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ERCOT Natural Gas Curtailment Risk Study

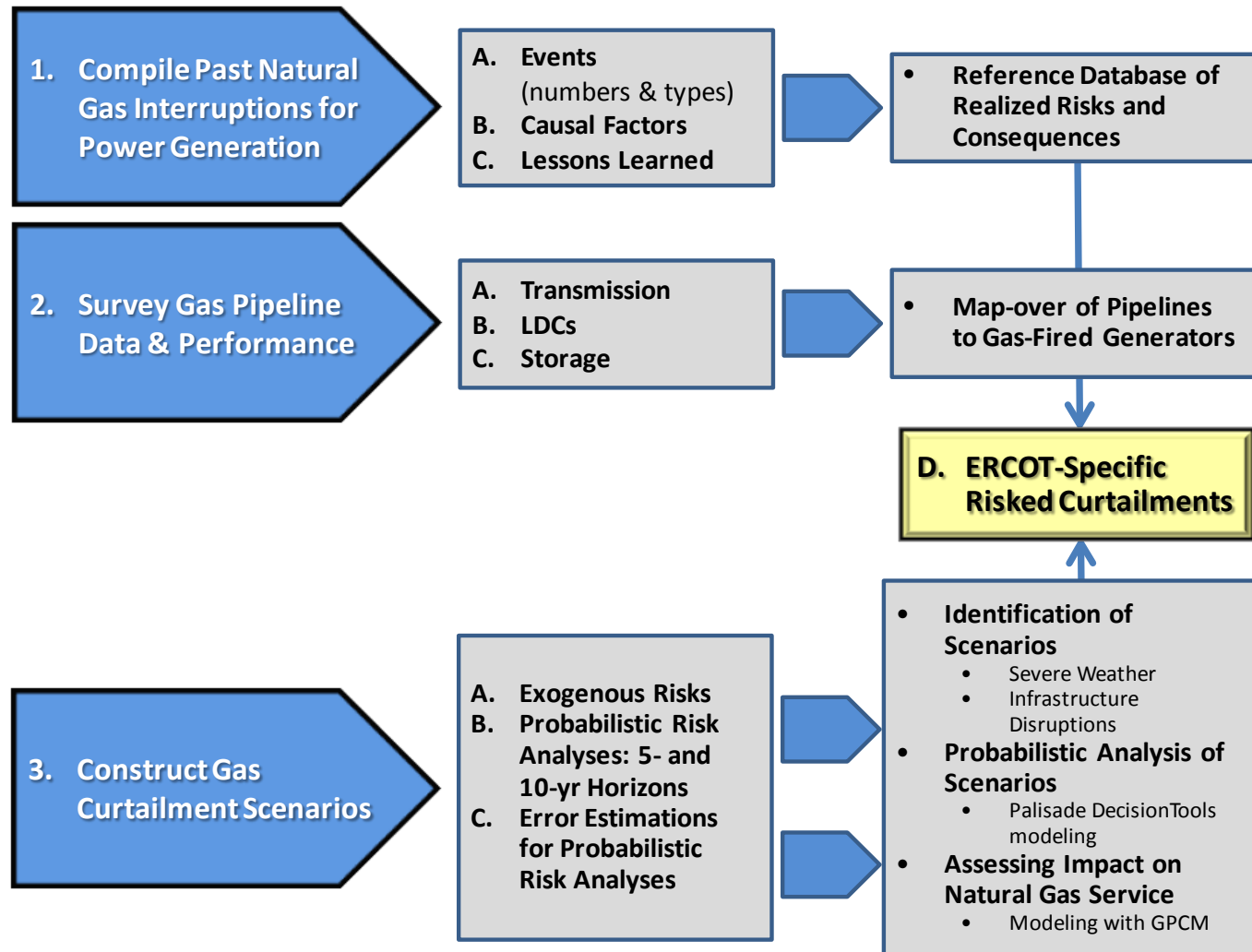
Review of Key Findings & Observations

February 2012

