related hazards with each subsequent edition of the NEC.

Several states in the South have begun the process to adopt it. This includes Georgia, North Carolina, Oklahoma, and Texas.

GEORGIA

The Georgia State Codes Advisory Committee (SCAC) met in November to form a task force to review and recommend adoption of the 2017 NEC. The task force met on December 8, 2016, and January 12, 2017, at the Department of Community Affairs (DCA) in Atlanta, after which it unanimously voted to recommend adopting the 2017 NEC with no state amendments. The task force will submit a final report to the SCAC in April. The SCAC will then study the report and vote on the final recommendation to be presented to the DCA board for consideration at its November 2017 meeting. The anticipated effective date of the 2017 NEC in the state is January 1, 2018.

NORTH CAROLINA

The North Carolina Building Code Council has formed an electrical ad hoc committee to begin review of the 2017 NEC. The first meeting of the committee was held on December 12 at the North Carolina Department of Insurance in Raleigh. The committee will report to the Standing Electrical Committee for its consideration and vote. Upon approval, a petition to adopt the 2017 NEC will be submitted to the Building Code Council. The anticipated effective date of the 2017 NEC is January 1, 2018.

OKLAHOMA

The Oklahoma Uniform Building Code Commission (OUBCC) will hold a public comment hearing on February 21, 2017, on a discussion and action to formally review the 2017 NEC for adoption as the state of Oklahoma minimum electrical code. Upon approval of this recommendation, the OUBCC is expected to form a Technical Review Committee. A final report will be submitted to the OUBCCC. Upon commission approval, the anticipated effective date of the 2017 NEC is November 1, 2018.

TEXAS

The Texas Electrical Safety and Licensing Act requires the Texas Department of Licensing and Regulation (TDLR) to adopt the revised NEC as the electrical code for the state of Texas. The 2017 NEC will be the minimum standard for all electrical work in the state when adopted on September 1, 2017.

Updates in these states and the progress of code adoption in the others will be reported in the June edition of *electroindustry* magazine. For more code adoption information in all 50 states, subscribe to the NEMA Code Alerts service at www.nema.org/technical/code-alerts.

Craig Updyke
Director, Trade and Commercial Affairs, NEMA

NEMA Advances Customs Classification of LED Lighting

As a member of the Global Lighting Association (GLA), NEMA discusses issues with trade associations representing lighting manufacturers. A current topic is how national customs authorities classify light-emitting diode (LED) lighting products that challenge the status quo.

The World Customs Organization (WCO) revises the Harmonized Commodity Description and Coding System (generally referred to as HS) every five years. It made several GLA-supported changes for LED lamps that took effect in January. Anticipating further changes in the 2022 code to accommodate LED luminaire componentry, the GLA developed common positions on which NEMA has met with U.S. Customs and Border Protection (CBP) officials who represent the country at the WCO.

"While U.S. Customs' attorneys are experts in product classification, we have found that they appreciate help from NEMA in understanding the components of LED lighting technology that are traded internationally and the recommendations of the global lighting industry," said Joe Howley, manager of industry relations for GE Lighting, chair of the NEMA Light Source Section, and past chair of the Lighting Systems Division. "We are usually able to come to a common understanding with U.S. Customs in part due to our proactive approach."

Although complete consensus on the GLA recommendations has not yet been achieved at the WCO, NEMA continues to confer with U.S. Customs and prepare for the 2022 HS.

NEMA successfully petitioned the U.S. Census and the U.S. International Trade Commission in late 2016 to create special statistical breakout subcategories for LED lamps. They are general purpose, decorative, directional, mini-directional, straight linear tube, and others. Government and industry now have an accurate understanding of what types and quantities of LED lamps are being imported by the U.S.

