August 23, 2019

U.S. Department of Energy
Office of Electricity
Attn: Guidance for Enhancing Grid Resilience

Re: Response to Request for Information Regarding Codes, Standards, Specifications, and Other Guidance for Enhancing the Resilience of Electric Infrastructure Systems Against Severe Weather Events

In response to the Notice of Request for Information (RFI)[1] issued by the Department of Energy (DOE) and published in the *Federal Register* on July 9, 2019, the Edison Electric Institute (EEI) respectfully submits the following comments on behalf of its members. EEI is the association that represents all U.S. investor-owned electric companies. Our members provide electricity for 220 million Americans, and operate in all 50 states and the District of Columbia. As a whole, the electric power industry supports more than seven million jobs in communities across the United States. Safe, reliable, affordable, and clean energy powers the economy and enhances the lives of all Americans.

Ensuring the resilience of the electric grid against severe weather events is of paramount interest to electric companies and the customers they serve. EEI's perspective on the questions raised in the RFI are grounded in our member companies' many years of experience preparing for and responding to electric system threats associated with severe weather events, natural disasters, and other phenomena that may impact electric reliability. Additionally, EEI's members are active participants in a growing set of initiatives that seek to make the critical infrastructure they operate more resilient.

The RFI seeks comment on current consensus-based codes, specifications, standards, and other forms of guidance for improving the resilience of electric infrastructure systems against severe weather events, with respect to both the design and operation of these systems. The information sought includes technical design specifications or requirements, corporate business practices, and analytic tools and methods for estimating economic benefits arising from efforts to enhance resilience. Noting the existence of well-documented standards developed by the North American Electric Reliability Corporation (NERC) and adopted by the Federal Energy Regulatory Commission, and the Institute of Electrical and Electronics Engineers, the RFI seeks

[1] *Codes, Standards, Specifications, and Other Guidance for Enhancing the Resilience of Electric Infrastructure Systems Against Severe Weather Events*, Notice of Request for Information, 84 *Fed. Reg.* 32,730 (Jul. 9, 2019).

additional information with respect to state- or locally-adopted codes and standards that have resilience implications or for less well-documented requirements or practices. The information sought includes: (a) scope and applicability; (b); origins; (c) validation; and (d) other important caveats about the requirement or practice.

As described in the attached Resilience Whitepaper EEI submitted to the Lawrence Berkley National Laboratory for its review of "Utility Investments in Resilience of Electricity Systems," approaches to resilience should be flexible, recognizing important variations across regions and electric systems that do not accommodate one-size-fits-all requirements.[2] Codes and standards tend to require uniform compliance; at the federal level, this compliance would be nationwide. Existing codes and standards for improving the resilience of electric infrastructure systems against severe weather events are either very region-specific, taking into account the local conditions electric companies face, or are written inclusive of regional differences by design. Accordingly, EEI does not provide with this response any state- or locally-adopted severe weather resilience codes or standards that are applicable on a nationwide scale, as regional differences may make nation-wide application of these codes and standards a less effective tool for addressing resilience. For this reason, these comments most directly respond to RFI question (d) on important caveats with respect to codes and standards that have resilience implications. These comments and the Resilience Whitepaper provide additional context for a consideration of severe weather resilience that takes into account existing industry mechanisms and practices.

Regions face different risks from different severe weather hazards, including hurricanes, wildfires, and other types of severe weather. This variability in the types of severe weather risks requires different regional approaches to resilience.[3] In addition, the local conditions electric companies themselves operate within vary greatly, including with respect to their location and climate, customer density and composition, their proximity to the coast, and the configuration of their delivery systems (i.e., the proportion of radial vs. nonradial lines, the length and capacity of lines, etc.). Any severe weather resilience codes and standards must accommodate these differences in severe weather hazards and company-specific features or risk expenditures that increase the costs for customers without providing resilience benefits.

Specific mandates or objectives of state regulators also factor into requirements that electric companies face and decisions they make. For example, the Florida Public Service Commission requires investor-owned utilities to file updated storm hardening plans every three years.[4] The stated driver and purpose of this requirement is to promote strengthening of Florida's electric infrastructure and to reduce the frequency and length of outages following the

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[2] Scott Aaronson, Vice President, Security and Preparedness, Edison Electric Institute, *Investor-Owned Electric Company Perspectives on Investments in Resilience*, p. 2, attached as Attachment A ("There is no simple answer or one-size-fits-all approach to resilience. The level and scope of resilience investments should be informed by risks and political consequences to the electric system and those it serves.") ("Resilience Whitepaper").

[3] *Id.*

[4] Florida Pub. Svc. Comm'n, Review of Florida's Electric Utility Hurricane Preparedness and Restoration Actions 2018, p. 5 (Jul. 2018), http://www.floridapsc.com/Files/PDF/Publications/Reports/Electricgas/UtilityHurricanePreparednessRestorationActions2018.pdf (Aug. 12, 2019).

intense 2004 and 2005 hurricane seasons.[5] The California Public Utilities Commission has developed maps of high fire threat areas, in which fire-safety regulations (including more stringent vegetation management requirements) apply.[6] In other regions that do not face hurricane or wildfire risks, the costs of imposing such requirements would outweigh any benefits.

