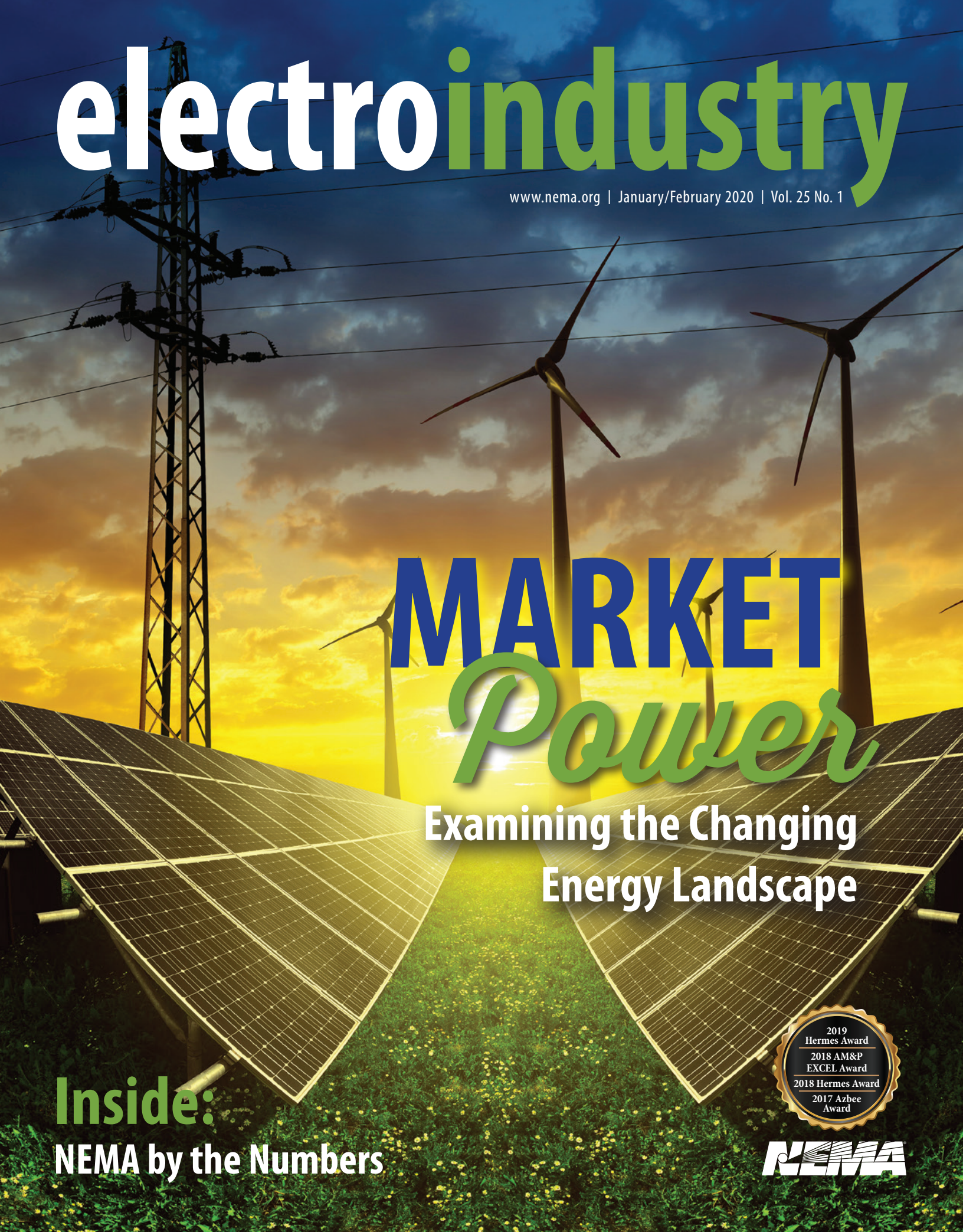
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Publisher | Tracy Cullen
Managing Editor | Jena Passut
Contributing Editors | Ann Brandstadter, Mariela Echeverria, Andrea Goodwin, William E. Green III
Art Director | Jennifer Tillmann
Advertising Executive | Pat Price
The Townsend Group
202.367.2462
PPrice@townsend-group.com

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Happy New Year!

I am pleased to welcome you to this issue of *electroindustry* devoted to "Changing Energy Markets." The start of a new decade is a fitting time to consider how the dramatic shift in the energy market seen over the last 10 years is expected to evolve over the next 10 years.

Currently, there are one million e-vehicles on the road in the U.S. By 2030, that number could increase tenfold. The demand for energy storage is predicted to be 28 gigawatts by 2022, while it was only three gigawatts in 2016. Over the next five years, the total installed solar capacity may double, reaching 100 gigawatts by 2021. But in a world where generation and load must meet equilibrium, how we integrate these technologies will make all the difference.

Smart buildings, fleets of electric vehicles, digital cities, energy storage, distributed generation—these are no longer just great storylines in futurists' musings. These technologies are here today, and they will play a key role in shaping our near-term and long-term futures for our economy and society.

So, what does all this mean for our industry?

NEMA Members' technologies will drive increased electrification and lay the foundation for a flexible and digital electric grid. Our industry makes intelligent systems capable of securely connecting hardware to command and control software systems optimizing performance and reliability. But unless policymakers and regulators establish the right market incentives, utilities and customers may not adopt these modern technologies.

These technologies also will increasingly find their way into our factories, and their impact will not be limited to the equipment that we operate and the products that we produce. Our workforce must transform too. This comes at a time when we are already experiencing a big crew change. But whether you grew up with slide rules or smartphones, everyone from production workers to engineers to data scientists must be open to learning new skills to thrive in the decade to come.

This issue of *electroindustry* focuses on the future of energy markets—how they are changing and how we can plan for that change, from updating rate structures to maximize the value of distributed energy resources to strategies to match consumption to renewable characteristics. I hope you enjoy it.

A closing thought: Those who bet on the status quo risk being left behind.

Raj Batra
Chairman, NEMA Board of Governors

Neil Chatterjee
FERC Chairman

The View from FERC: It's 20/20 from Here

The Federal Energy Regulatory Commission (FERC) has a wide-ranging portfolio of regulatory and oversight responsibilities when it comes to wholesale electricity and natural gas markets. Just as each of us requires 20/20 vision to be productive, FERC needs sharp vision going into 2020 because our work is profoundly important to our nation.

Why? Energy is what makes us strong. In fact, in 2017, total end-use energy expenditures in the U.S. were $1.14 trillion, or 5.8 percent of gross domestic product (GDP). In contrast, defense spending by the U.S. totaled $605 billion, or 3.1 percent of GDP.

The United States gained that strength in part through our ingenuity when it comes to energy production. For instance, thanks to the shale revolution, U.S. natural gas production has reached record levels. And, our exports of natural gas in the form of liquefied natural gas, or LNG, are poised to make the United States a leader in trade with our international partners while also offering environmental benefits on a global scale. FERC has played a critical role in contributing to this success story by reviewing and approving 11 LNG export facilities over the past 10 months.

But our work doesn't stop there. In the electricity space, FERC is taking several actions to modernize our nation's electric grid and further unleash the power of competition in markets. Our country is undergoing a rapid transformation in how we generate electricity, resulting in part from the rise of renewables and natural gas. We have also seen a surge in innovative technologies that will significantly improve the reliability, affordability, and security of generation resources, energy markets, and infrastructure. Amid these changes, FERC is working hard to make sure our policies create the right regulatory environment to benefit consumers.

