

Bulk Power System Reliability under a New Energy Paradigm

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RELIABILITY | ACCOUNTABILITY



Mission: To efficiently and effectively reduce risks to the reliability and security of the Bulk Power System in North America

- **Certified as the Electric Reliability Organization by FERC (pursuant to the Federal Power Act and recognized as such by Canada and Mexico**
- **Many programs executed through regional entities with delegated authority across North America**
- **Develop and enforce mandatory Reliability Standards**
 - Over 100 mandatory standards (1,500 requirements) in place
 - Developed and voted on by technical experts
 - Approved and Enforced by NERC and FERC
- **Assess current and future reliability**
 - Develop reports to assess resource adequacy and identify reliability issues
 - Analyze system events and recommend improved practices
 - Manage technical committees and stakeholder groups



- Resource mix shifting
 - Variable Energy Resources (wind and solar) with very different generation characteristics and stochastic production profiles
 - Demand side resources (roof top solar and demand response) “invisible” to system operators
 - Coal and nuclear in decline
 - Storage becoming viable option
- BPS load growth flattening
 - Pricing (rate) pressures
 - Business model challenges for utilities
- Reliability and security requirements increasing
 - Electricity is “fundamental” to modern society
 - Persistent security threat with sophisticated actors

- Replenishment of Essential Reliability Services
 - Reduced inertia
 - Frequency Responses
 - Voltage Support
 - Ramping and flexibility needs
- Rapid penetration of new loads, variable speed drives, EVs, LED Lighting
- System controls and relay protection coordination
- Modeling and simulation constraints
- Increasing interface with distribution-centric resources

- Natural gas expected to increase
 - Replace retiring generation
 - Offset variable resources
 - Meet increasing electricity demand
- Fuel not easily stored on-site
- Widely used outside the power sector
- Historically, disruptions are rare
- Interdependencies have larger effect with increased reliance

Resilience is a Characteristic of a Reliable System

NERC Reliability Assessments and Performance Analysis

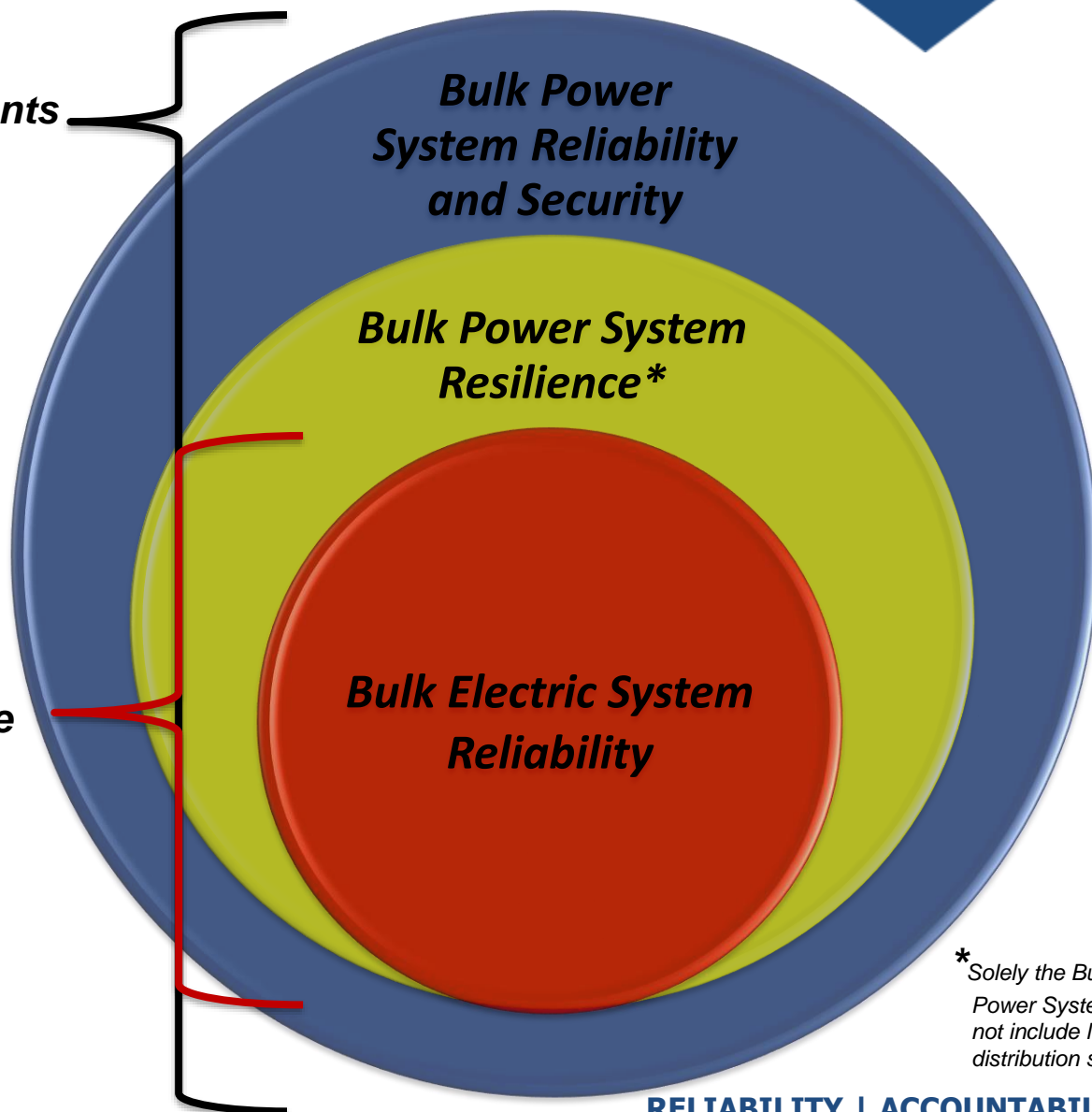
- **Reliability Assessments**
- **System Analysis**
- **Events Analysis**
- **Performance Analysis**
- **Situational Awareness**

