ERO Enterprise Longer-term Strategic Planning Considerations

November 2015

Background

The ERO Enterprise strategic planning process provides a three-year outlook for developing NERC and Regional Entity annual business plans and performance metrics. Strategic planning integrates priority reliability risks identified by the Reliability Issues Steering Committee (RISC), deliberations by government and industry leaders at ~~the~~**NERC's** annual Reliability Leadership Summit, NERC's annual State of Reliability Report, and other risk analysis results.

A recurring theme in ~~2014~~**the 5 to 15 year horizon** is that the **electric** power industry is entering a period of profound change that could affect ~~how reliability is achieved in the future.~~**the reliable operation of the Bulk Electric System (BES).** The ERO Enterprise must anticipate these changes**, identify** and ~~understand how they can affect the~~**address risks to** reliability ~~assurance role~~**, as well as mitigate them during this transformation**. This paper ~~provides an initial description of these longer-term issues and invites discussion by reliability stakeholders. As the paper is refined and vetted, it will be~~ **is** used **as input** to ~~guide~~**the** ERO ~~Enterprise~~**Enterprise's development of its three-year** strategic planning **activities** and **the** annual business ~~plans going forward. It is the intent of the ERO Enterprise leadership to update this longer-term outlook periodically as part of the annual strategic planning review and to perhaps incorporate these considerations directly into the annual strategic~~ plan ~~document itself~~**and budget**, once the concepts have been sufficiently vetted.

~~Belief Statement —~~ Significant Emerging Trends

~~A number of emerging trends identified by the RISC and Reliability Leadership Summit participants suggest sweeping changes over the next five to 15 years in~~ **The** resource mix ~~and power production technologies, including retirement of coal-fired~~ **comprising on-peak capacity has recently shifted to be predominately gas-fired** ~~generators and older oil and gas units; increased dependence on natural gas for power production; and increased utilization of renewables, distributed generation~~**: now 40 percent, compared to 28 percent just five years ago. This trend is expected to continue, as retiring coal, petroleum, nuclear, and other conventional generation is largely being replaced by gas-fired capacity and variable energy resources (VERs), both on the BES and integrated into the distribution system. The fundamental transformation of the resource mix is being driven by fuel and resource economics, environmental regulations, and legislation as well as state and provincial incentives and mandates for adding renewable VERs (e.g., wind and solar).**

Sustaining a reliable interconnected BES is critical during this period of innovation and integration of new resources and technologies onto the grid. These technologies include integration both on the bulk power and distribution systems of large amounts of VERs, increased use of gas-fired generation, high voltage

and distributed network system technologies, and end-use applications (such as plug-in vehicles and distributed energy resources). Additionally, the grid will face a host of cross-jurisdictional challenges, such as gas-electric and telecommunications-electric interdependencies and the addition of distribution-centric resources. As energy resources increasingly transition to the distribution system and distributed networks emerge, their reliability characteristics and contributions to grid reliability may not be the same as those resources they replace.

For example, essential reliability services (ERS) as well as the provision of a sufficient amount of control (ability to observe and dispatch) of resources will need to be addressed for the continued reliable operation of the BES. ERS and sufficient operational control is needed not only to balance resources with demand, but also to provide support to recover from severe events and restore the BES enabling reliable operation.

Alongside traditional analysis and assessment approaches, addressing cyber and physical security will play an increasingly prominent role in the design, construction, and deployment of new resources and technologies. Resource transformation provides opportunities for the industry to design a more secure system, along with the construction of more responsive resources that can deliver flexibility that ensures sufficient balance of ERS and overall resource control. Further, detailed assessments are required of energy-limited VERs, such as wind and solar resources to ensure that sufficient resources are available to maintain the reliable operation of the BES.

Similarly, the application of energy storage and Demand-Side Management (DSM) technologies has the potential to offer more options for balancing resources to meet demand with greater efficiency. New technologies (e.g., smart grid devices and applications, phasor measurement units (PMUs), remedial action schemes, new forecasting capabilities, greater system awareness, etc.) can also advance the industry's ability to dynamically control grid facilities and improve coordination among system operators, grid resources, and consumers. However, these considerations must be part of the design, construction integration, and interconnection of these new technologies.