One example of this is the Commission's efforts to break down barriers that could impede implementation of electric storage resources, like grid-scale batteries. Through our Order No. 841, FERC is requiring organized wholesale power markets around the country to establish rules that facilitate the participation of these storage resources. Our efforts to unleash the power of flexible storage technology will allow for greater competition in wholesale markets, which ultimately offers great benefits to consumers.

Competition—long one of the guiding principles at FERC—continues to prove its importance to the markets we oversee. That's why we are also working to modernize our decades-old regulations under the *Public Utility Regulatory Policies Act of 1978*, to introduce competitive pricing and transform our policies to meet today's realities.

Our focus on competition helps create a regulatory landscape that promotes smart transmission investments. This allows new generation resources to connect with consumers and ensures our nation's transmission infrastructure continues to be reliable. Our goal is to establish incentives and policies that reflect today's investment environment while providing the economic and regulatory certainty needed to build the grid of the future. At the same time, we continue to ensure that wholesale electricity and natural gas markets operate in an open and fair manner by providing just and reasonable rates for consumers.

Part of overseeing these markets means ensuring the grid is reliable and resilient. Our national economy depends on having a grid that meets the conflicting consumer demands for both greater interconnectedness and heightened security. The important task of ensuring the system is reliable and resilient depends on continued partnerships in the electric industry. The Commission works collaboratively with those in the industry to establish mandatory cybersecurity Standards. Our transmission system is the envy of the world, and it is our duty to ensure that, through enforcement of these Standards, consumers will continue to enjoy safe, reliable electricity for years to come.

Going into this new year, the Commission must continue honing our sharp, 20/20 focus to address the critical issues facing our nation's energy system. I am confident FERC is up to the challenge, and we stand ready to help our nation reach its full energy potential.

Neil Chatterjee

NEMA Launches Rail Electrification Council

Steve Griffith, Industry Director, NEMA

About a quarter of worldwide railroad systems are electric. In the United States, it's less than 1 percent.

Most analysts agree that long-haul transportation is more efficient and less expensive by train than by truck. The physics of steel rolling on steel is much more effective from an energy transfer perspective than that of rubber on concrete. Trains are also more efficient aerodynamically than trucks. A cleaner, more robust electrified railroad system could replace substantial amounts of truck traffic, easing congestion and pollution.

Retooling the operations of the domestic and North American rail system entails major reinvestment and manufacturing opportunities. Rail electrification is likely to involve the need for Standards in both the rail and utility industries, as well as supportive government policies at the State and Federal levels.

Recognizing this opportunity, NEMA has officially launched the Rail Electrification Council as the governing body for its ongoing rail electrification activity. The Council is open to all NEMA Members, as well as non-Members active in the rail sector.

NEMA Members' products and systems are building an electrified rail infrastructure that:

- Uses either electric locomotives (hauling passengers or freight in separate cars) or electric multiple units (passenger cars with their own motors) as a primary mode of transport
- Includes options for locomotives powered by batteries as well as hydrogen fuel cells
- Generates its electricity from large and relatively efficient power stations that is then transmitted to the railway network and then distributed to the trains
- Supplies electric power to railway trains and trams without an on-board prime mover or local fuel supply via a continuous conductor running along the track that can be either an overhead line or a third rail
- Provides better energy efficiency, lower emissions, and lower total operating costs than diesel alternatives

The NEMA Rail Electrification Council will focus on the following activities in 2020:

- Developing a business case analysis to convey the value of rail electrification
- Conducting a technology assessment to identify Standards gaps
- Promoting rail electrification through a targeted communications campaign, informed by the business case analysis
- Convening a coalition of aligned stakeholders to extend our influence

For more information about the Rail Electrification Council and its planned 2020 activities, email Steve Griffith, Industry Director, NEMA Transportation Systems Division, at steve.griffith@nema.org.

Book-a-Speaker

Steve Griffith, NEMA Industry Director, Transportation Systems Division, will give the keynote address on electrification transportation at the Argus Advanced Wire and Cable North America conference in Atlanta on February 4.

NEMA electroindustry experts are available to speak at your event. Need a speaker? Book a speaker at www.nema.org/book-a-speaker.

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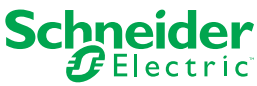

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Award Winners

Dr. Chuck Stearns, Principal Scientist at GE Healthcare, accepts the Röntgen Award for his contribution to the development and advancement in PET/CT imaging technology. The award celebrates pioneers within the Medical Imaging & Technology Alliance (MITA).

The Illuminations Award for Business Innovation is presented to a NEMA Member company that has demonstrated success through entrepreneurial growth or pioneered innovation. This year, Anne Smart, Vice President of Public Policy, accepted the award for ChargePoint, Inc. The company received the Illuminations Award for its demonstrated success in advanced technology in electric vehicle charging networks.

MEETING

Timothy H. Powers, retired former chairman, President, and Chief Executive Officer of Hubbell Incorporated, receives the Bernard H. Falk Award, which recognizes outstanding achievements in technology, public affairs, management, trade, and other fields relevant to the electroindustry.

Pat Avery, Vice President of Power Grid Automation at G&W Electric Company, accepts the Kite & Key Award, an honor that goes to individuals who have advanced the interests of the electrical industry through their involvement at NEMA.

Thomas J. Tobin, Chief Technology Officer at S&C Electric Company, also receives a Kite & Key Award.

Speakers at the NEMA annual meeting included, clockwise from top left, Matthew Eggers, Vice President of Cybersecurity Policy for the U.S. Chamber of Commerce; Michael Morgan, Partner and Co-Lead for Global Privacy and Cybersecurity at McDermott Will & Emery; Phil Squair, Vice President, Government Relations, NEMA; Panelists Michael Tschanz, Director, Technology & Analysis, Walt Disney World, Sujeet Chand, Chief Technology Officer for Rockwell Automation and Jason Handley, Director of Smart Grid Emerging Technology & Operations for Duke Energy; Donald R. Leavens, PhD, Vice President and Chief Economist for NEMA; Incoming NEMA Chair Raj Batra, President, Digital Industries, Siemens USA; and panelists Trevor Rudolph, Vice President of Global Digital Public Policy for Schneider Electric, Nazak Nikakhtar, Assistant Secretary for Industry and Analysis for the U.S. Department of Commerce; Colin Chummers, Vice President of Supply Chain Operations for Cisco Systems; and Jeff Weiss, Partner with Venable LLC.

Photos by Vanelli

Economic Gravity at Play in the Electric Power Industry

Doug Staker, Vice President of Utility Business Development, Enel X

Mr. Staker is a pioneer in the world of smart grid technologies, with a focus on smart metering and intelligent energy storage.

Today's electric power industry is migrating through various elements of change. The integration of renewable power at a scale that competes with traditional generation is impressive. Endorsed by renewable supporters and condemned by business-as-usual promoters, the reality is that a simple principle of physics is at play: economic gravity.

Wind and solar power generation are growing globally. There are a variety of reasons, but a fundamental element is that they produce a lower Levelized Cost of Energy (LCOE) than their fossil fuel and nuclear counterparts. A key component is that their fuel costs—the wind and sun—are free. In calculating LCOE, one needs to include both capital and operating costs in the equation. Wind and solar power are now at an LCOE that is competitive with natural gas and has surpassed coal in the past few years.

