

# Texas Power Grid Disruptions and the Implications for Grids Everywhere

OR

*“The Night the Lights Went Out in Texas”*

*A presentation for:*

**Homeland Defense and Security Information Analysis Center**

*March 16, 2022*

*By:*

**Michael Lambert**

# Today's premise ...

- Electricity is the bedrock of our modern society ...
- The grid that brings us our electricity is FRAGILE ...
- We need to recognize, embrace, plan and prepare for that fragility ...

# Today's mission ...

- Brief on the Texas 2021 electric power disruptions ...
- Highlight some other threats to the grid(s) ...
- Take a quick look at implication for planning and preparedness ...

**A red pill**

**A blue pill**

# THE trap ...

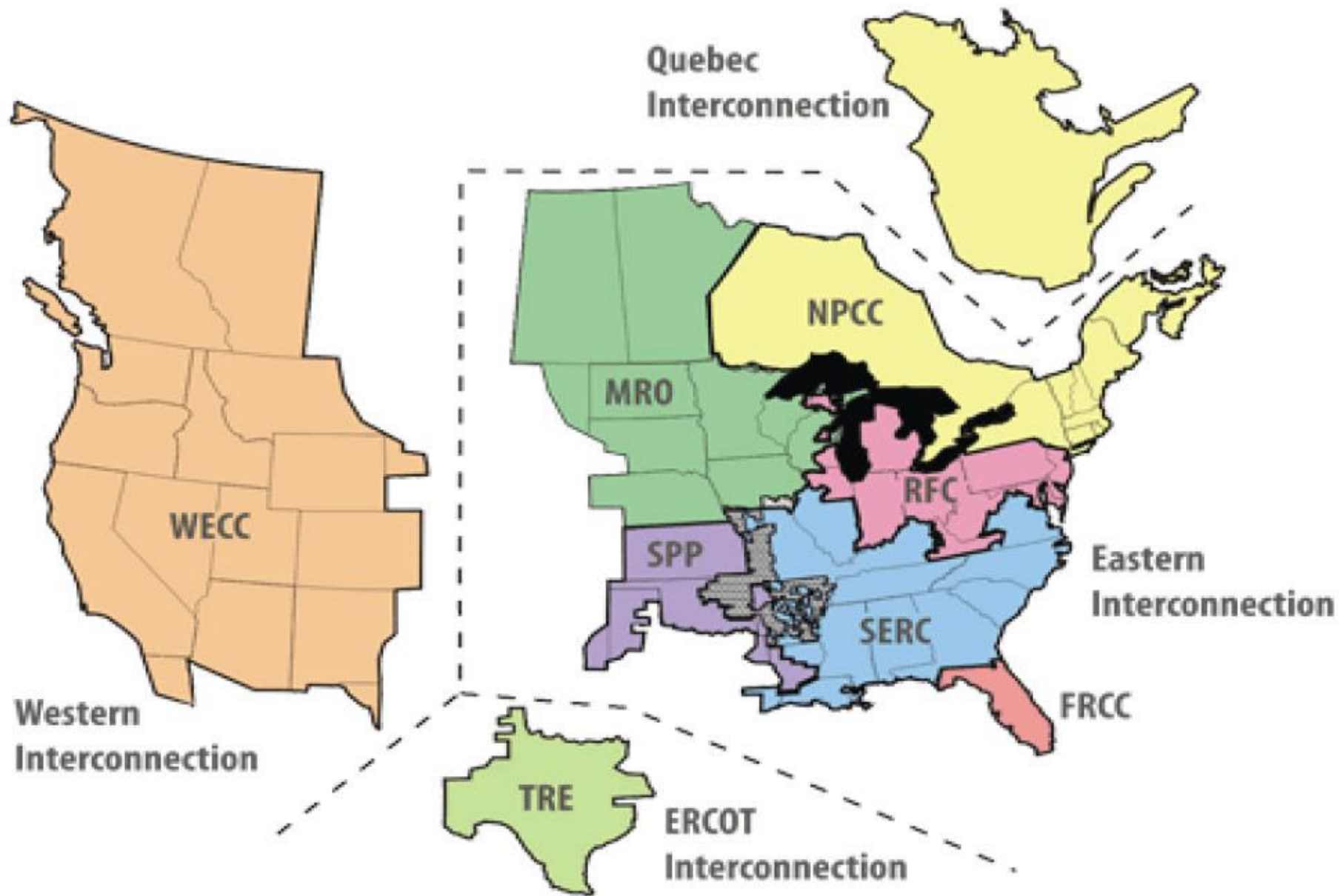
- Failure of imagination ...
- Inability to suspend disbelief ...
- “Whistling past the graveyard” ...

# THE trap ...

- Failure of imagination ...
- Inability to suspend disbelief ...
- “Whistling past the graveyard” ...
- **Misplaced confidence** ...

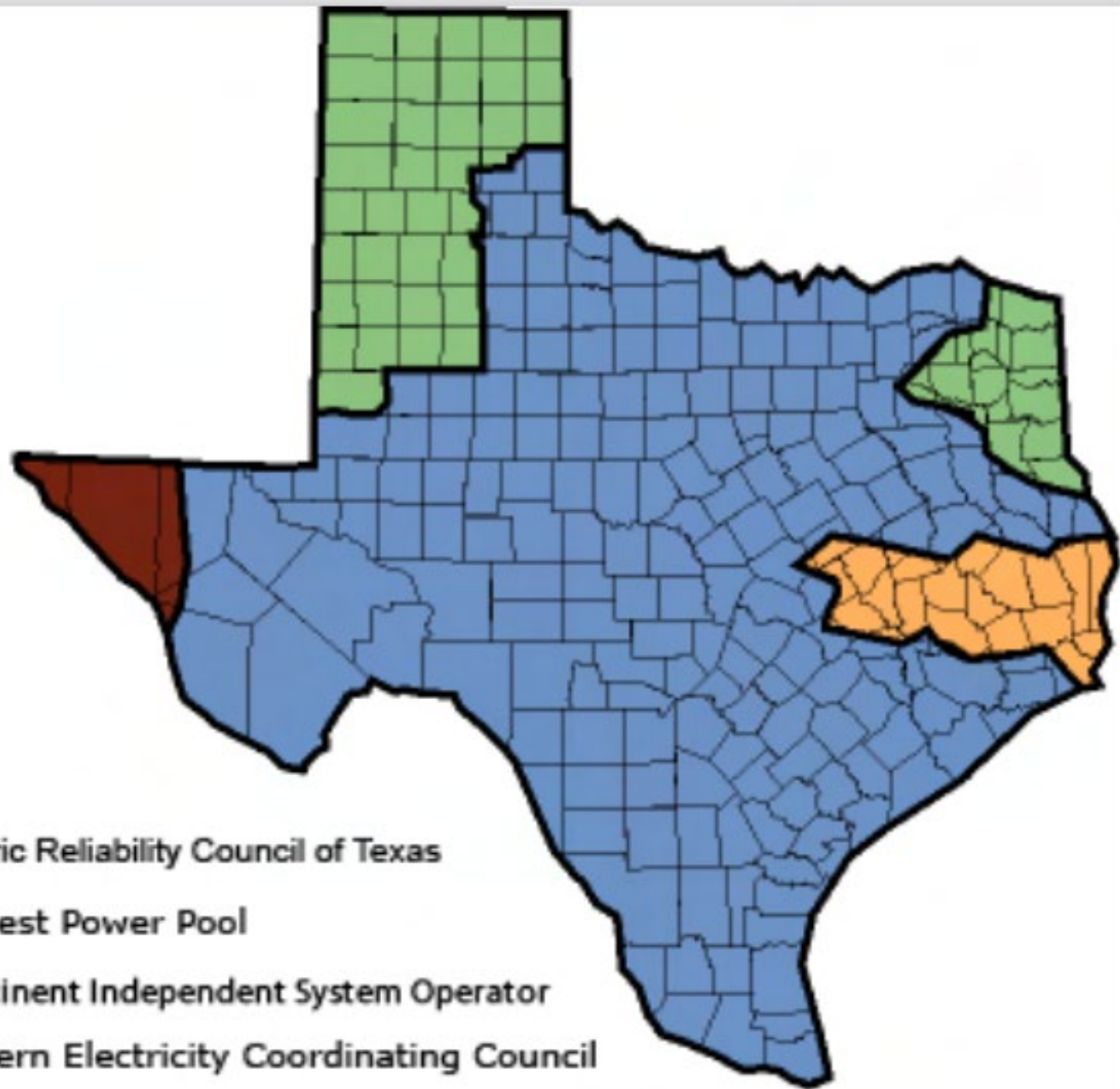
# The SPECIFIC trap ...