At the same time, the industry is facing historically flat load and revenue growth ~~and~~**with** low prices for production driven by a strong domestic supply of natural gas and, in some cases, by renewable energy supply standards or subsidies. These influences are resulting in low capacity prices ~~and~~**as well as** strained opportunities for earnings growth and capital investment in many regions. Projected future capacity margins in ~~a couple~~**multiple** regions have begun to show these effects~~ and declined~~**, declining** below targeted margins **as documented** in recent NERC and regional reliability assessments.

~~In addition to capacity requirements, it is not clear that the~~ **The** benefits of fuel diversity and the inherent reliability characteristics of various types of supply resources ~~are being~~**should be** sufficiently valued to assure future reliability of the grid. NERC has completed studies defining ~~essential reliability services~~**ERS**, such as frequency response~~,~~ **and** voltage ~~control, reactive power supply, stability controls, load following and regulation~~**support**, as well as studies highlighting the issues of eroding fuel diversity and natural gas interdependencies. Significant work is required to ~~ensure a full understanding~~**fully understand how the interconnection** of ~~how~~ new resource technologies**, along with substantial amounts of distribution-centric**

resources, can be planned and operated in concert with traditional resources to ensure reliable operations in the future.

~~At the same time that~~**While** resource mix and technologies are rapidly changing, customer and regulator expectations ~~of the industry~~ are also changing ~~rapidly~~. Industry is expected ~~to ensure the physical and cyber security of the grid, and to be prepared~~ to minimize customer disruptions and harms resulting from severe conditions, such as storms, extreme heat and cold, drought, ~~solar~~ geomagnetic disturbances, and physical and cyber security attacks. ~~There is an increasing awareness of the need to understand, analyze, and prepare for extreme conditions and balance reliability investments appropriately between normal design-based conditions and more extreme events.~~ An increased focus on ~~resilience~~**the industry's ability to recover and restore reliable operation of the BES** is referenced frequently as one approach to optimize preparations for extreme conditions and events for which prevention alone would be prohibitively expensive. **There is an increasing awareness of the need to understand, analyze, and prepare for risks from extreme conditions and balance reliability investments between normal design-based conditions and more extreme events.**

~~The strength of strategic planning is found in gathering a variety of perspectives from various constituencies, to include consideration of external factors that will impact the organization or enterprise. In the latest ERO Reliability Risk Priorities Report, October 2014 the RISC identified seven recommendations for NERC and industry action. Three of the recommendations are directly related to and consistent with the broader areas described within this paper:~~

- ~~Increase long-term reliability assessment efforts.~~
- ~~Identify a framework to conclude the identification of essential reliability services.~~
- ~~Take action to ensure generation and transmission resource and planning data consistency and sharing for long-term, robust regional operational planning and real-time situational awareness.~~

~~The ERO Reliability Risk Priorities Report also identifies 14 risk profiles, eight of which are directly related to these longer-range strategic planning considerations: changing resource mix, cyber attack, extreme physical events (acts of nature), extreme physical events (man-made), generator unavailability, loss of situational awareness, poor event response and recovery, and poor resource planning.~~

~~Although the current three-year strategic plan incorporates some activities to address these emerging issues, the ERO Enterprise executive leadership believes it is important to consider these longer-term industry trends in the planning of Enterprise initiatives and utilization of resources.~~

~~**ERO Enterprise** Considerations for Assuring Reliability on a Longer-term Horizon~~

~~***Resource Planning and Adequacy/Reliability Assessment***~~

~~Resource planning and future reliability assessments are increasingly challenged by the changing industry environment. Historically, reliability assessments have focused on comparing forecasted electricity demand to projected available resources, with weighting given to the projected resources based on the level of certainty of availability. This assessment approach utilizes normalized weather conditions at peak load conditions and, in most cases, relies on an adequacy criterion of loss of load one day in ten years. A target capacity reserve margin is determined to address uncertainties, and assessment results are~~

~~compared to the targets. This capacity-driven approach is necessary but may not be sufficient going forward.~~

