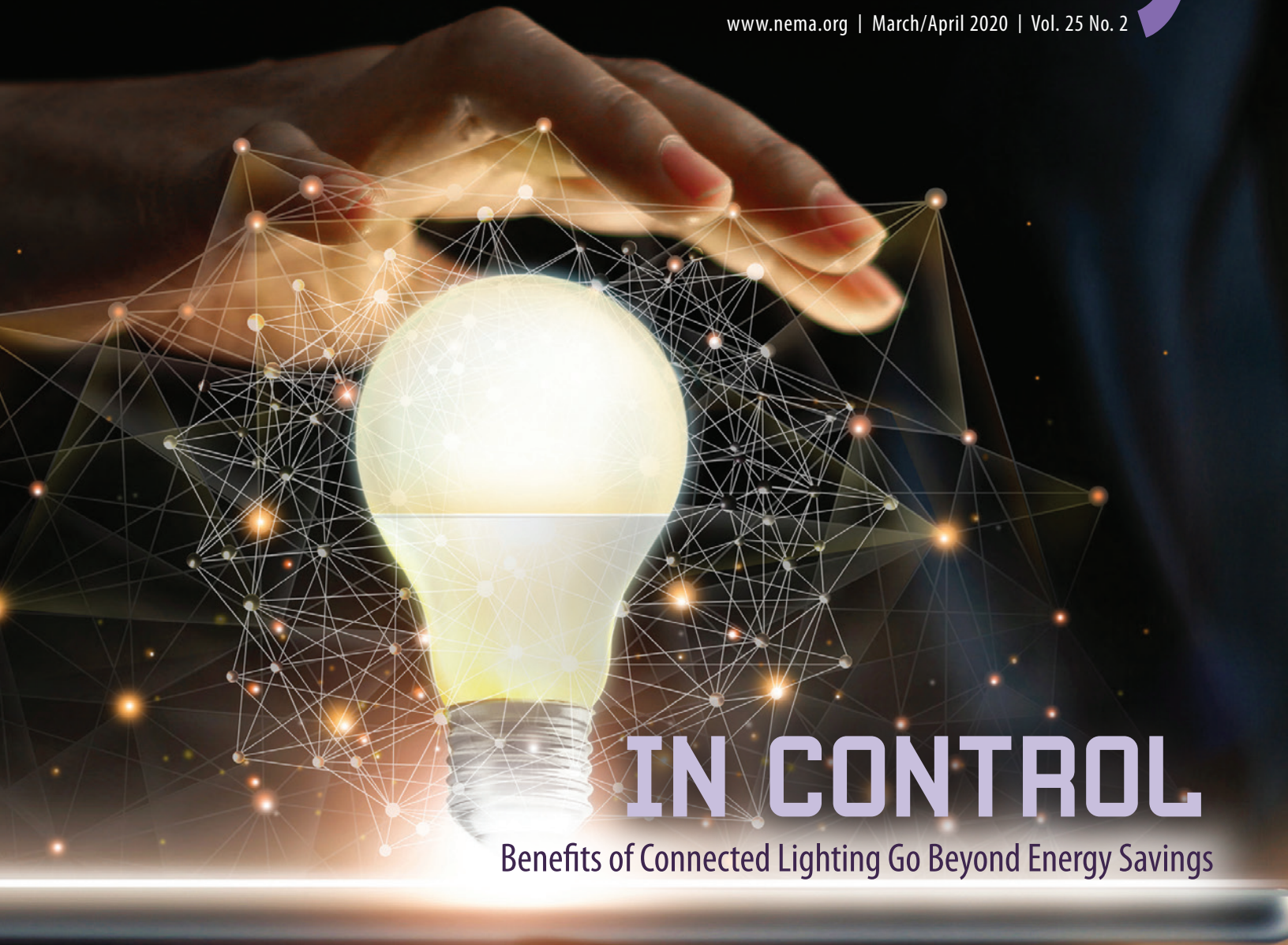


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IN CONTROL

Benefits of Connected Lighting Go Beyond Energy Savings



NEMA

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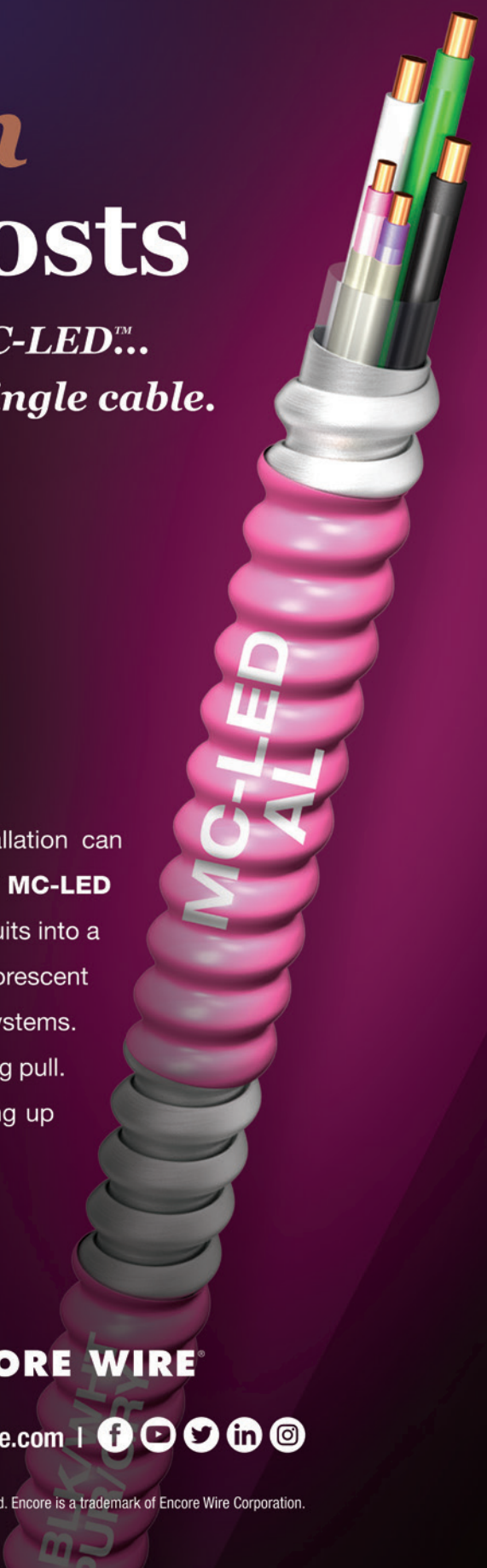
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From the moment we wake up until the time we switch off our bedside lamp, lighting is an integral part of many of the daily things we do. On-demand lighting is something that we rely upon and expect to be available as a matter of course. Writing this column made me reflect on how much we take modern lighting for granted.

The inventions that have shaped our world, such as the wheel and agriculture at the dawn of civilization through automobiles and airplanes in the last century, show how far we have come. The humble lightbulb certainly deserves to be considered in the same group. Electric light fundamentally changed how we lived and worked. And its follow-on effects, such as the way we design our buildings, cities, and factories, are testament to this fact. At the human level, electric light has given us greater flexibility across more hours and in more settings to safely occupy our time. Consequently, lighting will remain a non-negotiable component of all future energy strategies.

This is a story covering a 150-year history. In the beginning, the incandescent lamp replaced candlelight and lanterns. By the 1930s, the fluorescent bulb entered the market as a longer-lasting option and one that fulfilled the promise of being more efficient. Today, LED lightbulbs are installed in homes, businesses, and automobiles around the world, reigning as the leading technology in energy efficiency. And from the beginning through our times, lighting has become more convenient and inventive.

But the future of lighting is far more than an energy efficient light source. Now that lighting is digital, embedding sensors in lightbulbs enables us to capture ambient data to manage assets more effectively. Imagine using light bulbs to track wheelchairs in a hospital or monitor humidity in a manufacturing facility. With billions of light bulbs in use around the world, there is a near infinite pool of untapped data.

Welcome to the new age of lighting!