Craig Updyke
Director, Trade and
Commercial Affairs, NEMA

U.S. and Mexican Business Leaders Look Ahead

Executives and administrators from Mexico and the U.S. discussed NAFTA and other topics during the U.S.-Mexico CEOs Dialogue. Photo by Gustavo Dominguez

NEMA President and CEO Kevin J. Cosgriff participated in the December 6 and 7, 2016, meeting in Mexico City of the United States–Mexico CEO Dialogue, organized by the U.S. Chamber of Commerce and Mexico's Business Coordinating Council (Consejo Coordinador Empresarial).

High on the agenda was discussion of the result of the U.S. presidential election and its implications for U.S.-Mexico trade and economic relations. Mexican President Enrique Peña Nieto spent two hours with the group, which included the former U.S. Secretary of Commerce Penny Pritzker , ambassadors from both countries, and several Mexican government ministers. U.S. business leaders cautioned their counterparts against making any drastic adjustments before the Trump administration lays out policy proposals.

The goal of this dialogue's is to continue to develop recommendations for the new U.S. secretary of commerce and Mexico's Economy Ministry on ways to optimize, transform, and enhance North American trade and competitiveness. Specific areas for further work are the development of ideas for the enhancement and updating of the 1994 North American Free Trade Agreement (NAFTA) and implementation of new technologies that facilitate secure and timely cross-border freight transportation and create a "smart border."

COSGRIFF VISITS KEY PARTNERS IN MEXICO

During his visit to Mexico City, Mr. Cosgriff held a series of meetings to advance NEMA priorities in several areas. A key theme was Mexico's energy reforms and their important implications and opportunities for NEMA member companies.

Joined by NEMA Director for Latin America Gustavo Dominguez Poo, Mr. Cosgriff visited the leaders of NEMA's association counterpart in Mexico, CANAME President Pablo Moreno, and Executive Director Salvador Padilla. They discussed continued CANAME-NEMA collaboration and cooperation in 2017. A central theme of the discussion was electrical safety and the progress that needs to be made in Mexico to prevent counterfeit products from entering the market and being installed.

Mr. Cosgriff and Mr. Dominguez, who is based in Mexico City, visited ANCE, the leading standards developer and testing and certification organization for electrical products in Mexico, and CRE, Mexico's energy sector regulator.

CRE Commissioner for Electricity Marcelino Madrigal Martínez spoke in part about CRE's plans to develop standards for utility equipment that would replace those heretofore written by the state-owned utility, CFE, and the Commission's strong interest in cybersecurity.

Laurie Miller
Director, Statistical Operations, NEMA

Delving into the Lighting Industry Market

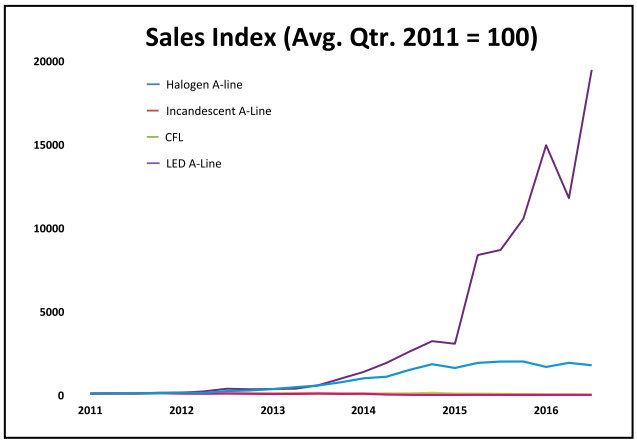
NEMA Business Information Services (NEMA/BIS) works closely with members of the NEMA Lighting Systems Division to collect domestic product shipment data. On a quarterly schedule, NEMA/BIS uses the data collected from members and seasonal adjustment factors to produce three lamp index reports which are focused on A-line, high intensity discharge (HID), and linear florescent lamp shipments.