How the Grid Works

Energy generation is only one part of the energy delivery system, which also includes transmission, distribution, and load. A vital aspect of the power grid is that it is a perfect "just-in-time" delivery system. Supply has to match demand; otherwise, the grid delivers voltage and frequency outside of the standard operational limits. These components are subject to two elements, time and location. Generation must follow and match load to keep the grid stable. Transmission and distribution systems need to be sized to meet peak demand. With the introduction of distributed energy resources, like solar, storage, and combined heat and power (CHP) systems, new market entrants can participate in the rules of economic gravity, where gravity pulls the economy in a direction that leans heavily toward lower costs when selecting resources.

Structured Markets

In the United States, utilities are subject to State and Federal oversight. That means we have 50 jurisdictions that influence how the commodity of energy is priced and delivered. In the late 1990s and early 2000s, new utility markets emerged in some regions of the country. New England, New York, the mid-Atlantic states, Texas, the Midwest, Southwest, and California restructured and formed new markets. Vertically integrated utilities were disaggregated in these regions. Generation was developed to be a competitive resource. Utilities retained transmission ownership, but the ownership is controlled and regulated by an independent group known as a regional transmission organization (RTO) or independent system operator (ISO). The utilities are paid via various tariff schemes developed by the Federal Energy Regulatory Commission (FERC).

Since most ISOs depend on energy transmitting across state lines, FERC becomes the regulator for these markets for generation and transmission.

Wholesale Markets

In restructured markets, utilities today are fundamentally in charge of the local distribution system. The pricing and control of generation and transmission are managed by the ISO that develops both day-ahead and day-of-pricing models that reflect current conditions.

These energy markets follow the rules of supply and demand and are subject to the laws of economic gravity—low costs win. Generators bid in both markets and are rewarded with participation as their price is accepted based on the amount of the resources needed to meet demand. The ISO accepts bids based on price (lowest price first, etc.) until enough megawatts are secured to meet the forecast demand for two different time periods: day-ahead and real-time.

Day-ahead offers are bid 24 hours ahead, and they are cleared based on price and the number of megawatts. The day-ahead pricing is cleared and published at 4 a.m. for the next day that will begin at midnight. There are 21 hours of notification before the pricing begins. In the real-time market, they forecast the shortage or imbalance in the system due to the variance between the day-ahead forecast and the 90 minute view of the current usage. It is very dynamic and can create price spikes that entice entrants to jump in and solve the shortage.

The transmission system is like a freeway: there are physical restrictions that limit the number of electrons (cars) that can flow. The ISO knows the limit of each line, and another generator is then selected past the point of congestion, which adds an element of locational benefit into the pricing equation. These elements follow the principles of economic gravity which are influenced by time of day and location; location-based, low-priced wins.

Retail Markets

In order to develop a full digitalization of the energy delivery system, the next frontier to establish is the distribution system. Along with the load it serves, the distribution system is the least automated and least understood component of the energy delivery system. To make things even more problematic, the distribution system is still managed with monthly metrics.

With the growth in distributed generation, we now have a changed model where energy can flow in both directions, and load can be managed to reduce congestion or to lower the need for peaking power. Market participants are pushing to have the ability to sell excess generation into the wholesale market, via the distribution system, and participate under the rules of economic gravity. Time and location have just as much value in the distribution system. There are also those who would like to develop local markets where excess solar energy could be sold to a neighbor via a market transaction.

Today where retail markets are restructured, distribution utilities get to charge for their service to deliver energy purchased from third-party resellers or energy marketers. The distribution utility charges for delivery of the energy. Energy is defined as the "supply" or the "commodity." So, in the restructured market, we have "supply" and "delivery" charges.

In the restructured retail energy markets, customers can buy their "supply" in the day-ahead market. They select an energy retailer that offers a variety of pricing models, but the two most popular are fixed (flat-rate) or hourly pricing based on the wholesale day-ahead market. The day-ahead model is known as an "indexed price."

For commercial customers, supply is measured as energy or kilowatt hours. Think of it as mileage. It measures the number of electrons delivered over a billing period, but it doesn't answer the question of the rate or speed of energy use. The rate at which energy is

measured is known as "demand." Customers are billed for "peak demand" which is the fastest average speed that the electrons were delivered to the customer. In most cases, demand is measured every 15 minutes. A meter keeps track of the peak demand measured during the billing period.

As an energy retailer develops pricing to end users, they buy energy in the day-ahead market and pay for the aggregation of all of their customers' peak annual demand, which is known as their installed capacity (ICAP). This is measured for each load at the peak hour of the year. To keep the billing simple, the retailers transform the ICAP charge into an energy charge (cents/kWh) along with their margin. As highlighted earlier, end users can choose to buy hourly energy or at a fixed rate. Retailers like to tell end users that a flat rate allows the energy manager to ensure budget certainty and eliminate any risk in the market.

Index pricing for energy supply is another example of economic gravity. Generators compete to sell their supply into a competitive market, and the laws of supply and demand prevail. So, as we develop the new frontier of the distribution system, why wouldn't we investigate how to develop variable delivery (e.g., hourly or real-time) pricing based upon market conditions in the distribution system? As we develop more distributed resources, especially solar and storage, we can better match supply with demand based on real-time pricing. Real-time distribution pricing can also reflect the laws of supply and demand locally and help support lower costs.

Continuing to build to meet the peak in a distribution system will result in continued growth in system costs. New methods in how regulators allow utilities to develop the distribution system have resulted in the development of non-wires alternatives (NWAs). New performance-based regulations for utilities encourage third parties to offer load-modifying resources to help eliminate the need at peak.

Case Study in New York

To develop pricing signals to help influence load modification, under the direction of the New York Public Service Commission, Enel X and Con Edison have developed a variation of what is known as a standby rate. Instead of having a monthly demand charge, we have a daily demand charge with a second demand component that is priced higher during the four hours of the network peak. In the residential districts of the outer boroughs that have the most potential of hosting rooftop solar, we have distribution system peaks that occur along with the residential peak (7 p.m. to 11 p.m.). Solar photovoltaic production occurs mainly between 10 a.m. and 2 p.m.

The ability to store and time shift this energy into the evening hours allows for the reduction of grid stress during peak hours and helps reduce the capital needed to support peak loading. Con Edison is incented by regulators to implement NWAs, as they get to keep 30 percent of the economic benefit derived in the benefit cost analysis study that the NWA-provider delivers. Instead of deploying more capital that has a lower utilization factor, Con Edison is rewarded with improving system utilization and saving money.

While the conversion from monthly demand charges to daily demand charges is a step in the right direction, the next phase is to move to hourly pricing for distribution charges. This market-based pricing scenario allows market participants to more easily stack the values across the energy delivery system. The market participants will help reduce the operating costs of the grid, benefiting all ratepayers. It will add competition to the distribution market and help solidify the principles of economic gravity. This will help to more cost-effectively integrate more variable supply from renewable resources and make the goals set out around clean energy a reality.

This new market-based pricing will allow for the evolution of the distribution utilities into a distribution system operator that can use market-based metrics to organize how the grid operates based upon the physics of economic gravity. That will help ensure that prices will be competitive and value maximized.