In this issue, we will explore what this new age of lighting means for electrical manufacturers from a variety of different perspectives. But any way you look at it, the future is as bright as it has ever been. ☺

Raj Batra

Chair, NEMA Board of Governors

Window on Washington

In some ways, the 116th Congress has been one long tease for those interested in energy/climate and infrastructure policy. But this situation changed over the course of a 24-hour period on January 28-29, 2020, with the release of two major proposals in the House of Representatives. These two proposals contain provisions that would, if enacted, be some of the most significant new energy and transportation policies in many years.

First, the Energy and Commerce Committee put forward a 622-page draft, *Climate Leadership and Environmental Action for our Nation's (CLEAN) Future Act*. Among many other things, this bill would:

- Set a national goal to achieve a 100 percent clean economy by 2050
- Require retail electricity suppliers to provide increasing percentages of clean electricity starting in 2022
- Require the Federal Energy Regulatory Commission to initiate a rulemaking to foster interregional transmission planning
- Direct the U.S. Department of Energy (DOE) to establish a program to provide funding for projects that improve resiliency, performance, or efficiency of the electrical grid
- Establish a program to replace inefficient transformers
- Establish a strategic transformer reserve program
- Tighten DOE requirements for model building energy codes
- Encourage use of performance contracting in federal facilities
- Provide for zero-emission vehicle infrastructure buildout; and
- Establish a DOE national plan for smart manufacturing technology development

The bill would also, unfortunately, weaken preemption provisions in current federal law to allow states to reference more stringent appliance Standards under certain circumstances.

Second, the House Transportation and Infrastructure Committee released a comprehensive \$760 billion plan titled *Framework for Making Transformative*

Infrastructure Investments Across the U.S. Among other things, this framework would:

- Provide additional funding for electric vehicle fueling infrastructure along designated highway corridors
- Create a new Airport and Airway Investment Program focused on investing in modernization projects
- Direct utilities to study, evaluate, and implement water- and energy-efficient technologies
- Provide \$4 billion over five years for electrical grid infrastructure to accommodate more renewable energy and to make the grid more resilient
- Provide \$17.5 billion over five years to local governments to fund energy-efficiency and conservation projects
- Provide \$850 million over five years to spur the development of smart communities infrastructure through technical assistance, grants, and training and
- Provide \$1.75 billion over five years in weatherization grants and programs to promote smart buildings and \$15 million for a pilot program to promote energy-efficient water distribution systems

The infrastructure framework is still in the conceptual phase of development, so NEMA expects legislative language to be released shortly. Even so, NEMA does not believe that these two omnibus proposals will move through regular legislative order in their current form during 2020. However, some of the provisions or concepts could end up in a new highway bill, which Congress must deal with before the end of 2020. Or they may be found in a narrowly drafted energy bill made up of standalone bills that have already passed the House.

Their primary purpose in being released now is to aggressively communicate the broad ambitions that these relevant committees have to provide Federal leadership and funding in the areas of clean energy and infrastructure. Should the Democrats take control of the U.S. Senate and/or the presidency after the 2020 elections, NEMA expects significant portions of these proposals to move forward. 📌



Phil Squair

Congress Overwhelmingly Approves USMCA

Craig Updyke, Director,
Trade and Commercial
Affairs, NEMA

Following positive bipartisan votes in the House of Representatives and Senate, in January the President signed into law legislation to implement the U.S.–Mexico–Canada Agreement (USMCA), which will replace the 1994 North American Free Trade Agreement (NAFTA). The House approved USMCA 385-41 on December 19; the Senate voted 89-10 on January 16.

“USMCA provides greater certainty for NEMA Members working with partners in Mexico and Canada and contains many positive provisions for the U.S. electroindustry in the areas of market access, Standards and conformity assessment, and regulatory cooperation,” said NEMA President and CEO Kevin J. Cosgriff.

“We look forward to working with the Administration, Congress, and our North American counterpart associations on the successful implementation of this important agreement,” Cosgriff added.

The date of entry into force of USMCA and repeal of NAFTA are still to be determined. The earliest option is July 1, 2020. As of press time, Canada had not yet completed its ratification procedures, but strong support was expected in Ottawa. Mexico’s Congress completed its approval procedures in December 2019, but Mexico must still put in place new legislation to meet all its USMCA commitments, including a new law on Standards and conformity assessment. 🇺🇸

Section Continues Work on Street and Area Lighting Projects

ASC C136 covers all types of street and area lighting, including lamp types, pole construction and support, tunnel lighting, enclosed architectural luminaires, system selection guides, lighting controls, ingress protection, and ancillary devices.

ANSI Accredited Standards Committee (ASC) C136 is publishing a new outdoor lighting Standard: C136.58-2019 *Luminaire Four-Pin Extension Module and Receptacle—Physical and Electrical Interchangeability and Testing*.

Committee work is continuing on several other new Standards:

- C136.50 *American National Standard for Roadway and Area Lighting Equipment—Revenue Grade Energy Measurement Devices within a Locking Type Control Device*
- C136.52 *American National Standard for Roadway and Area Lighting Equipment—LED Drivers with Integral Energy Management*
- C136.54 *American National Standard for Roadway and Area Lighting Equipment—Occupancy or Motion Sensors for Roadway and Area Luminaires*
- C136.57 *American National Standard for Roadway and Area Lighting Equipment—Wall Pack Luminaires for Exterior Lighting*

In addition to new Standards, ASC C136 maintains and revises existing Standards, including in-progress revisions of the following documents:

- C136.14 *American National Standard for Roadway and Area Lighting Equipment—Elliptically Shaped, Enclosed Side-Mounted Luminaires for Horizontal Burning High-Intensity Discharge Lamps*
- C136.15 *American National Standard for Roadway and Area Lighting Equipment—Luminaire Field Identification*
- C136.35 *American National Standard for Roadway and Area Lighting Equipment—Locking Type Power Taps (LTPT)*
- C136.41 *American National Standard for Roadway and Area Lighting Equipment—Dimming Control Between an External Locking Type Photocontrol and Ballast or Driver*

The committee is open to all materially affected and interested parties. However, to achieve and maintain balance, C136 is actively seeking additional Members in the Pole Manufacturer and General Interest categories. If interested, please contact David Richmond at David.Richmond@nema.org. 🇺🇸

David Richmond, Program Manager, NEMA

NEMA ANSI Committees Look Ahead to Busy Year

NEMA is the Secretariat for the American National Standards Lighting Group (ANSLG) is composed of three Accredited Standards Committees (ASC): ASC C78 Electric Lamps; ASC C81 Bases, Holders, and Gauges; and ASC C82 Electronic Ballasts and Drivers. These three ASCs cover lighting technology from incandescent to solid state.

Last year was a dynamic one for the ANSLG, with ASC C78 publishing 13 Standards. Among these were two new Standards, ANSI C78.53 *Performance Specifications for Direct Replacement LED Lamps* and ANSI C78.54 *Specification Sheet for Tubular Fluorescent Replacement and Retrofit LED Lamps*.

ASC C81 published ANSI C81.61 and ANSI C81.62, which cover lamp bases and holders, respectively. These two revisions added new base and holder systems for tubular light-emitting diode (TLED) lamps, including variants for non-grounded and low-voltage TLEDs.

In 2019, ASC C82 continued tackling test methods for standby power and dimming energy efficiency for LED drivers. Dimming LED drivers are a critical energy-saving strategy, and driver designers, testing houses, and regulators were lacking a measurement technique for energy estimation. The C82 committee has also been drafting a suite of Standards, the C82.77-X series, which covers electromagnetic compatibility (EMC). EMC is becoming much more relevant as the number of connected devices increases exponentially and the potential for electromagnetic interference increases along with it.

The committees will continue to be busy in 2020, with publication activity expected from all three. This will consist of a mix of reaffirmations and revisions, as well as some new Standards, such as the proposed ANSI C82.15 on LED driver robustness.

The NEMA Lighting Systems Division, as the secretariat of the three committees, is always looking for industry experts to participate in Standards development activities. NEMA is specifically seeking experts in the underrepresented User and General Interest categories for C78, Producer and General Interest

for C81, and User and General Interest for C82. Please contact NEMA at nemalighting@nema.org if you are interested.

NEMA is also the secretariat for ASC C137 Lighting Systems. This committee develops Standards and specifications for indoor and outdoor lighting systems installed in an application with consideration of human health and comfort, personal security, the physical environment, energy consumption, and daylight integration.