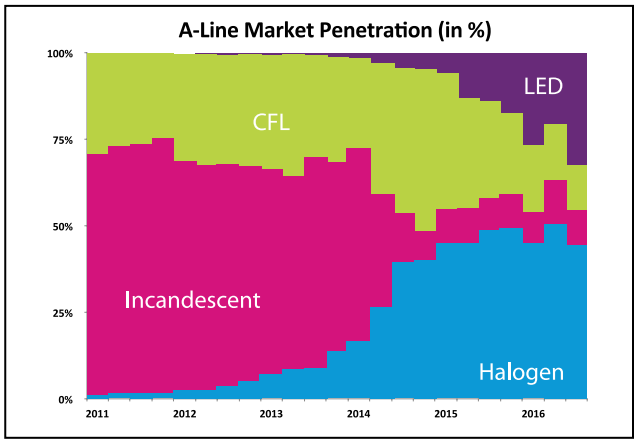
Two graphs are provided for each product group. The index is displayed on a line graph which depicts the changes in the market over time. A bar chart shows market penetration by product type within the consumer lamp market.

A-LINE LAMP MARKET

LED A-line lamps continue to grow, accounting for 32.4 percent of the market in third quarter 2016, and posting a 124.2 percent increase in shipments compared to 3Q 2015. They posted a 65.1 percent quarter-over-quarter (q/q) increase in the third quarter of 2016 compared to the previous quarter. Halogen, incandescent, and compact fluorescents lamps (CFLs) all posted a q/q decrease of 7.5 percent, 17.2 percent, and 12.8 percent, respectively. Incandescent lamp shipments showed a 5.6 percent increase in 3Q 2016 compared to 3Q 2015, while halogen and CFLs posted a 11 percent and 53.9 percent decrease for the same time period.

Halogen A-line lamps account for 44.5 percent of the consumer lamp market in 3Q 2016. CFLs captured 13.2 percent of the 3Q 2016 consumer lamp market and incandescents, 10 percent. Incandescent A-line lamps largely consist of 15W and 25W lamps.

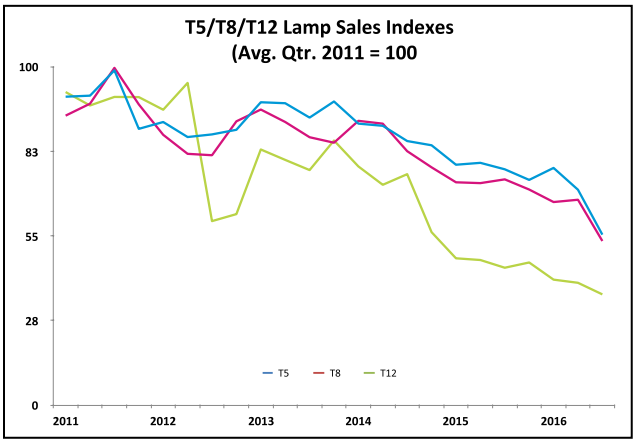


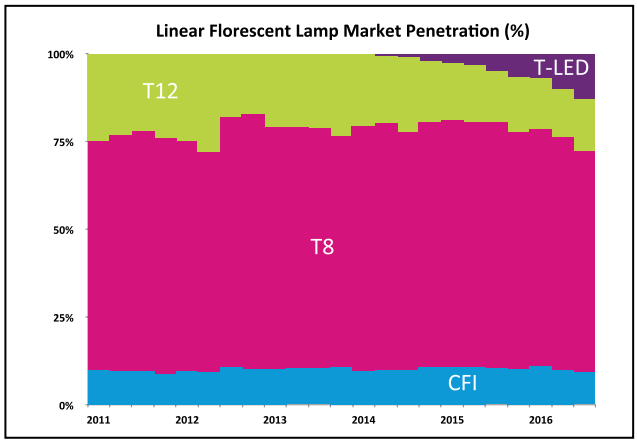


LINEAR FLORESCENT LAMP MARKET

Since 2014 the linear florescent lamp index has been on a downward trend and that trend continues in 3Q 2016. The index for T8 lamps which account for 63.0 percent of the consumer lamp market decreased on a year-over-year (y/y) basis by 27.3 percent in 3Q 2016 compared to 3Q 2015. T5 and T8 shipments also continued to decline decreasing by 27.7 and 27.3 percent respectively on a y/y basis.

