Evaluating Severe Natural Gas Disruptions and Interdependency Impacts to Bulk Power System Reliability

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Discussion Outline

• Overview of the risks associated with changing resource mix and NERC’s assessment role
• Natural gas risks and special assessments identifying specific areas of concern
• Recent electric reliability disruptions related to natural gas risks
• How the electric industry is responding and future challenges
About NERC: Mission

To ensure the reliability 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)
Key Messages

• Conventional generation retirements create BPS reliability concerns when **Essential Reliability Services** and **fuel assurance** mechanisms are not replaced.

• Declining reserve margins projected to tighten **operational reliability**, particularly under extreme conditions.

• Fuel diversity is a means to fuel assurance, but solutions need to consider **regional differences**.

• Finding solutions to the limited pipeline capacity problem should encompass **wholesale electric market** action as well as **natural gas regulatory frameworks**.
Increased dependence on natural gas for generating capacity can amplify the bulk power system’s vulnerability to disruptions in fuel supply, transportation, and delivery.

**Threat**
- Interruption (Fuel Contract Limitations)
- Curtailment (Physical Disruption to Natural Gas Facilities)

**Solution**
- Market
- Integrated Resource Plan, State Commission
- Reliability and Resilience Planning

**ERO**
- Identify, assess, and report on risks to BPS
- Support decision makers and provide technical expertise and data
- Establish performance requirements (Reliability Standards)
- Provide technical guidance (Reliability Guidelines)
Findings From Previous NERC Assessments

• Natural gas expected to increase
  ▪ Replace retired generation
  ▪ Offset variable resources
  ▪ Meet increasing electricity demand

• Fuel not easily stored on-site

• Widely used outside the power sector

• Disruptions are rare

• Interdependencies have larger effect with increased reliance
Variable generation is surpassing natural gas-fired generation for future capacity additions to the grid.
On-peak natural gas-fired capacity has increased to 455 GW, up from 359 GW in 2009.

100 GW of Tier 1 gas-fired capacity is planned during the next decade.

<table>
<thead>
<tr>
<th>Assessment Area</th>
<th>2024 (%)</th>
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<tbody>
<tr>
<td>FRCC</td>
<td>78.1%</td>
</tr>
<tr>
<td>WECC-CAMX</td>
<td>68.2%</td>
</tr>
<tr>
<td>Texas RE-ERCOT</td>
<td>63.3%</td>
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<tr>
<td>NPCC-New England</td>
<td>52.3%</td>
</tr>
<tr>
<td>WECC-SRSG</td>
<td>51.8%</td>
</tr>
<tr>
<td>WECC-AB</td>
<td>51.8%</td>
</tr>
</tbody>
</table>
Regional Fuel Assurance Conditions

CA/DSW
- Aliso Canyon/storage constraints
- System flexibility
- Pipeline constraints
- “Anti-gas” sentiments (CA)
- Limited firm service
- LDC Curtailment queue

New England
- Infrastructure constrained
- Limited firm service
- “Anti-gas” sentiments
- Pay-for-Performance

PJM
- Significant baseload retirements anticipated
- Declining fuel diversity
- Capacity Performance

Florida
- Firm service in place
- Dual fuel acceptable
- 78%+ gas on peak
- Lack of fuel diversity
In areas with high reliance on natural gas-fired electricity generation and limited supply infrastructure there is increased reliability risk.

**Fuel Supply Risk**

- ISO New England: 51%
- California-Mexico Assessment Area: 55%
- Southwest Reserve Sharing Group Area: 58%

**On-Peak Capacity of Existing and Anticipated Resources in Areas with Natural Gas Fuel Supply Infrastructure Constraints**
Differences in the Gas Generation Availability

- Dual-fuel maintained on-site
- Firm fuel agreements
- Multiple pipeline connections

- Dual-fuel capable
- Part of firm fuel portfolio
- Multiple pipeline connections

- Dual-fuel capable, no inventory
- Interruptible fuel, spot
- Single pipeline connection

- Not dual-fuel capable
- Interruptible fuel, spot
- Single pipeline connection

Higher individual reliability

Lower individual reliability
Aliso Canyon Out of Service and Resulting Electric Reliability Concerns

Potential Impacted Generation

- **LA Basin:**
  - 9,800 MW natural gas generation
  - ~95% of total local capacity

- **Rest of Southern California:**
  - >15,000 MW natural gas generation

Maximum Import Capacity

- 5,500 MW DC capacity
- 14,900 MW AC capacity
- 20,400 MW total*

* Typically limited to 17,000 - 18,000 MW
12 storage facilities have been identified that can *impact* > 2GW of generation.
Some areas are at risk of reliability impacts due to potential fuel supply issues

- **New England**: Extreme winter conditions can disrupt fuel
- **California and U.S. Southwest**: Fuel at risk from extreme events due to limited storage and supply infrastructure

- Fuel supply and transportation limitations can affect the ability of generation resources to deliver needed electricity
Gas Infrastructure vs. Gas Generation Build Out

Gas-Fired Generation Outpaces Natural Gas Pipeline Expansion

Source: Velocity Suite, FERC Form 2 Page 514
State Breakout of Miles of Transmission Lines
Red pipelines mean there were no interruptible flows on-peak.