- All power outages are geographically localized ...
- Power outages will have a finite, predictable duration ...
- Utility companies will send an army of workers to fix the problem ...
- Our neighbors, the state and the federal government will send the cavalry ...



Source: North American Electric Reliability Council





-  ERCOT - Electric Reliability Council of Texas
-  SPP - Southwest Power Pool
-  MISO - Midcontinent Independent System Operator
-  WECC - Western Electricity Coordinating Council



# ERCOT grid facts ...

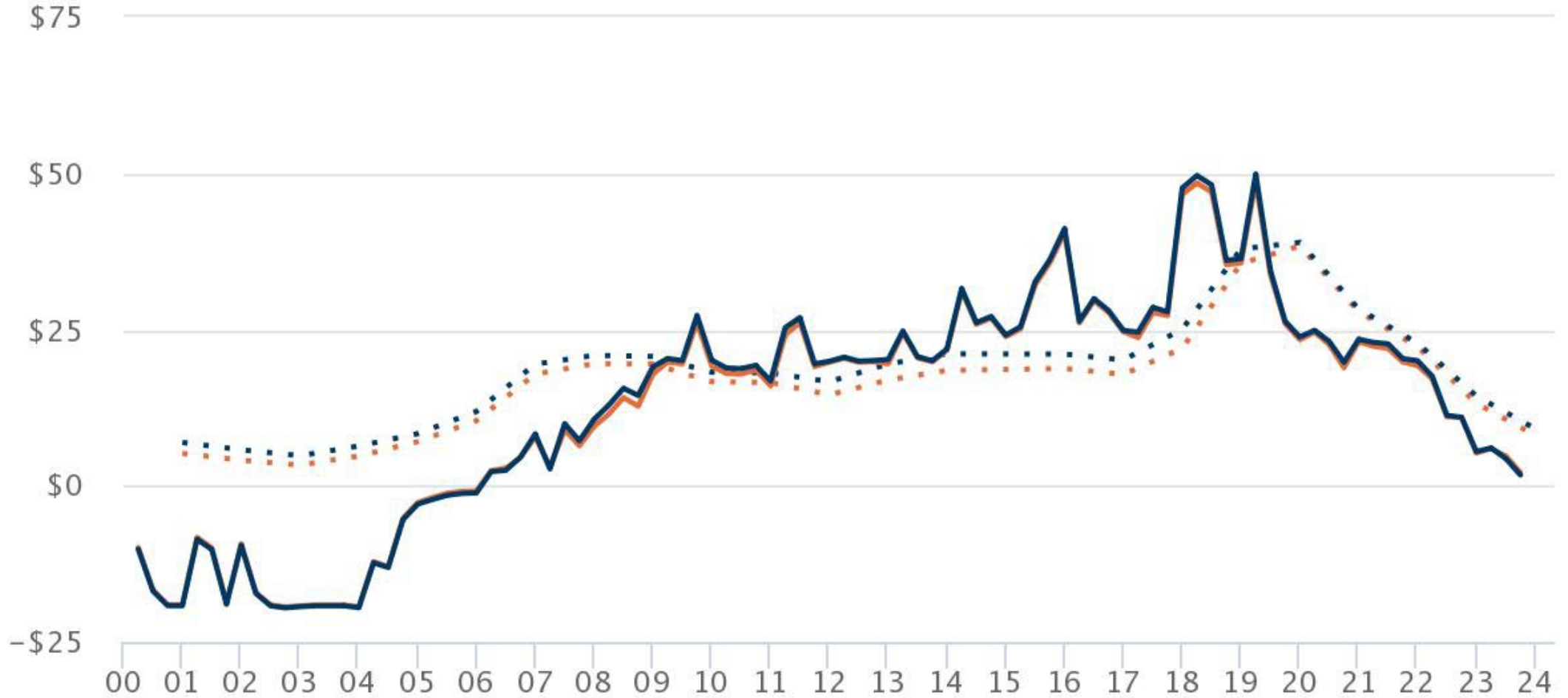
- Covers 75% of the state and 90% of the state's customer base ...
- 710 generation units and 46,500 miles of transmission line ...
- Deregulated/restructured ...
- “Non-discriminatory” supply side ...
- Increasingly reliant on “intermittent” generation fuel sources ...
- Limited interconnections to national grids ...
- Biased toward HOT weather operations and not cold ...
- Energy Only ...

# “Energy Only” ...

- Generation companies paid ONLY for the electricity they produce ...
- Bid into the system at their marginal cost ...
- No direct compensation for fixed costs ...
- No ability to compel generation companies to actually produce electricity ...
- Generation companies are induced to produce by price ...
- Reduced reserve capacity is a “feature” not a “bug” in the market ...
- Overall, consumer electricity prices lower ...

# System-Wide Prices

Hub Bus Avg.  
Feb 21, 2022 23:47



•• Day-Ahead Hub Avg.

