

NERC

NORTH AMERICAN ELECTRIC
RELIABILITY CORPORATION

NERC 2016 Annual Report

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RELIABILITY | ACCOUNTABILITY



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Letter from the President and Chief Executive Officer

Extraordinary change in the electricity industry presents new challenges and opportunities for reliability. This unprecedented period underscores the importance of an Electric Reliability Organization that understands and anticipates the most critical risks to the North American grid. The ERO is focused on known risks while continuing to identify trends and address emerging challenges. The security landscape is a dynamic risk requiring constant vigilance and agility. I am pleased that NERC's 2016 achievements demonstrate leadership and progress on all these fronts.

The bulk power system continues to perform well, demonstrating the results of NERC's risk-based approach to reliability, a strong learning environment and industry commitment. The State of Reliability 2016 shows year-over-year improvements. Key findings include a decrease in protection system misoperations, increased resilience to severe weather and decreased human error. There were no category 4 or 5 events, and no load loss due to reported cyber security events.

The Reliability Issues Steering Committee is instrumental in leveraging industry expertise to help inform NERC on current and emerging reliability impacts. High risk profiles identified by the RISC include cyber security, the changing resource mix, planning, and resource adequacy. These are evolving issues that require a larger amount of industry attention and resource focus to better understand and address impacts to the system.

NERC continues to invest considerable resources to study reliability dimensions around the changing resource mix. The *2016 Long-Term Reliability Assessment* identifies natural gas dependency, distributed energy resources and maintaining essential reliability services as the most pressing emerging reliability issues facing the bulk power system. While coordination between the natural gas and electricity industries is much improved, NERC's work on natural gas dependency finds risk to the bulk power system due to over-reliance on a single fuel source. NERC also published a report demonstrating the need for new resources to provide essential reliability services.

Reliability Standards achieved a number of important milestones in 2016. CIP Version 5 became effective on July 1. This development represents significant progress toward a risk-based, flexible approach to security of the grid. Finally, acting upon a FERC directive, a standard drafting team has begun work toward a new standard to address cyber security risks around supply chain issues.

The Electricity Information Sharing and Analysis Center continues its strong focus on strengthening and enhancing membership services, expanding products and increasing participation. Planning has begun on GridEx IV, the largest grid security exercise to date. In 2016, NERC issued two Level Two alerts – the first related to the cyber security event in Ukraine and another concerning distributed denial of service



attacks outside the electricity sector. NERC was also called upon to help analyze the Ukraine event so as to inform protection strategies in the United States.

NERC's international engagements on both sides of the border grew considerably in 2016. In Canada, NERC continued to strengthen relationships with provincial regulators, demonstrating the value of international collaboration. In Mexico, we are actively engaged with regulators and government officials in their efforts to implement energy reforms and establish a reliability framework. We anticipate further progress on the international front in 2017.

Finally, I would like to thank Fred Gorbet for his four years as chair of NERC's Board of Trustees. Under his leadership, Fred guided NERC through its evolution into a strategic, risk-based organization, which was all the more challenging given rapid changes occurring in the industry. Fred's leadership was also critical to NERC's enhanced engagement and effectiveness internationally. I look forward to his continued service on the Board.

Looking forward to 2017, NERC remains sharply focused on the reliability challenges and opportunities arising from a rapidly transforming electricity sector and emerging security risks. There is much work ahead. It requires continued vigilance and dedication on the part of everyone involved with the ERO. Given our progress to date, I am enthusiastic for the future of reliability.

A handwritten signature in black ink, reading "Gerry Cauley". The signature is written in a cursive, flowing style.

Gerry W. Cauley
President and CEO

2016 NERC Executive Management Group



Gerry Cauley
President and CEO



Charles A. Berardesco
*Senior Vice President,
General Counsel and
Corporate Secretary*



Mark Lauby
*Senior Vice President and
Chief Reliability Officer*



Marcus H. Sachs
*Senior Vice President and
Chief Security Officer*



Janet Sena
*Senior Vice President and
Director of Policy and
External Affairs*



Michael Walker
*Senior Vice President
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2016 NERC Executive Management Group



Stan Hoptroff
*Vice President and Chief
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Scott Jones
*Vice President of Finance
and Treasurer*



Ken McIntyre
*Vice President of Standards
and Compliance*



Sonia Mendonca
*Vice President of Enforcement
and Deputy General Counsel*



James Merlo
*Vice President of Reliability
Risk Management*



Timothy E. Roxey
*Vice President and Chief
E-ISAC Operations Officer*

NERC Overview

Dedicated to assuring the reliability of the North American bulk power system, the North American Electric Reliability Corporation (NERC) continued to make great progress toward maintaining reliability in 2016 through collaboration with the Regional Entities, registered entities and international partners. In its tenth year as the Electric Reliability Organization (ERO), NERC focused its efforts on coordination and collaboration, reliability for the future and addressing risks to reliability.

Throughout the year, NERC worked to improve its coordination and collaboration with Regional and registered entities as well as with international partners. This included the expansion of ERO Enterprise tools, a set of computer programs and databases that improve communication with external groups. Some new tools, like the Misoperations Information Data Analysis System (MIDAS), have come into service this year while more tools are planned in the future. NERC's international work over the past year emphasized the importance of a regulatory framework for reliability that works across the jurisdictions of three sovereign nations, involving greater cooperation with Canada and the first steps toward implementing historic energy reforms in Mexico.