In 2019, ASC C137 published three new Standards: ANSI C137.1 *0-10V Dimming Interface for LED Drivers, Fluorescent Ballasts, and Controls*; ANSI C137.2 *Cybersecurity Requirements for Lighting Systems—Parking Lots*, and ANSI C137.4 *Digital Interface with Auxiliary Power*.

For 2020, the committee is looking to publish new Standards for energy reporting, data tagging vocabulary (for interoperability of systems), and parking lot applications, among other topics.

Participation in ANSI lighting activities is open to everyone and does not require NEMA membership. However, an annual working fee is assessed. There are two semiannual meetings as a committee, but most of the Standards work is accomplished by teleconference.

NEMA is also seeking experts for C137 Lighting Systems in the underrepresented categories of User and General Interest. Please contact NEMA at nemalighting@nema.org if you are interested. ⑤

Michael Erbesfeld,
Program Manager, NEMA



THE NON-ENERGY BENEFITS OF CONNECTED LIGHTING

Steve Mesh,
Principal, Lighting
Education & Design

Mr. Mesh teaches
a full-day class on
networked lighting
controls on behalf
of the DesignLights
Consortium (DLC)

Lighting controls save energy. That's why many electric utility companies incentivize people for installing them, and, in some cases, they also incentivize manufacturers for making them. Any time a control device switches off or dims a light, it reduces energy use. Saving energy (and therefore money) is a great reason to install lighting control devices or systems.

There has been a rapid expansion of incentive offerings for networked lighting control (NLC) systems among utilities throughout the country. They know that NLC systems are the “next big thing” to hit the market. As incentives for older technology (such as compact

fluorescent lamps and wallbox occupancy sensors) are starting to go away, the utilities want new arrows in their quiver. NLC systems represent a major new opportunity.

Ironically, lighting power densities (LPDs) are rapidly decreasing and, as a result, the opportunities for saving energy are diminishing. Some industry experts have recently called for an end to energy codes altogether for this reason. As the financial argument for deploying lighting control devices or networked lighting control systems changes, what else can justify the use of this equipment? Answer: Non-energy benefits!

of Things (IoT) architecture means that NLC systems will increasingly be able to interface with—theoretically—anything.

What kinds of non-energy benefits are either currently offered or are in the works?

Asset Tracking

Some systems enable the user to determine where specific pieces of equipment (or even people) are within a facility. For example, some hospitals now equip things like wheelchairs or even crash carts with a discoverable “tag.” This type of system allows staff to immediately locate items that may be critically needed. One hospital gives doctors as well as patients similar tags. Their policy is that an exam cannot commence until three things are present in the appropriate exam room: 1.) doctor, 2.) patient, 3.) required diagnostic or other equipment. That policy helps to reduce wasted time—and remember, time equals money. These systems may use protocols such as Bluetooth or Bluetooth Low Energy (BLE) to discover the tags. Even if the NLC doesn’t use Bluetooth protocol to communicate with the light fixtures, sensors, and switches, the Bluetooth technology may piggyback on the fixtures. After all, light fixtures always have some source of power needed to run the Bluetooth network as well. And light fixtures are in every space in every building. So, it’s a great match.

Indoor Positioning

These days, you probably get around by using a global positioning system (GPS). Your car (or phone, for that matter) is a GPS receiver that takes signals from a handful of satellites to triangulate your position anywhere on the planet. What if this kind of triangulation could be deployed indoors? It can. The ubiquity of light fixtures throughout every space ensures that the lighting system is the perfect vehicle for creating the means to provide this triangulation indoors. This might be useful in a large space such as a warehouse, big-box retail store, or distribution center. This functionality might also be “piggybacked” by adding appropriate circuitry or equipment into light fixtures and/or NLC systems to provide this function.

Diagnostics and Reporting/Alerting

Many NLC systems currently on the market have diagnostic and reporting/alerting functions. Diagnostics are typically ongoing. For example, standalone ceiling-mounted occupancy sensors used in a wireless control system are usually battery-powered.

NLC systems are computer networks that happen to control light fixtures. Since these networks are digital, it means they are designed with the express intention of transmitting data. Fundamentally, these systems must transmit native commands telling light fixtures to turn on, dim, or turn off based on schedules, or based on input from occupancy sensors, photosensors, or switches. Increasingly, however, NLC systems are designed with the expectation that data from light fixtures, sensors, and switches will be shared. Many systems now have options for interfacing with other building systems using the BACnet protocol (and others). Additionally, the advent of true Internet



Instead of waiting for the battery to die, rendering the functionality of the sensor useless, some systems continuously monitor the signal from the sensor, which can then alert maintenance staff when the battery output is very low. At that point, they can head directly to the sensor in question and change the battery, avoiding sensor downtime, which might potentially increase light levels, load, and electricity use. The same type of ongoing diagnostics and reporting/alerting also happens for light fixtures and other devices used by the system. In an outdoor lighting system, monitoring and reporting on malfunctioning fixtures have the added benefit of improving the safety of drivers and/or pedestrians by allowing maintenance staff to quickly locate the equipment in question and repair or replace it.

Conference Room Scheduling

If a scheduling system can interface with a lighting control system, light fixtures and occupancy sensors can help staff know when a conference room is free or alert people already in the room that another group is coming in soon. For example, the scheduling software can send instructions to turn the lights on in the room a few minutes before the scheduled use. It might also send instructions to lower shades (if needed for A/V reasons), or even to change the temperature setpoint

THE CONNECTED RETAIL STORE: BRINGING ONLINE TO ON-SITE

Neil Egan, Director,
Communications,
Acuity Brands
Lighting

Back in the 1990s, thanks to the internet, online shopping emerged, bringing with it profound innovations, including the now-dominating mobile platform.

With this mobile platform, shoppers have taken control. They search, research, choose, pay, and ship—all whenever and wherever they want. Still, when they enter a physical brick-and-mortar store, they're provided the same level of control as was available 40 years ago. This is where **connected store innovation** helps converge the two disparate shopping experiences, by introducing a modern infrastructure and platform. Retailers can leverage the connected store by enabling connected shoppers to take control of their in-store shopping journeys.

That connectivity is facilitated by the overhead LED lighting infrastructure and is a prime example of Internet of Things capabilities working at their peak. Brick-and-mortar retailers are increasingly using the grid ceiling's LED lighting outfitted with advanced

sensor beacons to enable precise indoor positioning. The lights, embedded with Bluetooth® Low Energy and visible light communication technologies, act as all-in-one access points for indoor and adjacent outdoor environments.

And this solution has pinpoint accuracy that can target down to a specific aisle and item in store. These systems can then enhance retailers' apps with digital indoor maps that provide shoppers with location and navigation support within the store from their mobile device. This capability helps retailers convert missed sales and cross-sale opportunities. Examples of this in practice include customers who can locate products more easily, reducing their store exit without product purchase.

What does a connected store do?

The connected store is where everything—shoppers' mobile devices, shopping carts, store associates' scanners, displays, end caps, etc.—is digitally linked

on the HVAC system—then revert the shades and/or HVAC system back after that group leaves. It might blink or dim light fixtures five minutes before the next group comes in as a reminder that they must vacate the room shortly. This is getting into the realm of IoT, where diverse building systems must be able to interface—either with each other or even with non-building systems (e.g., with a software-based companywide scheduling system that isn't typically designed to “talk” with building systems).