Operator Training

E-ISAC

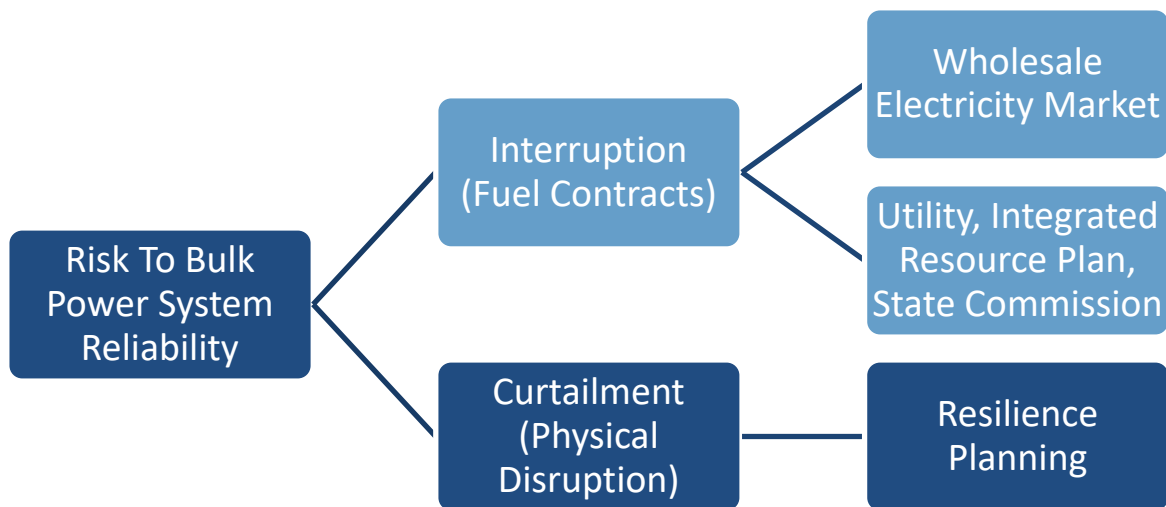
NERC Reliability Assurance

- **Standards**
- **Compliance**
- **Enforcement**
- **Registration**
- **Certification**