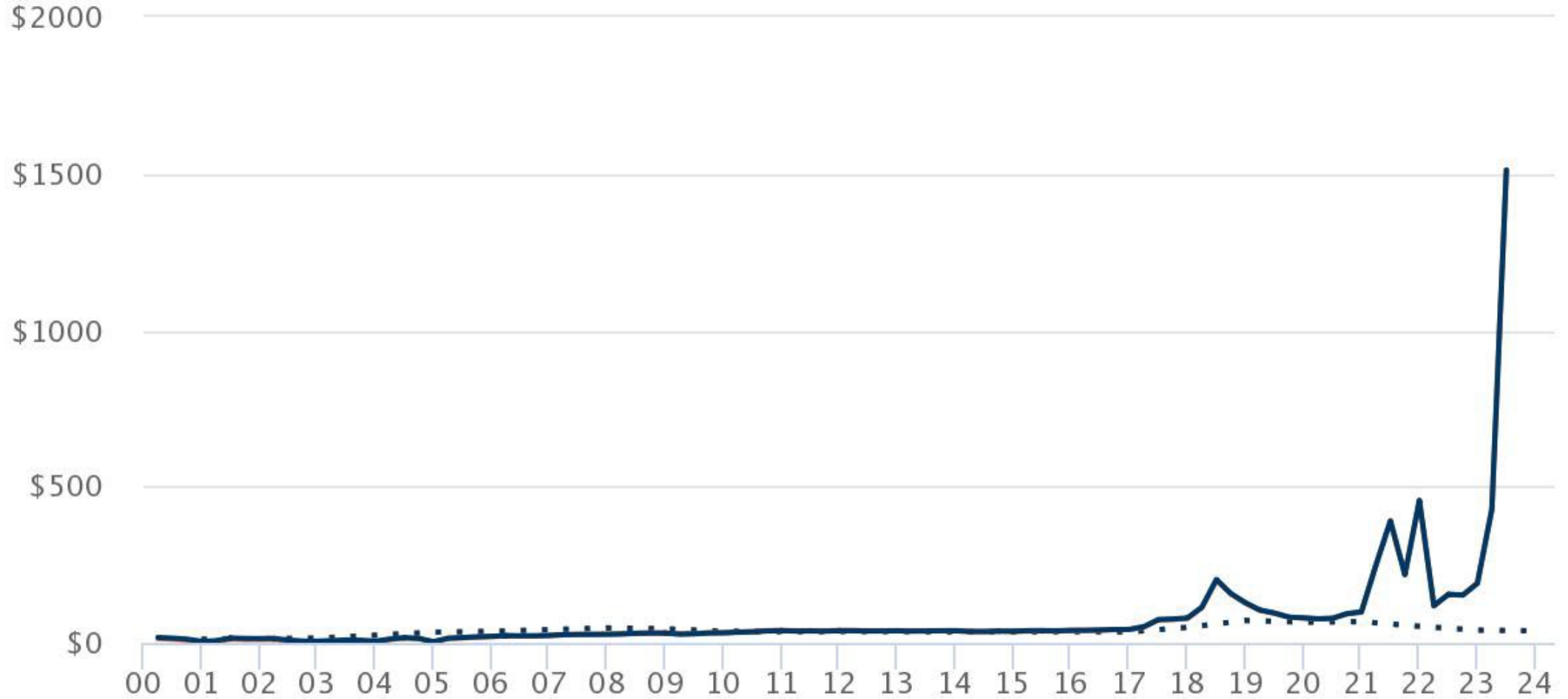
— Real-Time Hub Avg.

•• Day-Ahead Hub Bus Avg.

— Real-Time Hub Bus Avg.

# System-Wide Prices

Hub Bus Avg.  
Feb 23, 2022 23:32



•• Day-Ahead Hub Avg.

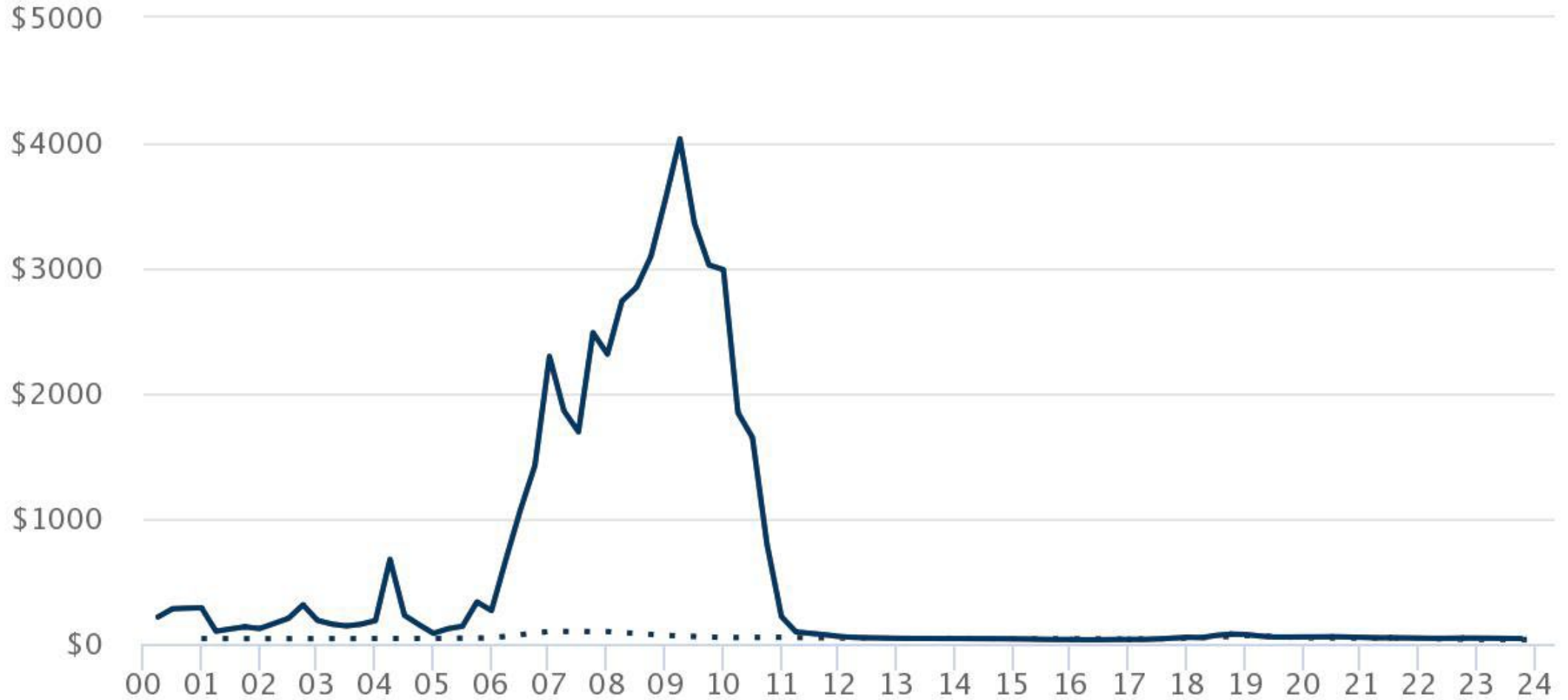
— Real-Time Hub Avg.