Another major effort in 2016 was the focus on reliability for the future. By implementing several risk-based approaches to achieving reliability, NERC focused on the risks most likely to impact the bulk power system and allocated resources more effectively without ignoring the lesser risks. New standards, like the suite of Critical Infrastructure Protection (CIP) Version 5 standards, serve to secure future reliability in the face of a changing electric grid. NERC reports, like the *2016 Long-Term Reliability Assessment*, the *Operational Risk Assessment with High Penetration of Natural Gas-Fired Generation* and *Potential Reliability Implications of EPA's Clean Power Plan – Phase II* all emphasize the importance of understanding and adapting to the changing resource mix of the bulk power system.

NERC's Electricity Information Sharing and Analysis Center (E-ISAC) worked to identify and help industry mitigate the risks associated with cyber and physical security to the electric grid. This involved enhancing industry participation in voluntary information sharing efforts through the Cybersecurity Risk Information Sharing Program (CRISP) and by regularly interacting with industry, stakeholders and policymakers. NERC's E-ISAC released a detailed report on the 2015 Ukraine cyber attack, demonstrating the value and importance of information sharing with the electric industry. In 2016, NERC hosted the sixth GridSecCon, which drew more than 400 participants from across industry.

Over the course of 2016, NERC continued to improve and mature, much as it has over the last decade since becoming the ERO. NERC's efforts to improve collaboration in North America and abroad help to mitigate current risks and look toward the assured reliability for the North American bulk power system. As the organization adapts to changing electric grid conditions and its role in international relations, NERC is prepared to meet challenges to assure a reliable and secure electric grid in 2017 and beyond.



2016 Achievements

Coordination and Collaboration

The past year was marked by further efforts to improve coordination and collaboration between NERC, the Regional Entities and international stakeholders. The international mission of the ERO recognizes that the interconnected bulk power system in North America is an international grid, requiring collaboration, not just across North America, but also across continents to assure continued grid reliability.

ERO Strategic Planning

On November 2, the Board approved the [*ERO Enterprise Strategic Plan and Metrics 2017–2020*](#). This document is the result of ERO Enterprise collaboration, including input from the Member Representatives Committee (MRC) and recommendations from the Reliability Issue Steering Committee’s (RISC) [*2016 ERO Reliability Risk Priorities: RISC Recommendations to the NERC Board of Trustees*](#).

The ERO Enterprise Strategic Plan and Metrics 2017–2020 identifies the vision, mission and core values and principles for the ERO Enterprise. NERC targeted five areas of strategic focus that center on developing and maintaining risk-responsive Reliability Standards; developing and implementing objective and risk-informed compliance monitoring, enforcement, and organization certification and registration programs; identifying and mitigating significant risks to reliability; identifying and assessing emerging risks to reliability; and ensuring effective and efficient ERO Enterprise operations.

The ERO Enterprise Strategic Plan and Metrics 2017–2020 contains two appendices that detail the metrics and their 2017 measures, thresholds and targets and the RISC’s 2016 risk profiles and recommendations. Each goal is mapped to associated metrics, and the contributing activities are mapped to associated risk profile recommendations as applicable. In 2017, the ERO Enterprise plans to develop a long-term strategy, furthering the culture of collaboration across NERC

and the Regions and reinforcing the unified goal of understanding and mitigating risk.

ERO Enterprise Tools

The ERO Enterprise tools that support NERC’s collaborative operations are an important component of the effort to assure reliability. These tools improve communication between registered entities, the Regions and NERC and also serve to provide valuable data used in reliability assessments, performance analysis and reliability risk management. NERC has several tools already in service and has plans to add more in the coming years.

The first of these tools, the Misoperations Information Data Analysis System (MIDAS), improves misoperations analysis coordination between NERC and the Regions, leading to faster and more accurate identification of acute reliability risks. Another tool, the Reliability Assessment Data System (RADS), automates the process of collecting and validating data used in the development of long-term and seasonal reliability assessments. A third tool is the Event Analysis Management System (TEAMS), which is used to collect information about specific reliability events for further analysis and potential lessons learned development.

TEAMS and RADS were completed in 2015, but 2016 is their first full year of use. MIDAS was finalized in 2016 and is already serving to improve misoperations coordination and communication in the ERO.

NERC also plans to add to the existing ERO Enterprise tools in the coming years. The first addition, the Generator Analysis Data System (GADS) Wind tool, is nearly complete and is slated to be ready in 2017. This addition to the GADS database will provide a platform for registered entities to report information about the operation and performance of wind turbines. This database will prove valuable due to the changing nature of the electric grid from the addition of large amounts of variable energy resources. Another tool NERC plans to create is an extranet to support collaboration with the registered entities and the Regions over the next few years.

The extranet will build on the work and lessons learned from NERC's current effort to review and upgrade its internal information technology systems. Once completed, the extranet will allow different involved parties to work collaboratively on documents in real-time, improving the efficiency of communication. The extranet is slated to be completed in 2019, with limited deployment beginning as early as 2017.