Integration with HVAC/BMS/Other Systems

As mentioned, NLC systems are increasingly being offered with options to talk BACnet (or other protocols) so they can interface with other building controls. That might be an HVAC system (for example, so both the HVAC and lighting systems can use the input from only one occupancy sensor). It might be a more comprehensive building management system. Another option that is being offered by some NLCs is the ability to interface with an “Automated Demand Response” (ADR) server. In at least one currently available NLC system, other equipment on-site talks with the ADR server, which is usually run by a third party and is off-site. That on-site equipment then connects via

low-voltage wires to the NLC, sending a simple signal that says “there is now a demand response event—change all lighting to levels as pre-programmed for the demand response event.” In other systems, all that's needed is to enter the URL for the ADR server. The functionality is the same. In certain locations, there are code requirements to use equipment with provisions to enable at least a 15 percent reduction in lighting power—automatically—based on the signal from the ADR server. Typically, fixtures must be dimmed by at least 20-30 percent before the average person can perceive the reduction. So, even if your utility doesn't offer a financial incentive for tying into an ADR server for your area, it may still pay by reducing lighting loads during times of peak demand. In most commercial and industrial buildings, evening out the load profile is typically a way to save energy and money even if you're not participating in an incentive program. ☺

Editor's Note: *This article was originally published at the Lighting Controls Association's website at www.LightingControlsAssociation.org.*

Another Use

Read how one company is taking Li-Fi to the sky at www.nema.org/LiFi

throughout the store, and each thing's location is recognized in real time. Retailers thus get a bird's-eye view of what is happening, moment by moment, on the sales floor.

In the IoT-enabled retail environment, shoppers already connected to the internet are further connected to the physical store, empowered to take the shopping experience into their own hands—just as they do when shopping online. The “where” and “when” data fed to a retailer's mobile app allows shoppers to access information they've never had before, such as “the product you're looking for is (here),” and “the bathroom is (there).” This logic benefits the retailer as well because store associates can use their time as product ambassadors vs. traffic controllers.

In a connected store, retailers can also adjust customer traffic patterns and store design based on collected data:

- Knowing how many shoppers are in the store—by hour and by day—to help schedule the right number of associates in the specific sections of the store
- Receiving alerts when shopping carts are waiting longer than three minutes at the check-out counters to indicate to store managers that they may want to open more cash registers in response to heavy demand
- Seeing where bottlenecks are created so managers can consider moving products out of the way to improve the flow of traffic for shoppers in a rush

With the growing deployment of connected stores, smart, connected LED lighting can assist retailers in tapping the potential to benefit both shoppers and their own operations. This new technology will help retailers take the “where” and “when” data and make extraordinary deployments in “how” it is used. ☺

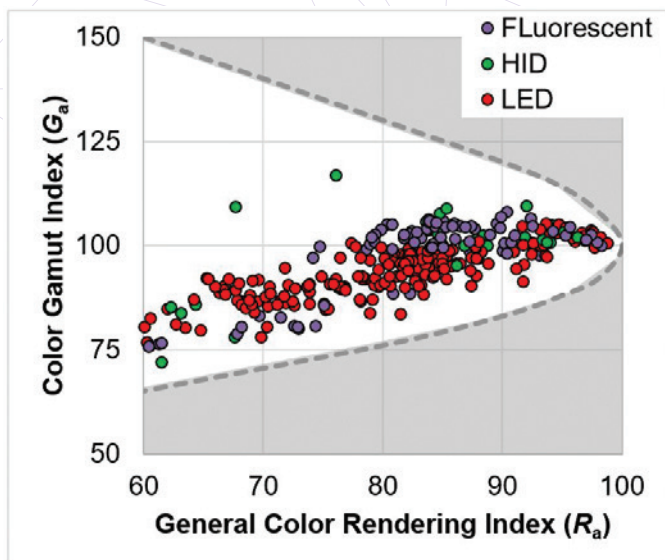
SPECIFYING LIGHT SOURCES BEYOND COLOR FIDELITY

Kees Teunissen,
Senior Scientist, Light
and Vision, Signify
Research

For many decades, light sources have been specified by their correlated color temperature (CCT) and general color rendering index (CRI)¹. With the adoption of light-emitting diodes (LEDs) for general lighting purposes, these two specification items, alone, are insufficient to fully characterize the appearance of object colors in a lit environment.

Color Fidelity

The CRI value indicates only the average difference in color appearance for eight color rendering index test-color samples (TCS) between a light source and a mathematical reference illuminant,¹ but it does not disclose the direction of the color shifts. Depending on the exact emission spectrum of the light source, colors may appear more (or less) saturated (colorful) under the light source than under the reference illuminant. Therefore, the appearance of object colors under two light sources with identical CRI values can still be different. To address this issue, it is important to specify changes in colorfulness in addition to color fidelity (aka CRI).



Beyond Color Fidelity

In Dec 2018, The Global Lighting Association (GLA)² published a document, endorsed by NEMA, with specification items to capture saturation effects.³ It includes a color gamut index, G_a , which represents an average change in colorfulness for eight CRI (test color samples) TCS. It is derived from the area formed by these TCS in color space. If the area for the test source is larger than for the reference illuminant, G_a will be >100 (colors will appear more colorful), and <100 when the area for the reference illuminant is larger. The range of possible G_a values increases with decreasing CRI (R_a) values (see figure). Consequently requiring high CRI values limits variations in G_a . Many studies have demonstrated the importance of red rendering, which is somewhat compromised to increase energy efficiency. Red rendering is already partly captured with the red color rendering index, R_9 , but again this index indicates only a difference without the direction. The GLA publication³, and the freely available accompanying calculation tool², also includes chroma indices for all TCS to indicate the direction of the color shifts, where C_9 represents the red chroma index. Indices G_a and C_9 are based on the CIE 13.3¹ framework and therefore fully compatible with CRI.

Color Preference

Preference for the rendering of object colors depends on the task, expectations, application, culture, and person and can therefore not simply be captured with one average index number. Knowledge of the intended application and expectations is essential to optimize the individual index values. The new indices, G_a and C_9 , supplement the existing ones, R_a and R_9 , and provide a more complete description of the color rendition properties of white-light sources. 

¹ CIE 13.3-1995, "Method of Measuring and Specifying Colour Rendering Properties of Light Sources," Vienna, Austria: CIE

² <https://www.globallightingassociation.org/>

³ "Application of CIE 13.3-1995 with Associated CRI-based Colour Rendition Properties," December 2018, <https://www.globallightingassociation.org/library>



Lighting's Role in Energy Conservation Is Market-Driven

Naturally-Occurring Market Adoption (NOMAD) is a familiar concept in energy conservation regulation. It refers to the proportion of energy savings that would have taken place in the market even if mandatory energy conservation Standards had not been adopted. That “proportion” is an estimate based on market data and trends.

The NOMAD experience is highly relevant to what has already transpired and is continuing to transpire with respect to light bulbs: while regulation has played a role in reducing electricity use by lighting products over the last 20 years, the market has accomplished a lot on its own as well and has already done the job that mandatory regulatory Standards could do, particularly for general service lightbulbs.

U.S. Energy Information Administration data documents that lighting has contributed more to U.S. energy conservation than any other electricity-consuming product, reflecting a concordance between lighting innovation, energy conservation, and environmental protection that is largely a market-driven phenomenon rather than regulation-driven.

As explained below, the estimated additional cost of electricity to a U.S. household because general service incandescent lamps are not eliminated from the market by mandatory regulation is equivalent, on average, to fewer than two chocolate bars per year in 2023. And the need for more electric power plants in the absence of regulation of general service light bulbs? None. The net difference in domestic utility-scale electricity generation between a regulatory and non-regulatory scenario for general service light bulbs is less than 1/10th of one percent by 2023.