In 2010, NEMA/BIS added tubular light-emitting diode (T-LED) shipments to the market penetration graph to begin tracking their impact on the market. When more historical data is available, T-LED shipments will be added to the index. In 3Q 2016, T-LEDs accounted for 12.8 percent of the florescent lamp shipments. T5 lamps claim a 9.4 percent share of the 3Q 2016 market and T12 lamps 14.8 percent.

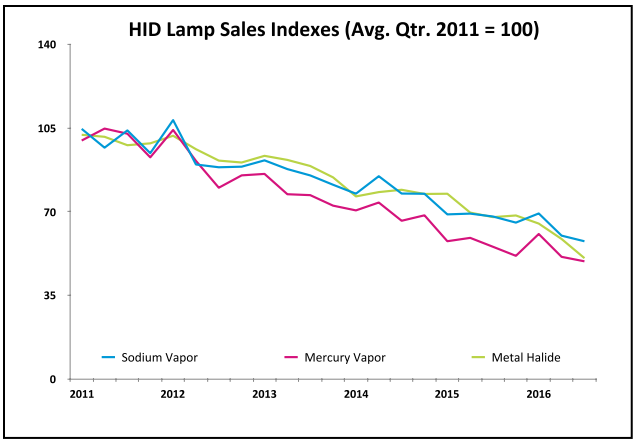


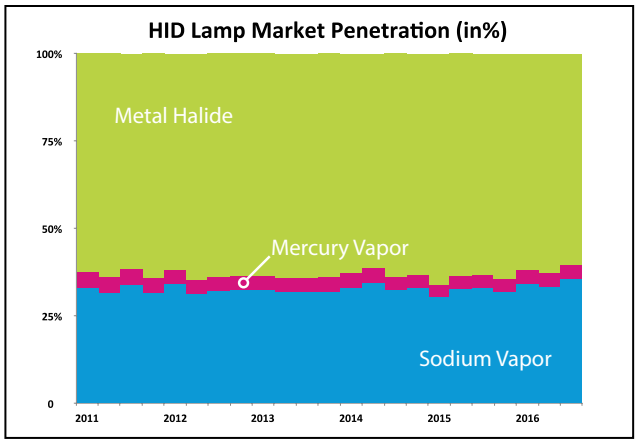


HID LAMP MARKET

NEMA's shipment index for high intensity discharge (HID) lamps continued to decline in the third quarter of 2016. Compared to the same quarter last year, metal halide lamp shipments fell 25.4 percent, sodium vapor lamps decreased by 15.2 percent, and shipments of mercury vapor lamps decreased by 11.0 percent.

Metal halide lamps accounted for 60.3 percent of the HID market in 3Q 2016, while sodium vapor and mercury vapor account for 35.6 percent and 4.2 percent respectively.