International Affairs

In 2016, NERC continued to emphasize the ERO's international mission. The North American bulk power system spans ten sovereign jurisdictions across three North American countries. As the grid continues to evolve in response to policy mandates, advances in technology and other drivers, a regulatory framework for reliability that is compatible and consistent across jurisdictional boundaries is essential. This framework provides clarity and certainty for planners and operators in order to prevent a recurrence of the international blackouts that led to the creation of an international ERO. Dedicated efforts by NERC and the ERO's international partners over the past several years have moved the reliability regulatory framework to a high level of consistency.

As some of the original proponents for an international ERO, Canadian stakeholders are committed to the bilateral principles on which the ERO is founded and continue to provide strong support for a Canadian role in continental grid oversight. In 2016, as in prior years, this support was demonstrated through participation of Canadian subject matter experts in NERC and Regional Entity processes, including standards development and reliability assessments.

Likewise, regulators in Canada have demonstrated their support of a continent-wide reliability framework by adopting standards and renewing and updating memoranda of understanding with NERC and Regions. As a result, versions of 82 standards are enforceable in at least six of the eight interconnected Canadian provinces (or in the case of regional standards, the majority of the provinces in that region). For reference, there are 99 continent-wide standards enforceable in the United

States and nine regional standards enforceable in regions that have both footprint that includes part of Canada, as of year-end. Because of industry structure and other regulations applicable in certain jurisdictions, every standard may not be applicable to be adopted in some jurisdictions.

In 2016, Mexico made significant progress toward implementing historic energy reforms, including the country's first comprehensive mandatory reliability framework. NERC continued to build relationships with the Mexican regulator, Comisión Reguladora de Energía (CRE) and officials from the Mexican Energy Ministry (SENER) as well as the system and market operator (CENACE) to offer support and resources to implementation efforts. While Mexico is at a different stage of implementing its mandatory reliability framework, Mexican stakeholders have expressed strong interest in engaging in North American collaboration in support of reliability, and considerable progress toward Mexican participation in the international ERO was made in 2016.



NERC and WECC staff tour CENACE control center in March with CENACE operations manager Mauricio Cuellar (far right)



Gerry Cauley (right) and Dominique Ristori, director-general for DG Energy of the European Commission, signing an Administrative Agreement of Cooperation (July)

Reliability risks are not unique to North America. The value of the international ERO model in addressing reliability risks has gained recognition beyond North America. In July, NERC signed an administrative agreement with the European Commission’s Directorate General for Energy to collaborate on grid reliability. The agreement recognizes the shared interest of NERC and DG Energy in grid reliability in the face of emerging challenges. The agreement signals the intent of both organizations to expand technical collaboration and exchange information related to ensuring grid reliability, including governance and standards.

As an international ERO, NERC will continue to reinforce the importance of sharing experiences in North America and learning from experiences internationally in order to secure a sustainable energy future.



Gerry Cauley (left) and Edward Schwerdt, president and chief executive officer of NPCC, signing an updated memorandum of understanding between NERC, NPCC and New Brunswick (August)

Reliability for the Future

As the ERO, NERC enhances and improves the reliability and resiliency of the bulk power system based on a technical foundation of data and analysis. Information sharing and discussion assure that stakeholders have a broad perspective and are able to develop focused efforts on the aspects that pose the most risk to reliability in the future. NERC and industry continue to monitor and prepare for the evolution of the bulk power system. The following ERO initiatives allow stakeholders to look ahead, quantify and forecast what is needed to maintain reliability and to adapt to meet these new needs.

Risk Identification and Mitigation

In 2016, the ERO focused on implementing several risk-based initiatives and identifying risks that will further allow the ERO to adapt to changing and emerging issues. When the ERO is able to employ a risk-based approach, it can focus resources on higher risk issues to the bulk power system, thus benefiting reliability. These initiatives focused on improvements to compliance guidance, event analysis and lessons learned to better reflect this evolving reliability approach.

Compliance Guidance

A key factor in the success of compliance monitoring and enforcement of mandatory standards rests on a common understanding among industry and ERO Enterprise Compliance Monitoring and Enforcement Program (CMEP) staff of how compliance can be achieved and demonstrated. For many standards, this is straightforward. For others, a variety of approaches may achieve the same objective.

NERC’s Compliance Guidance Policy, which was approved by the Board at the end of 2015, includes two types of compliance guidance: implementation guidance, which provides some examples for implementing a standard; and CMEP practice guides, which provide direction to CMEP staff on approaches to carry out compliance monitoring and enforcement activities.

[Compliance guidance](#) is intended to bring multiple benefits to industry, including a simple process for sharing endorsed implementation methods, collaboration with other registered entities and the ERO Enterprise and transparency.

Event Analysis and Lessons Learned

Version 3 of the [ERO Event Analysis process](#), which became effective on January 1, is intended to promote a structured and consistent approach to performing event analyses in North America, thereby promoting the reliability of the bulk power system. Through the event analysis process, the ERO strives to develop a culture of reliability excellence that promotes aggressive, self-critical review and analysis of operations, planning and critical infrastructure protection processes. The event analysis process also serves an integral function as a learning opportunity for industry, providing insight and guidance by identifying and sharing valuable information to owners, operators and users of the bulk power system who enable improved and more reliable operation.

The primary reason for participating in an event analysis is to determine if there are lessons to be learned and shared with the industry.