The trends based on market data are displayed in Figures 1-3. Domestic U.S. shipments of general service incandescent lamps have been naturally declining

since 2003, long before any regulatory Standards took effect. At that time, shipments of more efficient compact fluorescent lamps with a longer socket life were just starting to show significant growth. That

Clark Silcox,
General
Counsel, NEMA

Figure 1. General Service Incandescent Lamp Shipments Index 2001-2018

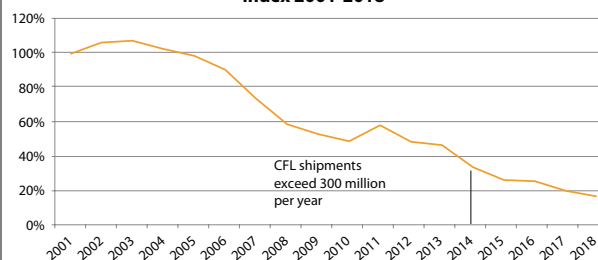


Figure 2. MBCFL Shipments Index 2001-2018 (2001=100)

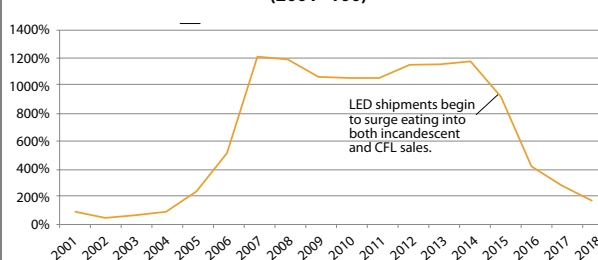


Figure 3. GS LED Shipments Index 2001-2018 (2001=100)

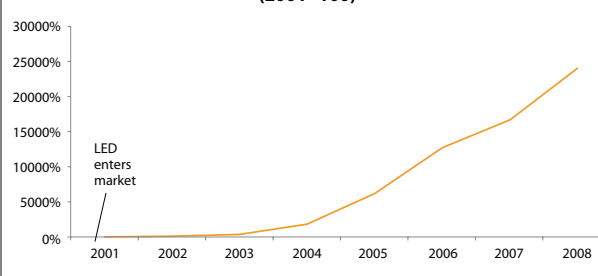
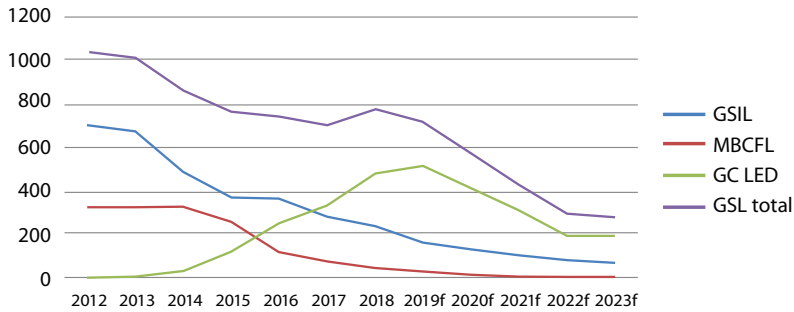


Figure 6. General Service Lamp Shipments 2012-2018 and forecast for 2019-2023 (in millions) - baseline scenario



growth accelerated in 2007 and continued through 2014; thereafter, shipments of general service light-emitting diode lamps started to accelerate in 2015.

Figure 6 compares the shipments of each of the three technologies of general service lamps since 2012 and includes a forecast through 2023.

Lightbulb shipments tell only part of the story because they are not a direct measure of electricity consumption; lamps in lamp sockets are a more direct measurement of electricity use. Another important input is the service life of the bulb—how long it resides in a socket. Longer-life CFLs and LEDs crowd out the ability of the shorter-life incandescent bulb to substitute in a socket at any point in time and therefore influence what type of bulb remains in lamp sockets. Ultimately shipment data combined with assumptions about lightbulb service life and data-derived lightbulb wattage enables reasonable estimates of electricity use by these lamps over time. Figures 4, 5, 7, and 10 display the estimates of the installed base showing general service lightbulb socket penetration by technology for 2012, 2019, 2021, and 2023 in the absence of regulation.

Figure 4. 2012 Estimated General Service Lamp Stock Allocation

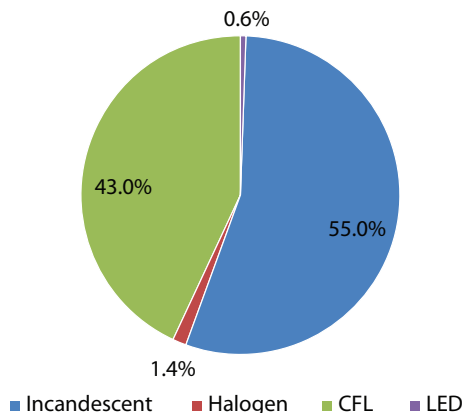


Figure 5. 2019 Estimated General Service Lamp Stock Allocation

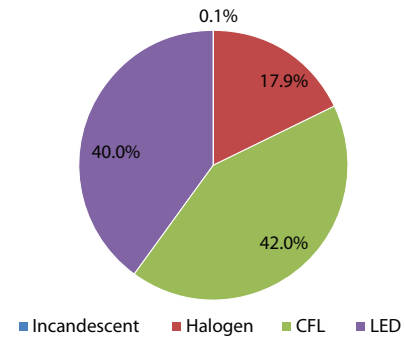


Figure 7. 2021 GSL Stock est. Baseline Scenario

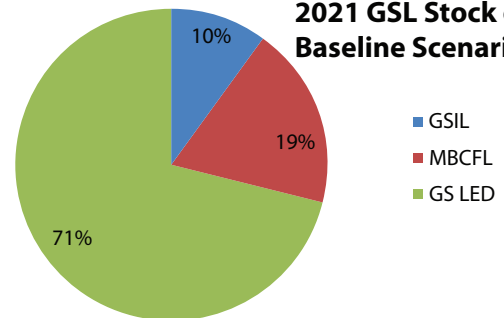
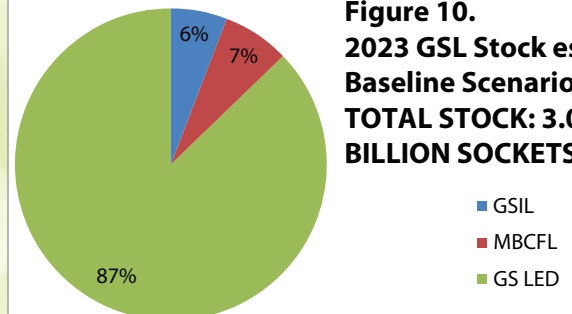


Figure 10. 2023 GSL Stock est. Baseline Scenario TOTAL STOCK: 3.0 BILLION SOCKETS



We compared the NOMAD scenario to a mandatory energy conservation requirement that could not be met by a general service incandescent lamp (the “ban scenario”). Incandescent light bulbs do not disappear from sockets overnight, but they do disappear from store shelves sooner and over time from sockets. The estimated socket penetration by the end of 2021 and 2023 under a scenario that banned incandescent lamps at some point in 2020 is shown in the two graphs on Page 13. The ban scenario model results in approximately five percent fewer (5 percent vs. 10 percent) general service incandescent lamps in sockets in 2021 under a regulatory scenario compared to the baseline scenario; by 2023, there are four percent fewer (two percent vs. six percent) general service incandescent lamps in sockets under a regulatory scenario compared to the baseline scenario.

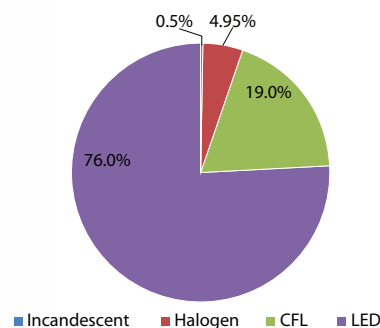
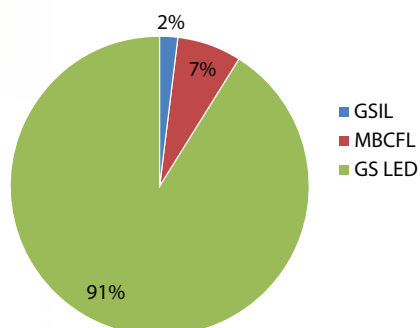
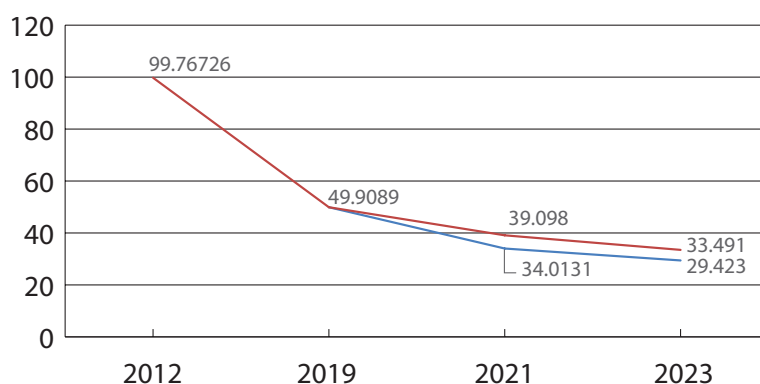
Figure 8. 2021 Estimated General Service Lamp Stock Allocation (2020 ban forecast)**Figure 11. Estimated General Service Lamp Stock Allocation: Ban Scenario**

Figure 9 compares the electricity use in the NOMAD scenario (red line) with the ban scenario (blue line). The two scenarios begin to converge by 2023. The graph confirms that most of the energy savings from the adoption of energy-saving lamps has already occurred. The difference in energy savings between the ban scenario and the baseline scenario results in our net energy savings estimate from regulation of 5.08 billion kilowatt hours by the end of 2021 or 0.116 percent of projected 4.28 trillion kWh utility-scale electricity generation in 2021. The 5.08 billion kilowatt hours represent only .017 quads of energy, which is about 17/1000th of a percent (0.01683 percent) of the 101 quads of energy consumed in the United States in 2018. Figure 9 projects the difference between the NOMAD scenario and the ban scenario and shows the difference narrowing by the end of 2023 as the electricity use under the two scenarios begin to converge, with the net difference declining to 4.0 billion kWh between the two scenarios, less than one-tenth of one percent (0.094 percent) of annual utility-scale electricity generation in 2023.