Any reasonable analysis of severe weather resilience codes and standards must take state and regional differences into account—and must recognize that the types and severity of events that pose a risk to resilience might be evolving as the climate changes. Otherwise, the use of codes or standards for some parameter of resilience performance would almost certainly be inappropriate and could be ineffective. In order to recognize regional variation in severe weather and other hazards, any national codes and standards should be less prescriptive about how to improve resilience and instead allow electric companies to evaluate and implement measures and make investments appropriate to the risks they face. In this way, the application of existing standards may be enhanced situationally as needed for prudent practices with the specific risks faced. Further, such an approach encourages electric companies and their regulators to balance the costs and benefits of particular actions aimed at improving resilience.

Prioritization of investments in resilience should be consistent with the severe weather risks a particular electric company faces, again recognizing the different challenges in localities or regions.[7] Electric companies should have the flexibility to weigh the costs of a given investment against the expected incremental increase in severe weather resilience to focus on lower-cost solutions with higher-than-expected benefits and to deploy resources strategically based on that analysis. Specific measures may include undergrounding of infrastructure, nontraditional transmission and distribution pole materials, smarter energy infrastructure, vegetation management, advanced grid management/proactive shutdowns, and extreme weather damage mitigation.[8] In particular, vegetation management is essential to the maintenance, reliability, and resilience of overhead transmission and distribution systems, especially with respect to wildfire prevention.[9] Again, all measures may not be appropriate for all circumstances, depending upon the needs of different electric companies and the costs of these investments. Finally, the importance of timely cost recovery for investments in resilience at both the federal and state levels cannot be overstated.

Any codes, standards, or best practices collected in response to this RFI could be considered in batches corresponding to four domains DOE previously suggested for distribution system resilience (preparedness, mitigation measures, response, and recovery).[10] These best

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[5] *Id.*

[6] California Pub. Utils. Comm'n, *CPUC Fire Safety Rulemaking Background*, https://www.cpuc.ca.gov/FireThreatMaps/ (Aug. 1, 2019).

[7] Resilience Whitepaper, p. 5.

[8] *Id.*, pp. 5-9. With respect to extreme weather damage mitigation, electric companies in flood-prone areas are reconsidering their design standards and taking proactive measures such as elevating and relocating equipment to address flood risk. *Id.*, p. 8.

[9] *Id.*, p. 7.

[10] *Electric Grid Resilience Self-Assessment Tool for Distribution System*, 80 *Fed. Reg*. 37,606 (Ju1. 1, 2015).

practices in each domain area could become the basis for electric companies making informed decisions on strengthening resiliency based on identifiable areas where future investments in new technologies and operating procedures could be made.

As the Resilience Whitepaper describes, improving resilience requires a strong partnership among stakeholders, including policymakers and regulators at the local, state, regional, and federal levels; customers; interdependent sectors; and electric companies. Ongoing coordination with regulators and other local, state, and federal entities is imperative to ensure alignment on the understanding of resilience, maintain situational awareness with respect to severe weather resilience, and identify appropriate, cost-effective priorities.[11] For example, the Electric Subsector Coordinating Council (ESCC) helps government and private sector partners deepen relationships.[12] The ESCC is comprised of the chief executive officers of 22 electric companies and nine major trade associations, including EEI, the American Public Power Association, and the National Rural Electric Cooperative Association. This group, which represents all segments of the utility industry and the full scope of electric generation, transmission, and distribution in the United States and Canada, serves as the principal liaison between senior officials of the federal government and the electric power industry to coordinate efforts to prepare for, and respond to, national-level incidents or threats.[13] This partnership leverages government and industry strengths to develop and deploy new technologies, share information, conduct drills and exercises, and facilitate cross-sector coordination.[14]

Additionally, electric companies engage in programs and practices to improve resilience, and any discussion of codes and standards should be framed within an understanding of these existing measures. Electric companies take a multifaceted approach to resilience issues at both the transmission and distribution levels that enables responsiveness to severe weather events. This includes mutual assistance, which is the cornerstone of electric utility transmission and distribution operations during recovery from power outages caused by infrastructure damage.[15] For decades, the electric power and natural gas industries have operated voluntary mutual assistance programs that work collaboratively to restore service following storms, earthquakes, wildfires, and other natural disasters. These mutual assistance programs provide a formal, yet flexible, process for companies to request and receive assistance from one another. Electric companies affected by significant outages often turn to the mutual assistance network—a voluntary partnership of electric companies from across the United States and Canada—to help speed restoration efforts whenever and wherever assistance is needed when it is safe to do so.[16]

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[11] Resilience Whitepaper, p. 2.

[12] *Id.*, p. 3.

[13] *Id.*, p. 11.

[14] *Id.*

[15] *Id.*, p. 12.

[16] *Id.* Building on the industries' culture of mutual assistance, and informed by lessons learned from major destructive cyber incidents overseas as well as by exercises held in North America, the ESCC directed the formation of the Cyber Mutual Assistance Program. The Program is a natural extension of the electric power and natural gas industries' longstanding approach of sharing critical personnel and equipment when responding to emergencies. By coordinating with the government and providing mutual assistance to address cyber threats, the electric power and natural gas industries are enhancing our nation's ability to defend and protect against threats and to meet customers' expectations.

