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

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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)
• 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
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
NERC-wide, on-peak natural gas-fired capacity increased to 442 GW, up from 280 GW in 2009.

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

<table>
<thead>
<tr>
<th>Assessment Area</th>
<th>2022 (%)</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>
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Reported GADS Outages of Natural Gas Generation Due to “Lack of Fuel” (2012-2015)
Pipeline and other natural gas infrastructure are not expanded or built without long-term firm service arrangement.
Top-20 Gas Pipelines by Peak-Day Delivery Arrangement

Red pipelines mean there were no interruptible flows on-peak

Source: ANL
• Aliso Canyon storage facility outage underscored risks to electric generation and potential reliability issues
• Evaluate impacts to BPS reliability as a result of potential disruptions and the loss of major natural gas infrastructure facilities:
  ▪ Key pipeline segment outages
  ▪ Disruption of LNG transport operations
  ▪ Natural gas storage disruptions
• Collaborative effort with Argonne National Laboratory analysis on critical facilities
• Advisory group established with electric, gas, research orgs.
2015 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
Increased dependence on natural gas for generating capacity can amplify the bulk power system’s vulnerability to disruptions in fuel supply, transportation, and delivery.
Step II: Storage Facilities

12 storage facilities have been identified that can impact > 2GW of generation.
Step III: Identifying Generation Risk Clusters

Northwest:
25 GW – 2016
4 GW – Planned

Southeast:
55 GW – 2016
7 GW – Planned

New England:
11 GW – 2016
5 GW – Planned

Mid-Atlantic:
95 GW – 2016
50 GW – Planned

South CA-AZ:
60 GW – 2016
17 GW -- Planned

East TX-OK-LA:
85 GW – 2016
28 GW – Planned

Florida:
38 GW – 2016
5 GW – Planned

* All values are approximates, various sources: EIPC, EIA-860, NERC LTRA
Step III: Generation Clusters

Higher individual reliability:
- Dual-fuel maintained on-site
- Firm fuel agreements
- Multiple pipeline connections

Lower individual reliability:
- Not dual-fuel capable
- Interruptible fuel, spot
- Single pipeline connection

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

- Dual-fuel capable, no inventory
- Interruptible fuel, spot
- Single pipeline connection
• Screening analysis identified 18 out of 19 clusters did not meet voltage criteria and power flow was unsolved.
• Electric transmission system is not designed to withstand simultaneous loss of significant generation.
• Changing electric power demand impacts storage facility reliance
• Firm fuel agreements provide the highest level of reliable natural gas transportation, but can be curtailed under force majeure conditions
• Aliso Canyon is a relatively unique situation given the Southern California dynamics
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 and Guidelines
- Enhance cause codes for GADS reporting
Questions and Answers