•• Day-Ahead Hub Bus Avg.

— Real-Time Hub Bus Avg.

# System-Wide Prices

Hub Bus Avg.  
Feb 24, 2022 23:47



Day-Ahead Hub Avg.

Real-Time Hub Avg.

Day-Ahead Hub Bus Avg.

Real-Time Hub Bus Avg.

# Grid Participants

- Bulk Generators ...
- Transmission/Distribution Utilities (TDUs) ...
- Retail Energy Providers (REPs) ...

*Each of the above must be separate corporate entities thereby giving them operational independence one from the other ...*

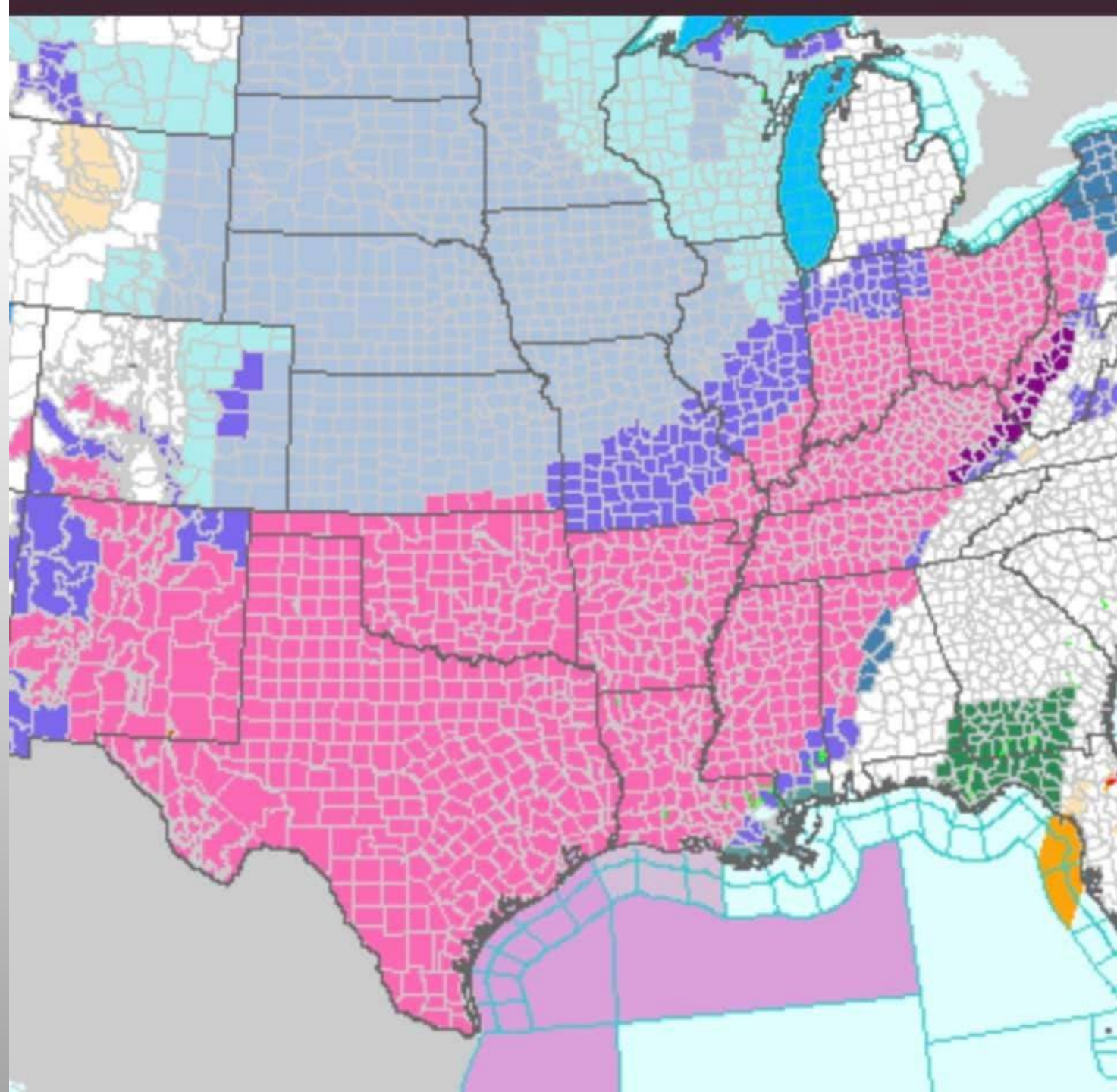
*Exceptions for **municipally-owned** and **co-ops** ...*



# Grid Oversight

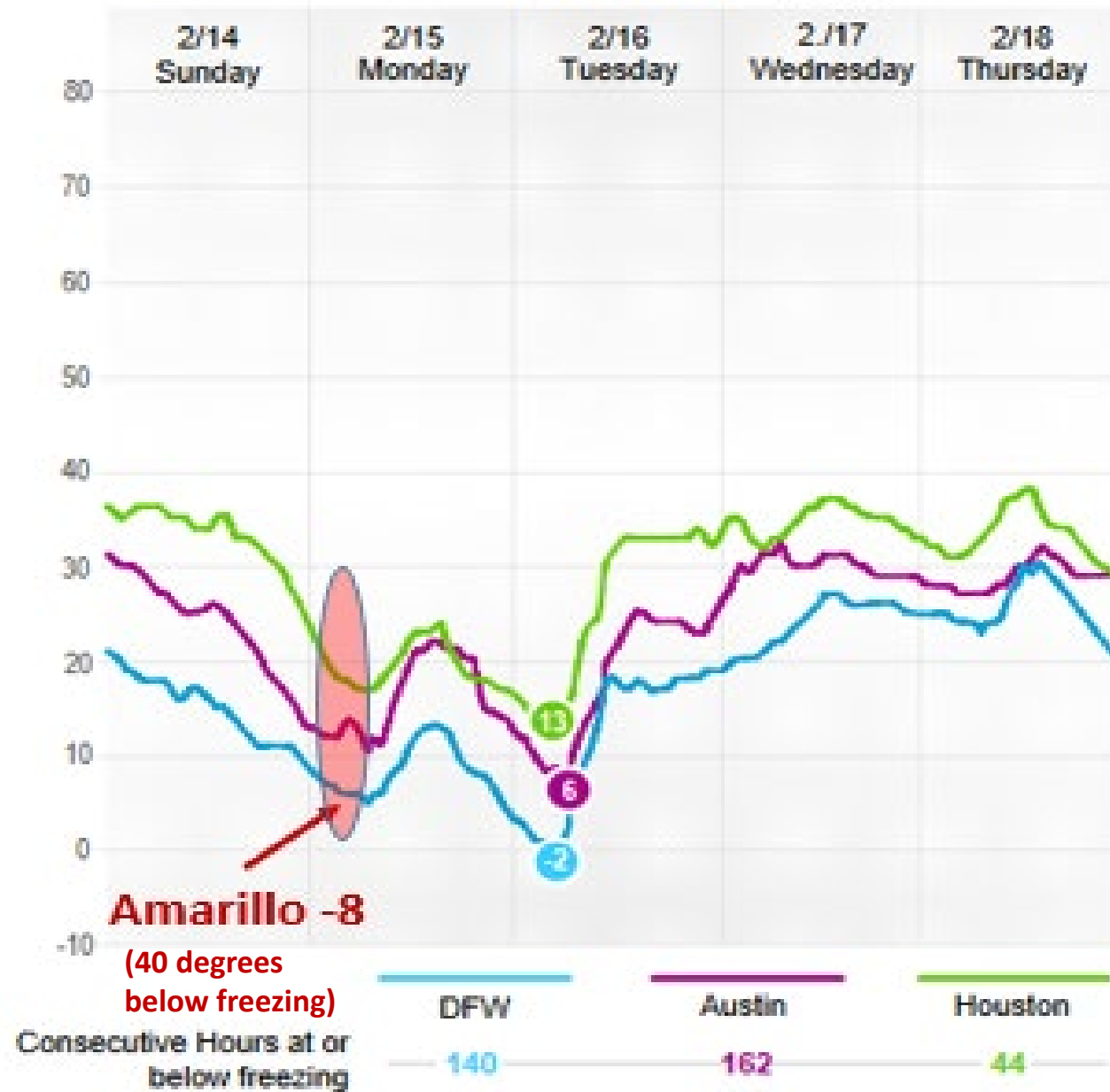
- Electricity Reliability Council of Texas (ERCOT) ...
- Public Utility Commission of Texas (PUCT) ...
- *Texas Railroad Commission (TRRC) ...*