The Push for Clean Energy

How to Modernize the Grid to Accommodate the Integration of Renewable Energy and Enable the Decarbonization of Society

Individuals, governments, and businesses are pushing to decarbonize society, and a core component of reducing carbon emissions is shifting to renewable energy for the generation of electricity. A transition to 100 percent clean, carbon-free electricity by 2050 is necessary in order to reduce greenhouse gas emissions by 80 percent.[1] Renewable generation has grown rapidly, doubling in the last 10 years,[2] and the global power generation mix is transitioning to renewable energy sources.

Though the effort to decarbonize via renewables is essential, the power grid's limited ability to accommodate renewable generation presents a challenge to the industry. In fact, increasing renewable generation capacity is not resulting in the expected growth in electricity generated from renewables.

This trend is the result of a saturation effect—as more increments of renewable capacity are added to the grid, the energy generation contribution of these capacity increments becomes smaller and smaller. Constraints that contribute to this saturation effect include transmission limitations based on new generation locations relative to load, increased transmission distances, and transmission congestion. Other limiting factors include lack of energy storage, coordination with other generation resources, and the challenge of balancing power supply and demand.

Transmission Distance and Congestion

Unlike fossil fuel plants, the most productive renewable generation sites are often located far from large loads. For example, North Dakota has excellent wind energy potential, but the state is far from any large load centers. This challenge will become increasingly relevant with the growth of renewable wind generation in the central U.S. region and offshore.

In addition, increasing the amount of remote renewable generation without sufficient transmission resources has led to transmission lines becoming congested. Consequently, renewables may be curtailed to keep lines within their thermal and dynamic stability limits.

Transmission infrastructure must therefore be enhanced to accommodate growing transmission needs over great distances. Specifically, long-haul transmission lines, such as HVDC (high-voltage, direct current) lines, could be installed to bring large amounts of remotely generated renewable energy to market. The National Renewable Energy Laboratory *Interconnection Seam Study* is showing that added transmission capacity assists in the growth of renewable generation.[3]

Audrey Wang Gosselin, Engineer, ABB Inc., and Gary Rackliffe, Vice President, Smart Grids and Grid Modernization, ABB

Mrs. Wang Gosselin is an engineer in the LEAD Early Career Program. She is bringing business development opportunities to ABB with the Smart Grids and Grid Modernization team. Mr. Rackliffe is Chair of the NEMA Utility Products and Systems Division Leadership Committee.

Balancing Supply and Demand

Balancing the supply and demand of power is becoming increasingly challenging due to the growing diversity of the power generation mix.

An iconic visual for illustrating this balancing act is the California duck curve, shown in Figure 1. The California duck curve was first published in 2013 by the California Independent System Operator, but it can also be observed in other grid regions that have seen a growing amount of renewable solar generation and an evening system peak.

The duck curve shows the net load on the grid on a typical day in springtime. Net load is the load served by the electric system, minus the load served by variable renewable generation such as solar and wind power.[4] The duck's belly is the midday dip in net load caused by the growth of solar generation. Whereas the duck's neck shows the ramping generation requirements that thermal peaking plants and transmission imports must fulfill to meet peak power demand in the evening.

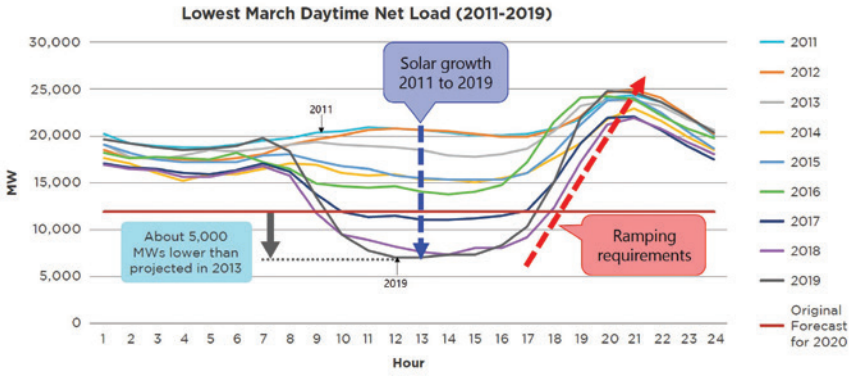

Figure 1. The California duck curve[4]

The duck curve reveals a timing imbalance between supply and demand. During the day, there is a risk of oversupply of generation in the early afternoon when solar power is available; oversupply can directly impact market prices, sometimes dipping into negative pricing. In the evening, base load generation, fossil fuel peaking plants, and energy imports are needed to meet the steep change in net load and the system peak demand.

The consequence of this phenomenon is that unless transmission is available for export demand, renewable generation may be curtailed to avoid negative pricing during the day. Base load generation is needed to reduce the strain on peaking plants that must rapidly ramp up to meet evening demand.

Strategies to Facilitate Higher Levels of Renewable Generation Deployment

Considering the constraints on the grid, the challenge for the power industry then becomes about mitigating the renewable saturation effects that could lead to curtailment.

INVESTING IN TRANSMISSION TO SUPPORT RENEWABLE GENERATION

Although distributed energy resources (DERs) are essential for our renewable future, the hype of DERs should not overshadow the importance of the role of transmission and centralized grid resources in the modern grid.

For example, Figure 2 shows the disparity between wind capacity and transmission capacity in West Texas. From 2007 to 2011, the Electric Reliability Council of Texas (ERCOT) significantly curtailed wind generation to keep transmission lines within their stability limits. Despite ample wind power production during these years, wind generation could not be delivered to customers due to transmission capacity limitations.

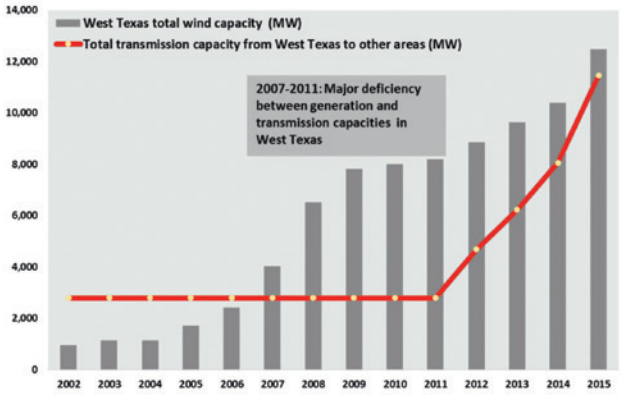

Figure 2. Total wind generation and transmission capacity in West Texas[5]

ABB conducted a series of studies on transmission line capacity, reactive power compensation to allow optimal power flow, and economic impacts. These studies allowed ERCOT investments to enhance the Texas transmission system and connect wind energy generated at remote wind farm locations with the more populated areas in Texas.

INVESTING IN ENERGY STORAGE SYSTEMS TO CAPTURE AND STORE RENEWABLE ENERGY

Utilities are responsible for meeting system demand and maintaining stable voltage and frequency on the grid, but these requirements are complicated by the

variability of renewables. Also, renewable generation is non-dispatchable and does not have 100 percent availability. Energy storage can be used to capture oversupply of renewable generation to shift this energy to help meet peak demand. Storage can also provide capacity firming services to complement renewables to maintain voltage and frequency stability on the grid.

The following are two primary uses of storage to mitigate the integration of renewables:

1. Excess generation can be captured and stored for use during peak demand. This approach is currently being used to address the California duck curve, which is used to show power production over a day and the imbalance between peak demand and renewable energy production. Energy storage systems are charged midday during over-generation hours and discharged in the evening during peak demand.
2. Storage systems can respond to sudden changes in frequency to maintain generation at a committed level. This approach, known as "capacity firming," was implemented by ABB in Hawaii to aid in firming-up solar generation on Kauai. The battery energy storage system that was installed, shown in Figure 3, can quickly respond to changes in generation levels, optimizing the efficiency of the solar photovoltaic (PV) plant and allowing for a smooth power output onto the grid.