With the changing landscape outlined above, the current approach **to reliability** may not adequately address risks associated with severe conditions, such as the extreme cold seen during the 2014 winter "polar vortex." **Coordinated efforts between electric and gas sectors are needed in order to meet future infrastructure needs to supply and transport fuel. Certain areas (with high levels of natural gas-fired resources) should examine system reliability needs to determine if more firm fuel transportation or units with dual-fuel capability are needed.** Dependency on natural gas infrastructure storage and delivery may not be adequately addressed with current planning and reliability assessment tools. ~~The~~**Therefore, the** risks associated with loss of fuel diversity ~~may not~~**must** be ~~properly weighed~~**understood, and preparations made to quickly recover and restore after unexpected extreme temperatures**.

Considerations for Assuring Reliability on a Longer-term Horizon

Reliability Assessment: Resource and Planning Adequacy

Historically, reliability assessments have focused on measuring reserve margins comparing forecasted electricity demand to projected available resources, with weight given to the projected resources based on their level of certainty of availability. This assessment approach uses normalized weather conditions at daily peak load conditions and, in most cases, relies on an adequacy criterion of loss of load of one-day-in-ten years. A target capacity reserve margin is determined to address uncertainties, and assessment results are compared to these targets. This capacity-driven approach is necessary, but may not be a sufficient way to assess resource adequacy going forward. The resource transformation will have reliability implications on industry planning and operations, as well as how NERC assesses reliability.

Increasing the sophistication of NERC's reliability assessments will include measurement of ERS and system security. As part of its assessment of long-term reliability with the existing Reserve Margin metrics, NERC will need to use new approaches to evaluate the changing behavior of the BES and potential impacts from physical and cyber attacks. For example, these enhanced approaches should consider the requirements for ERS, the amount of control (ability to observe and dispatch), which includes both grid and distribution-centric resources, as well as design assessment and operational mitigation for security robustness. Reliability assessments may need to evaluate the impacts on recovery and restoration plans from integration of distribution-centric resources, including mitigation of risks from physical and cyber attacks. Further, incorporation of probabilistic, scenario analysis, and transmission adequacy assessment techniques will be needed to measure the full effects on reliability from the variable, energy-limited resources, security, and the evolving system characteristics resulting from the new fleet of generation.

Based on previous assessments and analyses, as the level of VERs increases, more flexibility will be needed from the system. In the past decade, manufacturers have made significant advancements in control methods that can make VER power output more responsive to grid-level controls, including frequency response and demand response. NERC and the industry should support the development and integration of standardized models for VER, energy-only resources, asynchronous resources, distributed

generation resources, and composite load behavior models for stability and power-flow studies. An effective NERC oversight approach must be put in place to validate the reliability characteristics and event performance of these models.

In the face of resource uncertainty, enhancement of the framework and tools historically used for assessing future reliability ~~in the face of uncertainty,~~ will be needed to address asymmetrical risks (physical and cyber security), integration of new kinds of resources and technologies, and severe conditions (adequacy factors ~~for consideration~~ in addition to one-day-in-ten-year loss of load).

Potential areas of focus and development:

- Be a source of credible, independent information that can frame the complex problems and communications to assess the reliability of energy-limited and distribution-centric resources.
- Use tools for assessing reliability risks associated with natural gas infrastructure, including gas storage and ~~delivery, including~~ pipeline delivery:
  - This assessment should include a study of pipeline capacity and contingencies.
  - ~~Develop tools for assessing~~Fuel availability and deliverability should be specifically considered and integrated into resource adequacy and other planning assessments.
- Add probabilistic, scenario analysis, and transmission adequacy assessment techniques into NERC's traditional reserve margin metric approach to measure the effects on reliability ~~risks~~from the both grid and distribution integrated variable, energy-limited resources, distributed energy resources, and the associated ~~with uncertainty in~~evolving system characteristics.
- Incorporate the availability and control of distribution-centric distributed resources and demand response into the assessment of reliability risk. This includes measurement of the amount of operator control available compared to the amount needed for the reliable operation of the BES.
- Document reliability considerations~~,~~ and requirements from the reliability value of fuel and resource diversity, ~~and essential reliability services~~sufficient amount of control with the addition of distribution-centric resources, and VERs capability to contribute to replenishment of ERS.