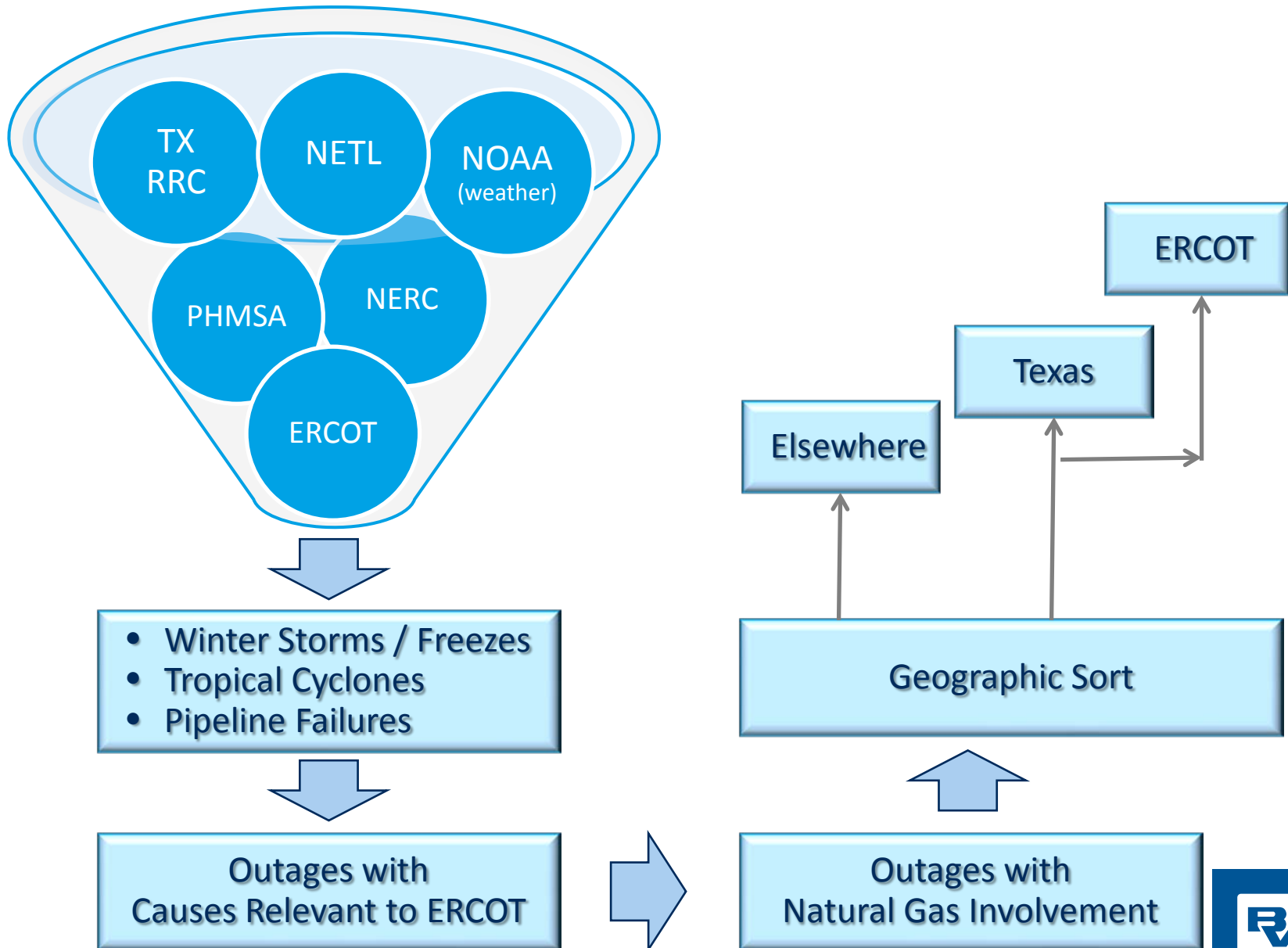


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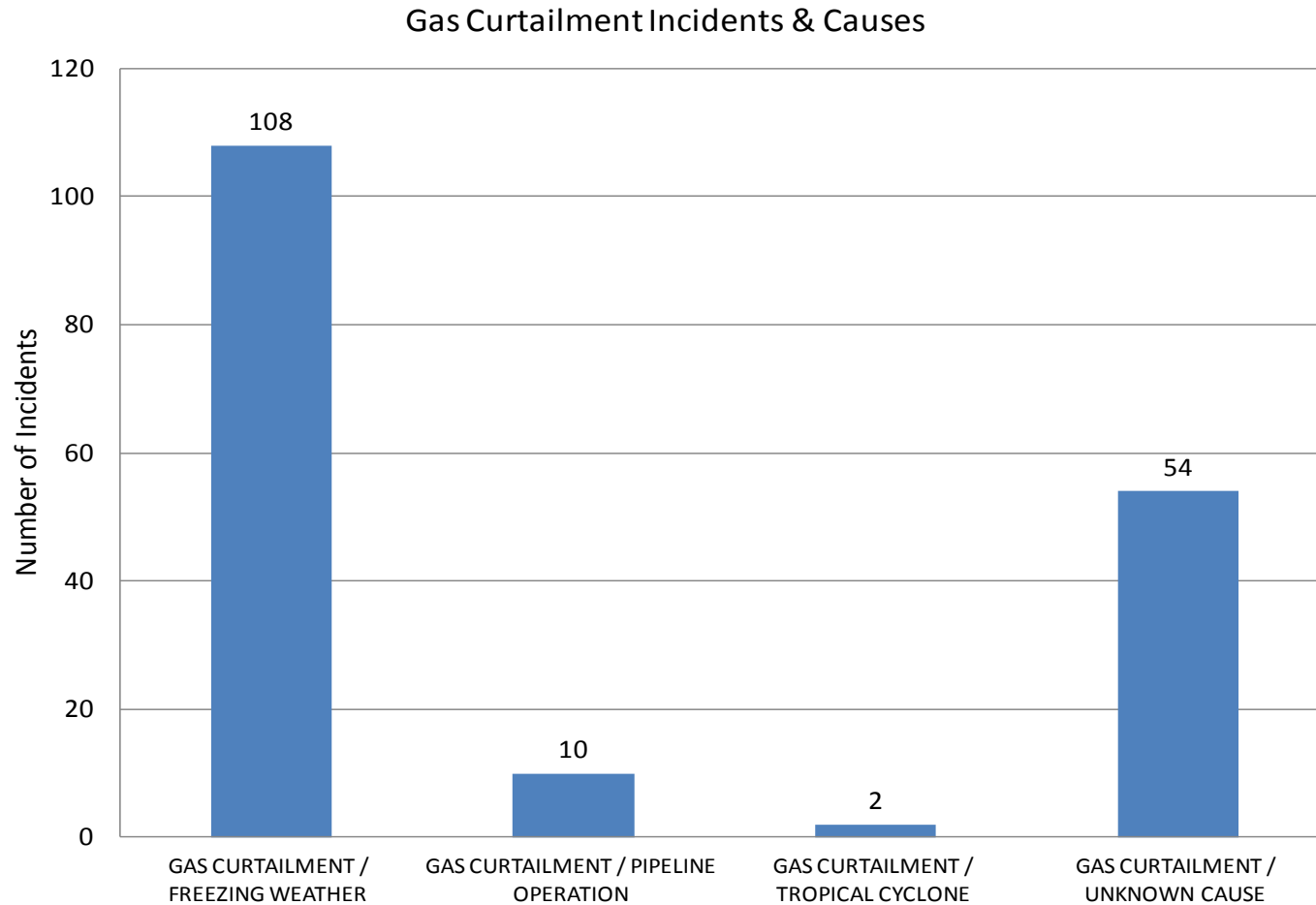
Natural Gas Curtailment Risk Study – Scope & Approach



Various Data Sources Were Explored to Identify Generation Loss Due to Natural Gas Curtailments

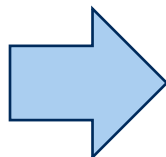


Review of Historical Natural Gas Curtailment Events - Freezing Weather Most Common Cause