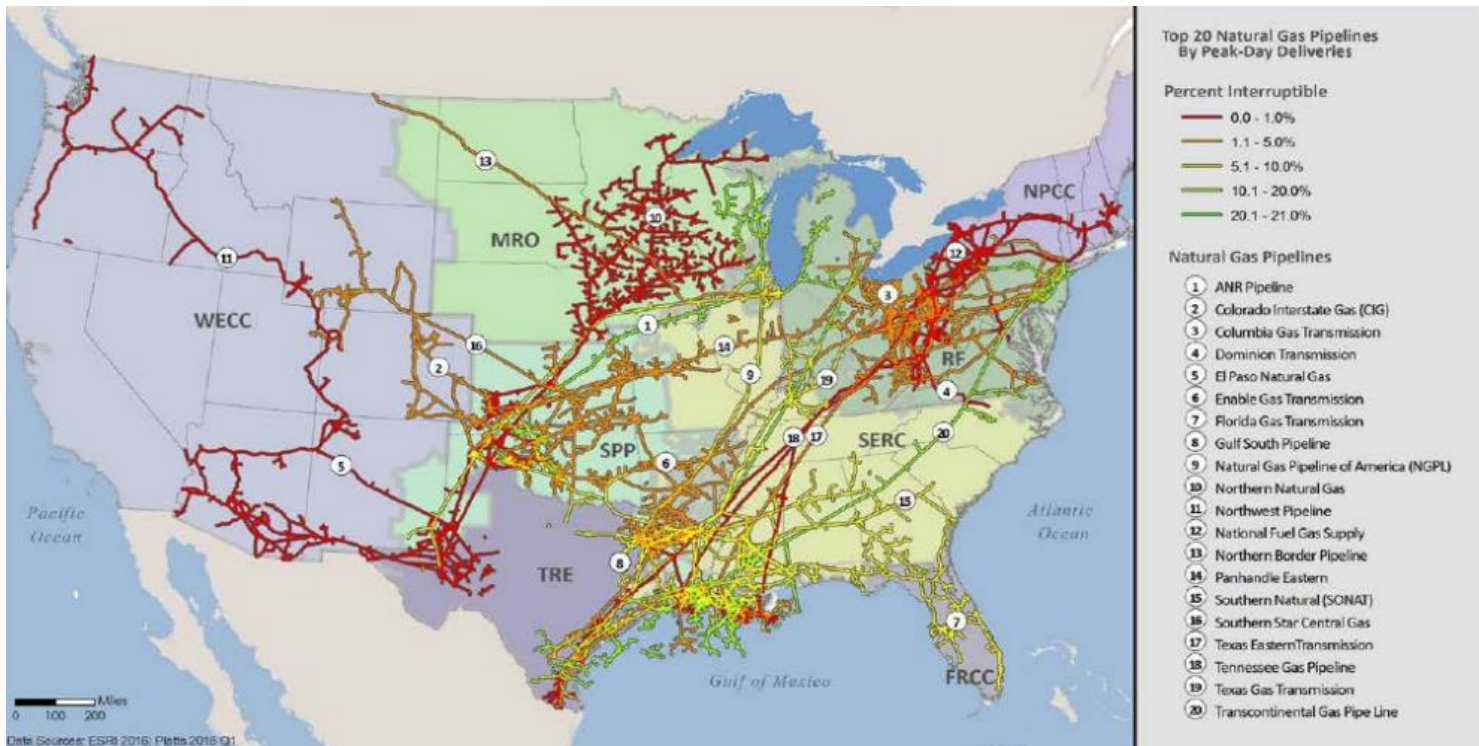


*Solely the Bulk Power System. Does not include local distribution systems.

- Increased dependence on natural gas for generating capacity can amplify the bulk power system’s vulnerability to disruptions in fuel supply, transportation, and delivery.