When severe weather or other events cause power outages, electric companies use this partnership to supplement by increasing their restoration crews and contractors. In addition, electric companies participate in spare equipment sharing programs to enable rapid recovery from events, thus providing additional resilience by leveraging "spare" equipment, capacity, expertise, and people to protect the electricity grid.[17]

Any consideration of severe weather resilience should recognize the need for flexibility due to regional and company variations and should take place in the context of existing industry practices and coordination with stakeholders. For the foregoing reasons, EEI urges the DOE to consider these comments and the attached Resilience Whitepaper and ensure that any future action that may be ordered as a result of this proceeding is consistent with the views expressed herein.

Respectfully submitted,

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[17] *Id.*

Investor-Owned Electric Company Perspectives on Investments in Resilience

By Scott Aaronson, Vice President, Security and Preparedness, Edison Electric Institute

Introduction

The Edison Electric Institute (EEI) appreciates the opportunity to contribute to the discussion about improving resilience for critical energy infrastructure. EEI's member companies—the nation's investor-owned electric companies—take their responsibility to support national and economic security very seriously; our members live and work in the communities they serve and understand that the infrastructure they own and operate plays a significant role in the life and safety of their customers.

EEI's member companies provide electricity for more than 220 million Americans and operate in all 50 states and the District of Columbia. As a whole, the electric power industry supports more than 7 million American jobs and contributes $865 billion annually to U.S. gross domestic product, about 5 percent of the total. In addition to our U.S. members, EEI has more than 65 international electric companies as International Members, and hundreds of industry suppliers and related organizations as Associate Members. EEI's members are committed to the reliability, security, and resilience of energy infrastructure.

While improving security and reliability is a priority for our members, providing an energy grid that also is resilient against all hazards is an increasing focus for the sector and policymakers. Acknowledging and understanding how key stakeholders define resilience is valuable, but it is not EEI's intent, nor the purpose of this paper, to further refine the definition. Rather, we aim to illustrate how electric companies are key enablers of resilience and how the energy grid provides a platform for resilient energy services that support customers and national security.

For reference, however, EEI and its member companies have relied on several organizations that have provided definitions of resilience that are useful in any national conversation. These include the National Academy of Sciences, which states that resilience "is the ability to prepare and plan for, absorb, respond, recover from, and more successfully adapt to adverse events."[1]

Other entities have provided similar definitions. The Federal Energy Regulatory Commission (FERC or the Commission) proposed to define resilience as: "[t]he ability to withstand and reduce the magnitude and/or duration of disruptive events, which includes the capability to anticipate, absorb, adapt to, and/or rapidly recover from such an event."[2] The North American Electric Reliability Corporation (NERC) built upon the National Infrastructure Advisory Council's (NIAC's) resilience construct to define resilience based on four outcome-focused abilities: (1) robustness—the ability to absorb shocks and continue operating; (2) resourcefulness—the ability to detect and manage a crisis as it unfolds; (3) rapid recovery—the

[1] National Academy of Sciences, Resilience @ the Academies, available at http://www.nationalacademies.org/topics/resilience/.

[2] *Grid Resilience in Regional Transmission Organizations and Independent System Operators*, Order Terminating Rulemaking Proceeding, Initiating New Proceeding, and Establishing Additional Procedures, 162 FERC ¶ 61, 012 at P 23 (January 8, 2018).

ability to get services back as quickly as possible in a coordinated and controlled manner; and (4) adaptability—the ability to incorporate lessons learned from past events to improve resilience.[3]

While there are various ways to define resilience, it becomes clear that the concept is based on a holistic approach to address dynamic and impactful risks to electric systems by anticipating, withstanding, recovering, and adapting to a wide variety of man-made or natural threats.

EEI's member companies are focused on providing a safe, reliable, and affordable supply of energy to their customers. The concept of resilience is embedded within these priorities. EEI's member companies invest more than $100 billion each year to make the energy grid smarter, stronger, cleaner, more dynamic, and more secure. These investments help to increase the integration of renewable resources into the energy grid; power the rapid increase in electric vehicles on the road; harden the grid to better withstand extreme weather events; and facilitate the adoption of a broad array of smart technologies that enhance the energy grid in ways that better serve communities while advancing security and reliability.

However, an inherent challenge with resilience is that risks to the electric system vary across the nation. For example, the filings made by regional transmission organizations (RTOs), independent system operators (ISOs), and individual electric companies at FERC raise different threats, concerns, and urgencies in different parts of the country. As a result, coordination at all levels is needed. This includes working locally with customers and state governments to address distribution system needs; regional coordination that acknowledges different threats to different parts of the country; and a national strategy that facilitates investment and looks holistically at the broader energy grid.

Improving resilience requires a strong partnership among policymakers and regulators at the local, state, regional, and federal levels; customers; interdependent sectors; and electric companies. This coordination among stakeholders is imperative to ensure alignment on the understanding of resilience and to identify appropriate, cost-effective priorities.