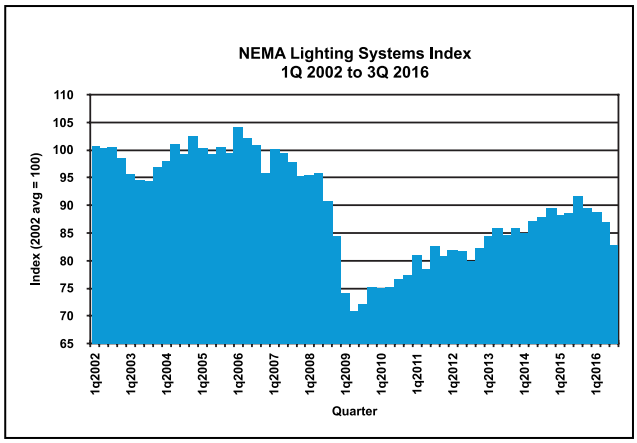




LIGHTING SYSTEM INDEX

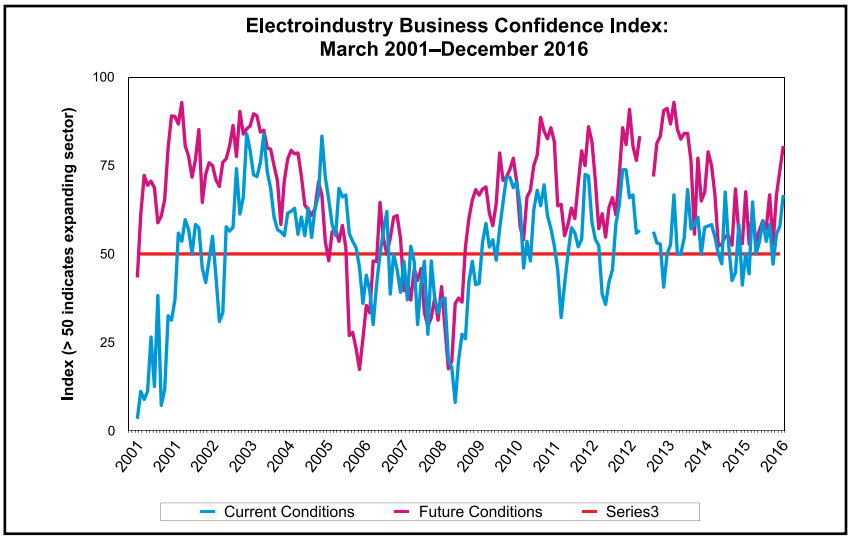
NEMA's Lighting System Shipment Index, a measure of demand for lighting equipment, decreased by 9.7 percent in 3Q 2016 compared to 3Q 2015 and 4.7 percent decrease compared to 2Q 2016.

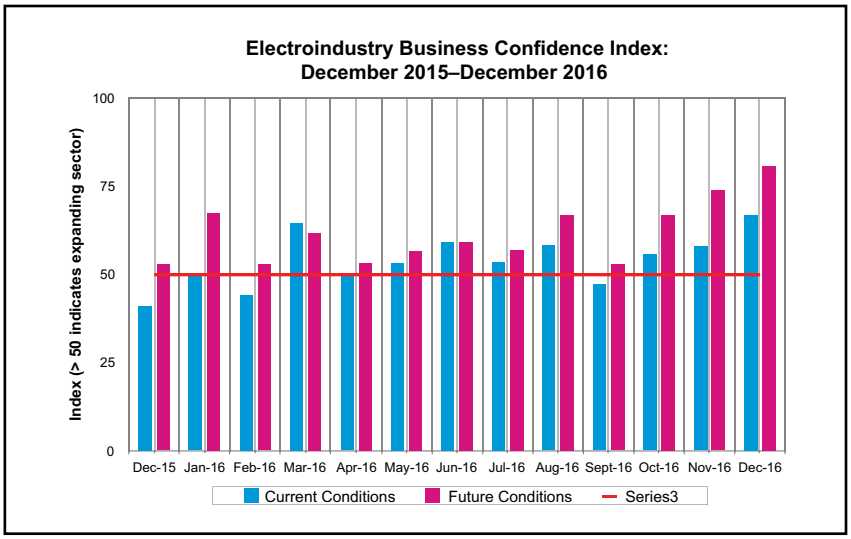
The decrease was driven by all components of the index that includes fixtures, emergency lighting, ballast, and lamp (large and miniature) components, all of which posted year-over-year decreases.

