Grid Modernization Index: Insights into a Transformation

Principles for the next decade of progress.

GRIDWISE ALLIANCE

Advanced Grid Research
OFFICE OF ELECTRICITY
US DEPARTMENT OF ENERGY

Contents

Foreword

by Ohio Commissioner Beth Trombold

Grid modernization efforts in Ohio started a few years ago with robust discussions on how the electric distribution system could improve through innovation. This dialogue was not unlike those occurring across the country focused on, among other things, deploying foundational grid technologies and pairing innovation with customer expectations—including giving customers control over their energy usage through enhanced data access in the same manner they have come to expect from other industries.

When I heard that Ohio had won the GridWise Alliance (GridWise) award for "Outstanding Progress" in its most recent ranking,[1] I felt a sense of accomplishment—Ohio had joined the exciting and important conversation taking place across the country. Having spent years of my professional career on staff at the Public Utilities Commission of Ohio (PUCO), and now as Commissioner, I view the task of preparing our grid for the future as a big lift, but a critical one.

GridWise and its members have been at the forefront of numerous demonstration projects and scaled grid modernization deployments seeking to transform the electric grid, maximize performance, and add economic and customer value. To help educate the industry, GridWise developed its Grid Modernization Index (GMI) — a tool that helps stakeholders understand and benchmark ongoing efforts to transform the grid across the country.

In 2018, Ohio's Public Utilities Commission released PowerForward: A Roadmap to Ohio's Electricity Future, which focused on guiding Ohio regulators and utilities in their efforts to enhance the consumer electricity experience. We then continued to discuss specific issues such as distribution system planning and data access through workgroups. Going forward, the Commission will address grid modernization issues and proposals on a case-by-case basis in utility and other proceedings. For example, the Commission recently solicited public comment to clarify jurisdictional issues around electric vehicle charging stations and found that the Commission's jurisdiction does not extend to entities providing charging services. Further, as utility investments change and modernization increasingly calls for new approaches beyond the traditional, a greater emphasis is needed on planning to address system complexities, leverage new technologies, and maximize benefits to ratepayers. Modernizing the grid also means modernizing how we plan for it.

As you all know, technology permeates our lives—and that was true even before the COVID-19 pandemic and the new reality of stay-at-home orders and teleworking. The new GMI Insights report emphasizes the value of grid modernization investments by highlighting transformative efforts taking place across the country, as well as analyzing the pace of change of distributed energy resources and grid resiliency efforts. It explores major changes and trends in the field and provides key insights and takeaways for decision makers to consider.

While every state's utility landscape is different, we can—and do—learn from each other. I encourage you to participate in the grid modernization conversation by reading this issue of GMI Insights. It is through these valuable partnerships that the grid modernization conversation drives forward and the future of our grid unfolds.

Respectfully,

Commissioner Beth Trombold

Public Utilities Commission of Ohio

[1]GridWise Alliance Grid Modernization Index (GMI) 2018: https://gridwise.org/grid-modernization-index-2018/

A Decade of Progress

On December 19, 2007, President George Bush signed into law the Energy Independence and Security Act of 2007 (EISA). This comprehensive energy legislation included a broad range of energy industry subject areas, focused on energy efficiency, renewable energy, carbon capture, and sequestration, and various other issues. Toward the end of the bill was Title XIII *Smart Grids*, provisions that focused on the electricity grid. Many organizations, including GridWise, were involved in crafting this legislation, committing to use this bill to modernize the grid and drive change throughout the industry. This legislation initiated a decade of change across the industry and is still powerfully relevant to the changes taking place today.

One year after EISA (and Title XIII) became law, President Obama signed into law the American Recovery and Reinvestment Act of 2009 (ARRA), committing substantial funding to "shovel ready" projects as an element of a broad national stimulus. Together these two federal laws enabled a rapid increase in smart grid investments across the industry. Many utilities already had plans to modernize their grid, but the ARRA grants provided an incentive to fast track these investments, with more than $10B expended across the electric industry. With these investments came a new awareness for many industry stakeholders that new technologies and solutions were entering the market with very compelling benefits, offering real alternatives to traditional infrastructure options for the first time.

The GridWise Alliance released its first Grid Modernization Index (GMI) in July 2013, designed to track the progress being made across the country in grid modernization by measuring over seventy-five different factors and calculating scores for each state on a 0-100 scale. Progress in many states was clear in the first few versions of the GMI. The fifth and latest version of the GMI was released in December 2018. Most, if not all, ARRA projects were completed by then, and the 2018 scores indicated a slowdown in most state's progress toward grid modernization. Although progress was continuing, federal incentives were exhausted, and policies and regulations were not typically "pushing" utilities to be aggressive.

More recently, new policy and market trends and realities are driving renewed action. Supplementing the legacy of Federal initiatives such as EISA and ARRA, policy initiatives at the state and local level increasingly prompted the changes now taking place across the industry. Many states, cities, and major companies are setting long-term policy goals that are pressing utilities to be more aggressive in their planned grid modernization investments. At the same time, innovative new technologies are giving many customers new cost-effective options that did not previously exist.

Hence, GridWise has focused this report on providing a set of unique insights derived from first-mover utilities that have been leading changes across the industry. As these changes accelerate and spread, new issues and challenges have emerged that provide insights and guiding principles for the decade ahead.

Preparing for the Decade Ahead

The progress of the last decade created a body of knowledge and experience that provides a template for a modernized grid that supports the energy, economic and environmental goals and demands of the government, businesses, and consumers. Driving this progress was the implementation of a new modern grid architecture funded by large grid investments.

In the decade ahead, however, much more will be required. The promise, indeed the necessity, of the electric industry in the future will require an acceleration of many of the changes initiated in the past decade if current policy goals and ambitions are to be realized. The decade ahead will require a fully modernized grid broadly deployed.

Market trends (see section Policy Trends and Market Dynamics Push for Change section of this report) are laying the economic foundation for the required grid modernization investments. Low-carbon energy sources are now demonstrably less costly than traditional fossil fuels. Distributed clean technologies are now seen as an asset for resilience versus a threat to system stability. Buildings and transportation are rapidly electrifying—two critical clean energy transitions required to meet our nation's sustainability objectives.

Businesses and customers have also adopted clean energy goals requiring a modernized grid and, in so doing, have set new expectations for the industry. Corporate commitments to 100% clean energy, in some instances within this decade, now dominate annual reports and marketing. Doing so is good business—it mitigates risk. It also drives growth! Customers are doing their part by demanding this change from themselves and the businesses from which they buy products and services. One study found that 50% of product growth from 2013 through 2018 came from sustainable market products—sustainable marketed products grew 5.6 times faster than those that were not.[3]

Many utilities are responding quickly to these new demands, adding more renewable energy resources, more storage, and vast charging networks to accommodate the rapid increase in electric vehicles. These plans necessarily include investments in modernizing the supporting infrastructure to improve flexibility, resiliency, and security while providing new services to consumers.

In short, utilities are building the required modern grid. What insights can we learn from these industry-first movers?

[3] https://hbr.org/2019/06/research-actually-consumers-do-buy-sustainable-products

In this report, GMI Insights, we document the successes of several first-mover utilities across the country and highlight the common principles that will drive real change in the decade ahead. We conducted a series of interviews that focused on some of the key trends driving the change, namely decarbonization, electrification, and resilience. **We hypothesized a report full of resounding success stories, instead the resulting conversations highlighted how important the process of change is to the greater goal.**

What became clear throughout the interviews is that technology is not a limiting factor in reaching our long-term objectives. While some technical challenges remain, cost-effective technical solutions are abundant, providing innovative new options for grid operators. The primary limiting factor has become the complex decision-making processes inherent in the highly regulated public/private partnerships fundamental to our industry.