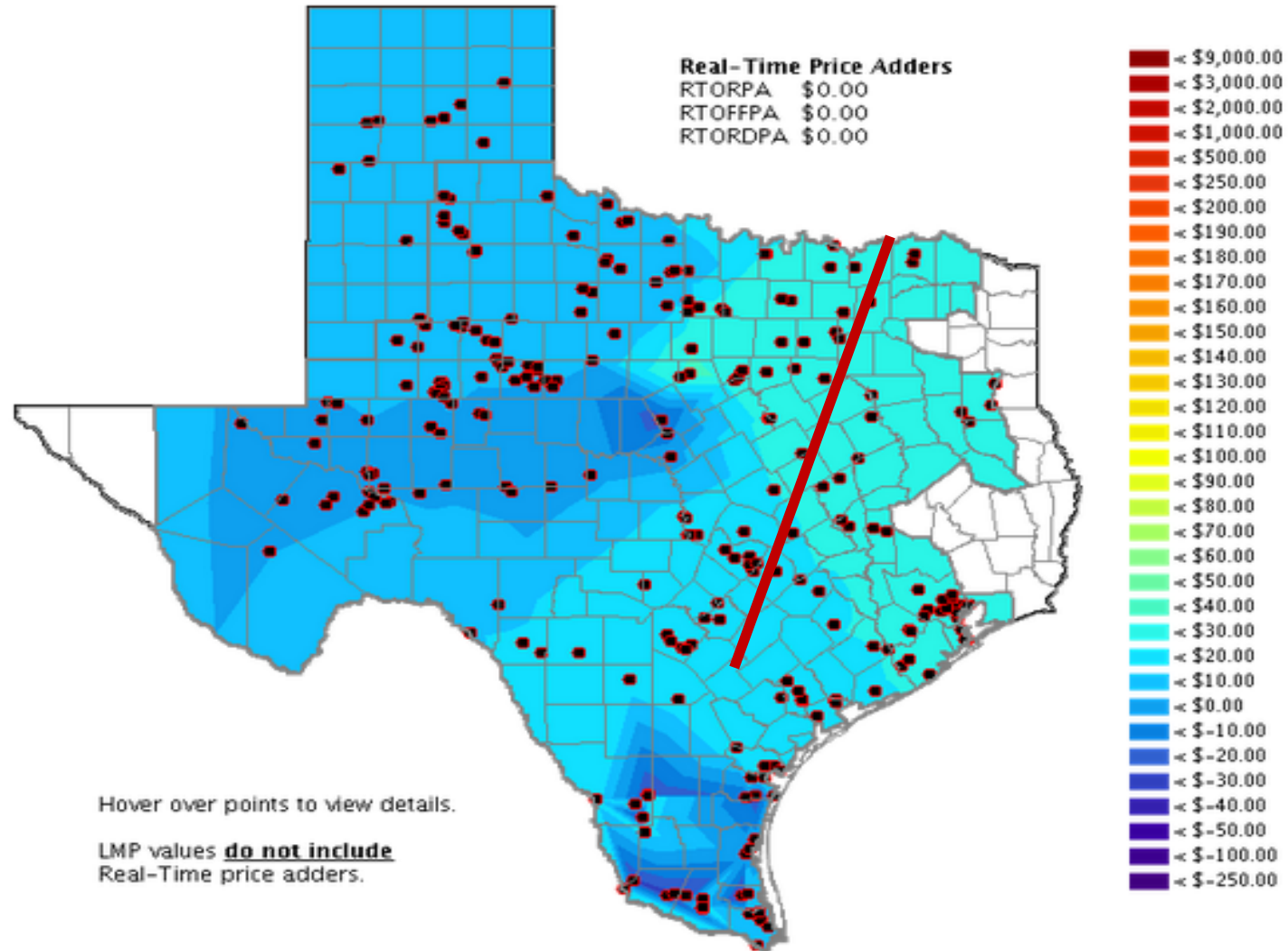
# 2021 Event Temperature

February 2021



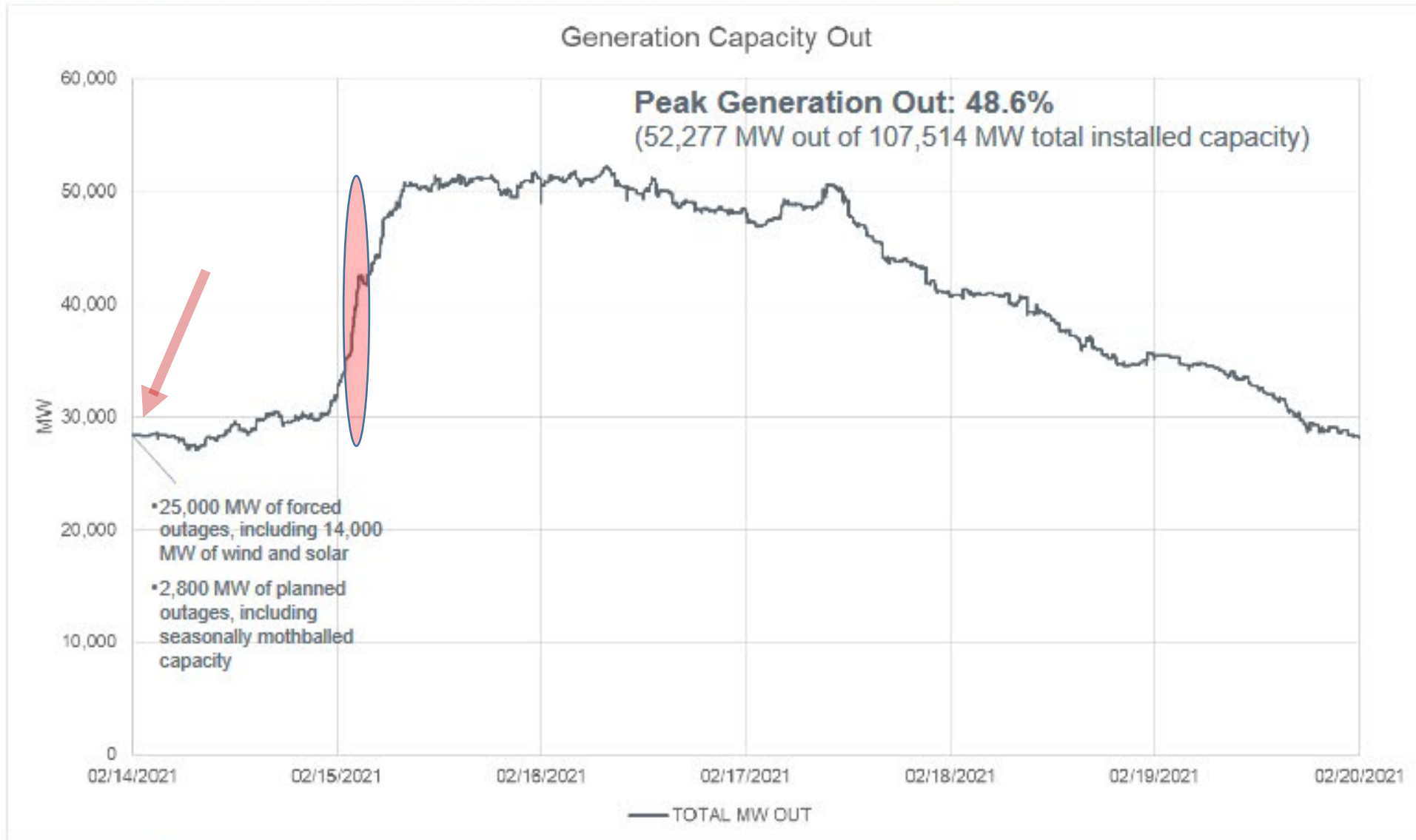
