NERC
NORTH AMERICAN ELECTRIC
RELIABILITY CORPORATION

2020 Long-Term Reliability Assessment

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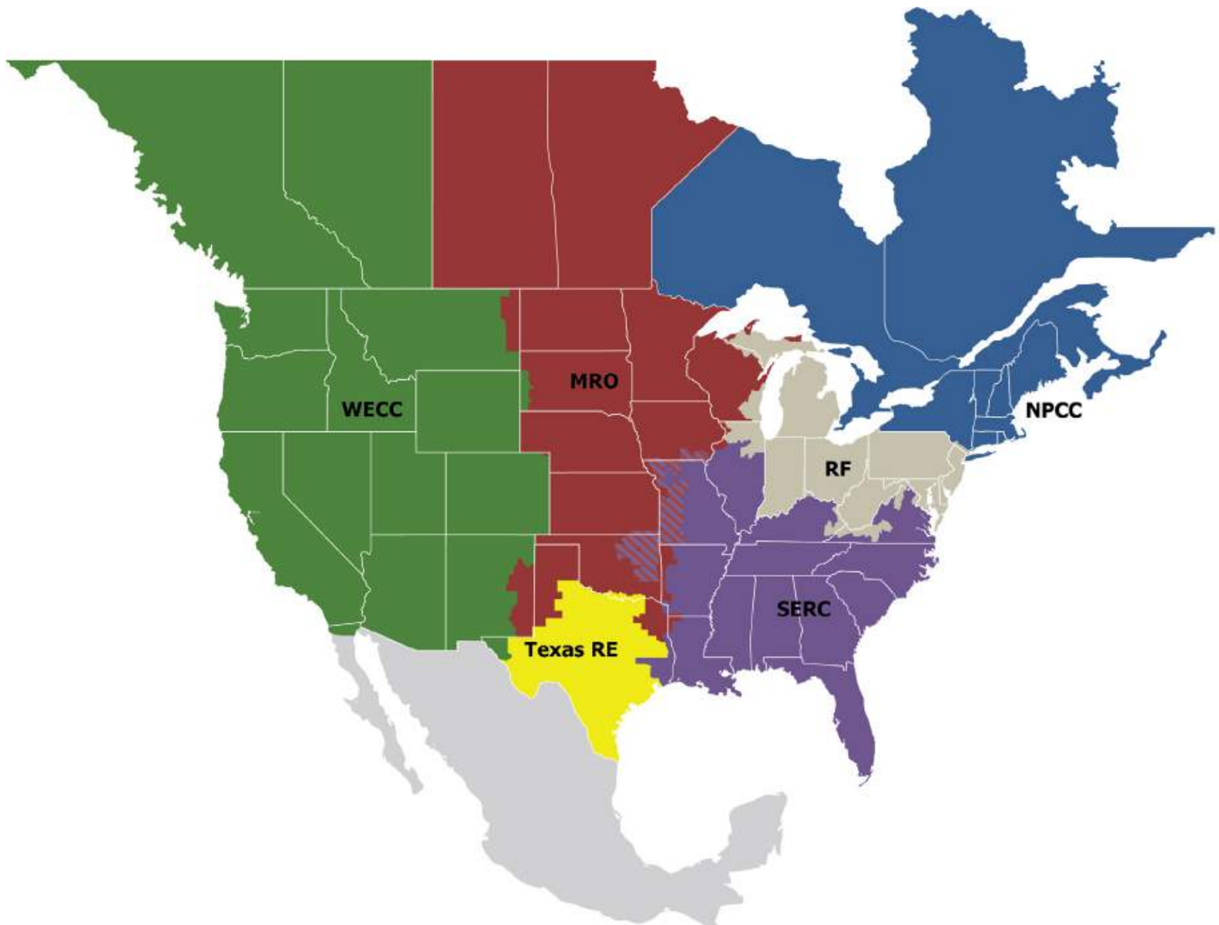
Preface

Electricity is a key component of the fabric of modern society and the Electric Reliability Organization (ERO) Enterprise serves to strengthen that fabric. The vision for the ERO Enterprise, which is comprised of the North American Electric Reliability Corporation (NERC) and the six Regional Entities (REs), is a highly reliable and secure North American bulk power system (BPS). Our mission is to assure the effective and efficient reduction of risks to the reliability and security of the grid.