As stakeholders in regions across the country analyze the complexity of grid modernization, they do so through the lens of their specific regulatory and legislative constructs. Understandably, not one approach fits all. However, even with this diversity of policy and economic environments, some themes are consistent across regions that support positive outcomes. An analysis of our interview results suggest five guiding principles for successful utilities' grid modernization initiatives:

- **Launch a formal change management process**. Establish clear goals; tell a compelling story; demonstrate leadership commitment and support.
- **Focus on collaboration**. Engage internal (across all utility departments) and external (customers, solution providers, nongovernmental organizations) stakeholders; break down traditional silos; involve underrepresented, hard-to-reach groups; learn from others' experience.
- **Create a culture of innovation**. Focus on internal utility culture, agile processes, and reduced time to market.
- **Embrace the digital transformation**. Break down technology silos, co-develop technology solutions, include systems thinking; ensure interoperability and cybersecurity at the outset.
- **Develop the future workforce**. Invest in people; train them for future technology; get their buy-in to changes.

This document will provide various examples and case studies of how these principles accelerated the required changes being made in each utility. It is not an exhaustive inventory of grid modernization efforts. Still, it does represent leading examples of processes whose outcome is the effective acceleration of the changes required to realize the modern electric grid.

Methods for Capturing Industry Insights

This report is based on a series of interviews with GridWise members that have unique experiences navigating three trends: electric system decarbonization; transportation electrification; and resilience. These interviews focused on the challenges and opportunities presented managing projects that specifically addressed the three trends listed above. Beyond shining a light on the planning considerations and outcomes of specific projects, when taken together, these interviews allowed GridWise to develop key insights on managing industry changes in collaboration with all stakeholders involved.

Defining challenges and lessons learned from grid transformation leaders:

The interviews each followed a set of six questions that enabled us to gather insights into the main challenges Electric Services Providers (ESP's) are addressing, key learnings they are applying to initiatives in real-time, and experiences they had not expected . We focused the interviews around one trend at a time, but quickly learned that initiatives are finding cross-cutting benefits to multiple departments within utilities and to many different stakeholders. The questions we used to draw this information out, included:

a. What is your organization's strategy regarding this trend(s) and how do current project(s) fit into that strategy?

b. How would you characterize the major challenges and opportunities posed by this trend(s)?

c. Given there are countless ways of engaging in this trend, why did you choose this specific project(s)?

d. How will you (or how did you) define success for this project? What metrics did you track and how?

e. What did you learn from this project (about your customers, your team, the market, market actors, partners)? Anything that surprised you?

f. What are 3 most important things you think other utilities should know or do before they engage in projects like this?

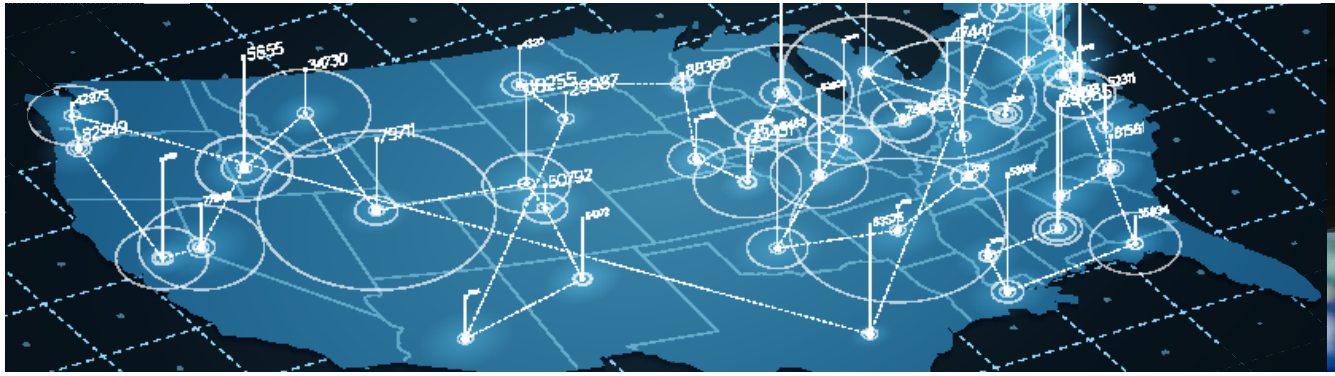
The primary objective of the GMI is to continue to serve as a comprehensive resource for stakeholders that not only assesses the progress made across modernization activities but also accounts for the most current and pressing industry trends. These trends were described in detail by GridWise in partnership with EY in a recent report that examined trends in the accelerated energy transition.[10] This GMI, along with the EY report, offer a comprehensive view of the rapid changes taking place.

[10]GridWise Alliance / EY Global Services Limited, "In an accelerated energy transition, can US utilities fast-track transformation?" (2019) https://gridwise.org/wp-content/uploads/2019/12/Perspectives-on-a-Future-Distribution-System.pdf

Taking Cues from Leaders

GridWise Alliance interviewed utilities from all regions of the U.S. Highlights from our interviews along with surprises we learned worth sharing are detailed below:

Utility	Utility Footprint	Key Highlight
AEP	Multiple states in Mid West	Determining best ways for utilities/startups to partner with one another
APS	Arizona	Utilizing data and information to activate Internal culture change
Avista	Washington	Becoming a trusted resource on EVs to communicate benefits and address potential concerns for customers
BGE	Maryland	Working with stakeholders to address foundational elements of EVs such as charging infrastructure
CenterPoint	Texas, Indiana	Exemplifying that resiliency issues are enterprise-wide and every single department has a role to play
FPL	Florida	Helping to create synergies among many different departments within the utility through improved data analytics
NYPA	New York	Having a clear vision of what resiliency means to the grid and translating that vision so all stakeholders can understand it
PGE	Oregon	Leading green tariff participation in the nation because customers are dedicated to decarbonization
REC	Virginia	Adapting quickly to market forces and increased enthusiasm of EV owners
Dominion	Carolinas, Virginia	Cultivating a collaborative effort among stakeholders will enable quicker success to addressing hosting capabilities around DERs
Duke	Carolinas, Florida, Ohio, Kentucky and Indiana	Understanding how stakeholders prioritize different utility activities and incorporating that into strategic planning



Insights into a Grid Transformation

GridWise's interviews with our member utilities sought to better understand how each is navigating its grid modernization efforts related to decarbonization of the electric system, electrification of transportation, and advancement of grid and customer resilience. While these concepts are not novel on their own, the way they are being integrated into utility planning and stakeholder processes are leading to transformations. When these concepts are prioritized, we begin to see them acting as the cornerstone of industry transformations. Interview results suggest five principles to guide utilities' grid modernization initiatives:

1. Launch a change management process
2. Focus on collaboration
3. Create a culture of innovation
4. Embrace digital transformation
5. Develop the future workforce

These themes were consistent across the member utilities' efforts and provide instructive guidance to other organizations regarding their own efforts. The subsections below provide further detail and examples of member utilities putting these principles into action.