Source: ANL
Outage Risk Evaluations Helps Prioritize Mitigation Planning – Western Interconnection

See the Western Interconnection Gas-Electric Interface Study:
Reported GADS Outages of Natural Gas Generation Due to “Lack of Fuel” (2012-2015)
Gas plants were affected by fuel shortages regardless of their pipeline contract statuses

- During some hours, firm contract plants made up all fuel shortages (firm is not a cure-all)
- In some regions, the peaks in the gas fuel shortage time series were sometimes mostly made up of capacity on firm pipeline contracts
Pipeline Single Points of Disruption (Major “Trunk” Lines)

New England

Interstate Directly Connected*
- Tennessee (3,221 MW)
- Algonquin (6,593 MW)
- Maritimes (2,356 MW)

LDC Directly Connected
2,330 MW

Source: EIPC, New England ISO
South CA-AZ

Interstate Directly Connected
- SoCal Gas
- PG&E
- El Paso

*most electric generation is directly connected to non-interstate LDC systems*
Pipeline Single Points of Disruption (Major “Trunk” Lines)

Florida

Interstate Directly Connected

- Gulfstream
- Florida
- Sabal Trail
• Maintain Fuel Security
  ▪ Maintain fuel and resource diversity
  ▪ Maintain firm fuel supply and transportation
  ▪ Maintain dual-fuel capability
  ▪ Maintain on-site fuel back-up inventory

• Resiliency Planning for Large Disruptions
  ▪ Evaluate largest/multiple facility outages regardless of likelihood
  ▪ State and Electric (e.g., ISO/RTO, local utility) partnerships
  ▪ Incentives and rules in market areas
  ▪ Security and risk assessment

• Enhance Situational Awareness
  ▪ System operator intelligence on fuel inventories, contracts, shipments
  ▪ Coordination with pipeline operators
• Texas - ERCOT
  ▪ Total load shed 20,000 MW at peak
  ▪ Load shed request duration: 70.5 hours
  ▪ Customer outage across Texas: 3.7M
  ▪ Lowest Frequency: 59.3 Hz
  ▪ Installed capacity out of service: 52,277 MW
    o Natural Gas generation offline: 26,000 MW
    o Wind generation offline due to icing: 14,000 MW

• Midwest to Louisiana - MISO
  ▪ Load shed: 1,430 MW
  ▪ Installed capacity out of service: 59,000 MW

• Dakotas to Southern Plains - SPP
  ▪ Load shed: 3,443 MW
  ▪ Installed capacity out of service: 25,000 MW

*Additional load shedding in Northern parts of Mexico due to natural gas shortage
Correlated Outages for Natural Gas Generators by Cause During the ERCOT February 2021 Event

Note: Extreme cold temperatures began on Monday morning.

Source: Electric Reliability Council of Texas (2020c).
• Out of all outages and derates caused by Fuel Issues, 87% were natural gas fuel supply issues.

• Most natural gas production not identified as critical load

• As a result, firm load shed contributed to the decline in production of natural gas.
Initial Lessons Learned and Findings

- Generation winterization challenges (primarily wind and natural gas), as well as natural gas infrastructure
- Demand forecasting and growth assumptions
- Load shedding impacted natural gas compressor and well-head operations, impacting natural gas generation
- Review of load shedding schemes
- Identifying energy limitations in the context of extreme weather and fuel availability
- Market refinements
Recommendations

Regulators and Policy Makers

- Dual-fuel capability, emergency plans, air permits
- Cyber and physical security
- Fuel assurance, natural gas infrastructure built into long-term resource plans, policies

Industry

- Scenario analysis of extreme events
- Dual-fuel testing and preparation can be improved
- Reliability signals in markets reflecting the risk of gas supply disruptions

NERC

- Review Reliability Standards
- Develop planning guidance
Key Risk Functional Areas

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
Critical Infrastructure Interdependencies

- The Gas System
  - Our technology is improving
  - We have a healthy reserve
- Production hasn’t missed a beat despite the pandemic
- COVID did introduce logistics complications...
- Housing
- Shift Scheduling
- Cross-Industry Communication has improved through the pandemic

Critical Infrastructure Interdependencies

- Efficient communication with other utilities is critical
- Success was had through hurricanes & COVID with good communication

Communications
- Refer to reliable data
- Cross-sector collaboration
- Security: Know differences of private and public

Electrical + Oil & Gas
- Oil & Gas can find solutions by collaborating

Collaborate
- Using technology to improve
- Knowledge is power

Telecommunications
- Telecommunications should also sync with electric oil and gas

Collaborate & Communicate
- Look for overlap in communication streams
- For parts: Keep in mind:
  - Structural integrity
  - Availability

NERC Reliability Leadership Summit 2021
Electric Gas Working Group (EGWG)

• Develop Guidelines and white papers
• Provide assistance to NERC Event Analysis where fuel disruptions are involved
• Recommendations for the development of tools/guides to enhance operational awareness of fuel related information
• Provide support in the development of metrics related to fuel assurance risk for the SOR
• Support the development of data collection requirements for fuel related issues for the LTRA
Fuel Assurance Reliability Guideline

- Definition of Fuel Assurance
- Fuel Supply Primer
- Analysis Considerations
- Risk Analysis Framework

Questions and Answers