Lessons learned are developed through a collaborative effort between NERC, the Regions and the registered entities and are an important tool for assuring the continued reliability and resiliency of the bulk power system. These documents are a vital resource for industry to identify a problem, find a way to mitigate it and share with all of industry. They also allow for events to have cause codes or characteristics and attributes assigned, which can then be used by the Event Analysis Subcommittee (EAS) to identify trends. Trends may identify the need to take action, such as a NERC alert, or may support changes to Reliability Standards.

In 2016, NERC, the Regions and registered entities collaborated to produce 13 lessons learned. All published lessons learned are available on the [Reliability Risk Management web page](#) and in the Lessons Learned Quick Reference Guides.

ERO Reliability Risk Priorities Report

The final [2016 ERO Reliability Risk Priorities](#) report was accepted by the Board on November 2. The report, developed by the Reliability Issues Steering Committee, focused on nine key risks to the reliability and security of the bulk power system. Defining these categories allows industry to focus efforts on these issues with the most potential to impact reliability.

Risks were identified as: the changing resource mix; bulk power system planning; resource adequacy and performance; asset management and maintenance; human performance and skilled workforce; loss of situational awareness; extreme natural events; physical security vulnerabilities; and cyber security vulnerabilities.

The report also informs the ERO Enterprise Strategic Plan, which is a key input into the annual business plan and budget. In addition, the recommendations for the mitigation of these risks are addressed through ERO Enterprise work plans and standing committee activities.



Utility workers service a transmission tower in Georgia

State of Reliability

NERC's [State of Reliability 2016](#) report highlighted the strong state of design, planning and operation of the bulk power system by reviewing past performance. Based on the year-on-year analysis, the bulk power system performed well in 2015. An improved understanding of the grid led to more accurate simulations, including better potential to assess blackout risk. This independent review of the bulk power system assesses the state of reliability based on the analysis of data and metric trends. The key findings and recommendations are then used to inform NERC's risk assessment and mitigation activities, standards development and other process improvements.

The *State of Reliability 2016* highlighted key recommendations including continued targeting of the top three causes of automatic protection misoperations, monitoring impacts of resource mix changes and strengthening of situation awareness for cyber and physical security and sharing of that timely and coordinated information in order to strengthen reliability across industry.



Protection system misoperations notably decreased to 9.4 percent — down from 10.4 percent in 2014. This decline in misoperations is due, at least in part, to a decline in communication failures and industry's focus on the instantaneous ground overcurrent function and on improving relay system commissioning tests. Other findings included improvement in bulk power system resiliency to severe weather; decrease in human error; and improvements made to steady-state and dynamic modeling.

The findings of the *State of Reliability 2016* report indicate that the bulk power system continues to perform well and that improvements across several areas in the past year bode well for continued reliable operation.

Standards Development

In 2016, NERC addressed all outstanding standards-related FERC directives and recommendations from [FERC Order No. 693](#). This order approved the first set of mandatory Reliability Standards. By addressing the 819 FERC directives and recommendations issued since 2007, NERC has developed a set of clear, concise, high-quality and technically sound results-based Reliability Standards. Moving forward, standards efforts will shift toward focusing on resiliency and the grid's ability to recover.

Reliability Standards will continue to be assessed for quality, content and alignment with other standards through enhanced periodic reviews. Most of the standards work in the next three years, as noted in the 2017–2019 Reliability Standards Development Plan (RSDP), will focus on enhanced periodic reviews, FERC directives (such as the recent order on Supply Chain Management), new or emerging risks (which may generate new standards development projects), Standards Authorization Requests and the new standards grading initiative — which uses an improved template to inform the enhanced periodic reviews as to the quality and content of the standards.

NERC has advanced numerous standards in the past several years and, in conjunction with the Standards Committee, will continue to seek input and recommendations from the Reliability Issues Steering Committee with regard to emerging or potential risks to reliability that may require revisions to existing standards or new standards development.

While NERC standards continue to evolve, 2016 saw significant efforts on key standards, such as Critical Infrastructure Protection, Supply Chain Management and Geomagnetic Disturbance standards.

Critical Infrastructure Protection Standards

The new suite of Critical Infrastructure Protection standards, also known as the CIP Version 5 (CIP V5) standards, went into effect July 1. The standards represent significant progress in mitigating cyber risks to the bulk power system by addressing remaining cyber security-related FERC directives, applying industry experience from earlier versions and leveraging lessons learned.

CIP V5 offers increased flexibility in implementing risk mitigation to individual entity operations, eliminates

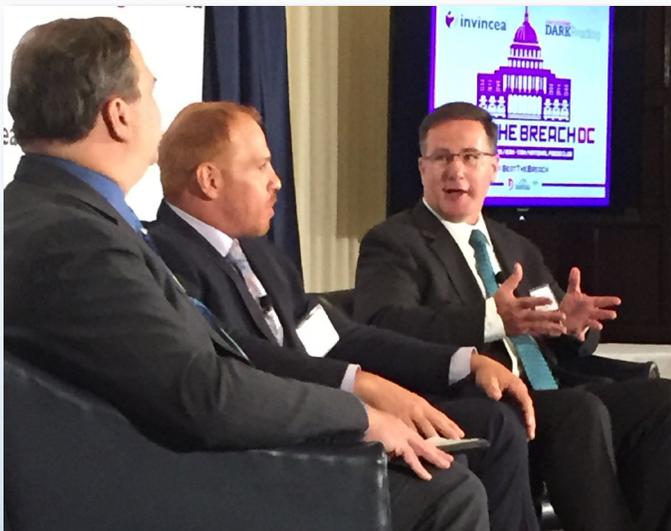
unnecessary documentation requirements and transitions from a rigid “in-or-out” classification to a more flexible “low-medium-high” impact-based classification at the system level. CIP V5 covers assets including servers, workstations, laptops, managed network switches, routers, firewalls, storage controllers, microprocessor relays and generation control systems.