Last Updated: Jun 25, 2021  
09:30

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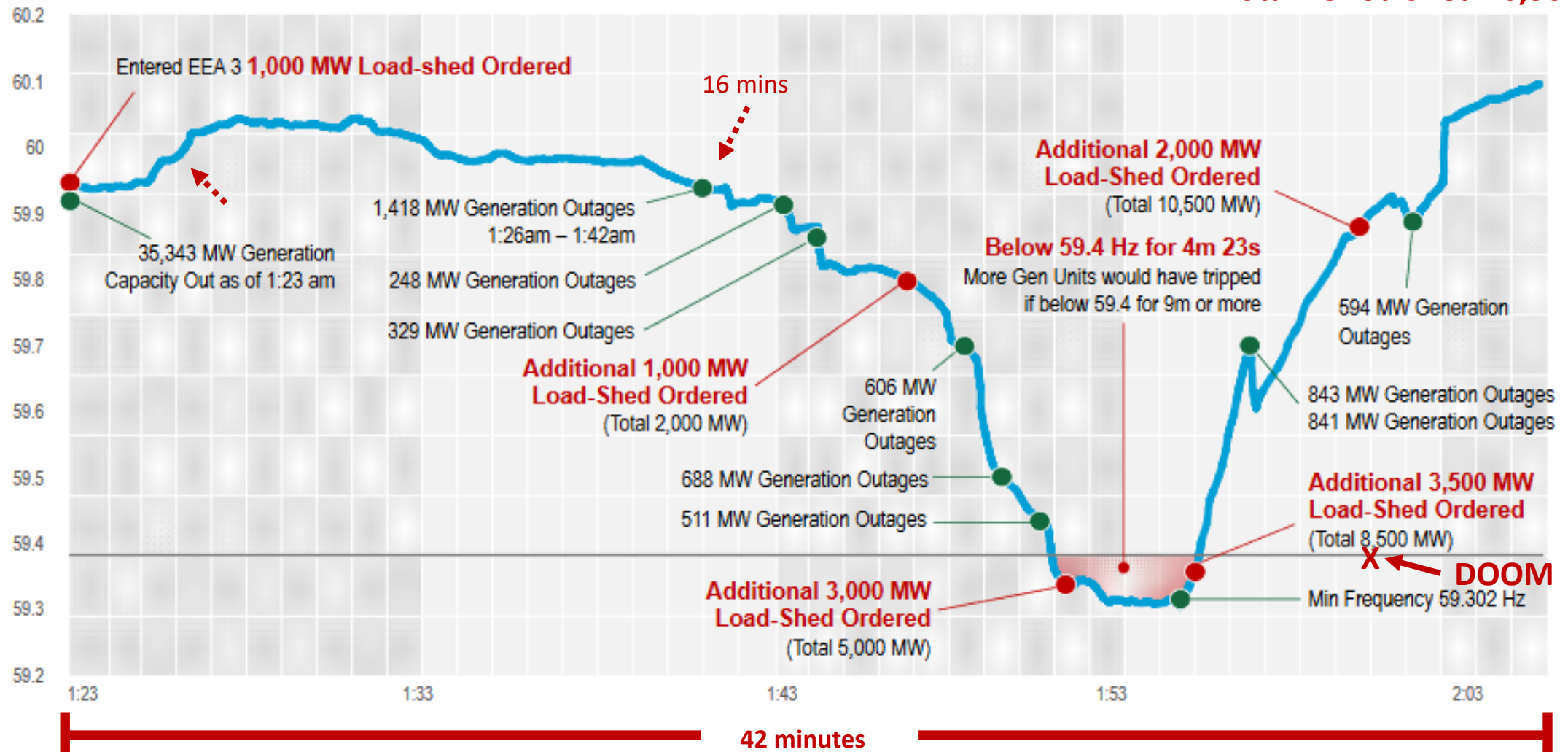
Select Data  View As