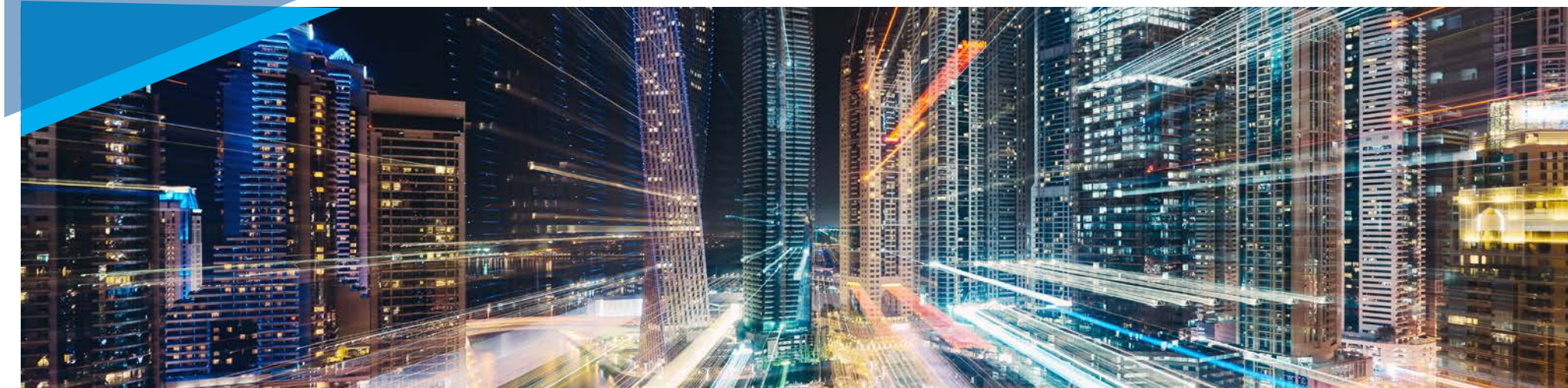
1 Launch a change management process

Change management is a systematic approach to specifying, implementing, and monitoring transformation within an organization. Doing this in a controlled manner will help individuals and organizations adapt more readily. Each of the GridWise member utilities whose grid modernization initiatives we highlight throughout this report are embracing key elements of change management as part of their efforts.

While change management is complex and nuanced, interviews with GridWise member utilities revealed at least three common themes associated with launching successful change management processes:

- Establishing clear goals
- Telling a compelling story
- Demonstrating leadership commitment and support

Establishing clear goals. Many of the utility representatives we interviewed emphasized the importance of establishing clear goals and creating a comprehensive plan to define success.



Baltimore Gas and Electric

CLEAR GOALS TO GUIDE TRANSPORTATION ELECTRIFICATION EFFORTS

In 2018, four of Maryland's largest electric utilities submitted a petition to the Maryland Public Service Commission for a suite of EV charging infrastructure pilot programs to be delivered over a five-year period. The programs' goals were to encourage EV adoption and use in Maryland and to advance the state's broader environmental goals. The Commission approved a modified version of the petition in early 2019, and later that year, BGE (owned by Exelon Utilities) began implementing the pilot programs in its service territory. BGE's programs include incentives and rebates for public charging stations and residential Level 2 EV chargers, as well as consumer education efforts and a demand charge credit for nonresidential customers to encourage fleet electrification. To enable common understanding of the program's goals and objectives, BGE representatives shared perspectives regarding the importance of making sure they had a clear plan of action internally—a "north star." They noted that a lack of clarity in this regard could prevent them from successfully delivering a seamless customer experience.

"What's your North Star? You need a clear goal that everyone's working toward."

– Christopher Budzynski
Director, Strategy and Business Development
Exelon Utilities

Florida Power & Light

STAKEHOLDER ENGAGEMENT TO SET PRIORITIES FOR GRID RESILIENCY

Florida Power & Light (FPL) has invested over $5 billion since 2006 to improve the grid and provide outstanding service reliability to its customers, which includes the strengthening the grid, installing over 5 million smart meters and 120,000 other intelligent devices. Hardened power lines perform 40% better in day-to-day operations, which means fewer outages are experienced by customers. And in severe weather like Hurricane Irma in 2017, every hardened transmission structure – the backbone of the energy grid – withstood the significant impacts of the hurricane.

FPL prioritizes restoring power to main lines that serve major hospitals and 911 centers, in addition to those facilities identified by the counties as critical infrastructure functions such as police and fire stations, water treatment plants, transportation providers and communication facilities.

Tell a compelling story. Weaving your goals into a clear narrative places them into the context and can help emphasize the importance of your mission. Several of the utility representatives we interviewed highlighted the importance of being able to tell a compelling story about critical grid modernization projects to customers, staff, regulators, and other stakeholders.

New York Power Authority

CONNECTING KEY INITIATIVES TO THE GRID MOD MISSION

As part of their vision to become the nation's first end-to-end digital utility, the New York Power Authority (NYPA) announced a Communications Backbone Program in 2017. The program involves installing fiber optic cables and other communications systems across 1,400 miles of transmission infrastructure and 16 power generating facilities in New York. NYPA's Vice President of Strategic Operations, Ricardo da Silva, stressed the importance of presenting a clear narrative around these efforts—both internally and externally—to ensure all parties understood the value of the organization's grid modernization initiatives. He also emphasized the presentation of facts such that all stakeholders understand the company's vision, how they intend to achieve the vision, as well as its importance. "The way we've been describing our smart generation and transmission efforts internally is that it's about embedding technologies to make sure that our assets remain resilient regardless of what happens in the future. It focuses on making sure that we're applying technologies—whether it's hardware infrastructure or data analytics or software tools—to provide the most accurate information to support decision-making. We started to do this to meet our vision 2020, now we're aimed at doing this to meet our vision 2030."

American Electric Power (AEP) - Ohio

TELLING THE START-UP STORY TO REGULATORS

AEP Ohio's Director of Environmental Public Policy, Paul Loeffelman, noted it was important to AEP to ensure regulators and policymakers understood their reasons for working closely with startups. To achieve this, the company made sure to communicate their rationale unambiguously. The idea was that if they can help policymakers understand the urgency of AEP's efforts, the utility may ultimately be able to more rapidly deploy new technologies to its customers to meet our vision 2030.

Demonstrating leadership, commitment, and support. Successful change management processes require genuine commitment from executives and senior managers to generate buy-in and support from staff at all levels. When we asked BGE representatives to list the most important things other utilities should know or should do before they start engaging in their own EV projects, the response was, "First and foremost, there should be internal commitment to transportation electrification. This can't be a side project. It needs to have executive-level support to generate broader support within the organization." Arizona Public Service (APS) staff shared a similar sentiment, asserting the need for high-level "champions" for their grid modernization efforts.

Executive-level commitment to new initiatives helps generate buy-in and support from staff at all levels.

2 Focus on collaboration

To create a strong foundation for grid modernization investments, utilities must ensure understanding among all stakeholders affected by the transformation. Collaborative processes create opportunities for utilities to strengthen relationships with their stakeholder networks and to become more collaborative and inclusive.

Our interviews with GridWise member utilities highlighted how collaboration generates benefits both for internal and external utility stakeholders. To yield the benefits of collaboration, member utilities highlighted the importance of the following:

- Engaging your stakeholders
- Breaking down internal silos
- Involving underrepresented groups
- Learning from other utilities' experiences

Engage your stakeholders. Grid modernization involves major changes to internal utility operations and customer-facing elements of the business. Engaging all stakeholders in knowledge sharing and decision-making helps ensure understanding and acceptance of these changes. These engagements offer opportunities to educate customers and for the utility to hear directly from customers regarding their interests, needs, and priorities.

"Grid modernization is a responsibility that extends beyond just one organization. It requires much greater collaboration and sharing of risk and reward. This is a very different mindset than the one utilities have traditionally embraced."

– Doug McMahon
Vice President and Head of e-Mobility and Grid Flexibility
New York Power Authority

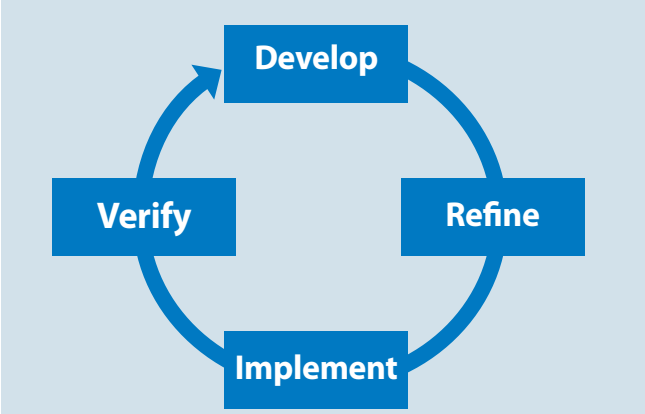
"If you haven't initiated a stakeholder engagement process, start now. Start yesterday."