Prior to the standards coming into effect, NERC and the Regions provided outreach and education to industry to help them design and implement an adequate level of controls for security. With CIP V5 standards in effect, industry has identified areas of opportunity within their companies to improve their security posture and not only meet the standards, but to consider industry best practices.

In addition to NERC and the Regions’ ongoing auditing activities, NERC is also supporting FERC in conducting in-depth compliance audits of several companies throughout the Regions. Working closely with FERC and the Regions ensures a common understanding for regulators of how well industry understands the new version of CIP standards and how well they are implementing security controls. Ultimately, it informs NERC and the stakeholders of where the next generation of standards needs to be to ensure the grid is both reliable and secure.

Supply Chain Management

In response to FERC [Order No. 829](#), issued July 21, NERC began coordinating efforts with stakeholders and industry to draft a Cyber Security Supply Chain Management standard. NERC put together a team of experts to research the industry risks around supply chain risk management, as well as to start drafting the standard. NERC facilitated open technical conferences to assist in gathering input and feedback on the issue. The order directed that the standard address software integrity and authenticity; vendor remote access; information system planning; and vendor risk management and procurement controls. FERC directed that the standard be completed by September 27, 2017.



Marc Sachs (far right) speaking at a conference on cyber security in Washington D.C. (March)

Geomagnetic Disturbance

In 2016, NERC continued work on the two-phase effort to address reliability risks caused by geomagnetic disturbance (GMD) events. The first stage standard (i.e., EOP-010-1 – Geomagnetic Disturbance Operations) took effect in April 2015. The standard requires entities throughout North America to have GMD operating procedures that can mitigate the potential impacts of GMD on the electric grid.

The second stage standard (i.e., TPL-007-1 – Transmission System Planned Performance for Geomagnetic Disturbance Events) was filed by NERC in January 2015 and approved by FERC in September 2016. The new standard requires entities throughout North America to perform state-of-the-art vulnerability assessments of their systems and equipment for potential impacts from a severe 1-in-100 year benchmark GMD event and mitigate against identified impacts. When needed, mitigation could include changes in system or equipment design, or the installation of hardware to monitor or reduce the flow of geomagnetically induced currents. Entities will begin implementing the new requirements in 2017 and must meet several steps leading to the completion of vulnerability assessments and mitigation plans by 2022.



Gerry Cauley testifies before the House Transportation and Infrastructure Subcommittee on Economic Management, Public Buildings and Emergency Management (April)

In approving TPL-007-1, FERC directed certain revisions to the standard that must be completed by May 2018. NERC is working on these revisions, which are aimed at enhancing the benchmark GMD event used in GMD vulnerability assessments, establishing deadlines for entities to complete mitigation actions and expanding the collection of GMD data.

NERC was also directed to continue its active GMD research and development efforts and to inform FERC on its plans. NERC coordinates with government, public and private research organizations in the United States, Canada and other countries to advance the understanding of GMD risks. FERC specified that NERC’s plans should include further data analysis of the benchmark GMD event, efforts to review and improve earth conductivity models with new data and continued research into the risks of geomagnetically induced currents-related harmonics on equipment.

Changing Resource Mix

NERC took another step in assuring the future reliability of the bulk power system through a cohesive series of reports in 2016, including the annual *Long-Term Reliability Assessment* and special assessments on the Environmental Protection Agency’s Clean Power Plan, natural gas dependency and essential reliability services. Individually and collectively, these assessments show the vital role NERC plays in educating the industry, policy makers, media and the public about the reliability risks of changing the resource mix for the bulk power system without adequate coordination and planning.

Facing Future Reliability Risk

Consistent with many of its recent assessments, the [2016 Long-Term Reliability Assessment](#) concluded that dependence on natural gas-fired generation continues to increase, as do coal retirements, nuclear retirements and the capacity of distributed energy resources, such as rooftop solar and wind. These trends pose differing risks to reliability, with NERC continuing to highlight the importance of mitigating gas supply disruptions and, for the second consecutive year, ensuring a sufficient level of essential reliability services so the bulk power

system can ramp quickly to sustain frequency and meet demand as the resource mix changes.

With the ongoing resource mix changes, NERC recommended that bulk power system planners take steps to avoid an over reliance on gas-fired generation between 2017 and 2026. Gas generation presents reliability challenges in Texas, Florida, New England and parts of the West. By 2021, natural gas-fired generation accounts for 63 percent of the anticipated on-peak capacity in Texas, 69 percent in Florida, 52 percent in New England and 68 percent in the Western Electricity Coordinating Council’s area. Dual-fueled generation and opportunities to secure firm gas supplies to power plants are available in those areas of North America and are, however, somewhat limited.

The *Long-Term Reliability Assessment* also called on planning coordinators and transmission planners to work with NERC, industry and states to develop a common framework and consistent policies for planning, modeling and forecasting the availability of distributed energy resources. Installations of distributed energy resources, including rooftop solar, are expected to continue at a rapid pace and could significantly impact the reliability of the bulk power system without sufficient visibility and operational control of them.