Electricity use by general service lamps (as a percent of U.S. utility-scale electricity generation) declined by over half from 2.46 percent to 1.19 percent from 2012 to 2019. The NOMAD scenario forecasts an additional decline of 0.28 percent by 2021 while the ban scenario forecasts a decline of 0.4 percent by 2021, a difference of 0.116 percent. The “net” energy savings from the

Figure 9. General Service Lamp Electricity Use in Billions of kilowatt hours (2012-2023 est.)

ban scenario after accounting for naturally occurring market adoption is less than one-tenth of one percent of domestic utility-scale generation in 2023. After 2021, the baseline scenario begins to converge toward the ban scenario and the incremental difference in energy savings year over year from a ban scenario is too small to have an impact on domestic power plant requirements.

On a household basis, the impact of not regulating is small as well. Dividing the estimated 5.08 billion kilowatt hours of net energy savings in 2021 under the ban scenario by 127.59 million U.S. households yields an average of 39.81 kilowatt hours of electricity per household in the U.S. in 2021. According to the most recent information from the U.S. Energy Information Administration (EIA), the average electricity usage per household in the United States in 2018 was 10,972 kilowatt hours. 39.81 kilowatt hours represent approximately 0.0036 percent of the average household electricity use in the United States. At an average price of electricity in the United States of \$0.1329 per kilowatt hour, the incremental average household cost of electricity in the baseline scenario over the regulatory ban scenario in 2021 is \$5.29 per year or \$0.44 per month.

For 2023, the differential impact between the two scenarios is even smaller. Using the same methodology, the model yields an average household cost of \$4.16 per year (\$0.34 per month) due to the continuing but dwindling presence of general service incandescent lamps in household lamp sockets. With private label chocolate candy currently costing about \$2.75 per piece, the difference in annual household electricity costs between the two scenarios is less than the cost of two pieces of chocolate candy per year. ☺

A longer version of this article appears on NEMA Currents at www.nema.org.

Can Connected Lighting Provide Grid Services *and* Effective Illumination?



Among the many ways LED lighting is changing the definition of what lighting can do and be is by enabling the development of connected lighting systems (CLS). LED technology facilitates the integration of intelligence, network interfaces, and sensors into lighting devices, which can result in reduced energy consumption and improved lighting performance. But CLS also has the potential to provide a broad range of electric grid services, particularly those that rely on a fast load modulation (such as frequency regulation)—for which many other building end uses (e.g., heating, ventilating, and air conditioning) are not well suited. While that potential has yet to be proven or quantified, a team of researchers at the U.S. Department of Energy's (DOE) Pacific Northwest National Laboratory (PNNL) is working to do just that. Through modeling and simulation, followed by lab and field testing, PNNL is investigating the ability of connected lighting systems to deliver grid services over a wide range of building and grid operating conditions, in ways that meet lighting-user needs and expectations.

Grid services support the generation, transmission, and distribution of electricity from the utility to the consumer and provide value through avoided electricity costs (such as reduced cost for generation or delivery of electricity)—thus saving energy. To date, grid services are generally provided by the supply side (e.g., integrated utilities, grid operators, and generators), but this can result in generators that remain idle for long periods of time, as well as (in the case of fossil-fuel generators) environmental concerns. Meanwhile, there's mounting evidence that providing grid services from the demand side (e.g., from commercial buildings) is an effective alternative with huge potential.

In 2018, the residential and commercial sectors accounted for about 39 percent of total U.S. energy consumption. More than 70 percent of total U.S. electricity use is approximately one-half to one-third the levelized cost of generated electricity, because it alleviates transmission and distribution congestion rather than exacerbating it. It also often leads to deferred or avoided infrastructure build-out and

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Pacific Northwest
National Laboratory
(PNNL)

Mr. Poplawski
is the Principal
Investigator for
Connected Lighting
Systems Research at
PNNL

upgrades. Beyond using less total energy, an energy-efficient building benefits the grid by maintaining low energy use even during typical periods of high demand.

To help pave the way for tapping the potential of buildings providing grid services from the demand side, the PNNL investigations hope to find answers to key questions: How can we quantify the potential for CLS to provide electrical grid services? Can CLS deliver substantial grid services under a wide range of building and electrical grid operating conditions in ways that balance stakeholder needs and expectations? How might CLS manufacturers develop more effective, grid-responsive CLS?

CLS is capable of both rapidly reducing and increasing their electrical demand, and CLS power draw can be quickly modulated by varying light output, spectrum, and distribution, thereby providing grid services at increments of anywhere from hours (e.g., for energy services) to seconds or even less (e.g., for frequency regulation and response). What's more, CLS can monitor energy use and space conditions that affect occupant satisfaction, and can share historical and projected data for coordination and optimization with other building equipment. However, the ability of CLS to deliver grid services while also delivering sufficient lighting service and occupant satisfaction has not yet been proven or quantified—which is where the DOE studies come in.

PNNL has developed a model for CLS using a set of parameters to represent key operation behaviors and constraints intended to maintain occupant satisfaction, including lighting power flexibility (maximum, nominal, minimum) over the course of the day for each of the DOE Commercial Prototype Buildings, delay in initiating response to a grid signal, and maximum lighting-load change rate. The model has thus far been integrated into a simulation platform that allows for the exploration of how CLS, acting alone, might respond to price signals from the grid. A lighting power demand curve that relates lighting load to electricity price was developed, and a transactive control method was simulated to quantify the amount of the grid service that might be obtained, given a specific price trajectory and demand curve.



PNNL is currently running simulations that explore the impact of response delay, change rate, and maximum lighting reduction on lighting demand reduction, energy consumption, and energy cost for a variety of building types—initially focused on office buildings of various sizes. The initial results show that the simulation platform is functioning as expected—CLS adjust their power demand over their allowed flexibility range in correspondence with electricity price. A higher price leads to a lower CLS power setpoint, and vice versa. The results of these simulations should shed some light on whether aggressive light-level reductions or change rates (which run the risk of upsetting occupants) or fast-responding CLS (which might be prohibitively expensive to deploy) are needed to deliver significant grid services.

Lighting in the residential and commercial sectors consumes about 232 billion kWh of electricity each year. The availability of CLS (which had a 0.5 percent share of the installed base in 2016) is expected to grow rapidly to 52 percent of all installed luminaires in the commercial sector by 2025, according to a DOE forecast. The lighting industry is currently focused on developing CLS that deliver value to their owners, operators, and occupants, but not necessarily to the electrical grid—in large part because manufacturers and their customers either don't understand the value of grid services or don't believe that lighting systems are well suited for providing such services. Changing that can make a huge difference in overall energy consumption, as well as in grid reliability.

The continuing investigations by the DOE in this area will extend to other price profiles, buildings types, kinds of grid services, and coordinated control with building HVAC systems. Stay tuned. ☞

U.S. DOE Rulemakings Show Impacts on NEMA Member Companies

The Office of Information and Regulatory Affairs (OIRA), an important subordinate entity within the White House Office of Management and Budget (OMB), recently published¹ its final report on the national impacts of significant rulemakings by Federal agencies from 2006 to 2016. Federal law mandates that OMB review any proceedings that may involve an estimated economic impact (benefit or cost) of approximately \$100 million.