– Derek Wenger
Manager, New Technology and Renewable Programs
Dominion Energy

Duke Energy South Carolina

STAKEHOLDER ENGAGEMENT TO INFORM GRID IMPROVEMENTS

In August 2018, Duke Energy convened the first in a series of workshops in South Carolina to ensure stakeholders understood the company's South Carolina Grid Improvement Plan Initiative, to obtain input and feedback from stakeholders, and to develop and implement a framework for ongoing collaboration. Output from the first workshop supported additional analysis and planning to revise the plan. Duke shared the revised plan with stakeholders during a second workshop in October 2018 and highlighted how they had incorporated stakeholder feedback from the first workshop. Input from the second workshop informed the Company's rate case filings during Q4 2018. Per Justin Brown, Duke's Director of Grid Solutions Planning and Regulatory Support, stakeholder collaboration informed and improved the final version of the Grid Improvement Plan.



Duke energy stakeholder engagement process

New York Power Authority

STAKEHOLDER SUPPORT TO ADDRESS T&D ISSUES

As part of NYPA's grid modernization efforts, the utility created the Advanced Grid Innovation Laboratory for Energy (AGILe), a world-class power systems laboratory, simulation space, and testing facility. AGILe's aim is to accelerate energy infrastructure improvements and lead to a more reliable and efficient electric grid. We discuss AGILe further in the "Cultivating Innovation" section below, but it is worth highlighting here that the effort created a collaborative environment in which a broad range of stakeholders – including representatives of utilities, academia, technology manufacturers, research organizations, and others – can work closely together to address distribution and transmission challenges.

Rappahannock Electric Cooperative

STAKEHOLDERS AS "EV EVANGELISTS"

Rappahannock Electric Cooperative (REC) developed an online customer education platform as part of the cooperative's efforts to bring the benefits of EVs to members. REC also sends staff to engage with customers at more than three hundred community events each year, frequently accompanied by the company's Chevy Bolt EV. According to David Koogler, Vice President of Member Services and External Affairs, these engagements educate members and REC staff alike. Through these events, REC learned that members who own EVs are eager to extoll the virtues of EVs to other members. "Tesla drivers will just bring their vehicles out and want people to ride with them. They become EV ambassadors because they say, 'this is great—we want other people to try it, and we think they'll buy EVs too.'" He shared another experience of meeting a member at a county fair. "There was a gentleman who told me he was in his eighties and had bought a Chevy Bolt—he was so excited about it. He was a champion for EVs—he could sell other people on them based on his own experience."

Rappahannock Electric Cooperative's Chevrolet Bolt

Break down internal silos. Most interview participants highlighted the value of multiple internal and external stakeholder perspectives in their grid modernization efforts, whether related to resilience, transportation electrification, or DER integration. Several also noted they were somewhat surprised by the value derived from bringing together parts of their organizations that do not typically interact.

"When it comes to grid modernization, every utility department has a role to play."

– Steve Greenley
Senior Vice President of Gas Operations
CenterPoint Energy

Arizona Public Service

MULTIDISCIPLINARY APPROACH TO GRID MODERNIZATION

APS recognized its Grid Modernization Plan would touch all parts of their organization. To ensure all parties understood and bought into the scope, scale, and imperativeness of the utility's evolving organization, technologies, and processes, the Company included representation from approximately thirty internal departments in its planning meetings—including Engineering, Technology Innovation, T&D Operations, Information Technology, Customer Technology, Corporate Strategy, and beyond.

According to Ivan Aguilar, APS's Manager of Advanced Grid Technology, the company saw how effectively this type of cross-disciplinary engagement can be when they encountered a feeder in danger of overload. "There was great collaboration between our distribution operations center, our field crews, our technology assessment team, and even our transmission operations folks. We brought in everyone who should have a say as to how we fixed it, and then we arrived at the decision that we need a new type of sensor to solve the problem. And that's how we decided to move toward a fiber optics center that we're hoping to demonstrate. I don't know if we'd have gotten there without everyone involved."

Portland General Electric

BREAKING DOWN SILOS TO ADDRESS DEMAND RESPONSE

Portland General Electric (PGE) highlighted the necessity of breaking down silos as the utility moves further into demand response. The utility's IRP includes the goals of acquiring at least 69 MW and 77 MW of new demand response resource for the summer and winter, respectively, in 2020 while working toward longer-range DR resource targets of 162 MW for summer and 191 MW for winter. Larry Bekkedahl, PGE's Vice President of Grid Architecture, Integration, and System Operations, shared that as the utility has moved deeper into demand response (DR) and load flexibility, they have had to consider more dynamic devices and the utility's ability to control the grid impacts of these devices. For PGE, this has required expanding connections between internal departments such as the sales force and grid operations, or between dispatchers and the marketing department, and so on. Mr. Bekkedahl suggested that establishing these connections among internal utility departments is part of the broader transition utilities are undergoing as they modernize the grid.

Florida Power & Light

BREAKING DOWN SILOS TO IMPROVE EFFICIENCY

FPL found the high level of engagement and collaboration across numerous departments required to support the utility's resiliency planning efforts yielded some unanticipated and beneficial consequences. For example, meetings involving representatives from the utility's infrastructure hardening team, vegetation, customer service and others yielded opportunities to package activities such as pole inspections and switch replacements into one site visit, thus lessening the impact on local communities and their permitting departments.

Involve underrepresented, hard-to-reach, and/or disadvantaged groups. Successful collaborative processes engage all stakeholder groups—even those who are difficult to reach. One of the most successful strategies GridWise member utilities reported pursuing in this regard was to engage these groups on issues of mutual concern.

Avista

BREAKING DOWN SILOS TO ADDRESS DEMAND RESPONSE

As part of a suite of pilot programs operated between 2016 and 2019, Avista offered a trial program designed to help bring the benefits of transportation electrification to disadvantaged and low-income community members. To do this, Avista sought input from more than fifteen local agencies and non-profit organizations regarding how electric transportation could best serve these individuals and communities. The utility solicited proposals and ultimately provided two organizations—the Spokane Regional Health District and Transitions for Women—each with a Level 2 EV charger and a plug-in electric vehicle. The organizations' used the EVs to provide critical services to community members, including to deliver food and to provide rides to and from medical appointments, job training classes, and overnight shelters. Avista has engaged in ongoing collaboration with stakeholders from these groups and others--including Habitat for Humanity, Spokane Housing Ventures, Spokane Neighborhood Action Partners (SNAP), the Spokane Regional Transportation Council, and Spokane Transit Authority--to better understand how Avista's electric transportation and mobility programs can best serve traditionally disadvantaged communities.

Learn from other utilities' experiences. Many of the member utility representatives we interviewed underscored the importance of leveraging other organizations' experiences when undertaking efforts related to resilience, transportation electrification, and DER integration. Many noted that the value of learning from others' experiences was one of the most important things other utilities should know or should do before embarking on their own efforts. Several GridWise member utilities cited this as among the most important things other utilities should do before engaging in grid modernization efforts.

- Dominion Energy's DER team reported leveraging the work of another GridWise member utility, APS, as they developed their DER integration strategy in South Carolina (prior to the State's enabling legislation being signed into law). The team highlighted the value of reviewing APS's plans and decisions in informing their own plans.
- BGE's transportation electrification team recommended connecting with other utilities who have undertaken similar efforts. They noted a lot of utilities are doing good work on transportation electrification and highlighted the value of organizations like GridWise in helping to compile and disseminate insights from utilities' experiences.
- Avista staff also noted the value of learning from other utilities' efforts around transportation electrification. "You don't have to go it alone," said Rendall Farley, Manager of Electric Transportation. "You can partner with others and learn from their experiences."