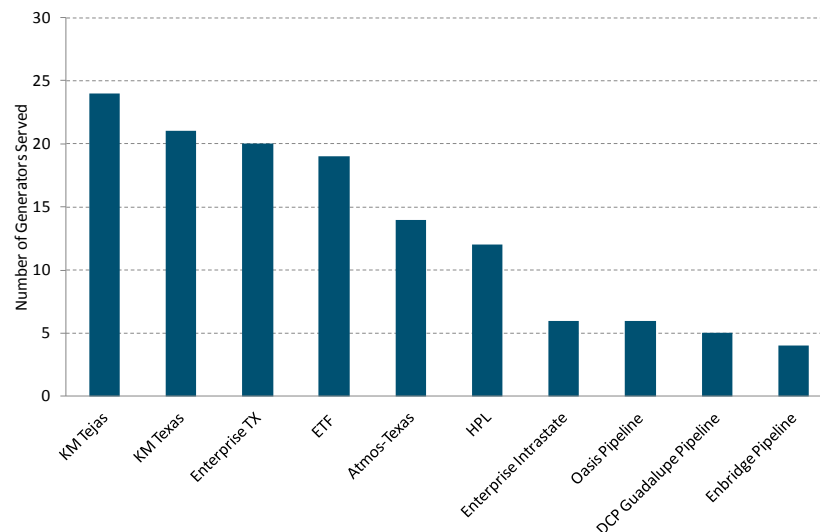


Review of Natural Gas Infrastructure – Generators Demonstrate Redundancy Of Natural Gas Supply

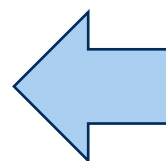
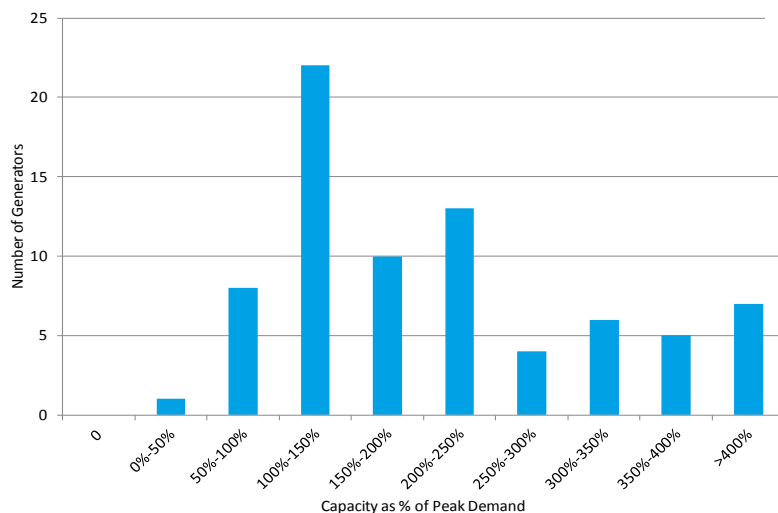
Intrastate Pipelines Dominate In Serving Electric Generators Within ERCOT