# Generation Capacity Out February 14 – 19, 2021



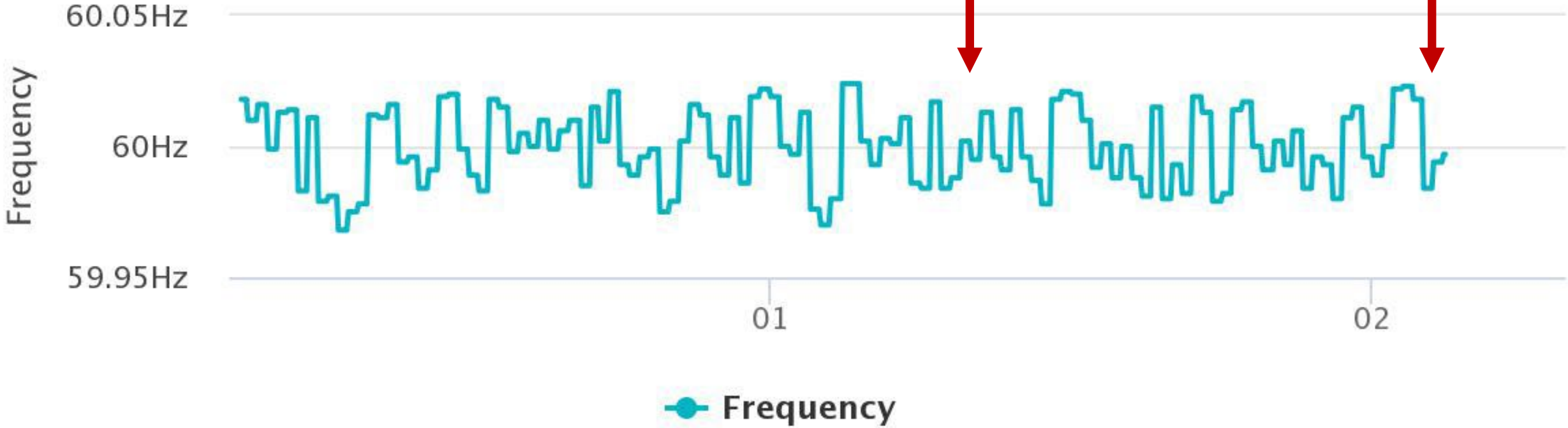
# Rapid Decrease in Generation Causes Frequency Drop

Total Period Loss 6,704 MW  
Total Period Shed 10,500 MW



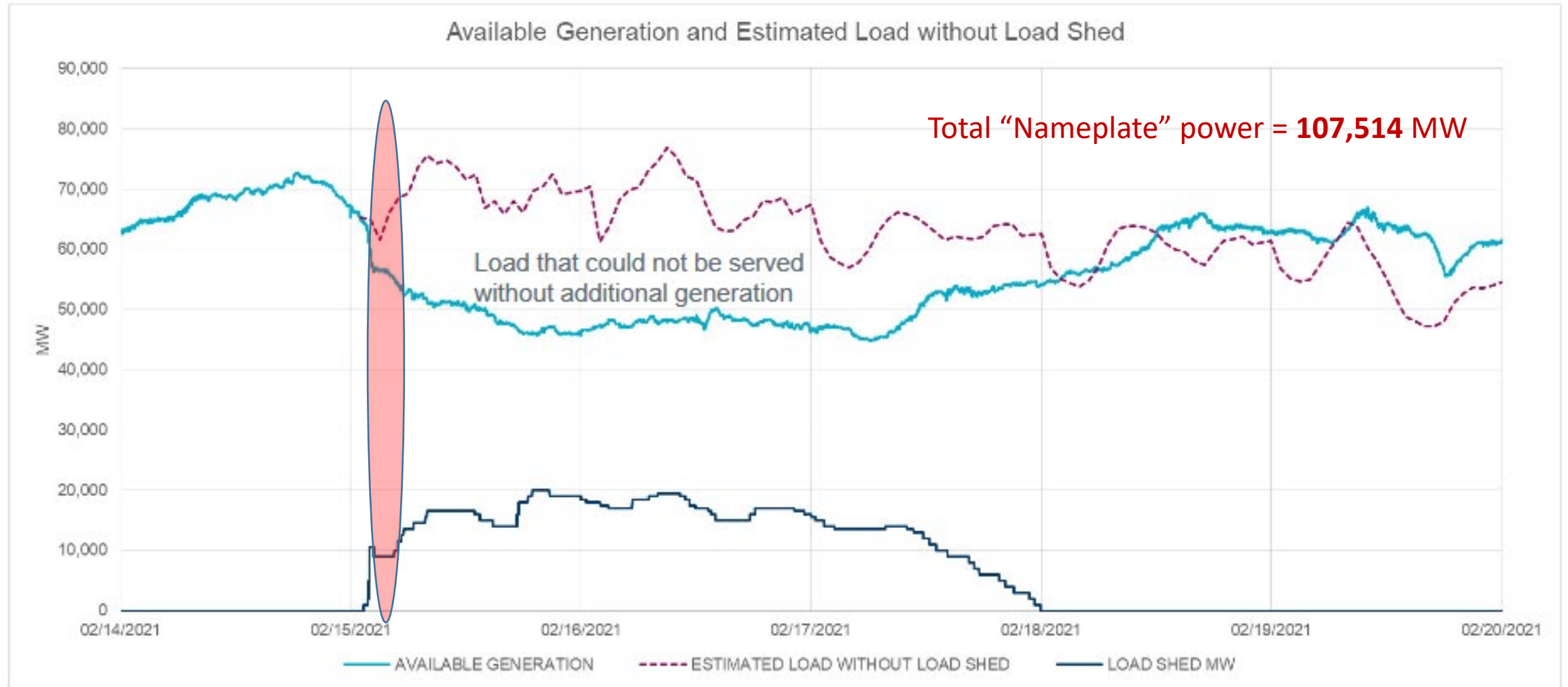
# Ancillary Services

Feb 15, 2022 02:06





# Available Generation and Estimated Load Without Load Shed



Available Generation shown is the total HSL of Online Resources, including Quick Starts in OFFQS. The total uses the current MW for Resources in Start-up, Shut-Down, and ONTEST.



## Load Shed Ordered By Transmission Owner

Transmission Operator	% of MW
AEP Texas Central Company	8.7
Brazos Electric Power Cooperative Inc.	4.95
Brownsville Public Utilities Board	0.37
Bryan Texas Utilities	0.51
CenterPoint Energy Houston Electric LLC	24.83
City of Austin DBA Austin Energy	3.71
City of College Station	0.28
City of Garland	0.75
CPS Energy (San Antonio)	6.79
Denton Municipal Electric	0.48
GEUS (Greenville)	0.15
Lamar County Electric Cooperative Inc <sup>*</sup>	0.07
LCRA Transmission Services Corporation	5.96
Oncor Electric Delivery Company LLC	36.01
Rayburn Country Electric Cooperative Inc.	1.3
South Texas Electric Cooperative Inc.	2.52
Texas-New Mexico Power Company	2.62
<b>ERCOT Total</b>	<b>100.00</b>