Figure 3. Battery energy storage systems installed by ABB in Hawaii[5]

INVESTING IN DEMAND MANAGEMENT TO 'DISPATCH' LOAD TO MATCH RENEWABLE GENERATION

The future grid will include shaping demand to match the characteristics of renewable generation. Today, the grid is managed by forecasting load and dispatching generation to meet peak demand. By reversing this idea—managing the load to respond to the available renewable generation—utilization of renewable generation assets will increase.

One approach for implementing this concept of demand-side management is to incentivize power consumption at certain times of the day with time-of-use rates or real-time pricing.

Considering the duck curve again, moving demand from the evening to the afternoon when solar PV generation peaks will decrease system generation capacity requirements and increase solar PV generation asset utilization. Both effects improve the economics of the grid.

Looking to the future, demand-side management will prove to be critical with the growth of the electric vehicle market. EV charging could dramatically increase peak load, potentially exacerbating the effects of the duck curve, unless the effects of this added demand are preemptively mitigated with managed charging strategies.

KEY TAKEAWAYS

1. Renewable generation must be immediately consumed, stored, or transmitted to other regions needing generation. The energy timing and geography constraints must be addressed, or renewable generation will be curtailed, resulting in diminished benefits from renewable investments.
2. Utilities must modernize their grids now to address the saturation effects that can lead to curtailment of renewable generation.
3. A modern grid will need transmission capacity along with storage to accommodate higher levels of renewable generation.
4. Finally, a modern grid will also need active shaping of customer load to align demand with renewable generation characteristics.

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5. ABB, "Meeting the Challenge of Modernizing the Grid to Stabilize the Integration of Renewable Energy," ABB Power Grids North America, Raleigh, 2019, bit.ly/ABBReport

Grid Modernization and System Planning: PUCO's Perspective

Innovation and technology are rapidly changing the world as we know it, and the electricity sector is no exception.

Consumers want control and access to information; many are constantly on their smartphones, whether it be for social networking, shopping, managing their finances, or working. Why should electric service be any different. Consumers should be able to leverage data to manage personal energy use and costs. As new products and services become available, we must plan for their incorporation into the business of electric distribution.

In August 2018, after more than 100 hours of public forums, the Public Utilities Commission of Ohio (PUCO) released the PowerForward Roadmap. This roadmap, which lays out a direction for grid modernization in Ohio, was developed after 127 industry experts provided presentations to help us better understand how technological enhancements could affect our future electric distribution grid. To follow, two workgroups (Data and Modern Grid, and Distribution System Planning) held over the last year further developing specifics related to grid planning and data access issues in Ohio.

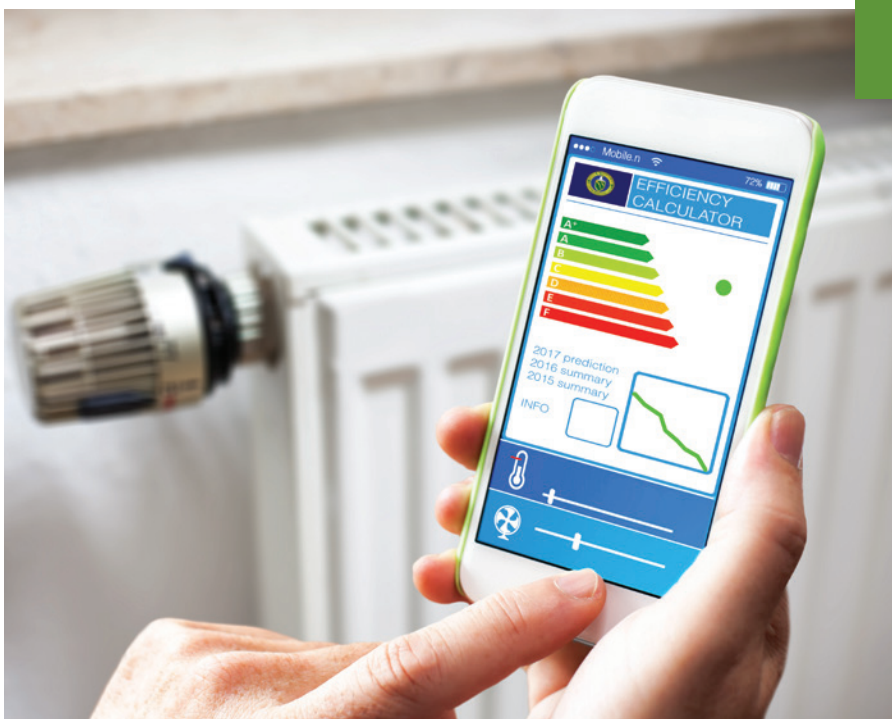
On market development, the Data and Modern Grid workgroup looked at ways to realize the full potential of data from advanced meters, such as allowing customers better access to their usage data and the ability to authorize the release of that data to competitive suppliers and third parties. The group evaluated how advanced meter data is being used for wholesale settlement purposes. The use of this data for settlement (versus generic load profiling) will enable retail marketers in Ohio to develop more innovative products and services and will allow customers to make more informed, actionable decisions about usage. The workgroups will release reports of their findings in early 2020.

The PUCO also benefits from watching what is happening in other states exploring these topics, such as Colorado, Minnesota, Pennsylvania, Maryland, and Rhode Island, and from collaborating at the national level.

In February 2019, the National Association of Regulatory Utility Commissioners (NARUC) and the National Association of State Energy Officials (NASEO), with support from U.S. Department of Energy (DOE), announced the Task Force on Comprehensive Electricity Planning. Ohio joined the task force along with 14 other participating states and Puerto Rico, and I was honored to accept a leadership role as Co-Vice-Chair.

The two-year effort serves as a resource for states as they pursue individual paths in modernizing the grid and accommodating new technologies. The Task Force seeks to develop new pathways for comprehensive electricity planning, with the ultimate objective of improving grid reliability and resilience, optimizing the use of distributed energy resources, avoiding unnecessary costs to ratepayers, and increasing transparency of grid-related investment decisions.

The Task Force is developing guiding principles for states to consider in terms of distribution system planning and outcomes. This shared expertise will help states better frame policy discussions about the grid of the future and chart a path forward for grid modernization projects.



The Task Force held two workshops, with another two planned in 2020. Between in-person meetings, it holds regular conference calls and webinars. Each participating state brings the expertise of its commission and state energy office, and offers diversity in terms of geography, market models, planning approaches, and state goals.

For example, if a state wanted to move its utilities from traditional planning to IDP, that effort would be impacted by whether the state is vertically integrated or fully restructured, whether the state has a renewable portfolio Standard, energy efficiency mandates, demand response programs, etc. The Task Force endeavors to give states model "templates" that could be used to guide like states in future integrated distribution planning efforts. The next in-person meeting is in April 2020 and the final product will be publicly released at the end of the two-year process.

The next in-person meeting is in April 2020, and the final product will be publicly released at the end of the two-year process. If you are interested in learning more about the Task Force or wish to view a library of relevant information, visit www.naruc.org/taskforce.