Top-20 Gas Pipelines by Peak-Day Delivery Arrangement



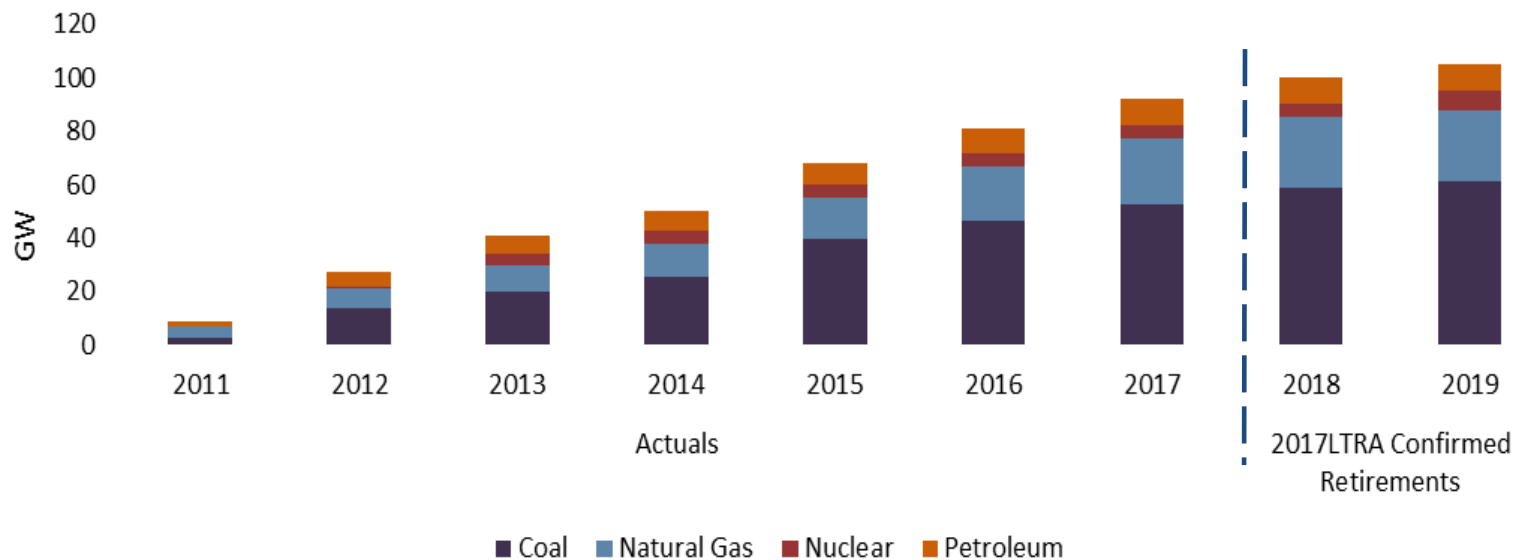
- Red pipelines mean there were no interruptible flows on peak pipeline day and virtually no “Firm” capacity available for sale
- Some electric generation customers can buy “Firm” from secondary market, if available

Source: ANL

- Gas infrastructure adequacy
 - To meet volumetric needs as industry shifts to gas/renewables mix
 - To meet flexibility as ramp rates “steepen and deepen”
 - Pack and draft availability/utility as pipeline utilization rates increase
 - In-market storage to serve as a shock absorber
- “N-1” conditions on the natural gas system
 - Single point of failure/ability of electric system to compensate
 - Loss of pipeline
 - Loss of major compressor station
 - Loss of storage facility (e.g., Aliso Canyon)
- Operational alignment
 - Situation awareness/information sharing/transparency
 - Scheduling and balancing (“5 minute electric market” versus “natural gas day”)
- Regulatory policy/curtailment queue
- Security (physical and cyber)

- Dual Fuel capability
 - Environmentally challenging, though some successes with critical LADWP units
 - Liquid fuel infrastructure limitations limit effectiveness to shorter term disruptions
- Electric Storage
 - Promising technologies
 - Scalability

- New England
- Southern California/Desert Southwest
- PJM
- Other?



- Over 100 GW of conventional generation retired Since 2011 (2017 LTRA)
- LTRA future projections do not account for unannounced retirements



Questions and Answers