~~*Resilience*~~Recovery and Restoration

The electrical sector provides an indispensable service and historically high reliability, even in the face of extreme conditions and severe events. However, ~~there is increased attention~~government, regulators, and consumers have increasing expectations ~~surrounding~~for system performance as well as the ability to quickly recover and ~~recovery~~restore from severe conditions or events. ~~Resilience~~As the structure and characteristics of the grid ~~and the ability to recover from events have become a key focus areas for the government~~ change, recovery and ~~industry.~~restoration plans will need to include an all-hazards approach to address existing and emerging risks.

Potential areas of focus and development:

- ~~Be a source of credible, independent information that can frame the complex problems and communications to support the continued evolution of broader resiliency efforts.~~

- Foster the development of risk-based approaches to ~~evaluating~~**evaluate** extreme ~~condition risks~~**conditions** and the **incremental** value ~~of~~**as well as the potential benefits from either** addressing ~~those risks~~ or not **addressing these risks**, including ~~work~~**discussions** with the insurance industry to understand valuation of severe risks.
- ~~Foster the sharing of best practices on resilience.~~
- ~~Foster~~**Promote** an all-hazards approach to ~~resilience~~**grid restoration and recovery plans. Include scenarios for centralized and decentralized resource control, along with physical and cyber security mitigation**.
- ~~Develop~~**Acquire** a ~~better~~**deeper** understanding of the consequences ~~of~~**from** extreme events on interdependent infrastructures, such as natural gas, telecommunications, and transportation, ~~and associated~~**as well as potential** risk mitigation options.
- Develop an improved understanding of supply chain **cyber security** issues and the **potential** impact on ~~bulk power~~**BES** reliability ~~risks~~.

Situational Awareness and System Control (~~*While Integrating*~~**with the Integration of** New Technologies)

The changing resource mix, gas dependency, and resource adequacy challenges outlined above require greater understanding of the individual technologies and how they can be integrated into overall grid operations and control. The changing nature of the load combined with potential increases in micro grids, distributed generation, ~~demand-side management~~**DSM** programs, and rooftop solar will impact grid operations. Some of these technologies may result in less visibility for the system operators and less controllability for the dispatchers. Additionally, the sophistication of the operator's tools with increased information and greater data delivery speeds will place burdens on system operators. This complexity of the individual technologies and their inter-relationships is driving a perception of increased vulnerability. Leveraging technology**,** while attempting to achieve simplicity in operations and planning**,** is a critical task.

Potential areas of focus **and development:**

- Be the ~~voice~~**guardian** of reliability, assessing the impact of changing technologies and ~~articulating the~~**their potential** impacts on reliable operations.
- ~~Document~~**Consider the impacts of ERS on interconnection-wide reliable operations by:**
- **Completing** the ~~reliability considerations and the reliability value of essential reliability services.~~
  - ~~Complete~~ development and deployment of ~~essential reliability services~~**the ERS** framework and tools~~.~~
  - ~~Consider~~**Studying the** development of technology-neutral ~~reliability standards~~**Reliability Standards** for ~~essential reliability services.~~**ERS**
- Ensure the visibility, situational awareness, and dispatch or control of **a sufficient amount of** distributed and non-traditional resources as needed by system operators to ensure ~~bulk power system~~**BES** reliability.

- Foster system operator training and situation awareness that focuses on simplifying operations for users in an environment rapidly becoming too complex.
- Develop tools to evaluate the reliability impacts of the changing composition of load, to include electric vehicles.
- Engage equipment vendors in developing built-in solutions to address security vulnerabilities, resilience, failure prevention, and adequate controls.
- Engage the Institute of Electrical and Electronics Engineers (IEEE) and the International Electrotechnical Commission (IEC) in producing ~~more~~ timely technical standards for grid reliability**, resource interconnection,** and security.
- **Work with government and other regulators to develop resource interconnection requirements that ensure system operators can continue to maintain ERS and provide sufficient amount of control of grid and distribution connected resources to ensure the reliable operation of the BES.**