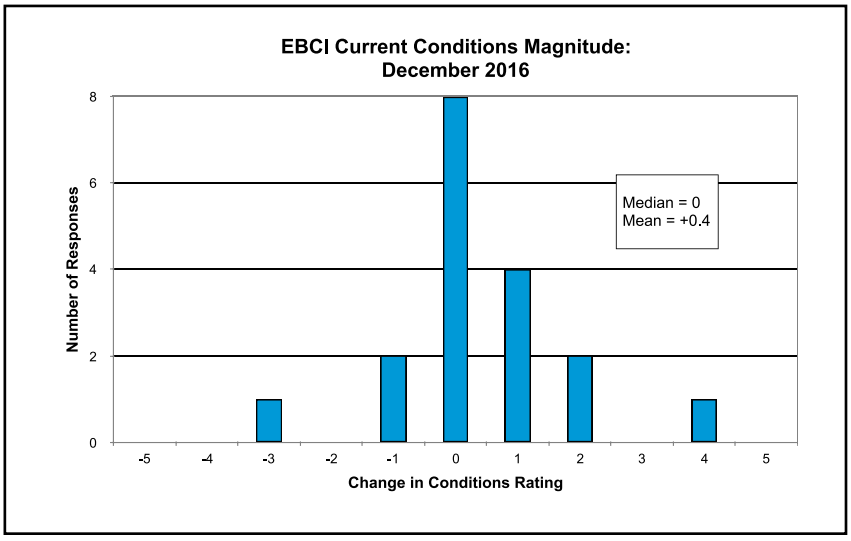


Steve Wilcox
Director, Market Research, NEMA

Despite Slowdown, Bullish Sentiment Predominates







Although some respondents noted weakness in their markets, the Electroindustry Business Conditions Index (EBCI) panel members sent the current index to a16-month high.

The EBCI benefited from a decidedly positive shift overall as it moved from 57.9 in November to 66.7 in December. The share of those reporting worse conditions mirrored November's report at 11 percent.

The major movement in the EBCI came about due to the shift from unchanged conditions, which registered at 63 percent in November, to better conditions, reported at 23 percent last month. In December, both unchanged and better came in at 44 percent.

The survey's measure of the intensity of change in electroindustry business conditions moved further into positive territory, as the mean rating ticked up an additional one-tenth of a point to +0.4 from its previous reading of +0.3 in November. Panelists are asked to report intensity of change on a scale ranging from –5 (deteriorated significantly) through 0 (unchanged) to +5 (improved significantly).

The future conditions index continued to strengthen, reaching 80.6 in December. The two previous months saw this figure climb, starting at 66.7 in October and moving up to 73.7 in November. The share of those expecting better or unchanged conditions edged up, but most of the shift in confidence came from the 10 percent fewer respondents expecting worse conditions, a sentiment expressed by only six percent of respondents in December. This month, 67 percent of our panelists reported expectations of better conditions versus 63 percent in November, while 28 percent foresaw unchanged conditions this time, compared to 21 percent last month.

Visit www.nema.org/ebci for the complete December 2016 report.

Save the Date

NEMA's 91st Annual Membership Meeting

November 8 & 9, 2017
Hyatt Regency Coconut Point
Bonita Springs, Florida

I Am NEMA

ENLIGHTENED ABOUT LIGHTING

Madeleine Bugel, NEMA Program Manager

Before joining NEMA as a program manager in May, I was unaware of the magnitude or scope of the lighting industry. After being exposed to the Lighting Systems Division and the vast range of what our member companies do, I am much more appreciative of the presence of lighting in my day-to-day life.

I first became immersed in the mercury-containing lamps recycling programs in Maine and Vermont. One of my responsibilities was to visit the states, personnel, and collection sites that participate in the program. It was tremendously helpful to see the programs in action.

Having studied Arabic and lived in Amman, Jordan, I am excited to use that knowledge and experience in another aspect of my work, which involves creating an outreach program for the Middle East–North Africa region and working toward fair market access for NEMA members in the Kingdom of Saudi Arabia.

I am excited to continue learning through NEMA, contributing to the Lighting Systems Division, and engaging my international background.

STOCKART

10 istockphoto@angsabiru
14 istockphoto@PPAMPicture
20-21 istockphoto@simon2579
33 istockphoto@YinYang
34 istockphoto@alptraum
35 istockphoto@lundborg
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Phone: 1.866.797.4272
Email: certinfo@csagroup.org

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