Understanding Environmental Regulation Risk

Distributed energy resource trends will continue regardless of the Environmental Protection Agency’s Clean Power Plan. The combination of state renewable portfolio standards and federal tax credits will usher in 100–110 GW of wind and solar by 2030, NERC found in *Potential Reliability Implications of EPA’s Clean Power Plan – Phase II*. The EPA rule would expedite this trend by 10–20 GW.

Absent the EPA rule, consumption of coal use would increase by up to 300 TWh per year and natural gas generation would drop by up to 550 TWh with projection prices flattening for coal and rising for natural gas. Under the final rule, coal generation decreases by up to 375 TWh and natural gas output increases by up to 87 TWh.

Annual growth rates for electricity demand have fallen over the last several years for reasons unrelated to the Clean Power Plan. Data shows average growth of 0.61 percent annually and the rule would slow demand growth to 0.31 percent annually. The Clean Power Plan would accelerate this decline by providing direct and indirect incentives for increases in efficiency and other demand-side activities that reduce load.

Targeting Single-Fuel Risk

While electricity demand has been trending downward, NERC assessments in 2016 continued to show potential reliability risk from the increased reliance on gas-fired generation in the long- and short-term.

In its first special short-term reliability assessment, NERC concluded that gas-fired generators in certain areas could face fuel shortages because gas accounts for more than 40 percent of their generation capacity through the 2017/2018 winter. Consistent with the *LTRA* findings, [*Operational Risk Assessment with High Penetration of Natural Gas-Fired Generation*](#) showed that parts of California, New England, New York and Texas are increasingly vulnerable to gas supply interruptions because of factors including extreme weather, pipeline constraints and the unforeseen loss of the Aliso Canyon gas storage facility in the Los Angeles basin. For gas-fired

generators, supply interruptions are a winter issue in certain areas due to peak use for heating and a summer issue in other areas because of peak use for cooling.

Steps to mitigate the continued reliability risk of increased reliance on gas generation include high levels of coordination between the electric and natural gas industries, which can lead to a more resilient bulk power system and increased situational awareness.

Addressing Distributed Resource Risk

Future situational awareness and resiliency will increase if the reliability impact of distributed energy resources is accounted for by bulk power system operators and planners. Essential reliability services, which are not inherent in renewable generation on the grid today, were featured prominently in NERC assessments.

In November, FERC proposed to require that large and small generators provide primary and sustained frequency response capability and apply certain operating requirements based on NERC guidelines. The proposal recognized the importance of frequency response as an essential reliability service.

The operating characteristics of smaller distributed energy resources, including rooftop solar, were also a focus for NERC in 2016. The newly formed NERC Distributed Energy Resources Task Force discussed the need for observability and control of these resources as well as appropriate load and generation modeling to evaluate their potential bulk power system impacts. NERC is scheduled to release a *Distributed Energy Resources Task Force report* in February 2017.

In light of the potential impacts of distributed energy resources, NERC wants to partner with industry to examine reliability during periods that will critically stress the bulk power system, including those hours when demand is low and contribution from wind and solar is high. Planning for resources that are variable in nature, connect to the grid asynchronously or sit behind the meter require different approaches to assure future grid reliability.



Addressing Risks to Security

NERC's E-ISAC worked to identify and help industry mitigate cyber and physical security risks to the bulk power system in 2016 with greater information sharing capabilities, a strong response to cyber security events and opportunities internationally and the launch of a pilot project for automatic threat information sharing among utility networks.

Expanding Information Sharing

Information sharing efforts were enhanced by the increased participation of portal members and broader industry about potential cyber and physical security risks, increased industry participation in the Cybersecurity Risk Information Sharing Program (CRISP), continued issuance of NERC alerts when appropriate and regular interaction with industry, stakeholders and policy makers.

CRISP facilitates real-time, computer-to-computer data exchange involving potential security threats identified through the monitoring of participating utilities' networks. The number of companies participating in CRISP grew in 2016 as the program includes more than 30 utilities serving 75 percent of U.S. electricity consumers. A key CRISP benefit for non-members continues to be that registered entities throughout North America can receive valuable unattributed threat information, including indicators of compromise, through the secure E-ISAC portal.

To address emerging cyber risks, the E-ISAC also launched a pilot project to test automated threat information sharing technology among the networks at a select group of utilities in anticipation of commercializing the technology at a later date.

Inside the Ukraine Mitigation

NERC's involvement in the investigation of the Ukraine cyber attack and its robust information sharing with industry following the event, which included weeks of analysis, culminated in a confidential alert to the North American electricity sector and showcased the benefits of industry membership in the E-ISAC. Ukrainian utilities

affected by the attack lacked the basic cyber hygiene embodied in NERC's Critical Infrastructure Protection standards, according to a [lessons learned report by NERC and the SANS Institute](#).

Stronger Partnerships with Canada and Mexico

Mexican officials built upon their participation in GridEx III by asking NERC to conduct a Cyber Risk Preparedness Assessment on Mexican utilities. NERC also commented with the Edison Electric Institute on a [United States-Canadian grid security and resiliency strategy](#).