Reliability | Resilience | Security

Because nearly 400 million citizens in North America are counting on us

The North American BPS is made up of six RE boundaries as shown in the map and corresponding table below. The multicolored area denotes overlap as some load-serving entities participate in one RE while associated Transmission Owners/Operators participate in another.



About This Assessment

NERC is a not-for-profit international regulatory authority whose mission is to assure the reliability of the BPS in North America. NERC develops and enforces Reliability Standards; annually assesses seasonal and long-term reliability; monitors the BPS through system awareness; and educates, trains, and certifies industry personnel. NERC's area of responsibility spans the continental United States, Canada, and the northern portion of Baja California, Mexico. NERC is the ERO for North America, subject to oversight by the Federal Energy Regulatory Commission (FERC, Commission) and governmental authorities in Canada. NERC's jurisdiction includes users, owners, and operators of the BPS, serving more than 334 million people. Section 39.11(b) of the U.S. FERC's regulations provide that "The Electric Reliability Organization shall conduct assessments of the adequacy of the Bulk-Power System in North America and report its findings to the Commission, the Secretary of Energy, each Regional Entity, and each Regional Advisory Body annually or more frequently if so ordered by the Commission."

Development Process

This assessment was developed based on data and narrative information collected by NERC from the six REs on an assessment area basis to independently assess the long-term reliability of the North American BPS while identifying trends, emerging issues, and potential risks during the upcoming 10-year assessment period. The Reliability Assessment Subcommittee (RAS), at the direction of NERC's Reliability and Security Technical Committee (RSTC), supported the development of this assessment through a comprehensive and transparent peer review process that leverages the knowledge and experience of system planners, RAS members, NERC staff, and other subject matter experts; this peer review process ensures the accuracy and completeness of all data and information. This assessment was also reviewed by the RSTC, and the NERC Board of Trustees (Board) subsequently accepted this assessment and endorsed the key findings.

The Long-Term Reliability Assessment (LTRA) is developed annually by NERC in accordance with the ERO's Rules of Procedure[1] and Title 18, § 39.11[2] of the Code of Federal Regulations,[3] also referred to as Section 215 of the Federal Power Act, that instructs NERC to conduct periodic assessments of the North American BPS.[4]

Considerations

Projections in this assessment are not predictions of what will happen, rather they are based on information supplied in July 2020 about known system changes with updates incorporated prior to publication. The assessment period for this *2020 LTRA* includes projections for years 2021–2030; however, some figures and tables examine data and information for the 2020 year. The assessment was developed by using a consistent approach for projecting future resource adequacy through the application of the ERO Reliability Assessment Process.[5] NERC's standardized data reporting and instructions were developed through stakeholder processes to promote data consistency across all the reporting entities that are further explained in the **Regional Assessments** section of this report. Reliability impacts related to physical and cyber security risks are not specifically addressed in this assessment; this assessment is primarily focused on resource adequacy and operating reliability. NERC leads a multifaceted approach through the Electricity-Information Sharing and Analysis Center (E-ISAC) to promote mechanisms to address physical and cyber security risks, including exercises and information sharing efforts with the electricity industry.

The LTRA data used for this assessment create a reference case dataset that includes projected on-peak demand and system energy needs, demand response (DR), resource capacity, and transmission projects. Data and information from each NERC RE are also collected and used to identify notable trends and emerging issues. This bottom-up approach captures virtually all electricity supplied in the United States, Canada, and portion of Baja California Norte, Mexico. NERC's reliability assessments are developed to inform industry, policy makers, and regulators and to aid NERC in achieving its mission to ensure the reliability of the North American BPS.

1 NERC Rules of Procedure - Section 803

2 Section 39.11(b) of FERC's regulations states the following: "The Electric Reliability Organization shall conduct assessments of the adequacy of the Bulk-Power System in North America and report its findings to the Commission, the Secretary of Energy, each RE, and each Regional Advisory Body annually or more frequently if so ordered by the Commission."

