To assure the effective and efficient reduction of risks to the reliability and security of the North American bulk power system

- Develop and enforce reliability standards
- Assess current and future reliability
- Analyze system events and recommend improved practices
- Encourage active participation by all stakeholders
- Accountable as ERO to regulators in the United States (FERC) and Canada (NEB and provincial governments)
The ERO Enterprise

Independence & Objectivity
Top Talent & Expertise
Collaboration with industry
Innovative & Risk-Based Programs

A Highly Reliable and Secure Bulk Power System

Effective, Efficient, Collaborative
• Pandemic Preparedness
  ▪ At this time, NERC has not identified any specific threat or degradation to the reliable operation of the bulk power system (BPS)
  ▪ However, risks are elevated with emergence of COVID-19

• Supply Chain Risks
  ▪ Three NERC Alerts related to Supply Chain issued
  ▪ Standards and Industry Partnership activity underway

• Batteries/Storage
  ▪ Battery Energy Storage Systems (BESSs) growing at increasing pace

• Distributed Energy Resources (DER)
  ▪ DER penetration impacts the Bulk Electric System (BES) in numerous ways
  ▪ Accurate modeling/measurement will be critical
Further review and consolidation has resulted in four high level risk profiles:

- **Grid Transformation**
  - A. Bulk Power System Planning
  - B. Resource Adequacy and Performance
  - C. Increased Complexity in Protection and Control Systems
  - D. Situational Awareness Challenges
  - E. Human Performance and Skilled Workforce
  - F. Changing Resource Mix

- **Extreme Natural Events**
  - A. Extreme Natural Events, Widespread Impact
    - • GMD
  - B. Other Extreme Natural Events

- **Security Risks**
  - A. Physical
  - B. Cyber
  - C. Electromagnetic Pulse

- **Critical Infrastructure Interdependencies**
  - A. Communications
  - B. Water/Wastewater
  - C. Oil
  - D. Natural Gas
• Higher penetration of renewables – variable resources
  ▪ Most are inverter-connected
  ▪ Ramping needs increase for load following
  ▪ Capacity value

• Retirement of large fossil-fired generation plants

• Changing System Inertia
  ▪ Trade-offs between inertia and Fast Frequency Response

• Emergence of distributed energy

• Changing sources of reactive support for voltage control
  ▪ Lower levels of synchronizing torque
  ▪ Increasing use of power electronics

• Increasing energy constraints from the generation fleet
## Rapid Evolution of “Edge” Technologies

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Rapid Evolution of the Energy Sector

- Inverter-Based Resources
- Distributed Energy Resources
- Hybrid Plants
- Cyber Attacks
- Internet-Connected Devices
- Electric Vehicles
- ...

Time
Planning challenges

• Traditional model out the window
  ▪ Historically Generation → Transmission → Distribution
  ▪ Emerging Generation → Transmission ↔ Distribution ← Generation
• System protection with fault levels ≈ load levels
• Adequate reactive resources
• Under frequency load shedding settings
Operating challenges

- Operator visibility into distributed energy resources
- Inverter-based resources
- Distribution impacts on transmission system
- Voltage regulation
- Under frequency load shedding
- Regulating reserves
- Cyber security of distributed energy resources
What is Limiting Wider Use of PMU Data

- Historical practices has data quality at its core
  - SCADA data used widely, highly redundant, easy to flag bad data
  - State estimation used to filter out bad data
  - Advanced applications (e.g., contingency analysis) use filtered measurements
  - Bad data is thrown out

- Synchrophasor technology used for complex use cases
  - Raw measurements used in early days with less attention to data quality than maybe was needed
  - Additional data quality considerations (e.g., time synchronization)
Oscillation tools have had success on the BPS

- Advanced applications are using wide-area measurements to detect (and identify the source of) oscillations.
- PMUs were able to pick this up and determine an oscillation was occurring.
- Tools should be able to identify the source (or close to it) in real-time and to inform operators of relevant and applicable actions to take.
- This requires a wide-area view across all RCs within an interconnection.
- Fortunately, there are projects underway to make that a reality, even in the Eastern Interconnection.
- Example includes the June 2016 and January 2019 disturbances that both resulted in the unit coming offline.
January 2019 Sustained Oscillation Event
• Data quality is critical
  • High data quality data for the control room needed, else operators will “not trust” the tools that leverage PMU
  • Having trust in the measurement source is key to a successful advanced application

• Synchrophasor data quality needs attention & improvement
  • Data availability should be near 100% (unless planned)
  • Data accuracy understood and documented (used appropriately)
  • Data quality tools on front end of all applications (screening)
  • Data quality flags/alarms built into all applications (warning)
  • Operational decisions made when data quality is high (reliable)
  • Data quality institutionalized (business processes)
High speed data is important to understand the behavior and performance of inverter-based resources:

- Data faster than PMUs is needed for point-on-wave behavior. DFRs or similar within the plant controller.
- Inverter-level oscillography is critical to understand individual inverters during severe disturbances.
Today...
Questions and Answers