Natural Gas Pipelines Serving ERCOT Electric Generators

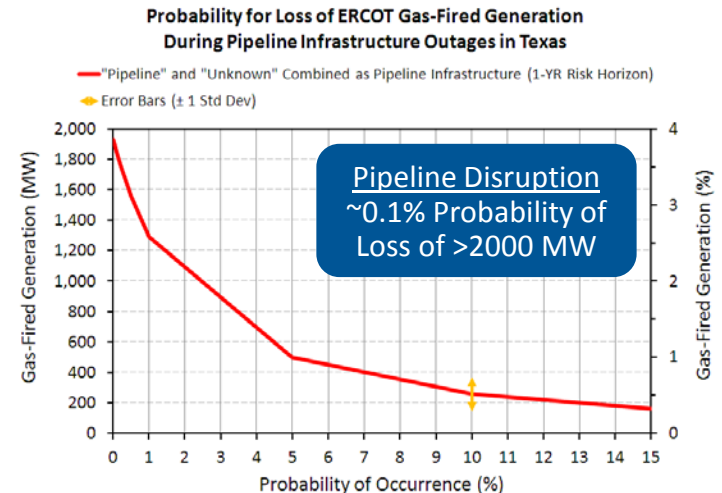
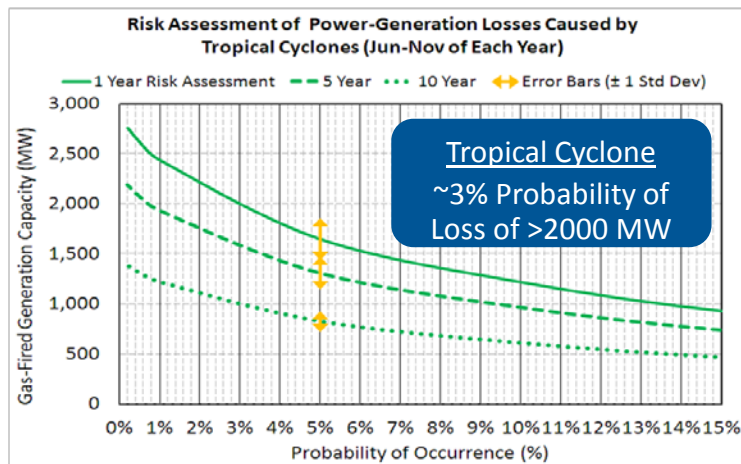
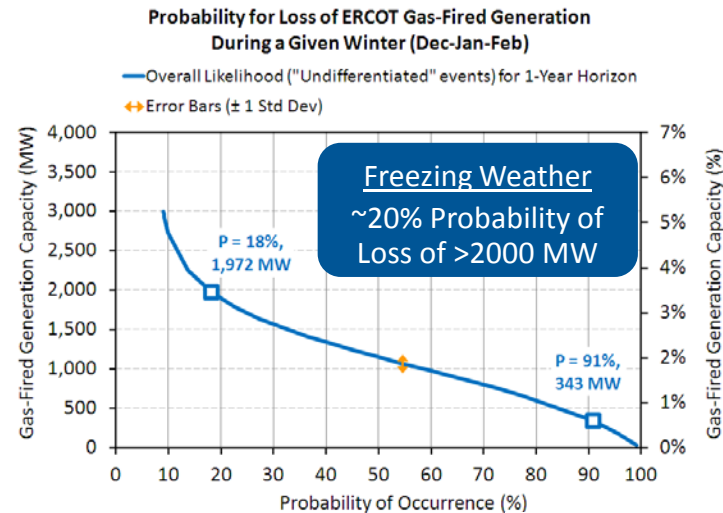