1. What level and scope of resilience do we need, and how much are we willing to pay?

There is no simple answer or one-size-fits-all approach to resilience. The level and scope of resilience investments should be informed by risks and potential consequences to the electric system and those it serves. Risks to the system from cyber and physical attacks, fuel availability and security, and extreme weather are evolving rapidly to varying degrees across the nation. For example, the risk of hurricanes, wildfires, and extreme weather vary by region, requiring different resilience measures and levels of investment. In addition, the changing energy mix introduces potential new fuel security and reliability risks; as traditional coal and nuclear

[3] North American Electric Reliability Corporation, *August 15, 2018, Agenda Member Representatives Committee at Agenda Item 8*, https://www.nerc.com/gov/bot/MRC/Agenda%20Highlights%20nad%20Minutes%202013/MRC-Agenda_Package_August_15_2018.pdf.

generation retire, dependence on natural gas and, increasingly, on renewable sources requires new resilience strategies and investments.

Customer needs and expectations also are changing. Residential, commercial, and industrial customers have different needs regarding reliability, outages, and recovery. While some customers value greater control over their energy choices and are participating in the active management and even production of the electricity they consume, others are more concerned with a high level of reliability, resiliency, and power quality. As more distributed energy resources and other new technologies integrate with the energy grid and as new organizations participate in retail and wholesale markets, new vulnerabilities and potential attack surfaces emerge, increasing the need for enhanced security and resilience measures.

It is important to have a national view and federal situational awareness regarding resilience strategy and priorities, particularly as it relates to national security. Again, a one-size-fits-all approach is not the answer. Local, state, and regional considerations and solutions are needed, operating in concert and coordination with federal approaches. Electric and natural gas company collaboration with regulators at all levels is essential to manage the evolving system successfully and to keep it reliable, resilient, and cost-effective.

Regarding cost-effectiveness and diversity of needs, different customers and regions will require different investments and resilience strategies. Developing a framework for regulators, customers, electric companies, and other stakeholders to support needed infrastructure and to recover costs appropriately will be key. Sharing best practices that can be tailored to various risks will support sound investment decisions. Partnership among electric companies; federal, state, and local regulators; and other organizations focused on customers, policy, and technology will be an important part of this effort. Coordination among these stakeholders will help to ensure that the most critical needs are identified and that solutions are developed for specific states, regions, and customers.

While electric companies have always taken their responsibility to ensure reliability seriously, the past two decades have highlighted the important role that other critical infrastructure sectors must play in supporting security and resilience. The Electricity Subsector Coordinating Council (ESCC) is helping government and private-sector partners deepen relationships with other, interdependent critical sectors (i.e., sectors that the electric systems depend on and that depend on the electric sector), including the financial services, communications, water, natural gas, and transportation sectors. Planning to defend, mitigate, respond, and recover to and from "black-swan" events requires coordination among all of these sectors.

2. Who's responsible for resilience, and how should other entities coordinate with utilities when there are mutual benefits?

Addressing resilience is a responsibility shared by federal, state, and local governments; NERC in its role as the congressionally sanctioned "Electric Reliability Organization;" customers; interdependent sectors; and energy grid asset owners and operators. The diversity of responsibility can be seen just among the federal government with congressional funding related to grid hardening and resilience going to the Departments of Energy (DOE), Homeland Security

(DHS), and Defense (DOD). This includes research, development, and deployment programs for innovative technologies and strategies that address high-impact/low-probability events; recognize the work around improving security and resilience for defense critical electric infrastructure; and support FEMA's partnership with electric companies to respond to and recover from extreme weather events. Each of these departments has a very different role when it comes to interaction with the electric sector, but each is vital to ensuring a holistic approach to energy grid resilience.

From the federal regulatory perspective, FERC's authority over market and bulk electric system reliability can help to address grid hardening and resilience from a national, transmission system perspective, while recognizing, as noted in the response to Question 1, that state and local entities also must have the ability to secure appropriate resources and solutions to ensure and address regionally specific resilience needs. Additionally, the Commission should continue to monitor risks through non-regulatory offices, like the Office of Energy Infrastructure Security (OEIS), to ensure they remain well-informed and fully understand the threats stakeholders face and how best to leverage FERC's authorities to improve energy grid security and resilience. Convening events, such as technical conferences, is an important role for the Commission, providing the stakeholder community a valuable venue to address evolving threats.

NERC, in addition to developing and enforcing the reliability standards, which include aspects of resilience, conducts assessments to identify potential reliability risks. These risks may be addressed by making modifications to the reliability standards, by developing reliability guidelines, or by other appropriate actions to maintain the reliability of the bulk-power system, while improving system resilience. NERC should continue to use its technical resources, including industry expertise, to support future assessments and risk identification. NERC's biannual GridEx exercises also support resilience, helping to prepare for response and recovery against large-scale cyber and physical security incidents. The fifth GridEx will take place in November 2019 and represents the gold standard for private sector-led exercises, helping to prepare grid operators; emergency responders; federal, state, and local officials; the vendor community; and other key stakeholders for potentially catastrophic threats.

Providing state and local regulators with information to understand the value of resilience also is necessary to balance innovation, security, and cost-effectiveness within their jurisdictions. Local governments can align their planning and potential investment with electric companies and engage with customers, particularly in planning for incident response. Similarly, electric companies should coordinate with state, local, and federal governments, as well as customers and interdependent infrastructure sectors, to align resilience efforts to local expectations.