Response to Distributed Denial of Service Attack

NERC enhanced the reliability of the grid through its response to a non-utility distributed denial of service (DDOS) attack. Prior to the attack, NERC issued a confidential alert on best practices to defend against DDOS threats.

GridSecCon Growth in 2016

NERC's sixth annual grid security conference drew more than 400 participants, who heard from NERC President and CEO Gerry Cauley that the Ukraine incident was a "game changer" requiring the industry to assess the breadth of its connectivity to the internet and narrow potential access points for potential adversaries. The discussion at GridSecCon also focused on the ongoing cyber and physical security collaboration of U.S. and Canadian utilities with government agencies and how CIP V5 Reliability Standards provide the foundation for a comprehensive grid security approach.



Gerry Cauley speaking at GridSecCon 2016 in Montreal (October)

NERC Regional Entities

FRCC

Florida Reliability Coordinating Council is a not-for-profit company whose mission is to promote and assure the reliability of the bulk power system in Peninsular Florida.

Stacy Dochoda, president and chief executive officer

MRO

Midwest Reliability Organization covers roughly one million square miles spanning the Canadian provinces of Saskatchewan and Manitoba, the states of Iowa, North Dakota, Minnesota and Nebraska, the majority of the states of South Dakota and Wisconsin and portions of Illinois, Michigan and Montana.

Daniel Skaar, president and chief executive officer

NPCC

Northeast Power Coordinating Council, Inc. includes the state of New York and the six New England states, along with the Canadian provinces of Ontario, Québec and the Maritime provinces of New Brunswick and Nova Scotia. Overall, NPCC covers an area of nearly 1.2 million square miles, populated by more than 56 million people.

Edward Schwerdt, president and chief executive officer

RF

ReliabilityFirst's territory stretches from the eastern seaboard to Lake Michigan and includes the District of Columbia and all or part of the states of Wisconsin, West Virginia, Virginia, Tennessee, Pennsylvania, Ohio, New Jersey, Michigan, Maryland, Kentucky, Indiana, Illinois and Delaware. The ReliabilityFirst footprint consists of approximately 23 percent of the nation's population; 23 percent of the nation's gross domestic product; numerous, densely populated metropolitan centers; and the interconnection of two of the world's largest energy markets.

Timothy Gallagher, president and chief executive officer

SERC

The SERC Reliability Corporation is a nonprofit corporation responsible for promoting and improving the reliability, adequacy and critical infrastructure of the bulk power supply systems in all or portions of 16 central and southeastern states. The SERC Region covers an area of approximately 560,000 square miles, populated by nearly 53 million people.

Gary Taylor, president and chief executive officer

SPP Regional Entity

The Southwest Power Pool Regional Entity (SPP RE) is an independent and functionally separate division of SPP, Inc. SPP RE promotes and works to improve bulk power system reliability within SPP RE's footprint, an eight-state area that includes all or parts of Arkansas, Kansas, Louisiana, Mississippi, Missouri, New Mexico, Oklahoma and Texas.

Ron Ciesiel, general manager

Texas RE

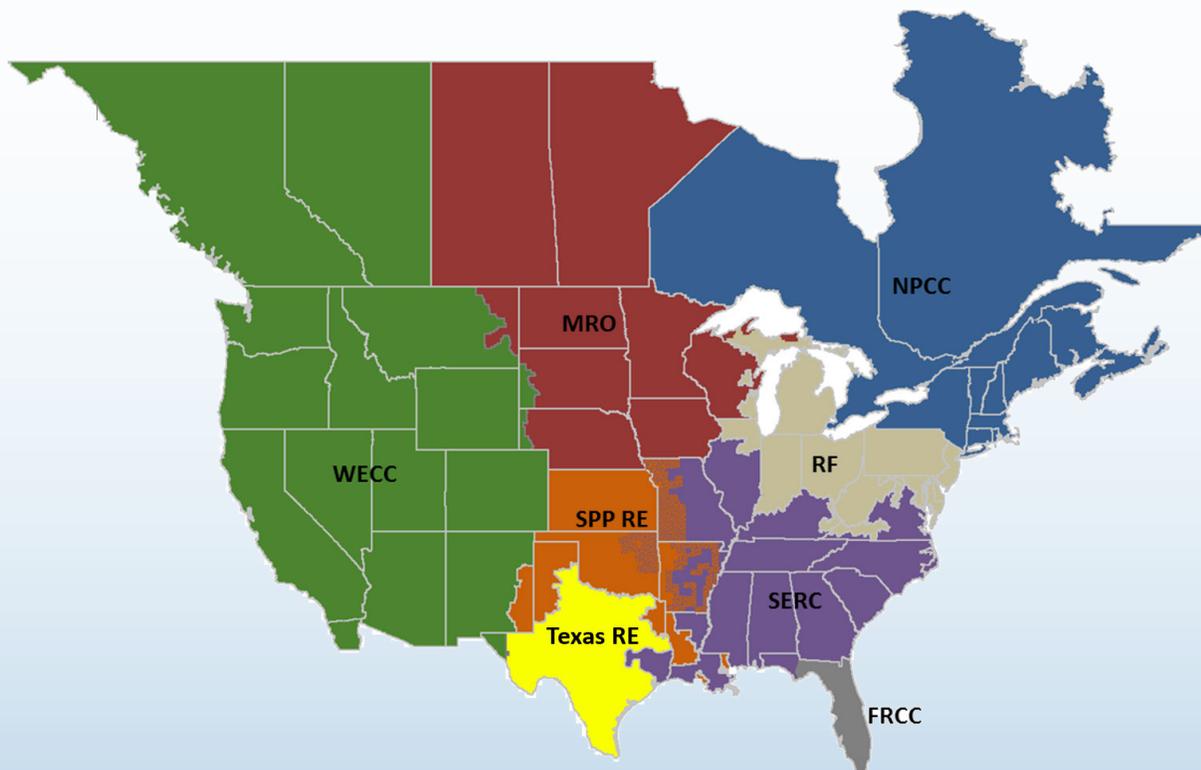
Texas Reliability Entity, Inc. is a nonprofit corporation responsible for ensuring reliability of the bulk power system in the Electric Reliability Council of Texas (ERCOT) Region. The ERCOT Region is located exclusively within Texas and represents 90 percent of the state's electricity load and 75 percent of the Texas land area.