Pipeline Capacity as % of Peak Needs for ERCOT Generators

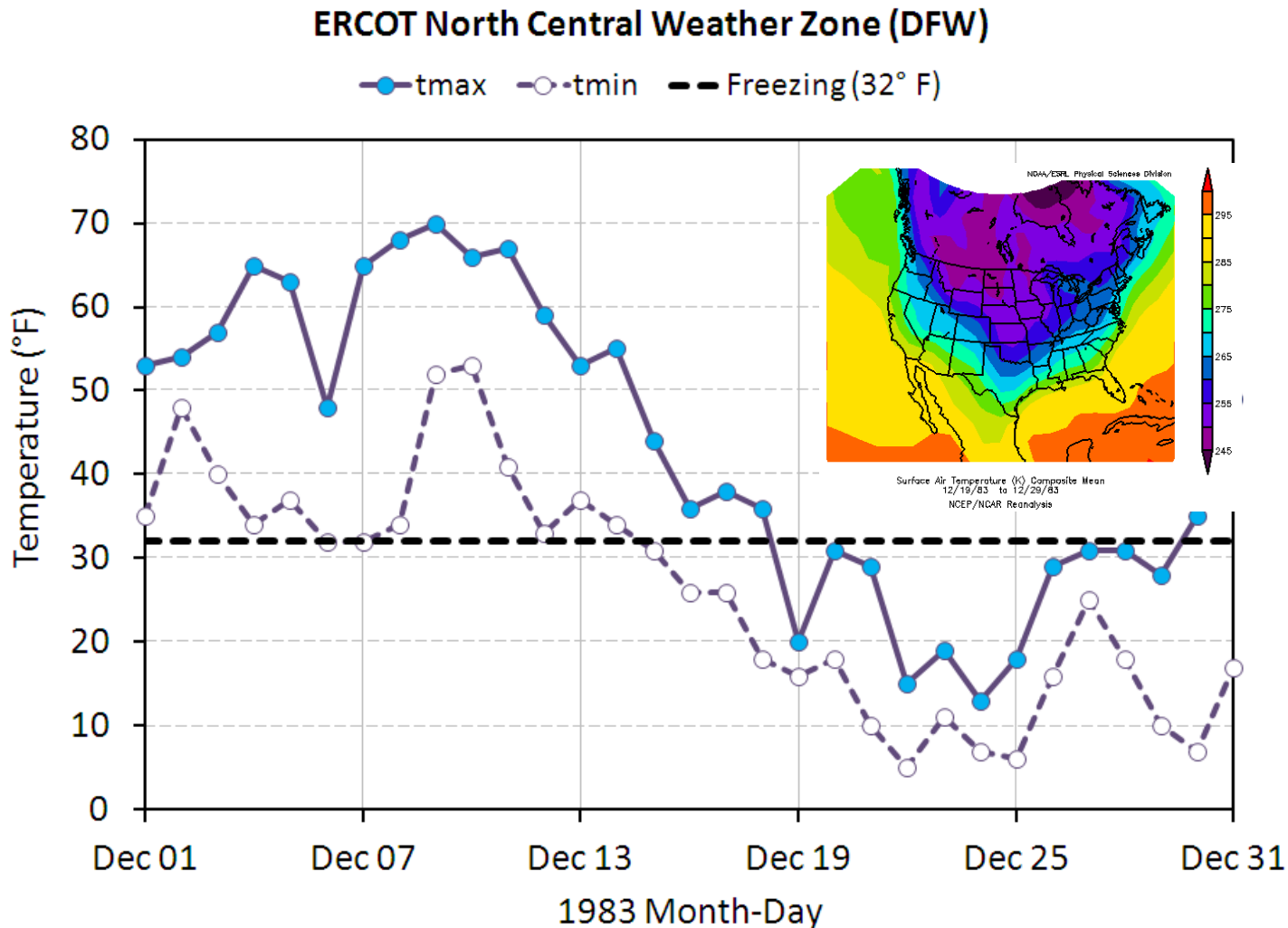


Majority of ERCOT gas-fired generators have access to capacity in excess of their peak needs & multiple pipeline interconnects

Analysis of Curtailment Scenarios – Risk of Generation Loss is Highest for Freezing Weather



Dec 1983 Was Distinguished as ERCOT's Longest Sub-Freezing Event (Most Consecutive Days) Since 1950



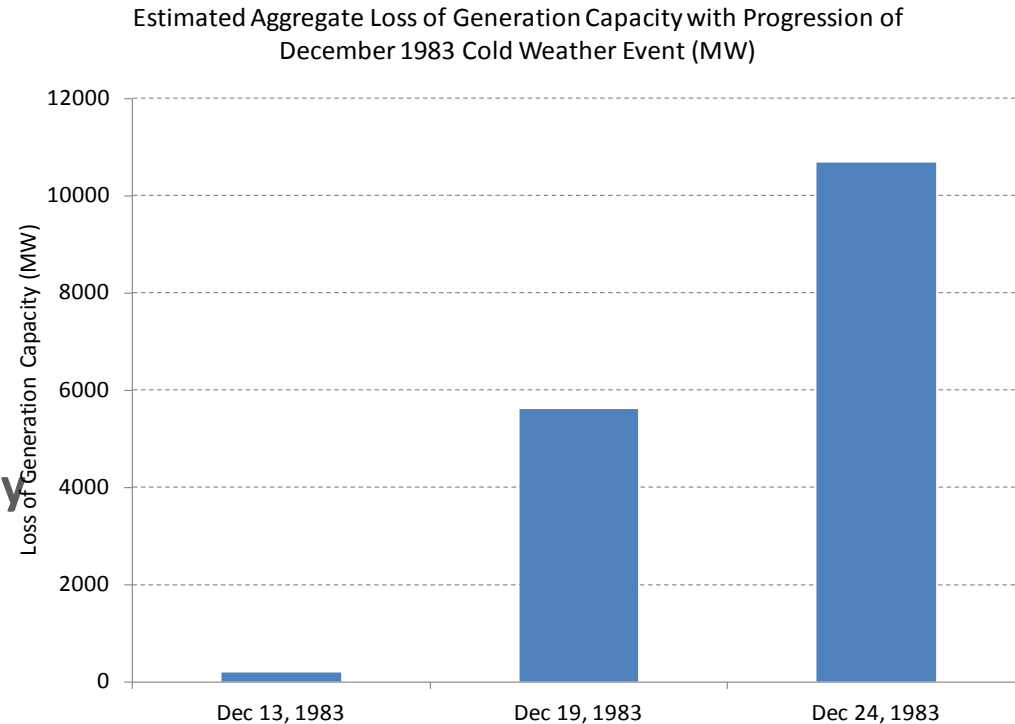
- Analysis examined the impact on natural gas production and generation capacity if this cold weather event were to re-occur