Electric company resilience programs often are tailored to meet specific threats or needs. In some cases, hardening or resilience benefits will accrue across the customer base (e.g., storm hardening for hurricanes); however, in other cases, there may be an individual customer who needs a higher level of resilience for a specific threat (e.g., an industrial facility or military base) where a cost-sharing approach may be more appropriate. The key is flexibility so that electric companies can tailor their resilience efforts to meet customer needs and expectations.

Electric companies also should continue to invest in grid hardening and resilience, share best practices, and participate in technology pilots. As these investments are made, electric companies will need to engage with state, local, and federal governments, as well as customers and interdependent infrastructure companies, to balance expectations for grid hardening and resilience.

As the most critical of critical infrastructure sectors, the electric sector often serves as the center of gravity for relevant stakeholders to engage on significant issues. Improving sector and critical infrastructure resilience more broadly is a shared responsibility that requires electric sector leadership and proactive engagement with multiple stakeholders.

Opportunities for coordination on resilience include electric system planning, identifying system risks, research and development, cross-sector coordination, joint emergency preparedness and response exercises, information sharing between the private sector and government, emergency/critical spare equipment sharing programs, and mutual assistance to support response and recovery. These coordination efforts should continue to build upon existing industry-government partnerships and programs, such as the ESCC's partnership with the Energy Sector Government Coordinating Council, established cross-sector efforts in collaboration with the DHS and respective sector-specific agencies, information sharing and analysis centers, and the states.

3. What types of utility investments have the most impact on improving resilience, and how can utilities and regulators tell whether utility investments in resilience are impactful?

The most impactful resilience investments are those that enhance resilience against a multitude of hazards. By focusing on managing potential consequences, rather than focusing simply on prevention, electric companies avoid chasing the latest defensive measure against always evolving threats and, instead, prepare to respond to all hazards. Prioritization of assets and prioritization that accounts for a company's particular risk profile also ensure more efficient resilience investments.

Electric companies and their regulators should work together to determine the right investments to improve the resilience of the energy grid for particular localities or regions. Some specific measures that have shown value include:

- **Undergrounding** – Moving infrastructure underground can have a positive impact on reliability. However, a wholesale move to underground substantial portions of existing distribution facilities is prohibitively expensive and, in areas where there is flooding or inundation risk, could be counterproductive. Instead, a more prudent approach requires looking at each opportunity to underground lines on a case-by-case basis that weighs costs and benefits with customer needs and expectations, as well as engineering considerations and alternative approaches to achieve resilience. This ensures that a variety of cost-effective solutions, including undergrounding, tree wire, or more aggressive vegetation management, are considered depending on the location.

- **Nontraditional Transmission & Distribution Pole Materials** - Considerable improvements have been made in the development of pole materials used for transmission and distribution overhead lines. While these new materials have higher upfront costs than traditional wood poles, they often provide greater resistance to weathering, insects, rusting, high winds, and even fire, and include materials such as concrete, advanced coatings for steel, high-strength fiberglass, polyurethane resins, etc. In some cases, these upgrades are more cost-effective long-term than more traditional materials.

- **Smarter Energy Infrastructure** - The energy grid is evolving rapidly, driven by advances in technologies and changing customer expectations. We already have seen substantial improvements driven by smart meters, advanced energy management systems, and transmission and distribution planning. These breakthroughs increase protection of equipment, enhance situational awareness of grid operations, reduce maintenance costs, and improve response times during outages. The grid's evolution has improved SCADA systems and network security; provided advanced analytics; deployed more intelligent sensors; improved automation of core functions; enhanced protection of hard-to-replace equipment from protective relays; provided better substation and distribution controls with intelligent end devices; created opportunity with dynamic line ratings; and provided more ubiquitous communications supporting a wide range of grid needs and solutions.

- **Distributed Energy Resources (DERs)** – As the number of DERs on the system grows, new infrastructure and technology are required. Policymakers, regulators, grid operators, and others should work together to ensure DER deployment is done in a way that, ideally, enhances overall grid resilience, but at least does not harm the security and reliability of the energy grid. Moreover, stakeholders should engage in discussions to ensure that appropriate actions are taken regarding preparedness efforts for new market entrants, including cybersecurity preparedness, targeted training and drills, and close coordination with other infrastructure sectors and critical stakeholders (e.g., larger customers, first responders, hospitals, public transportation agencies).[4] In addition, the strategic deployment of storage at both the transmission and distribution level could enhance reliability and resilience. For storage to be able to play the most robust role possible, additional research and development is needed to reduce costs and improve performance. In addition, key questions about which entities can own and deploy storage need to be answered.

- **Cybersecurity Protections** – Digital electric infrastructure is advancing rapidly with great benefits. At the same time, associated cybersecurity risks are proliferating. Threats to critical infrastructure are escalating, and attack vectors are changing. These changes create new challenges to protect electric infrastructure. NERC reliability standards, including the Critical Infrastructure Protection (CIP) Standards, are one of the tools to support security for the bulk-power system. However, flexible security measures also are

[4] Critical Consumer Issues Forum, *Security & Resilience at the Distribution Level: Integrating Technologies at the Grid Edge* (Jul. 2018), http://www.criticalconsumerissuesforum.com/wp-content/uploads/2018/07/CCIF-Report-on-Security-Resilience-July-2018.pdf.

important to ensure the energy grid remains secure and safe while leveraging these new technologies and enhancing the operational efficiency, electric system reliability, and overall resiliency.