Beth Trombold, Commissioner, Public Utilities Commission of Ohio

Commissioner Trombold, who serves as Vice-Chair of the PUCO and Co-Vice-Chair of the Task Force on Comprehensive Electricity Planning, has focused her work extensively on grid modernization and regional electric transmission issues.

Philip Squair
Vice President of Government Relations, NEMA

NEMA Promotes USMCA and Key Tax Provision

As this article is being written, the nation's capital and much of the country are watching congressional hearings on the possible impeachment of the President. Amid this, NEMA continues to promote significant initiatives to implement policies that help NEMA Members be successful and profitable.

In recent months, NEMA has engaged in two significant grassroots campaigns. The first campaign urged passage of the U.S.–Mexico–Canada (USMCA) trade agreement, and the second campaign supported passage of legislation to accelerate the expensing of qualified improvement property (QIP).

The U.S. electroindustry depends on trade within North America. As such, both NEMA and the Administration view approval of USMCA as a top priority. Members of Congress, state Governors, and local officials should understand this and move toward bringing legislation across the finish line. The electroindustry has emphasized these points in more than 30 letters to Congress.

NEMA also pushed Congress to pass a key tax provision that benefits the electroindustry and its customers. QIP projects are those related to any improvement to the interior portion of an existing nonresidential building such as remodeling, installing energy-efficient upgrades, replacing floors or lighting fixtures, installing electric vehicle charging stations in the garage, or making safety and access upgrades.

Due to a drafting error in the *Tax Cuts and Jobs Act of 2017*, the period over which businesses can expense these facility improvements has nearly tripled—from 15 to 39 years. The error—acknowledged as such by both Republicans and Democrats—also excludes these improvements from bonus depreciation, which allows businesses full deductibility of allowable investments over a period as short as one year.

NEMA is part of a broad coalition looking to pass the QIP fix, and our strategy was to include legislation in a year-end, must-pass spending bill. So far, the QIP campaign has resulted in 393 letters being sent to 85 different Representatives and Senators, a tremendous turnout that adds momentum to our efforts on Capitol Hill.

SPOTLIGHT

I Am the Electroindustry

In a world of constant technological advancement and evolution, the electric motor has managed to remain virtually unchanged since its invention over a century ago. When I founded Infinitum Electric in 2016, I set out to change that. Much like the NEMA commitment to advancing industry Standards, Infinitum prides itself in raising the electric motor bar when it comes to efficiency, durability, physical footprint, and access to analytics, another major NEMA pillar we stand behind.

Throughout my career in engineering, NEMA has served as a tremendous resource and guide to help advance the various projects I've been a part of. Now, as the founder and CEO of my own growing company, I look forward to leveraging our NEMA membership even more extensively.

Becoming a NEMA Member and being recognized as a company that meets the organization's high industry Standards of safety, reliability, and efficiency are incredibly important to us as a young growing company. With the NEMA stamp of approval, we're able to show the world that we're committed to the highest levels of quality, helping to establish further trust in our business and products as people continue to learn about us and what we're all about.

With our patented PCB stator-based motor technology, we've developed the potential, within the entire electric motor industry, to drastically increase the efficiency of all the world's electric-based applications. Our unique design means our electric motor efficiency exceeds IE5 Standards. This puts Infinitum in the unique position to help set a new Standard for the industry: a Standard we can better communicate and discuss as Members of NEMA, seeing as it is an organization that has always served as a champion for raising the Standards bar.

We're proud of the work we're doing at Infinitum, and as a newly selected NEMA Member, we're thrilled to be able to join a community that values Standards, reliability, resilience, safety, and analytics the same way we do.

Ben Schuler, Founder and CEO, Infinitum Electric

Alex Boesenberg
Senior Manager of Regulatory Affairs, NEMA

NEMA Regulatory Update and 2020 Outlook

Despite the recent departure of Department of Energy (DOE) Secretary Rick Perry, DOE staff seem to have maintained their stride. The Administration continues to focus on improving regulatory proceedings, particularly in terms of transparency and fairness of analytical review.

For example, after a very modest number of "no new Standard" decisions in the previous 25 years of DOE regulatory review (five total; NEMA is responsible for two of these), the DOE in 2019 proposed several such outcomes, including some for NEMA products.

Lighting products, a favorite product sector for energy-efficiency attention, saw two proceedings recommended for "no new Standard"—general service incandescent lamps and fluorescent lamp ballasts. Neither comes as a surprise; both technologies are highly mature, maximized in design, and rapidly losing market share to solid-state lighting. Between very small incremental potential for increased efficiency, financial analyses cannot justify such investments when sales are in decline.

The LED revolution is well underway, and legacy technology is finally getting a break from previously aggressive regulatory schedules and attention. There is still plenty of work to do in managing these existing regulations at both the Federal and State level, and NEMA will continue to represent Members in this sector.

Standards and test procedures for electric motors, as well as distribution transformers, are also in routine review. Also in the news at the time of this writing, the 2016 regulations for uninterruptible power supplies (among others) are likely to have been officially recognized, despite the lost DOE appeal against publishing them.

If published, the regulations cannot be edited or revised from the 2016 version, so given that industry has had more than two years to come to terms with the contents, it is hoped that any potentially negative impacts are readily mitigated.

The DOE was not alone in issuing items of interest: President Trump issued two Executive Orders in October 2019, (EO) 13891 and 13892, titled "Promoting the Rule of Law Through Improved Agency Guidance Documents" and "Promoting the Rule of Law Through Transparency and Fairness in Civil Administrative Enforcement and Adjudication." These orders are focused on reducing the perceived abuse of federal agency guidance documents.

When offering guidance about the interpretation of a regulation under agency management, such documents can become tools of enforcement, and a previously untouched sector can find itself suddenly under scrutiny and facing potential penalty. The EOs seek to increase the opportunity for public comment, awareness, and scrutiny of such guidance and to make that guidance subject to formal public notice and comment procedures, similar to rulemakings.

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Jack Lyons
Northeast Field Representative, NEMA

Massachusetts on Track to Lead on NEC

It is the start of the 2020 *National Electrical Code*® (NEC) adoption season, and Massachusetts is on track to kick off with a January 1, 2020, adoption date. The Board of Fire Prevention Regulations (BFPR) will have met December 5, 2019, to promulgate the 2020 NEC as the electrical installation regulation for the commonwealth. If the process goes as planned and the amendments that the Electric Advisory Board are accepted by the board, Massachusetts will continue to be the first state in the nation to adopt the 2020 NEC.

The advisory committee worked over the past six months, even before the technical session at the National Fire Protection Association (NFPA) conference occurred, to look at the changes and the effects these changes have on existing state amendments. There were many amendments that were able to be deleted due to the changes in the NEC.

Some of the highlighted amendments advised moving forward with full arc-fault circuit interrupter (AFCI) expansion in a dwelling, deleting an amendment to now require available fault current marking on service equipment, and identify NFPA 1® as the recently adopted fire code for the state. The advisory committee modified the measurement rule for ground-fault circuit interrupter (GFCI) coverage around sinks, keeping the doorway language in the rule in 210.8 but requiring the cabinet sink base receptacle to be GFCI protected.

There is also some ambiguity of NEC printed versions. Massachusetts does not automatically adopt tentative interim amendments (TIAs) that are approved by the NFPA Standards Council during the cycle of the current code. Therefore, the only version that will be adopted on January 1, 2020, will be the first printing. This will lead to some confusion, as all future NFPA approved TIAs will be printed in subsequent printings and will not be enforceable unless they go through the promulgating process of the BFPR. Authorities having jurisdiction and contractors will have to be sure what book is being referred to while planning or inspecting a job and what TIAs have been accepted in Massachusetts.