This NEMA-focused staff analysis looks at the major rulemakings of the U.S. Department of Energy (DOE) as compared to other trade associations and regulated entities. The DOE publishes several rules each year that directly impact how products and appliances are constructed and how they perform.

In the report, OMB catalogs and summarizes 85 published “major” rules of several agencies, the DOE included. This report focuses on DOE minimum energy conservation Standard rules, which dictate the performance requirements of both commercial and consumer components and finished goods/systems. For the sake of brevity, this summary addresses only those rules involving estimated benefits (energy savings) of at least \$1 billion. All monetary figures given herein are taken from the OMB report, which tables all financial figures in 2001 dollars.

Some notes and findings:

- Of the 22 major rules identified in the report, NEMA Member products account for nine of these milestones; the closest trade association siblings (AHRI and AHAM) had six and five, respectively.
- For rulemakings involving greater than \$1 billion (2001) energy savings, an estimated total national benefit of approximately \$10.87-\$19.12 billion was forecast, of which NEMA Member product rules account for \$4.9-\$12.1 billion—more than half of national energy savings estimates.
- For rulemakings involving greater than \$1 billion (2001) energy savings, an estimated total national cost of approximately \$4.1-\$5.7 billion was forecast, of which NEMA Member product rules account for \$1.5-\$2.3 billion of these estimates—a little less than half of total national costs.

Importantly, a final rule is almost always preceded by three to four milestone events and documentation, all requiring review, analysis, and public comments from stakeholders. Thus, for every DOE rule (typically taking between three and five years to complete), NEMA must comment two or three times for each rule. Considering a product class needs a Federal test procedure to be examined for minimum energy conservation Standards potential, every product class involves two rulemaking sequences. This is not clearly captured in the Office of Information and Regulatory Affairs summary.

One may readily deduce that since NEMA Member products are impacted by nearly 50 percent of all major rules, NEMA Members have borne the brunt of DOE regulatory responsibility in terms of cost of compliance and energy saved.

The study shows that the electroindustry has proven it meets the spirit as well as the letter of the law, especially where energy efficiency is involved. Collectively, we should be proud of our contributions to the national benefit. NEMA is proud of our Members' commitment to participation in, and compliance with, energy conservation Standards. 🌱

¹ https://www.whitehouse.gov/wp-content/uploads/2019/12/2019-CATS-5885-REV_DOC-2017Cost_BenefitReport11_18_2019.docx.pdf

NEC Keeps Pace with Technology

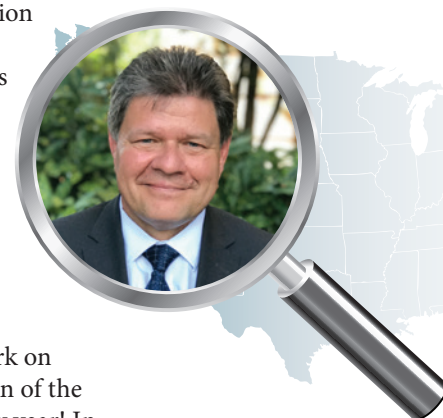
We've all heard the phrase the "Roaring Twenties," a time that saw the introduction of many new products and technologies, when the automotive, film, radio, and chemical industries all took off.

History appears to be repeating itself as we see emerging technologies in the electrical industry with the vast expansion of things such as light-emitting diodes (LED) and the Internet of Things (IoT). As we embrace new and advancing technologies, the *National Electrical Code*® (NEC) continues to remain relevant and serve as the benchmark for electrical safety for these and other technologies.

Massachusetts has already adopted the 2020 NEC, and 11 more states have commenced their adoption processes to update from the 2017 to the 2020 edition. While each state has its own unique adoption process, we have found there are similarities common to the majority. Some States

adopt by statute, whereas others adopt through an administrative rule. In some cases, adoption is by reference only—usually through a building code. In a perfect scenario, states would adopt automatically as soon as the next edition is issued. Unfortunately, this isn't the case and it is through these unique local and state-adoption processes that we are sometimes met with challenges, either to delay adoption or attempt to introduce amendments.

The Field Representatives continue to work on your behalf to support the timely adoption of the NEC unamended, and 2020 will be a busy year! In the Midwest Region, Iowa, Minnesota, Nebraska, North Dakota, Ohio, South Dakota, and Wyoming have begun their adoption processes. I anticipate this list will grow as we move further into 2020, as states across the U.S. continue to recognize the importance of timely adoption. 📍



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Installation Guidelines for Expansion and Expansion/Deflection Fittings provides information on the proper application and installation of fittings intended for use in hazardous and non-hazardous locations in accordance with the *National Electrical Code*; the *Canadian Electrical Code, Part I*; the International Building Code; and the National Building Code of Canada.

NEMA FB 2.40-2019 is available for \$88.

ANSI/NEMA WC 51/ICEA P-54-440-2009 (R2019) *Ampacities of Cables Installed in Cable Trays* is available for \$140.

NEMA MS 14-2019 *Characterization of Radiofrequency (RF) Coil Heating in Magnetic Resonance Imaging Systems* is available in electronic download at no cost.

NEMA GFCI P1-2019 *GFCI Replacement Recommendation* is available in electronic download at no cost.

NEMA XR 28-2018 *Supplemental Requirements for User Information and System Function Related to Dose in CT* is available in hard copy for \$160 and in electronic download at no cost.

ANSI C18.1M, Part 2-2019 *American National Standard for Portable Primary Cells and Batteries with Aqueous Electrolyte—Safety Standard* is available for \$114.

ANSI C18.3M, Part 1-2019 *American National Standard for Portable Lithium Primary Cells and Batteries—General and Specifications* is available for \$117.

ANSI C18.3M, Part 2-2019 *American National Standard for Portable Lithium Primary Cells and Batteries—Safety Standard* is available for \$114. 

SPOTLIGHT

I Am NEMA



As the Director of Statistical Operations for NEMA/BIS I have the opportunity to work across all Divisions of NEMA. While I oversee all of the statistical reports, I am personally responsible for managing the Lighting Division statistical reports. This includes collecting, analyzing, and publishing statistical reports as well as managing Member committees to maintain and create valuable statistical programs. As the lighting industry continues to evolve, keeping the statistical reporting reflective of the current market is important.

I began my career at NEMA just out of college, working on statistical programs, including for the Lighting Division. After five years at

NEMA I left to pursue other opportunities, including working for other trade associations and as a contractor for the Energy Information Administration. In 2015 I was excited to return to NEMA to take the role of Director of Statistical Operations within NEMA/BIS. It was great to come back with a new perspective and see how the electrical manufacturing industry had changed.

I enjoy working with NEMA Members and staff to provide them with reliable and timely data that is used to make informed decisions. 

**Laurie Soucy, Director,
Statistical Operations, NEMA**

EU Green Deal Includes Climate Border Measure

The European Union (EU) adopted a Green Deal policy paper in December 2019 that commits the 27-nation bloc to use trade policy in promotion of carbon emission reductions. Overall, the EU aims to achieve full carbon neutrality by 2050 through a series of policy initiatives leading to the decoupling of economic growth from resource use, according to the document.

Embedded in the paper is a commitment to propose to Member states “a carbon border adjustment mechanism, for selected sectors, to reduce the risk of carbon leakage” into the EU. Such a measure would “ensure that the price of imports reflect more accurately their carbon content.” EU advocates of such a measure have previously indicated it would be aimed at imports from countries such as the United States, which is not a party to the United Nations Paris agreement to reduce global carbon emissions.

The border adjustment mechanism, which would likely take the form of a tax or import tariff, “will be designed to comply with World Trade Organization (WTO) rules and other international obligations of the EU” and “would be an alternative” to current carbon leakage risk mitigation measures such as free allocation of emission allowances and compensation for increased electricity costs. WTO rules allow Member states to impose regulations for environmental protection and conservation of exhaustible natural resources, but they are required to be well designed and minimize barriers to trade. Orgalim, representing Europe’s engineering industries, warned that the EU must be cautious and carefully reflective in its design of measures to address leakage of carbon into the EU from “countries that do not share Europe’s climate ambitions.”