An example of a cost-effective resilience approach that leverages consequence management against rapidly evolving cyber threats is the establishment of the Cyber Mutual Assistance (CMA) program. CMA was developed by the ESCC and has grown to a voluntary group of more than 150 electric and natural gas companies from all across North America that are committed to helping each other in the event of a cyber attack. Modeled on traditional mutual assistance, CMA requires very little in the way of upfront resource commitments, but it could have extraordinary benefit for an electric company should the need ever arise.

- **Physical Security Protections** – NERC's CIP Standards focus on protecting substations that are most critical to the reliable operation of the bulk-power system. This includes installing physical security systems, such as electronically controlled access, barriers, and video surveillance, to protect critical facilities. In addition to actions taken in response to mandatory standards, electric companies assess facilities by their relative importance to (1) the delivery of electricity; (2) the national defense and impact on the national economy; and (3) customer and employee safety.

- **Asset Management** – Efforts are underway to leverage the vast amount of data collected around tracking, monitoring, and maintaining assets to improve asset utilization and to identify weaknesses or impending failures predictively. These technology developments and process improvements are leading to fewer unexpected equipment failures and improved maintenance cycles, which require fewer equipment replacements and save customers money. These advancements will lead to greater efficiencies and improved utility, reliability, and resiliency. The data collection and analysis required are a new cost to some companies, but these costs likely are offset by the improved outcomes and system savings.

- **Vegetation Management** – Vegetation management is key to ensuring that overhead transmission and distribution systems are well-maintained and managed. Without effective and proactive management of utility rights-of-way, both reliability and resiliency can be impacted negatively. Electric companies are rethinking vegetation management solutions to better inform their processes through improvements in data analytics; rights-of-way monitoring; consideration of the impacts outside of their rights-of-way; and improved forest management. Federal, state and local government cooperation that reconsiders utility rights-of-way is essential.

- **Advanced Grid Management / Proactive Shutdowns** – Advanced grid management, including programs to deenergize circuits during certain high-risk emergency conditions (e.g., dry and windy conditions that create high fire risk), are beginning to be used and considered, but raise significant legal and policy questions that state and federal regulators have not addressed yet.

- **Extreme Weather Damage Mitigation** – Electric companies in many flood prone areas, such as coastal regions, have experienced increased risks resulting from flooding at substations and other associated electrical equipment. This issue has led these companies to reconsider their design standards and to take proactive measures to raise the elevation of equipment and substations and, where practical, relocate affected equipment to areas less prone to these events. In some cases, the use of mobile substation equipment has provided added resilience and additional capacity in emergency situations.

- **Support for Smart Meter Investments** – Smart meters are one of the most important resilience investments for the distribution system. In addition to providing valuable electricity usage information to customers, these devices provide situational awareness to electric companies, including outage reporting that allows for more timely response. However, recently several state commissions have rejected proposals to deploy these devices. While each smart meter filing is unique, EEI's member companies would appreciate support in future proceedings that recognizes and enumerates the value of these investments to support distribution system resilience.

- **Support for Greater Visibility into Distribution Systems** – Unlike operations in the Bulk Power System, which are highly visible, energy companies rarely have equivalent visibility into their distribution systems. Investments made to improve this visibility is increasingly needed as more DERs are added to the system, as they inject variability and can complicate electric company operations.

- **Support for State Regulatory Commissions on Cyber Security at the Distribution Level** – State regulatory commissions have jurisdiction over distribution system policies, including cybersecurity. Many of these commissions lack the resources, staff, and access to sensitive information that would help them to address these issues. Providing support to these entities through the National Association of Regulatory Utility Commissions (NARUC) would be helpful to promote best practices among the states, especially as the "Internet of Things" and DERs proliferate and add to the "attack surface" of the distribution system.

- **Support for Transmission Investments** – Investments in transmission are challenging given the difficulty of siting these facilities, determining proper cost allocation for these long-term assets, and determining an adequate Return on Equity for projects. Yet the resilience and reliability attributes of these investments are rarely, if ever, included. Support for quantifying these attributes and investments is important for long-term resilience of the entire energy grid.

- **Support for Advanced Research for Development and Deployment of Transmission Sensor Technology** – Deploying sensor technology on energy infrastructure can provide predictive analytics to make maintenance more efficient. Further, sensors can help detect anomalies on the system and even help to prevent the spread of wildfires. Support for these investments will help increase the resilience of the nation's transmission system, particularly, but not exclusively, in the Western United States.

- **Support for Other Critical Infrastructure** – Electric companies in many areas are taking proactive measures to improve reliability and resiliency to identified critical customers (e.g., police, fire stations, hospital, military and government facilities, etc.) through measures such as redundant infrastructure. While these improvements can be costly, the benefits they provide during major events can outweigh the cost. The issue of resilience also must be looked at holistically since electric companies depend on other sectors, including water to generate steam and cool systems, telecommunications to operate, and transportation or pipelines to move the fuel that generates electricity.