Lane Lanford, president and chief executive officer

WECC

Western Electricity Coordinating Council's territory extends from Canada to Mexico. It includes the provinces of Alberta and British Columbia, the northern portion of Baja California, Mexico and all or portions of the 14 western states between, which totals approximately 1.8 million square miles.

James Robb, chief executive officer



Letter from the Board of Trustees Chair

This is my final letter for the Annual Report as I step down as chair of the NERC Board of Trustees this month. While I will continue to serve on the Board, my four years as chair have been special to me. I had the opportunity to oversee many key initiatives that improved the focus and direction of NERC and strengthened the overall collaboration of the ERO Enterprise. The organization has matured significantly in my time as chair. I am proud of the strides we have made to meet the challenges we face as the ERO and to seize opportunities to assure the reliability and security of the North American grid.

The progress we have made could not have occurred without the strong and constant support of my fellow trustees and the unwavering commitment and leadership of Gerry Cauley and the senior management team at NERC. I am grateful to them.

Reflecting on 2016, there are two themes that dominate our many accomplishments: first, we developed a strong culture of collaboration; and second, we continued to bring disciplined risk management to all of our activities.

With respect to collaboration, I am especially pleased that we approved a single, coordinated ERO Enterprise Strategic Plan in 2016. This unified plan, which for the first time includes accountability metrics based on outcomes rather than inputs, exemplifies both the culture of collaboration that we are building across NERC and the Regions as well as our focus on understanding and mitigating reliability risks. I want to thank the executives and Regional Boards for their contributions to this effort.

Another key area of collaboration is with our international stakeholders. When I became chair in 2013, I saw considerable untapped potential in the international ERO model. I charged management with increasing outreach to Canadian electricity regulators. I am excited with the progress we made toward recognizing and realizing the value of the international ERO model and enhancing reliability collaboration across North America, including the rapid strides we are making to include Mexico as part of the ERO. I am grateful to the Canadian regulatory community and particularly to those who have contributed directly to making our unique regulatory model effective and demonstrating the value of the ERO to government and industry stakeholders in Mexico. Mexico's participation will enrich our work as the ERO as the country brings new perspectives and solid technical expertise to our North American reliability efforts.

In addition to Mexico, this year saw NERC expand its outreach through numerous international forums, working with the Department of State, the Department of Energy, NARUC, CAMPUT and others, as policymakers in North America noted the increasing importance of security and reliability and the critical role NERC plays in supporting both.



Beyond North America, I consider it a high compliment and a real measure of our success that more countries and regions are interested in learning about the ERO model. This year, at the request of the Electricity Directorate of the European Commission, NERC entered into an agreement to collaborate on regulatory, governance and technical matters. Like North America, Europe has a grid that spans multiple sovereign jurisdictions with many diverse owners and operators. It is a point of pride for us that we are seen as the leading regulatory model for multi-jurisdictional grids. We should also be open to learning from experiences outside North America to improve what we do.

With respect to our continued focus on disciplined risk management, we continue to deepen the ERO knowledge of risk analytics and assessments. Effective risk management forces us to be data driven and evidence based. And it also forces us to continually look ahead so we can stay ahead of the curve. We made significant improvements this year in data analysis related to reliability and security. From major international events, such as Ukraine to assessments tracking the changing resource mix to improving data sharing among North American stakeholders, NERC's footprint is evident, focused and credible. From a North American perspective, the advances made in our analytic and analysis efforts have deepened the understanding of risk and provided stakeholders with improved tools to assure the reliability of the interconnected grid.

In closing, I would like to reiterate my appreciation for the support of my fellow trustees and the NERC's senior management team and staff. I also want to thank the Member Representatives Committee, the members of the Board's technical committees and the Regional executives and their Boards. Together we have moved the organization forward to a more strategic focus and positioned it well to face the future with confidence.

It has been a pleasure to serve as your chair for the past four years, and I look forward to being a part of the continued success of this organization.

A handwritten signature in black ink, appearing to read "Fred Gorbet", is written in a cursive style.

Fred Gorbet
NERC Board Chair

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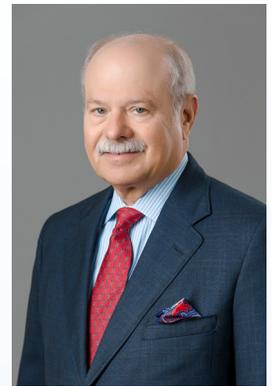
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