3 Title 18, § 39.11 of the Code of Federal Regulations

4 BPS reliability, as defined in the **Demand Assumptions and Resource Categories** section of this report, does not include the reliability of the lower-voltage distribution systems that account for 80% of all electricity supply interruptions to end-use customers.

5 *ERO Reliability Assessment Process Document*, April 2018: https://www.nerc.com/comm/PC/Reliability%20Assessment%20Subcommittee%20RAS%202013/ERO%20Reliability%20Assessment%20Process%20Document.pdf

In this *2020 LTRA*, the baseline information on future electricity supply and demand is based on several assumptions:[6]

- Supply and demand projections are based on industry forecasts submitted and validated in July 2020. Any subsequent demand forecast or resource plan changes may not be fully represented; however, updated data submitted throughout the report drafting time frame has been and included where appropriate.
- Peak demand and Planning Reserve Margins (PRMs) are based on average weather conditions and assumed forecast economic activity at the time of submittal. Weather variability is discussed in each RE's self-assessment.
- Generating and transmission equipment will perform at historical availability levels.
- Future generation and transmission facilities are commissioned and in-service as planned, planned outages take place as scheduled, and retirements take place as proposed.
- Demand reductions expected from dispatchable and controllable DR programs will yield the forecast results if they are called on.
- Other peak demand-side management programs, such as energy efficiency (EE) and price-responsive DR, are reflected in the forecasts of total internal demand.

In April 2020, NERC published its *Special Report Pandemic Preparedness and Operational Assessment: Spring 2020* to advise electricity stakeholders about elevated risk to electric reliability as a result of the global health crisis.[7] NERC continues to assess risks to the reliability and security of the BPS from the global health crisis and reports on industry actions and preparedness in this *LTRA*.

6 Forecasts cannot precisely predict the future. Instead, many forecasts report probabilities with a range of possible outcomes. For example, each regional demand projection is assumed to represent the expected midpoint of possible future outcomes. This means that a future year's actual demand may deviate from the projection due to the inherent variability of the key factors that drive electricity use, such as weather. In the case of the NERC regional projections, there is a 50% probability that actual demand will be higher than the forecast midpoint and a 50% probability that it will be lower (50/50 forecast).

7 https://www.nerc.com/pa/rrm/bpsa/Alerts%20DL/NERC_Pandemic_Preparedness_and_Op_Assessment_Spring_2020.pdf

Reading this Report

This report is compiled into two major parts:

ERO-Wide Reliability Assessment

- Evaluate industry preparations to meet projections and maintain reliability
- Identify trends in demand, supply, and reserve margins
- Identify emerging reliability issues
- Focus the industry, policy makers, and the general public's attention on BPS reliability issues
- Make recommendations based on an independent NERC reliability assessment process

Regional Reliability Assessment

- 10-year data dashboard
- Summary assessments for each assessment area
- Focus on specific issues identified through industry data and emerging issues
- Identify regional planning processes and methods used to ensure reliability

Executive Summary

The electricity sector is undergoing significant changes that are unprecedented in both transformational nature and rapid pace. Such extraordinary evolution presents new challenges and opportunities for reliability, resilience, and security. Advances in technology, customer preferences, policies, and market forces are altering the generation resource mix and challenging the conventional understanding of the reliability role of baseload power that was traditionally provided by large, centralized generating units. While efforts are underway to address these risks, the management of reliability, resilience, and security will require increased focus by all.

The addition of variable energy resources, primarily wind and solar, and the retirement of conventional generation is fundamentally changing how the BPS is planned and operated. Resource planners must consider greater uncertainty across the resource fleet as well as uncertainty in electricity demand that is increasingly being effected by demand-side resources. As a result, reserve margins and capacity-based estimates can give a false sense of comfort and need to be supplemented with energy adequacy assessments. Energy assessments are key to understanding the reliability needs of a future BPS and are presented in this report.

This *2020 LTRA* is the ERO's independent assessment and comprehensive report on the adequacy of planned BPS resources to meet electricity demand across North America over the next ten years. It also identifies area trends and emerging issues that affect the long-term reliability and security of the BPS.