Electric company response and recovery programs and processes also are critical resilience investments because it is difficult to anticipate all threats and may be cost-prohibitive to guarantee protection against all hazards. These programs include:

- Information sharing and analytics
- Mutual assistance networks, including cyber mutual assistance
- Spare equipment sharing programs
- Business continuity programs
- Emergency management structures
- Emergency drills and exercises
- Ability to operate the energy grid in degraded conditions
- Cross-sector information sharing and situational awareness programs
- Lessons learned and best practices sharing
- Use of drones

With respect to prioritization, electric transmission infrastructure is the backbone of the nation's energy grid, and investment in transmission infrastructure will continue to play an important role in electric system resilience. This access to varied generation and extra capacity enhances system stability and allows for communities to be restored more quickly when an incident occurs. This is the hallmark of a resilient system. However, as with the distribution system, flexibility is needed to address regional differences in transmission planning and development to promote a stronger, more robust system.

4. Should utilities take more proactive approaches to investments in resilience?

Electric companies already are taking a more proactive approach to investments in infrastructure. This includes investing in new and upgraded transmission and distribution infrastructure; using advanced technologies to enhance communications; improving operating efficiency and reliability; and enhancing protection to enable a more secure, flexible, and resilient electric system.

It is estimated that electric companies have invested more than $285 billion in transmission and distribution since Superstorm Sandy, helping to harden the energy grid and make it more resilient. These investments include advanced monitoring systems, high-temperature low-sag conductors, underground cables, fiber optics, advanced high-capacity composite core conductors, new transmission lines, energy storage devices, enhanced condition-based monitoring, and mobile transformers and substations. These investments support electric company operations and other investments and enhancements in the transmission and distribution systems that, among other things, allow for the integration of distributed energy resources on the grid in a safe and reliable manner.

EEI's member companies are investing in efforts to harden transmission and distribution system infrastructure to resist storm damage, while also developing new technologies and techniques that allow for faster restoration of transmission service. In the case of Hurricane Irma in 2017, more than 4.4 million customers lost power, and Florida Power and Light (FPL) was able to restore electricity within 10 days versus the 18 days it took to restore power to 3.2 million customers after a similar storm, Hurricane Wilma, in 2005. FPL credits the reduced power outages and improved restoration efforts on infrastructure improvements (e.g., steel and concrete poles and burying power lines) and smart grid technology (e.g., flood monitors and smart meters). These efforts demonstrated improved restoration and recovery and reduced overall costs. In addition to investments in the transmission and distribution system, EEI's members continue to invest in the generation resources and new generation technologies necessary to maintain resource adequacy.

As the threats to the reliability of the bulk-power system have evolved, the Reliability Standards developed and enforced by NERC and FERC have evolved, too. Although there appropriately is not a resilience standard or requirement, FERC has taken steps directed at elements of resilience, including significant work to address bulk-power system reliability through NERC Reliability Standards, assessments, and risk identification. Collectively, the Reliability Standards developed by NERC inherently account for resilience by supporting robustness, resourcefulness, rapid recovery, and adaptability.

- The CIP Standards address risks from cyber and physical attacks. Many of the CIP requirements provide enhanced protections that help ensure that systems can resist, absorb, and rapidly recover from coordinated physical and cyber attacks.
- The Transmission Planning Standards are designed to ensure that the bulk-power system operates reliably through many system conditions and contingencies, including solar events, spare-equipment shortages, and generation retirements, assuring affected systems

appropriately absorb the impacts of changing conditions and continue to remain reliable throughout.

- The Emergency Preparedness and Operations Standards ensure entities have plans, facilities, and personnel in place that are capable of recovering rapidly from events (e.g., system restoration, loss of control center functionality, GMD events) that could impact the reliable operation of the bulk-power system.
- The Protection Control (PRC) Standards include loadability standards that ensure that key elements of the bulk-power system will remain in service while absorbing short-duration overload conditions, allowing time for system operators to mitigate the situation without unnecessary loss of load or damage to equipment. The PRC Standards also address stable power swings to ensure bulk-power system elements do not trip unnecessarily during system oscillations resulting from large disturbances, which allow the system to absorb and recover without unnecessary loss of load or without contributing to events that might result in much larger power disturbances.

In addition to developing and enforcing the Reliability Standards, NERC assesses various risks that may impact the reliability of the bulk-power system,[5] including resource adequacy issues that cannot be addressed fully by reliability standards or requirements.[6] However, NERC's reliability assessments and historical operational information can inform discussions between electric companies and state regulators responsible for addressing potential resource adequacy issues. The states and RTOs/ISOs may need to conduct additional analyses to identify issues unique to their local systems,[7] including impacts caused by factors outside of NERC's bulk-power system focus, expertise, and regulatory authority.[8]

As mentioned, it is impossible to defend against all threats; therefore, resilience planning also must include consideration of how the industry proactively prepares for and responds to threats. The chief executive officers of 22 electric companies participate in the ESCC, which represents all segments of industry and the full scope of electric generation, transmission, and distribution in the United States and Canada. The ESCC is the principal liaison between senior officials of the federal government and the electric power industry for coordinating efforts to prepare for, and respond to, national-level incidents or threats to critical infrastructure. This partnership leverages government and industry strengths to develop and deploy new technologies, share information, conduct drills and exercises such as GridEx, and facilitate cross-sector coordination.