As we prepare and advocate to adopt all revised codes for the sake of safety, resilience, and efficiency, let us hope for a successful year.

Ann Brandstadter
Manager, Standards Publications and Marketing, NEMA

New Standard Covers EV Charging Across Networks

EV Charging Network Interoperability Standard—A Contactless RFID Credential for Authentication (U_R Interface) addresses the credentials part of a complex standardization system allowing electric vehicle (EV) drivers to recharge their vehicle batteries across different EV charging networks.

NEMA EVSE 1-2018 is available for $160 in hard copy and in electronic download at no cost.

ANSI C137.1-2019 *American National Standard for Lighting Systems—0-10V Dimming Interface for LED Drivers, Fluorescent Ballasts, and Controls* is available for $90 in hard copy and electronic download.

ANSI C137.4-2019 *American National Standard for Lighting Systems—Digital Interface with Auxiliary Power* is available for $80 in hard copy and electronic download.

ANSI C78.53-2019 *American National Standard for Electric Lamps—Performance Specifications for Direct Replacement LED (Light Emitting Diode) Lamps* is available for $75 in hard copy and electronic download.

ANSI C136.58-2019 *American National Standard for Luminaire Four-Pin Extension Module and Receptacle—Physical and Electrical Interchangeability and Testing* is available for $50 in hard copy and electronic download.

ANSI C136.4 2019 *American National Standard for Roadway and Area Lighting Equipment—Series Sockets and Series-Socket Receptacles* is available for $66 in hard copy and electronic download.

Gustavo Dominguez Póo
Director, NEMA Latin America

Craig Updyke
Director, Trade and Commercial Affairs, NEMA

CFE Shares Mexico Grid Project Plans

Mexico's transition and transformation continues under President Andrés Manuel López Obrador, popularly known as AMLO, who took office in December 2018. While his predecessor, Enrique Peña Nieto, had pursued reform and partial privatization of the electricity sector to promote efficiency and new renewable generation, in his first year, AMLO demonstrated his objective of retaining federal government control of energy.

The energy sector remains dominated by the state-owned electric utility, known as CFE, and petroleum company, Pemex. Asserting that Mexico can produce all the energy it needs, AMLO slowed energy reforms begun under the previous government, ended bidding from private-sector companies seeking to build new generating plants, and shelved plans for four new long-distance transmission lines that would have facilitated interconnection with the U.S. grid.

In October 2019, Pablo Realpozo del Castillo, CFE project manager for transmission lines and substations, briefed the Mexican industry on the utility's 2019 to 2024 expansion plans.

In the generation area in 2019, CFE began 11 new thermal electric plant projects accounting for 6,500 megawatts (MW). At the end of the year, six of those 11 are on schedule to be completed (4,200 MW), while five projects (2,300 MW) will remain under construction into 2020. RFPs for additional thermal electric projects accounting for more than 3,800 MW and valued at over $2 billion are expected in 2020. CFE is also making investments in the modernization of 18 existing hydroelectric plants (280 MW) and conversion of 16 existing dams to produce electricity (200 MW).

In transmission and distribution (T&D), current projects accounting for 1,785 megavolt amperes (MVA), 226 circuit kilometers (CKM), and $155 million will be completed in 2019. From 2020 to 2021, four additional projects are to be completed, accounting for 1,580 MVA, 646 CKM, and $493 million in total. New projects in the pipeline account for 1,828 MVA, 1,000 CKM, and $593 million. Of those, 11 projects are planned for bid between 2020 and 2021, accounting for 260 MVA, 224 CKM, and $72 million. Private sector companies may be contracted by CFE to build T&D projects, but CFE will own and operate them.

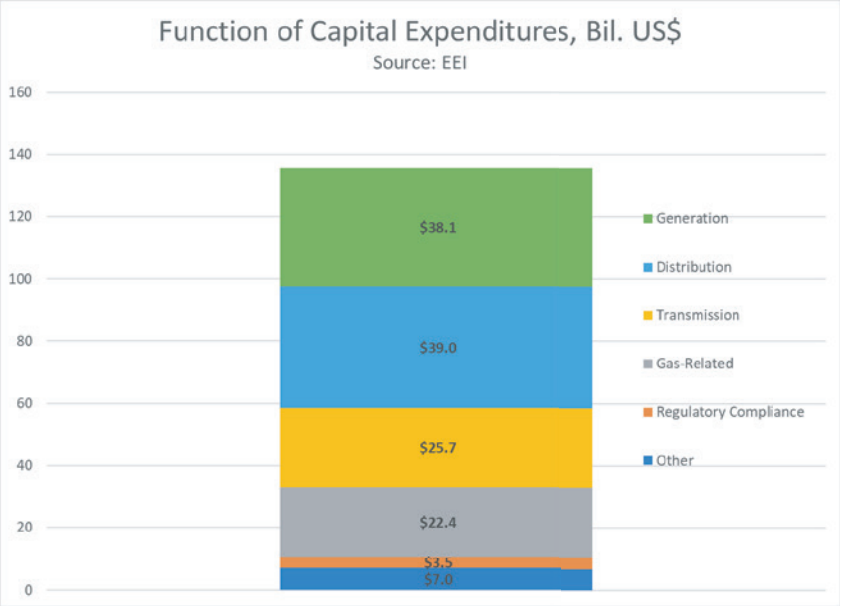
Industry observers question whether execution of CFE plans will be enough to meet Mexico's growing electricity demand, projected to continue to rise three to four percent annually.

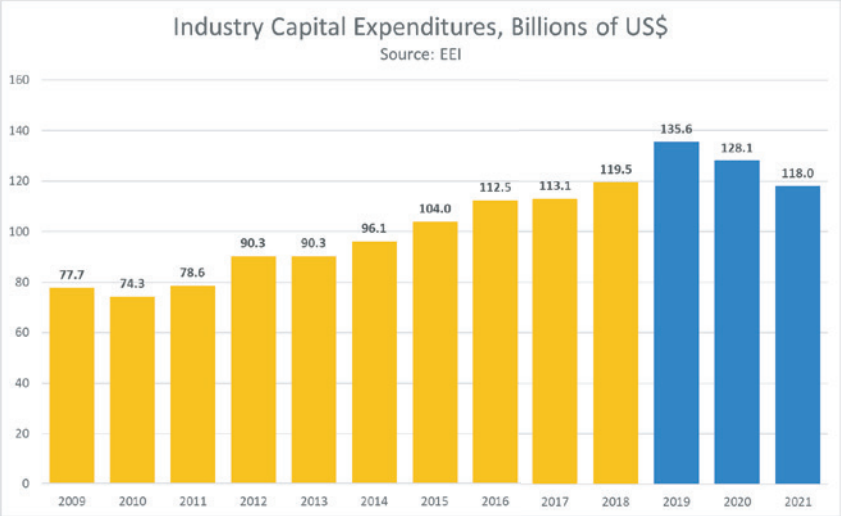
Utility Sector Embraces Microgrids as Capital Expenditures Expected to Remain Elevated

Fred Ashton
Economist, NEMA

Despite modest growth in U.S. electricity consumption over the last decade, 2019 saw record capital expenditures by utilities. Wildfires, hurricanes, and cyberattacks forced utilities to accelerate spending to replace aging infrastructure with more digitized equipment that could help prevent future failures from manmade and natural disasters, according to an analysis conducted by Deloitte.[1]

The Edison Electric Institute[2] predicted that capital expenditures by U.S. investor-owned electric utilities would reach $135.6 billion by the end of 2019, an increase of more than 13 percent from the previous year. Of the $135.6 billion, $38.1 billion was expected to go toward generation, $39.0 billion for distribution, and $25.7 billion for transmission projects.