3 Create a culture of innovation

Today's utilities operate in highly dynamic environments where standard/routine methods, technologies, and operating models are evolving to accommodate the digital grid of the future and related new emerging technologies such as renewables and electrified transportation.

GridWise member interviews revealed that some utilities are adopting agile processes proven successful in other industries, such as technology and software development, to foster innovation in their organizations. They are doing this by:

- Initiating culture change from within
- Establishing processes to support innovation

American Electric Power (AEP) Ohio

EMBRACING INNOVATION CULTURE

AEP has developed a process based on agile principles to globally search for and validate innovative technologies that provide customer and grid benefits to integrate into the distribution grid of the future. AEP's areas of interest center around emerging technologies related to platforms, transportation electrification, and resiliency that will help achieve the vision of a decentralized, digitalized, and decarbonized grid.

In 2018, AEP initiated culture change at the highest level of the organization with CEO Nick Akins driving the charge (and echoing the principle of "demonstrating leadership commitment and support"). AEP appointed a Vice President in charge of Innovation and Technology with a multi-disciplinary team of seven AEP staff tasked with cultivating cutting-edge energy solutions being developed around the globe.

Paul Loeffelman, Director of Environmental Public Policy, noted that where once the company was risk-averse and would not talk to companies capitalized under $100 million, AEP was open to exploring co-developing solutions with significantly smaller companies with market capitalization under $1 million and with a skeleton staff as small as one to three people.

A mindset shift in risk appetite and management support at the highest levels and backing the process with dedicated human resources to realize the vision is a foundational step in initiating the culture change from within the organization required to foster innovation.

AEP Chairman, President and CEO Nick Akins (left) and Heila Technologies CEO Francisco Morocz (middle) discuss the successful multiple microgrid orchestration pilot under simulated distribution grid conditions at an AEP operating company test site.

American Electric Power (AEP) - Ohio

SUPPORTING INNOVATION THROUGH STRATEGIC PROCESSES

As noted in the "Launch a change management process" and "Focus on collaboration" sections above, starting with a clear vision and goal is key and communicating this vision and getting buy-in from key stakeholders is essential.

AEP has established processes to support their innovation efforts. In 2019, AEP sponsored the IllumiNation Energy Summit to facilitate a conversation with four hundred industry leaders, technology partners, regulators, and legislators to discuss grid modernization and the energy transformation. AEP also undertook four key steps in working with policymakers to craft new ways to evaluate technologies:

- Sharing the company's vision with legislators and economic regulators
- Identifying startup solutions with deployment capabilities
- Demonstrating how the startups' technologies would benefit the company
- Ensuring policymakers understood the speed at which the company aimed to move forward with co-development, testing, and piloting the startups' technologies

AEP's Vice President of Innovation and Technology, Ram Sastry, has an open call/reverse pitch to solution providers inviting them to submit proposals answering six key questions pertaining to the activities and timeline to a minimum viable product that can solve a problem for AEP and demonstrate benefits to AEP and its customers and associated costs.

AEP Innovation and Technology Group Operating Model

AEP also actively participates in scouting for innovative solutions through its participation in technology incubators like Free Electrons and Starter. The incubators provide the startups with coaching and expenses and provide an audience with companies like AEP that pilot and validate the startups' technologies. AEP considers five hundred applicants through each of these accelerators and winnows these down to around thirty promising solutions. Products/services are purchased, and an investment is made for wider deployment after the benefits are clearly shown.

AEP's executives believe that they have turned the "math upside down" in terms of innovation with this approach of identifying "diamonds in the rough" or technologies that are not quite market ready, but that through a collaborative process have the potential to be successful and cost-effective. AEP has shepherded some technologies through this development cycle that are now procurement-ready.

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New York Power Authority

COLLABORATION AROUND INNOVATION

NYPA's Advanced Grid Innovation Laboratory for Energy (AGILe) supports innovative approaches to testing technological impacts on the electric grid. AGILe has a "digital twin" model of New York's statewide electric system. Using onsite digital simulators, NYPA engineers and external collaborators can model new technologies' impacts on the bulk electric power system before deploying them full-scale. This innovation enables users to assess whether new grid technologies will produce the desired outcomes; anticipate any potential negative consequences of installation; and optimize equipment settings before deployment. In the past, NYPA hired external vendors to perform these studies, which was typically costly and time-consuming. According to NYPA, "by developing these capabilities in-house, not only does NYPA better manage its costs and testing timeframes, but NYPA teams also benefit from the cumulative learnings from running studies themselves, continually building the organization's growth and expertise." The AGILe lab is currently located in NYPA's office in White Plains, NY, but as it grows, NYPA envisions its future as a stand-alone collaborative facility with engagement and support from other utilities and entities.

4 Embrace digital transformation

Digitalization is a key force driving the energy transition and will have substantial impacts on many aspects of the power industry. With the emergence of the smart grid, the available volume of grid data is increasing exponentially. Our interviewees discussed the convergence of operational technologies (OT) and IT with the data that is emerging from within the grid, such as from sensors, controls, smart devices, and smart meters, but also from external sources such as weather forecasts and geospatial information systems. Emerging approaches and technologies such as big data analytics, blockchain, and cloud computing can drive a digital transformation in grid operation. Utilities are using these to address the complexity of grid operations by improving situational awareness and decision support.

Interviews revealed the following three key areas of focus for utilities when navigating their digital transformation journeys:

- Thinking about the whole system
- Leveraging smart grid technologies
- Harnessing the power of data

Thinking about the whole system. As many new technologies are brought on board, some utilities are beginning to find that individual technologies might be in competition or conflict with each other, decreasing their effectiveness. Adopting a systems thinking approach enables optimization of the whole system through this evolution, rather than the parts, to realize greater benefits.

Arizona Public Service

THE IMPORTANCE OF SYSTEMS THINKING IN THE CONTEXT OF INCREASED DER PENETRATION

As Arizona Public Service (APS) integrates distributed energy resources (DER) onto its grid, the utility is developing an integrated approach as part of a distributed energy resource management system (DERMS) to meet grid modernization objectives and improve reliability via technology deployment.

The APS team discussed the approach they used to arrive at their decision for a very high-level integration of their advanced distribution management solutions (ADMS) for distribution control. The driver was their experience with individual technologies they used for fault location, isolation and service restoration (FLISR) and volt-var optimization (VVO) that were implemented on various feeders within specific areas. They realized that in some cases the goals of the individual technologies might be in competition or conflict with each other, decreasing their effectiveness. However, by combining them beneath an integrated ADMS, the parameters could be tuned such that the technologies worked effectively together.

As a result, APS chose to purchase an ADMS system which allows them to do "algorithmic stacking" on a per-feeder basis. For feeders on the APS system that need both FLISR and VVO, the ADMS is configured and the execution of the algorithms tuned in such a way such that when a FLISR operation completes, the power quality operations immediately follow to keep power stable and flowing for customers.

The APS team noted that DERMS was a "system of systems" and that it was important to make good decisions regarding how each component "played together." They stressed that with rapid technological change, the need to maintain forward and backward interoperability and ensuring that systems work together effectively was critical to optimize the whole system.

Leveraging smart grid technologies. The opportunities to achieve greater reliability, efficiencies, and economic and environmental benefits from a smarter grid are key drivers of utilities' digital transformation journeys. The smart grid relies on increased automation, controls, computers, and new technologies working together to self-heal in the case of outages and respond quickly to increasingly variable and multi-directional flows of energy.

CenterPoint Energy

RESPONSE TO HURRICANE HARVEY

In August 2017, Hurricane Harvey hit Southeast Texas. A Category 4 storm, Harvey flooded Houston with up to nearly fifty-two inches of rain in some areas over a 4-day period. CenterPoint Energy reported 1.27 million electric outages and, in some cases, up to ten days to restore power to its customers. The utility's smart grid, including distribution automation devices such as intelligent grid switches, allowed CenterPoint to minimize the impact on customers by isolating problems and restoring service through these devices.