# Types of circuits ...

- Underfrequency circuits
- Critical loads
- The rest of us

## 2011 vs. 2021 Event Comparison

	2011	2021		
Maximum generation capacity forced out at any given time (MW)	14,702	52,277	←	<b>3.6x</b>
Generation forced out one hour before start of EEA3 (MW)	1,182	2,489		
Cumulative generation capacity forced out throughout the event (MW)	29,729	46,249*		
Cumulative number of generators outaged throughout the event	193	356	←	<b>1.8x</b>
Cumulative gas generation de-rated due to supply issues	1,282	9,323		
Lowest frequency	59.58	59.30	←	
Maximum load shed requested (MW)	4,000	20,000		
Duration load shed request (hours)	7.5	70.5	←	<b>9.4x</b>
Estimated peak load (without load shed)	59,000	76,819	←	<b>1.30%</b>

\*Note: "Cumulative" values for 2021 were calculated using NERC 2011 report methodology. Cumulative amount for 2021 starts at 00:01 on February 14, 2021

# Impacts ...

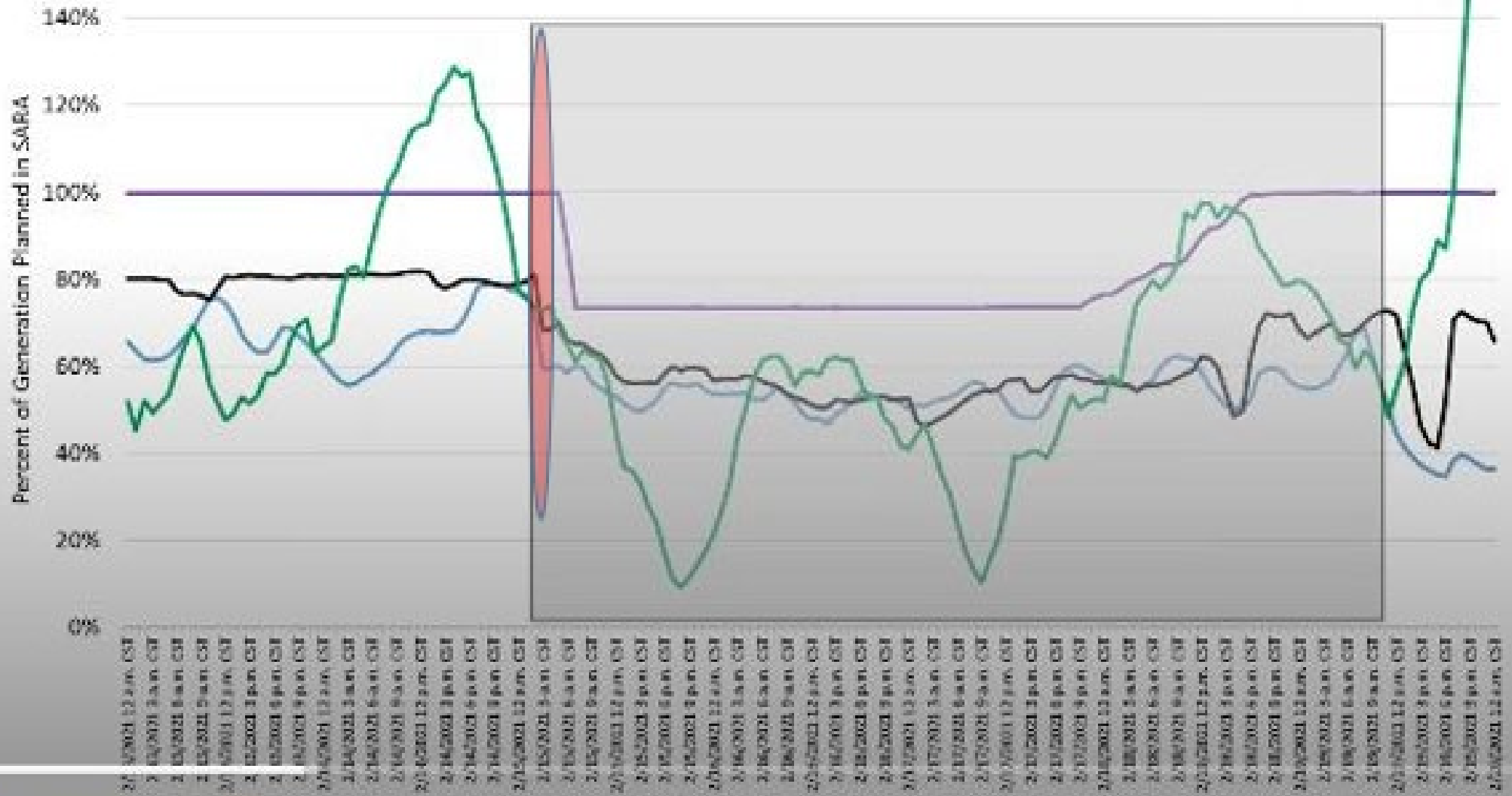
- Estimates that ~250 people died ...
- 4.5 million METERs without power (~10 million people) ...
- At LEAST 12 million people without water ...
- Supply chains across the state disrupted ...
- Industry (including petrochemical) shutdown ...

# Incident myths ...

- There was chaos ...
- The grid collapsed ...
- Weather decimated the transmission/delivery system ...
- The demand exceeded the **total** generation **capacity** ...
- Interconnection with other grids would have saved the day ...
- Failure of the “intermittents” caused the problem ...

# Actual Generation as a Percent of Planned Extreme Weather Capacity

— Natural Gas — Coal — Nuclear — Wind — Load Shed Period



Source: U.S. Energy Information Administration, EIA, Winter 2020-2021 SARA Revised Generation Analysis



18:05 / 1:01:41

# Natural threats ...

- Very hot weather ...
- Very cold weather ...
- Very windy ...
- Very wet (floods) ...
- Wildfire ...
- Earthquake ...
- The Sun ...



# Human made threats ...

- Sabotage ...
- Coordinated physical attack ...
- Coordinated electromagnetic interference attack ...
- HEMP ...
- Cyberattack ...

# Technical threats ...

- Improper design ...
- Component failures ...
- Operational errors ...

# Electric grid structural challenges ...

- Aging infrastructure ...
- Growing demand ...
- Pressure to move toward intermittent sources ...
- Decreasing number of stable generation facilities ...
- IT/OT convergence ...
- Growing complexity of systems ...

# Takeaways ...

- The grid CAN fail ...
- Secondary generation sources are insufficient ...
- Just-in-time resourcing is not your friend ...
- Your neighbors may very well NOT be there for you ...
- No matter how well planned and prepared you think you are ... you aren't ...

# Things to think about ...

- Long-duration, wide-spread power outages need to be considered in public policy and strategic planning ...
- Jurisdictions and governmental agencies need to do impact assessments on their AORs ...
- EOPs need specific plans and annexes to deal with one ...
- Jurisdictional leaders need to develop relationships with utility providers and regulators ...
- Appropriate organizations need to be on the “critical load list” ...
- Jurisdictions need to establish supply chain working groups ...

**“Disasters are like water ...  
they will find every crack in  
your vessel and make a big  
mess ...”**



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