Data Source:

Black & Veatch
analysis of data from
National Climatic Data
Center (NCDC).

Impact of December 1983 Cold Weather Event on ERCOT's Current Generation Capacity

- Application of December 1983 winter event to February 2012 gas system would imply supply losses of up to 24% on the coldest day
- Associated potential loss of generation capacity within ERCOT is estimated to be 11,000 MW on coldest day due to supply disruptions
- However, regional pipeline capacity is estimated to be adequate to meet generation demands; it should be noted that localized pipeline constraints on delivery systems could still cause some curtailments



Gas Curtailment Observations & Lessons Learned

- **Data availability**

- Documented gas curtailments outside of contractual agreements were relatively rare - most events reviewed appeared to be contractually permitted
- ERCOT's operator logs were most directly applicable of the various primary data sources reviewed
- There was limited overlap between curtailment or disruption data available through natural gas focused and power focused entities:
 - NETL and other sources of curtailment data from power focused entities placed limited or no emphasis on capturing or reporting the natural gas fuel aspect of recorded events – natural gas curtailment was inferred in most cases
 - Pipeline electronic bulletin boards and other natural gas focused sources in turn did not capture impacts of gas curtailment events on electric generators in detail – impact was inferred where possible

Gas Curtailment Observations & Lessons Learned

- **Nature and impact of historical events reviewed**
 - The majority of gas curtailments appear to be winter events associated with freezing weather
 - Physical disruption of upstream supply and/or contractually permitted curtailments triggered by cold weather
 - Some secondary effects from tropical cyclones (hurricanes, tropical storms or tropical depressions)
 - Very few and isolated incidents of curtailments related to pipeline operations
 - Pigging
 - Line rupture

Gas Curtailment Observations & Lessons Learned

- **Best practices and lessons to be learned**
 - Market liquidity and commercial agreements appear to largely be effective in procuring natural gas supply for electric generators
 - Survey responses indicate that a sample of electric generators in DFW area have entered into contractual agreements that allow curtailment of their natural gas supply in the event of extreme cold weather
 - The relatively small number of curtailment events outside of contractual agreements that were identified indicate flexibility in the natural gas market to obtain supply without firm contracts in most cases
 - Switching to oil was observed in historical data as a mitigation measure when gas curtailments were in effect due to contractual terms; the economics of switching may place restrictions on the ability to switch to oil going forward.
 - Connectivity to multiple pipelines or to storage facilities would provide fuel-supply redundancy for generators when curtailed by one pipeline
 - Majority of ERCOT generators reported interconnects with multiple pipelines and access to pipeline capacity in excess of their peak needs

Gas Curtailment Observations & Lessons Learned

- **Best practices and lessons to be learned**
 - Increased coordination between natural gas and power industry regulating agencies could help ensure cross-capture of information as the role of natural gas as a fuel source for power generation continues to grow
 - If ERCOT is expected to monitor fuel impacts on the reliability of the electric grid, better data capture of curtailment incidents is needed
 - ERCOT Operator logs
 - Training of ERCOT Operators to better recognize names and locations of gas pipelines and gas utilities
 - Annual reporting by generators to ERCOT
 - Inclusion of gas-delivery issues as a regular report element
 - Continue to improve ERCOT coordination with RRC
 - Fostering of communication pathways and reports for gas-delivery incidents affecting power-generation facilities
 - In addition to cost considerations, contractual agreements that require curtailment of gas supply to generators or mandatory curtailment policies as defined by the TRRC could inhibit a power generator's ability and motivation to acquire firm gas supply. Review of these agreements and policies could help determine whether new policies or regulations are required to increase the reliability of ERCOT generation

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