Mark Mitchell, Rhonda Welch, and Steve Greenley of CenterPoint Energy discussed additional major resilience/grid hardening effort investments undertaken in response to Hurricane Harvey. Sophisticated real-time analytics now provide decision makers with the critical information they need for better situational awareness. Improved outcomes in efficiency and problem resolution from grid modernization investments included avoidance of 41 million outage minutes for customers, 16.71 System Average Interruption Duration Index (SAIDI) minutes saved due to automation, remote turn on and off ability for safety, and 99% accuracy on billing based on actual readings for 700,000 customers.

AEP-Ohio

DIRECT LOAD CONTROL AND MANAGED EV CHARGING

AEP has experienced overloading on transformers serving neighborhoods with a high penetration of EVs. The thinking and the market activity thus far on customer EV charging has been time-of-use rates that rely on consumers to modify behavior based on lower rates for charging at off-peak times versus peak times. Shifting EV load through variable pricing is a necessary measure, but it will not suffice when EV penetration achieves critical mass. Utilities are turning to integrated Advanced Distribution Management Solutions (ADMS) / Distributed Energy Resource Management System (DERMS) platforms that will have the ability to identify grid challenges down to the transformer level and dispatch DERs to alleviate. Utilities are experimenting and partnering with solutions providers that offer more precise load management capabilities.

AEP Ohio is currently implementing a pilot using an innovative technology to shift residential Level 2 EV charging to times that the grid needs additional capacity or to remove stresses based on a signal from the distribution operator. The utility has found it can more precisely manage the grid according to dynamic factors, and the customer's car will be charged by the time the user needs it. On the commercial side, AEP Ohio has deployed a grid balancing software platform after a successful pilot. The utility has also piloted solutions that can optimize for building loads, EV charging, solar generation, and storage all on the same platform, which may be of interest to utility customers in some areas who face potentially high demand associated with commercial EV charging.

Harnessing the power of data. As grid operators move toward digitalization of their operations and work practices, they are discovering the power of harnessing the treasure trove of data they are accumulating from their grid modernization efforts. Data analytics tools and platforms provide the capability to analyze structured and unstructured data in real-time and will enable new use cases and business opportunities.

Arizona Public Service

DATA VISIBILITY AND NEW METRICS

The APS team collectively discussed a project related to their Roadrunner 14 feeder, a heavily loaded feeder with a high DER load. The project explored a solution that aimed to fix the voltage/reactive power imbalance between the different phases of the distribution feeder due to non-uniform loading and variable DER penetration. The project involved installation of telemetry devices and a series of single-phase capacitor bank controllers versus gang operated capacitor banks.

A serendipitous discovery for APS was that not only did they have volt/VAR imbalance, but they also had harmonic issues. The data APS has typically measured in order to feed its analytics, engineering, and operation activities mainly consisted of voltage, low and full currents, and in some cases, depending on the calculations, just VARs. Through this project, APS has begun to capture new data metrics and it now places a higher importance on harmonics. This project brought data visibility to a problem that likely existed for a long period of time, and via that data visibility, enabled appropriate groups could act on it.

AEP-Ohio

DATA ANALYTICS AND THE POWER OF AMI

The AEP team discussed using a new technology that leveraged smart meter data to improve predictions on failures and other dynamic factors their systems. While this solution was good, they were underpredicting failure occurrences on the grid. AEP identified that the data quality was insufficient and with the addition of some software to address this issue they were able to improve the predictability. Keeping with the innovation approach described within the "creating a culture of innovation" guiding principle, the initial test of this solution used data from 20,000 meters. Having been proven in that pilot, AEP will next test the scalability and performance of the solution by expanding it to 100,000 meters.

5 Develop the future workforce

Grid modernization, increased penetration of renewables and other DERs, and transportation electrification have resulted in changing needs and new opportunities with respect to the electricity sector workforce. The skills required for a modern grid workforce are also being shaped by broader trends, including the Internet of Things (IoT), increased automation and artificial intelligence.

While we did not specifically ask about workforce challenges in the interviews, this became an overarching theme in many of our conversations. Many interviewees highlighted specific workforce gaps and shortages. To realize the full potential of a modernized grid, utilities highlighted the importance of the following:

- Retraining, retaining, and recruiting the grid workforce
- Recruiting staff with new emphasis on skillsets
- Addressing unanticipated needs

Retraining, retaining, and recruiting the grid workforce. A 2017 GridWise Alliance report listed specific workforce classifications affected by smart grid deployment, including line technicians, meter readers, engineers, substation operators, and communication technicians. The current workforce will require training to develop the higher-level skills needed for installing, monitoring and repairing new digital technologies, as well as performing analysis of millions of bytes of data generated by a modern digital grid. The Department of Labor projects that as much as half of the energy industry workforce will retire in the next 5 to 7 years. This aging workforce could represent a challenge that could be converted to an opportunity for utilities as they look to shore up the ranks of traditional utility industry roles such as linemen and technicians in their workforce.

Portland General Electric

ADDRESSING TRADESPERSON SHORTAGES

Larry Bekkedahl, Vice President of Grid Architecture, Integration, and System Operations, noted that there has been a shortage of tradespeople in general over the last ten years. He estimated that just in Portland alone this shortage was around 35,000 workers and across all trades, including electricians, linemen, steel workers, and others.

Portland General is employing an innovative grassroots strategy to address this shortage by working in local high schools to communicate to students the appeal of energy industry professions as financially viable career pathways for those entering the workforce. Bekkedahl also noted PGE has a greater need for engineers as the penetration of renewables has increased, and that the trend towards greater renewable energy made the utility industry an appealing option and helped to attract top talent.

Recruiting staff with new emphasis on skillsets. Our interviews with GWA member utilities also underscored the need not only to retrain the utility industry's traditional workforce required but also to recruit workers with new skillsets. These include protection and safety services, asset management, planning, customer services, communication and advertising, and geographical information services (GIS), climatologists, data analysts, computer scientists, cybersecurity experts, IT hardware specialists, engineers etc. Utilities are further challenged as they are competing with other industries such as high-tech and finance which have long been default choices for some of these top talents to fill the gaps and meet their evolving needs.

Arizona Public Service

DATA ANALYTICS NEEDS

Mark Haughn, Arizona Public Service, noted when discussing their DER integration efforts that the biggest challenge with their DERMS is managing the data. He underscored that to be able to use data in real time, the data must be accurate. Given the complexity of managing this data and the associated challenges, the need for sophisticated data analysts and geographic information systems (GIS) analysts was pressing and that hiring and training needed to start immediately if APS wanted to be ready to go live with their DERMS solution in 2022.

CenterPoint Energy

NEED FOR INSTALLATION AND MAINTENANCE PROFESSIONALS WHO ARE TRAINED IN AUTOMATION

When discussing CenterPoint Energy's resilience/grid-hardening efforts, the company's Senior Vice President of Gas Operations, Steve Greenley, noted that all the automation in the field presented a maintenance issue that utilities must address. When musing on the challenges associated with this, he said, "What's the long-term strategy around all of that automation? Not just installation but also maintenance and lifecycle requirements. What skill set will do it? Finding the right folks to do the work as the grid gets more complex is challenging."

New York Power Authority

DATA ANALYTICS NEEDS

Ricardo DaSilva, the Vice President for Strategic Operations made a similar observation as APS' Greenley (above), when discussing NYPA's resilience efforts, referring to the "exponential incremental need around data and to transmit data." He also noted that NYPA did not want to continue to rely on third-party solutions, instead preferring to "take their destiny in their own hands" to transmit and analyze data at the utility's digital hubs and develop a holistic situational awareness solution internally.

Addressing unanticipated needs. When discussing transportation electrification and DER integration, interviewees highlighted the need for a workforce well-versed in areas outside of their prior core focus and/or for a workforce with interdisciplinary skillsets/knowledge to address unanticipated or revolving needs.