Following the devastation caused by Hurricanes Maria and Irma, Puerto Rico found itself with 80 percent of its transmission and distribution systems destroyed. Since then, the island has focused much of its recovery effort on investing in microgrids. According to an article by Wood Mackenzie,[3] the microgrid market in Puerto Rico is forecast to reach 228 megawatts by the end of 2024, with cumulative market investment exceeding $419 million.

Many utilities are embracing decentralization, moving away from generating and transmitting electricity using a centralized system. An article published by *Microgrid Knowledge*[4] cited the results of an Accenture survey revealing that 40 percent of the utilities they surveyed said that "they see microgrids along with energy storage and data as key opportunities through 2025." Additionally, Lola Infante, senior director at EEI, noted at the Microgrid 2019 Conference that "half of all microgrids have some utility involvement compared to 10 percent a few years ago." Infante also commented that utilities are investing a combined $100 billion to upgrade their networks.

Microgrids currently provide less than 0.2 percent of U.S. electricity, so the industry is undoubtedly in its infancy. However, capacity is expected to more than double in the next three years, according to the Center for Climate and Energy Solutions.[5] Utilities are likely to continue developing and incorporating this technology as part of their electricity distribution plans to mitigate incidences like those experienced in the aftermath of Hurricanes Maria and Irma.

1. 2020 Power and Utilities Industry Outlook, Deloitte, 2019, bit.ly/2020PowerOutlook.
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3. "Puerto Rico Microgrid Market to More than Double by End of 2024," Wood Mackenzie, June 3, 2019, bit.ly/PRmicrogrid.
4. Ken Silverstein, "Utilities are Giving Microgrids the Jolt They Need to Get Up and Going," Microgrid Knowledge, May 21, 2019, microgridknowledge.com/utility-microgrid-2019.
5. Microgrids At-a-Glance, Center for Climate and Energy Solutions, www.c2es.org/content/microgrids/.

2020 Editorial Calendar

March/April
Lighting Systems Connected lighting
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

The Power of Choice

Florida voters could face a difficult choice at the ballot box in November 2020: whether or not to completely overhaul the state's electric utility market. Florida is currently a "vertically integrated" market, meaning electric utilities own generation, transmission, and distribution assets. Those that own generation and transmission supply to their private distribution networks while also selling electricity to other distribution utilities through bilateral contracts. The consumers (Florida residents and businesses) have little or no choice in who provides their power.

A current ballot initiative could change all that. A Petition for Electricity Choice in Florida is seeking enough signatures to allow Floridians to vote whether or not to open up the state's wholesale (generation and transmission) and retail (distribution) markets to competition. As of December 2019, the petition has nearly 550,000 signatures.

The Florida proceedings are worthy of the industry's consideration as a microcosm of a trend in electricity markets: consumer choice. Today, most of the country's energy markets are deregulated, and market overseers rely on generator bids to establish prices. Florida's move in this direction would not be unique. What is of far greater interest is what might happen at the retail level. Even in deregulated markets, allowing consumers to choose who provides their electricity is rare, but it is becoming less so.

According to the U.S. Energy Information Adminisration, as of November 2018, 13 states have residential retail choice programs. While the total number of participants in those programs has declined recently, more states are considering implementing such programs, and current programs are considering expanding (i.e., to include more retail choice capacity or to include non-residential customers).

The concept of customer choice expands far beyond the supplier. For example, the RE 100 is a group of well over 200 U.S. companies that have pledged to purchase solely renewable energy. Companies like IKEA, Apple, Kellogg's, and Morgan Stanley are on the list. With enough purchasing power to dictate preferences, even in non-consumer choice distribution networks, these companies are moving markets.

Virtually every state now allows consumers to make at least some decisions about the energy they consume, beyond the simple question of quantity. With advanced metering infrastructure and time-of-use opt-in clauses, optional demand response programs, and net metering, the concept of consumer control is becoming more and more prevalent. Demand for equipment and systems that can efficiently and effectively enable that control will continue to grow. Smart meters, distributed energy resource management, and advanced distribution management systems are just some examples.

I do not know what Florida's final ballot wording will look like come November. Nor can I predict the "perfect" balance between competition and monopoly in energy markets. But I do know that energy consumers collectively have more energy choices than ever before. How users apply that power is up to them.

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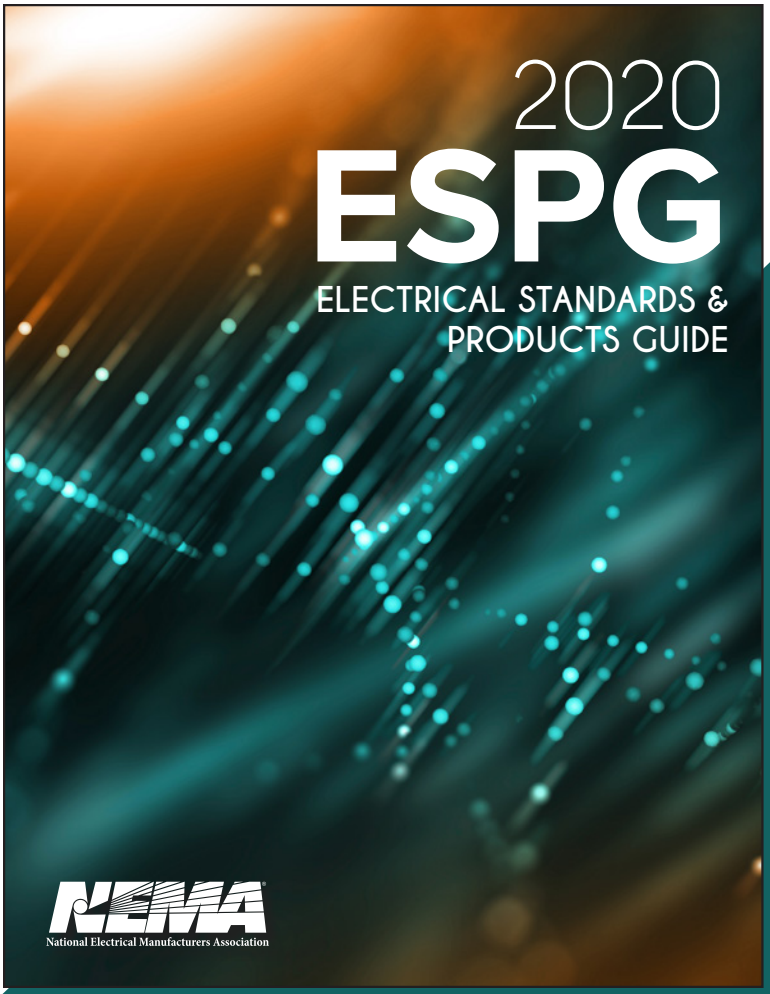

The 2020 Electrical Standards & Products Guide is now available. Published online, ESPG features the listings for more than 700 publications, as well as sales contact information, by product type, for hundreds of electrical manufacturers.