A summary of the key findings is as follows:

Most areas are projecting to have adequate resource capacity to meet annual peak demands. However, measures of energy adequacy from the ERO's probabilistic assessment (ProbA), which accounts for all hours in selected study years of 2022 and 2024, are cause for concern in several areas. The following explains these concerns in detail:

- Nearly all parts of the Western Interconnection (WI), with the exception of Alberta, face heightened loss of load risk. The WECC-CAMX assessment area (primarily California), which was a subject of concern when the prior ProbA was conducted in 2018, could face periods where resources are insufficient for area energy needs, potentially resulting in up to 22 hours of load-loss in 2022. The recent experience during the wide-area heat wave in August 2020 provides evidence of the challenges faced in the WI to reliably serve the changing demand profile with the evolving resource mix. In the Northwestern United States and Rocky Mountain areas, probabilistic studies are beginning to show potential for loss of load as well. Like California, the risk is concentrated during the summer months and occurs in the late afternoon or early evening hours after demand has peaked but as solar resource output diminishes. Across the WI, an increased reliance on transfers from neighboring areas is an emerging risk, particularly during western-wide weather events.
- In Texas, a large amount of new wind and solar generation has recently been added, providing on-peak capacity to lift reserve margins for summer peak demand. However, there is increasing risk of tight operating reserves during other periods as thermal generation capacity has declined. Although recent probabilistic studies do not reveal unserved energy, ERCOT studies show reduced availability of operating reserves over a range of several hours around the time of peak demand in summer. They also show the amount of available reserves in nonpeak months, such as March and October, to be declining to become months that see the lowest peak-day reserves during the year.

- In the Midcontinent Independent System Operator (MISO) area, most risk remains concentrated during summer peak periods. Reserve margin projections of on-peak capacity are falling and are projected to be below Reference Margin Level targets beginning in 2025. However, the ProbA is identifying the emergence of risk during times when demand is not at peak levels (e.g., during spring or fall seasons when planned generator outages for maintenance could coincide with unseasonably high load). MISO's probabilistic study shows 27.3 MWh of unserved energy and the potential for 0.2 hours of load shed in 2022.

To ensure reliability during the transition to greater reliance on wind and solar resources, emerging resource and energy adequacy issues must be addressed. Planning for long-term resource adequacy is becoming increasingly complex with a resource mix that is more unpredictable and less energy-assured. Furthermore, tomorrow's grid operators will use a resource mix that is delivered by the long-term planning decisions of today and must be equipped with models, technology, and strategies to ensure they can do so effectively. These are challenges that need to be overcome but are not insurmountable. The emerging reliability challenges are characterized as follows:

- The capacity that variable resources contribute to serving peak electricity demand differs from thermal generation because output depends on the environment, climate, and local weather conditions. As a result, variable resources typically contribute less on-peak capacity than the rated nameplate value. To assess reserve margins, variable energy resources are "derated" to reflect estimated energy production during peak hours. In the operating time frame, grid operators face the risk of forecast inaccuracy from unanticipated weather or environment conditions. Forecast errors can affect reliability in two ways: there is the potential for energy production from wind and solar resources to be less than anticipated as well as the potential for demand forecasts to be inaccurate in areas with increasingly embedded solar PV generation from the distribution network. As a result, operators must increasingly balance uncertain loads with uncertain generation.
- As more solar and wind generation is added, additional flexible resources are needed to offset these resources' variability. This is placing more operating pressure on those (typically natural gas) resources and makes them the key to securing BPS reliability. Insufficient flexible resources was a contributing cause to the load shed event in California during the wide-area heat wave in August 2020.
- Natural-gas-fired generation provides 40% of the aggregate on-peak electricity supply capacity in North America, and 41 GW of that capacity is in late-stage planning for addition over the next 10 years. As natural-gas-fired generation continues to increase, vulnerabilities associated with natural gas delivery to generators can potentially result in generator outages due to both insufficient natural gas infrastructure or alternate fuel delivery and/or disruption to natural gas or alternate fuel deliveries. These risks are most heightened in New England, the desert Southwest, and California, where there is increased reliance on natural gas generation and limited back-up fuel.