Portland General Electric (PGE)

SAFETY AND BUILDING CODE EXPERTISE

When discussing EV efforts and installation of EV chargers, PGE's Vice President of Grid Architecture, Integration, and System Operations, Larry Bekkedahl, noted PGE was working through some challenging new intersections. He said, "There's a dilemma that resides between National Electric Safety Code, which has traditionally been on the utility side of the meter. And then the National Electric Code was within the building, or the customer side of the meter. Well, a charging station is a meter. So where does one code stop and the other start/apply?" Portland General is working with the International Brotherhood of Electrical Workers (IBEW) to address this. PGE also identified skilled workers that understood how to work with large scale/wall batteries in a residence and the need to develop a workforce to support this growing need.

Avista

UTILITY STAFFING FOR EV EFFORTS

Rendall Farley, Manager of Electric Transportation at Avista, underscored the need to keep in mind unanticipated workforce needs when discussing Avista's EV efforts. He expressed that Avista was surprised at the frequency of issues and the ongoing operation and maintenance costs encountered with networked Level 2 and Direct Current Fast Charging (DCFC) chargers compared to non-networked chargers. Identifying it as an area the industry needed to get right, he cautioned that utilities need to staff their own EV projects well and that it was likely to be more work than anticipated.

Policy Trends and Market Dynamics Push for Change

Transportation Electrification. Rapidly declining costs of EVs coupled with new state policy goals have reframed transportation conversations as a facet of "beneficial electrification"—displacing the direct use of fossil fuels with electricity to reduce emissions and cost. Electrification demands that utilities plan for the requirements of significant, complex, and diverse new loads. Consumer choice and dozens of new EV models being offered by manufacturers are driving diversity and transforming the transportation sector. Public services such as city buses, school buses and other fleets also offer exciting new economic options. As with clean energy, we see these as the beginnings of an enduring trend, not individual or piecemeal requirements.

Electrifying transportation is not just a key pathway to decarbonize but is also an economic opportunity for the electric power industry and its consumers.[5] By 2025, annual passenger EV sales are expected to hit 10 million units worldwide, and projections show 28 million new EVs sold by 2030.[6] States implementing zero emissions vehicle (ZEV) policies have tasked municipalities, utilities, and regulators with developing transportation electrification plans in pursuit of a shared policy vision. Forty-three states (+D.C.) formally implemented policies and/or programs to support EVs and charging infrastructure in 2019.[7] State policies and regulations will need to evolve to address many details including ratemaking, smart charging, and related infrastructure investments. Transportation electrification in some cases may require major upgrades to grid capacity. Thoughtful approaches to EV charging will mitigate the need for some of these upgrades.

Emphasis on Resilience. Advanced distribution technologies and distributed energy resources offer flexibility in grid design and operation and can strengthen the grid's resilience. The major Northeast blackout in August 2003 left 50 million people without power and billions of dollars in economic impact. Major storms of the past two decades starting with Katrina, Maria, Harvey, Matthew and of course including Superstorm Sandy each had a major impact on the electricity grid, and as a result; reliability and resiliency have become major policy priorities in much of the U.S. A higher intensity and frequency of storms, increased threat of wildfire, longer-lasting heat waves, and other extreme weather events cost the nation over $300 billion in damages in 2017.[8] The power grid must adjust to a new climate reality, and a system built for the climate of 50 years ago is being forced to quickly adapt. These new challenges threaten the safe and reliable operation of the distribution grid. The associated power disruptions endanger the reliability of our electricity supply and lifeblood of the U.S. economy at a time when power disruptions are much less tolerated. Fortunately, new options exist to manage these power systems, promoting grid flexibility while building resilience into the system.

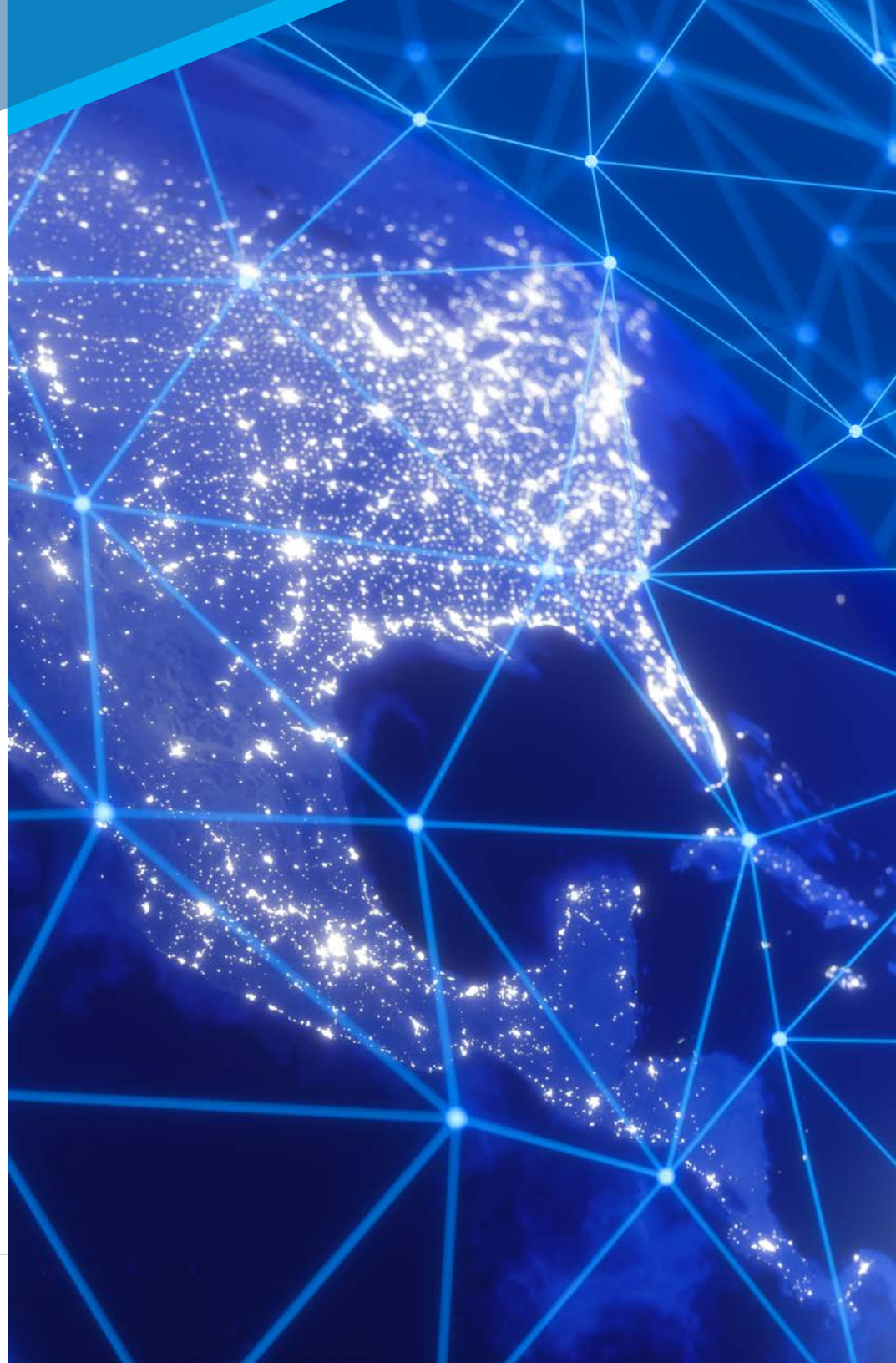
Regulators are prioritizing investments that ensure the electricity distribution system becomes more resilient, able to adapt to weather extremes, aging infrastructure, and other challenges ahead, whilst protecting ratepayers against inefficient distribution grid spending and customer rates. Grid-edge communication and other outage management technologies will serve a pivotal role as more states investigate storm protection planning across the nation.