Although it is unlikely the Commission will move forward quickly in 2020 with a proposal, U.S. electroindustry companies that sell into Europe should be aware of this emerging primary risk as well as possible proliferation of such measures around the world similar to EU-originated regulations on chemicals, use of hazardous substances in electrical and electronic equipment, and end-of-life equipment management.

Among myriad policy proposals, including sustainable finance, circular economy measures, and evaluation of rules on government subsidies, the Green Deal paper also references the bloc’s inclusion of climate commitments in its trade agreements. “The Commission will propose to make the respect of the Paris agreement an essential element for all future comprehensive trade agreements.” In addition, the power and advocacy of the EU will be used to “shape international Standards that are in line with EU environmental and climate ambitions.”

COMMERCE ICTS SECURITY RULEMAKING RAISES UNCERTAINTY

In January, NEMA joined 30 technology and business trade associations in a letter to Commerce Secretary Wilbur Ross raising concerns about the transparency and uncertainty of a proposed process through which the Secretary could block or force the unwinding of U.S. companies’ transactions in information and communication technology and services with a “foreign adversary.” NEMA and the other signatory organizations—including the Edison Electric Institute—urged the Secretary to recast the proposal with more clarity and detail and then seek additional comments from the public. The Secretary’s authority derives from a May 15, 2019, Executive Order on Securing the Information and Communications Technology and Services Supply Chain. ☎

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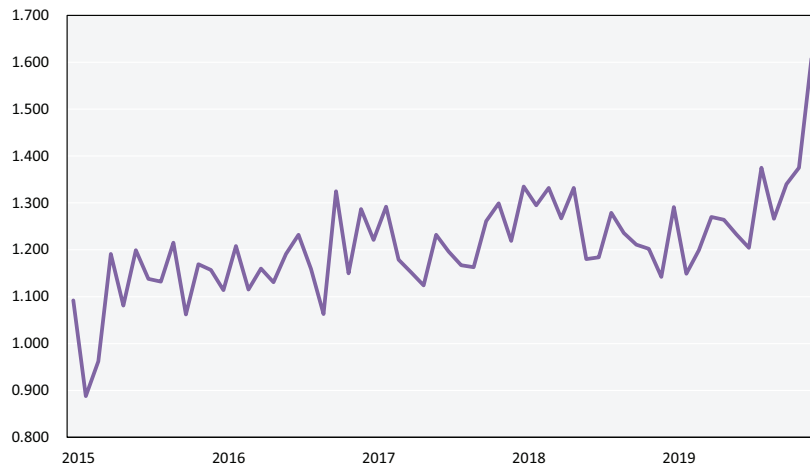
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Key Lighting Product End Markets Signal Little Growth for Industry

Nonresidential fixed investment in structures, a key end market for lighting products, has struggled to gain traction over the past year and will likely detract from overall GDP growth again in 2020. Fixed investment in structures has declined in four of the previous five quarters as of Q3 2019, according to the U.S. Bureau of Economic Analysis, and has subtracted a cumulative 0.9 percentage points from overall GDP growth over that period. The outlook for the fourth quarter is grim, with the expected quarterly decline to measure 13.7 percent on an annualized basis.

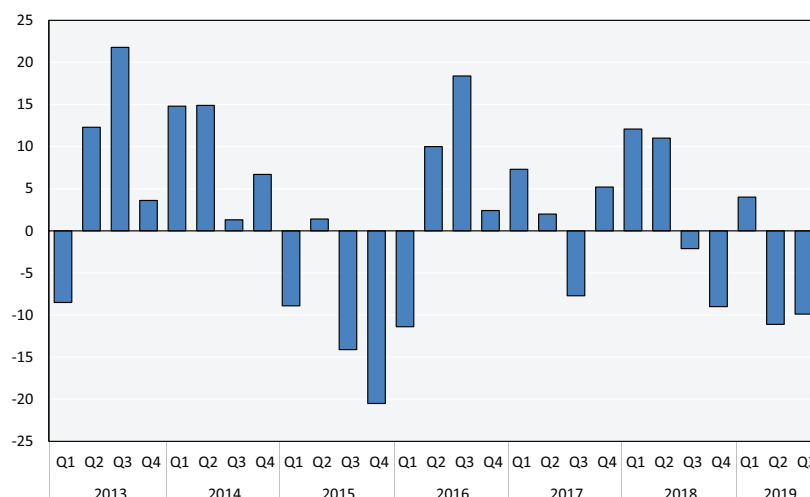
Housing Starts, Millions of Units, SAAR

(U.S. Census Bureau)



Private Nonresidential Fixed Investment in Structures, % Change Q/Q SAAR

(U.S. Bureau of Economic Analysis)



A major cause of this weak performance is the fall in investment in mining and petroleum structures as oil prices have declined. Another likely source of lackluster investment has been the uncertainty surrounding trade. Various private industry surveys have pointed to the trade dispute between the United States and China as a main cause for holding back capital spending.

Some sectors of the economy have been hit harder than others. Private sector construction spending on educational facilities had the steepest decline, slumping 12.2 percent over the previous 12 months as of November 2019. Spending on commercial, transportation, and communication projects has also seen mid-single-digit annual declines.

However, beginning in August 2019, the residential housing market has shown signs of life. After contracting for six straight quarters, residential investment rebounded in the third quarter of 2019. Recent monthly reports from the Census Bureau showed that housing construction may have finally lifted from the doldrums. The December report showed that housing starts rose to a 13-year high, reaching an annual rate of 1.608 million units. After the Federal Reserve reversed course in 2019 with a series of three rate cuts, the 30-year fixed mortgage rate has followed suit, dropping to an average of 3.65 percent during the third week of January 2020, down from its near-term peak of 4.94 percent in November 2018. A multi-decade-high level of home builder optimism at the start of 2020 following the decline in rates signals that the momentum in the housing market is likely to continue.

The outlook for lighting equipment shipments is rocky, with growth expected to be less than 1 percent in 2020. It is likely to remain weak if nonresidential investment in structures continues to underperform the broader economy. However, the recent "phase one" trade deal between the U.S. and China may help alleviate high levels of uncertainty and put upward pressure on investment. @



ENDNOTES FROM THE **PRESIDENT**

Lighting industry disruption continues with light-emitting diode (LED) market penetration accelerating and domestic U.S. manufacturing base for lamps of all types shrinking. Reduced barriers to market entry and falling production costs allowed new manufacturers to join an industry that was once dominated by a few large companies. In turn all these factors have contributed to acquisitions, mergers, and spin-offs as organizations adapt to a changing landscape.

The disruption has also had a positive effect. The U.S. Energy Information Administration (EIA) reports that, although overall electricity usage in the U.S. increased about 1 percent per year, since the start of the 21st Century, electricity use for lighting has decreased 57 percent in commercial and industrial applications. With LED efficiencies reaching more than 120 lumens/watt, manufacturers and consumers alike are beginning to expect more from their lighting than energy efficiency. The benefits of next-generation LEDs outlined in this magazine issue concentrate on consumer preference, convenience, and security—without the loss or mention of efficiency. For example, Li-Fi is an optical networking technology that brings wireless connectivity to a new level utilizing LEDs to transmit data securely within a specific space. The emerging technology of quantum dots used in lighting (QLEDs), also has shown encouraging promise of heightened color control and flexibility.

As lighting technologies continue to advance and change, the industry leaders within NEMA contribute materially with technical Standards that assure lighting quality and allow product differentiation in all areas. For instance, new LED Standards have been developed for outdoor lighting, linear tube fit-systems, LED driver communication, energy reporting, and standby power. Just as importantly, our technical work reinforces NEMA advocacy for prudent and judicious regulations. Often it is the technical depth-of-argument NEMA brings to regulatory and legislative processes that determines the outcome. ☞

Kevin J. Cosgriff
NEMA President and CEO

2020 Editorial Calendar

May/June

Transportation Systems
The internet of transportation

July/August

Building Systems
Energy management

September/October

Industrial Products & Systems
Improving the manufacturing process

November/December

Building Infrastructure
Increasing productivity in manufacturing



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