The latest industry projections included in this *2020 LTRA* provide further evidence of the rapid growth of inverter based resources on the BPS and distribution networks; these include most solar and wind as well as new battery or hybrid generation. These resources respond to disturbances and dynamic conditions based on programmed logic and inverter controls as opposed to physics and mechanical characteristics. Some inverter-based resource performance issues have been significant enough to result in grid disturbances that affect BPS reliability, such as the tripping of a number of BPS-connected solar PV generation units that occurred during the 2016 Blue Cut Fire, the 2017 Canyon 2 Fire, and 2020 San Fernando Disturbance in California. Several findings and recommendations in this report are aimed at promoting the reliable integration of these resources by addressing modeling and coordination needs. In addition to ensuring planning studies and operating models accurately account for new resource types, heightened cyber security awareness and risk-reduction engineering should be pursued to reduce the attack surface and mitigate reliability and security concerns.

To address these emerging risks and prevent similar issues from happening in other areas, NERC has developed the following recommendations for the industry and policy makers:

- Regulators and policymakers in risk areas should coordinate with electric industry planning and operating entities to develop policies that prioritize reliability, such as promoting the development and use of additional flexible resources, energy-assured generation, and resource diversity.
- Regulators and policy makers should consider revising their resource adequacy requirements to consider new risks that emerge during non-peak hours, limitations from neighboring systems during system-wide events, and the reduced resource diversity and/or increased reliance on a single fuel source or delivery mode.

- Industry should identify and commit flexible resources to meet increasing ramping and load-following requirements that result from increased variable energy resources and not solely to meet peak load capacity requirements.

Furthermore, to ensure the ERO and industry are developing solutions in advance of these emerging risks, NERC has developed the following recommendations for the ERO and the industry:

- The ERO should enhance the reliability assessment process by evaluating energy adequacy risks in seasonal reliability assessments to help inform stakeholders of reliability needs and potential solutions in the short-term.
- To better identify fuel supply risks during planning, the ERO should collaborate with industry to identify design-basis fuel supply scenarios of normal and extreme events for use by BPS and resource planners. Design-basis criteria should then be considered in planning-related Reliability Standards, such as TPL-001.
- The ERO should increase communication and outreach with state and provincial policymakers on resource adequacy risks and challenges to ensure the risks being presenting in all ERO reliability assessments are well known and understood.
- The ERO should advance the efforts to modify existing Reliability Standards to account for inverter-based resource performance and characteristics. In particular, protection and control, data sharing, and modeling-related standards all need to consider the new risks imposed by inverter-based resources connected to both distribution systems and the BPS.
- The industry should verify that inverter-based resource models used for steady state and dynamic power systems analysis agree with the as-built, plant-specific settings, controls, and behaviors of the facility. Generator Owners/Operators should engage with equipment manufacturers and coordinate with their Transmission Planner/Planning Coordinators to understand the modeling challenges and proactively address deficiencies identified in several ERO event reports and power system modeling assessments. Industry has achieved success by using ERO guidelines to support system-specific interconnection and control design requirements.
- REs and model-building designees should enhance their reviews of steady-state power flow and dynamics base case models for model deficiencies associated with existing and newly-interconnecting BPS-connected inverter-based resources.
- The ERO and industry should address aggregate DER data needs for transmission planning and operational studies and develop guidance for BPS planning with increasing DERs.

NERC Reliability Standards

BPS reliability encompasses two priorities that must be addressed simultaneously. The first is operating reliability, supporting the operational needs of the grid to maintain stability and withstand sudden disturbances. The second is adequacy, the ability of the electricity system to produce and deliver energy to end-use customers at all times.

NERC Reliability Standards are the planning and operating rules that electric utilities follow to support and maintain a reliable electricity system. These standards are developed by the industry by using a balanced, open, fair and inclusive process accredited by the American National Standards Institute (ANSI). While NERC does not have authority to set Reliability Standards for resource adequacy (e.g., reserve margin criteria) or to order the construction of resources or transmission,* NERC independently evaluates where reliability issues may arise as well as identifies emerging risks through reliability assessment. This information, along with NERC recommendations, is then available to policy makers and federal, state, and provincial regulators to support decision making within the electric sector.

* NERC is prohibited by Section 215 of the 2005 Federal Power Act from adopting standards that require adequate resources be in place or order construction of generation or transmission. Resource adequacy and the contruction of bulk power facilities is fully within state and/or provincial jurisdiction and authority.