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[5] *See e.g.*, NERC and U.S. Department of Energy, *High-Impact, Low-Frequency Event Risk to the North American Bulk Power System* (Jun 2010); NERC Severe Impact Resilience Task Force, *Severe Impact Resilience: Considerations and Recommendations* (May 2012); NERC, *Special Reliability Assessment: Potential BPS Impacts Due to Severe Disruptions on the Natural Gas System* (Nov. 2017); NERC, *Potential Reliability Impacts of EPA's Clean Power Plan*, Phase I (Apr. 2015) and Phase II (May 2016).

[6] Resource adequacy issues may be identified by NERC in assessments, but the Reliability Standards or requirements cannot and should not be the means to require entities to secure resources to address resource adequacy issues. 16 U.S.C. §824(o)(a)(3); *Planning Resource Adequacy Assessment Reliability Standard*, Order No. 747, 134 FERC ¶ 61,212 at P 21 (2011).

[7] *See e.g.*, ISO New England, *Operational Fuel Security Analysis* (Jan. 17, 2018), available at https://www.iso-ne.com/static-assets/documents/2018/01/20180117_operational_fuel-security_analysis.pdf.

[8] NERC's authority is limited to the operation of existing bulk-power system facilities. 16 U.S.C. §824(o)(a)(3). Threats to other infrastructure sectors that may impact the bulk-power system are not within NERC's authority or expertise.

In addition, mutual assistance is the cornerstone of electric company operations during recovery from power outages caused by infrastructure damage. Electric companies affected by significant outages often turn to the mutual assistance network—a voluntary partnership of electric companies from across the United States and Canada—to help speed restoration whenever and wherever assistance is needed when it is safe to do so. When natural disasters cause power outages, electric companies use this partnership to increase their restoration crews and contractors.

Since Superstorm Sandy in 2012, electric companies have enhanced mutual assistance programs[9] to scale to national-level incidents. EEI's members created the National Response Event (NRE) framework to support the industry's Regional Mutual Assistance Groups (RMAGs) in the event of an incident that has national implications. This effort includes the development of emergency response playbooks and protocols to facilitate situational awareness and information sharing, an online tool to streamline the allocation of restoration resources, and a robust exercise program to prepare company personnel. These enhancements have allowed the industry to support large restoration efforts in recent years.

In addition to the industry's voluntary mutual assistance programs to restore power and respond to cybersecurity threats, electric companies participate in spare-equipment sharing programs to enable rapid recovery from events. For example:

- The Spare Transformer Equipment Program (STEP) provides a mechanism to share assets when equipment is destroyed deliberately and is based on binding contracts for access to hard-to-replace transformers.
- SpareConnect is an online tool for transmission asset owners and operators to connect and share transmission and generation step-up transformers and related equipment (e.g., bushings, fans, and auxiliary components) in the event of an emergency or other non-routine failure.
- Grid Assurance is a stand-alone company that focuses on critical transmission equipment procurement, security and strategic equipment warehousing, equipment management, and logistics support to facilitate rapid deployment of critical long-lead time equipment in light of a grid emergency.
- The Regional Equipment Sharing for Transmission Outage Restoration (RESTORE) program provides additional sources for obtaining critical transmission equipment following disastrous events.[10]

Investments in the transmission and distribution infrastructure that facilitate the use of clean energy will continue to be important to resilience. Tracking development and proactively planning transmission investment to accommodate EV charging stations supports resilience. Additional transmission infrastructure is needed to access that energy, to modernize transmission

[9] Public power utilities and electric cooperatives have parallel and complementary mutual aid networks to support their members. All three segments of the electricity subsector share information and coordinate mutual assistance efforts through the Department of Energy's Emergency Support Function – 12 and the Electricity Subsector Coordinating Council.

[10] Recently authorized by the Commission. Jurisdictional Regional Equipment Sharing for Transmission Outage Restoration Participants, Order Authorizing Acquisition and Disposition of Jurisdictional Facilities, 163 FERC ¶61,005 (April 3, 2018).

assets to meet growing customer demand for new and innovative services. Such initiatives, with an eye on affordably and reliability, have the capability to reduce the magnitude and/or duration of disruptive events. Additionally, for more proactive approaches to be successful, policymakers, regulators, and customers also must support resilience investments.

5. How can decision making about resilience investments be improved?

More support from stakeholders at the local, state, regional, and national levels would help to prioritize risks to resilience and inform investments required to address those risks. While customers, new grid service providers, regulators, policymakers, and other critical sectors all can help inform how best to improve system resilience, energy grid operators play a unique role in enabling resilience for some of the nation's most critical infrastructure.

Given limited resources and an always evolving threat landscape, prioritization of investments and a focus on consequence management will be key components to improving resilience. Moreover, all stakeholders will have to grapple with questions about costs and benefits, especially when making investments to address high-risk, low-probably events or investments based on evolving research and new data. This will require robust information sharing and collaboration to identify risks and will require protecting sensitive security information. Also, establishing clear criteria to resolve the tension between transparency and security issues raised by resiliency planning will be essential. Finally, sharing lessons learned and best practices on resilience investments will help to improve future investments.

As electric companies plan for change and more frequent and extreme weather events amid a changing climate, there will be an increased need for improved data, models, planning, and flexible design options. The quality of decision-making will be improved with better weather and climate data that can be used when making investments and maintenance decisions within an electric company's service area.