Rapid shift to low-carbon energy sources. As the deployment of clean energy technologies has increased at an exponential rate over the last decade, the costs of new wind, solar and storage technologies have dropped dramatically. As new economic realities of low-cost clean energy apply downward pressure on electricity prices, a shift is occurring from high to low carbon-intensive resources. Consumers, ranging from large corporate buyers to individuals and aggregated communities, demand both cleaner energy and cost savings. Regulators are being tasked with determining appropriate utility business model revisions as formerly inaccessible markets open to new players, placing new pressure on regulators and utilities to find innovative new methods for implementing these options.

The power sector has passed a tipping point as clean energy technologies frequently become the preferred resource. Legislatures and local governments are stepping up their commitments to clean energy. In 2015, Hawaii passed the nation's first law mandating

a transition to 100% renewable energy. Since then, ten more states plus D.C. and Puerto Rico have adopted laws or issued executive orders with 100% clean energy targets. Dozens of other cities,[9] utilities and private companies have also made similar commitments. Decarbonization has now gone far beyond a trend to a dominant policy driver for the decades ahead. Utilities, now faced with a host of technical, competitive, and regulatory challenges, are reconsidering business models to address these trends head on as they position themselves to serve consumers into the next decade. States and regulators must ensure that these resources are optimally deployed to ensure reliable and equitable operation of the system, working with the utilities on clean commitments of their own.

Utilities are expanding their clean energy supply options by increasing operational flexibility with storage and automated systems. In addition, they are continuing to emphasize efficiency using new enhanced data-driven platforms and apps to allow consumers to better manage their electricity use. The prevalence of advanced grid technologies, including advanced metering infrastructure, smart home Internet of Things (IoT) devices, and third party vendor platforms enable new customer engagement opportunities. These technologies help consumers shape their own energy destiny while accelerating rates of falling renewable power costs have opened up consumers, utilities, and policy makers alike to consider new opportunities for energy services.



[5]IPCC: transport emissions could increase at a faster rate than emissions from the other energy end-use sectors and reach around 12 Gt CO2eq/yr by 2050

[6]BNEF: https://about.bnef.com/electric-vehicle-outlook/

[7]NC Clean Technology Energy Center: https://nccleantech.ncsu.edu/2019/08/07/the-50-states-of-electric-vehicles-states-focus-on-transportation-electrification-planning-charging-station-regulation-in-q2-2019/

[8]NOAA National Centers for Environmental Information (NCEI). (2019). Billion-Dollar Weather and Climate Disasters. https://www.ncdc.noaa.gov/billions/.

[9]2015 Environmental Report Card for Los Angeles County, https://escholarship.org/uc/item/9wx3h39j

Making a Difference in 2020

Policies are evolving faster than actual changes to the grid. The process for making investment decisions that are both large and complex is difficult and time consuming. For example, this year the Virginia State Corporate Commission approved several grid transformation investments yet did not approve the AMI component of a utility proposal, citing the utility's failure to fully justify benefits to customers. The Virginia decision comes on the heels of decisions in other states, including Hawaii, Massachusetts and Kentucky, in which utilities have faced difficulty in gaining approval for AMI investments even though industry experience over the past decade overwhelmingly supports these investments.

Strong policy signals that promote regulatory certainty are needed as states, cities, and utilities transition their power systems to serve a new paradigm—the driving forces of which are taking shape in a challenge of push and pull: Pushed by governors, state legislatures, mayors and regulators prioritizing decarbonization, the integration of electric vehicles, and higher reliability; and pulled by consumers (of all types) who request access to new renewables, storage and the associated elements of control, use new tools (apps) and engagement platforms for managing their energy use, and implement many complex energy supply and management solutions at their locations.

Accommodating many—if not all—of these driving forces marks an inflection point for the electric power industry. As utilities respond and implement changes, policies, regulations, and business models must evolve to ensure prudent investments. All the while, more frequent and damaging service disruptions, as well as increasing cybersecurity threats, force utilities and regulators to reconsider reliability in the face of new realities. The electric power industry faces a period of tremendous change in the decade ahead with the resulting grid becoming highly networked, highly optimized, highly functional, and highly secure.

Robust stakeholder engagement and better cost-benefit analyses are essential for both utilities and regulators to articulate and demonstrate the benefits of grid modernization investments—to tell a compelling story that will build support for needed investments. GridWise Alliance recommends that commissions consider the full suite of benefits that new technologies can provide to the entire grid, from improved reliability and resilience to lower costs to climate and environmental benefits.

The GridWise Alliance proposes a series of specific recommendations, fit into the context of the guiding principles described in the last section to better articulate the process changes needed to address the challenges in the decade ahead.

Launch a formal change management process.

- Utilities must recognize the broad impact changes will have across their organizations and dedicate the resources to effect the required change.
- Industry executives must clearly articulate their commitment to change and create a vision that drives the change.
- Utilities must develop a compelling narrative that goes further than explaining the benefits of investment and instead engages all stakeholders into the achievements derived from the projects.
- Regulators should establish a process to educate decisionmakers on the change process and its broad implications to effective investment decisions.

Focus on collaboration.

- Regulators must require utilities to include stakeholder engagement as part of the planning process. Regulators could also establish a formal stakeholder process through an investigatory docket to bring together stakeholders to negotiate

recommendations that would inform commission proceedings.

- Utilities must bring together parts of their organization that do not typically collaborate to share analysis from data derived from new technologies and produce the greatest value from the investment.
- Utilities should document the full set of benefits to customers, not just cost and cost-effectiveness, and develop a communications and engagement strategy to convey these benefits to stakeholders.
- Regulators should convene technology workshops with utility, policy makers, regulators and staff, academics, local businesses, and others to educate stakeholders on emerging grid technologies to explore potential benefits and improve stakeholders' ability to respond to innovation.

Create a culture of innovation.

- Regulators should encourage meaningful and timely pilot programs that address the business case, research, and customer services needs of the industry.
- Stakeholders should encourage inclusion of demonstration projects for new technologies in utility planning processes.
- Regulators should allow utilities to pursue innovation by defining and communicating reasonable risk to the customer if a technology does not prove beneficial.
- Regulators could open investigatory dockets to examine barriers to innovation and what incentives or policies would stimulate utility innovation.

Embrace the digital transformation.

- Utilities should ensure that the approach to digitalization includes all processes/ systems that impact grid operations.
- Regulators and utilities must ensure that grid modernization efforts anticipate the rapid changes happening to technologies, allowing for relatively simple future upgrades that increase functionality and security.
- All stakeholders need to be able to harness the power of data, data analytics and the associated benefits to planning and operation.

Develop the future workforce.

- Regulators should require that customer education strategies include proactive outreach and a digital platform for engagement.
- All stakeholders should participate in state workforce consortia convened by groups like the Center for Energy Workforce Development (CEWG), National Governors Association Center, or Distribution Contractors Association (DCA).
- Utilities in conjunction with state entities should conduct skillset evaluation across job categories, comparing existing workforce skills to desired skillsets for 21st century grid, to inform training and recruitment efforts.
- States should develop collaborative STEM programs including state government, educational entities, and utilities.

GridWise and its members will use these recommendations to foster positive transformation in the utility industry. These recommendations, among other factors, will also frame how the Grid Modernization Index tracks states moving forward. ***We urge stakeholders to continue to explore the forces leading grid modernizations and apply the observations described here GMI Insights to your own processes.***

About GridWise Alliance

GridWise uniquely serves the electricity industry by leveraging diverse stakeholder perspectives to articulate the numerous benefits of grid modernization. GridWise helps create a common understanding of the numerous and transformational operations-focused and policy-related changes taking place across the electricity industry. Our work ensures that emerging policy is aligned with industry best practice to facilitate effective and wide-spread change. For more information about the GridWise Alliance, please visit: http://www.gridwise.org.

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