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NORTH AMERICAN ELECTRIC RELIABILITY CORPORATION

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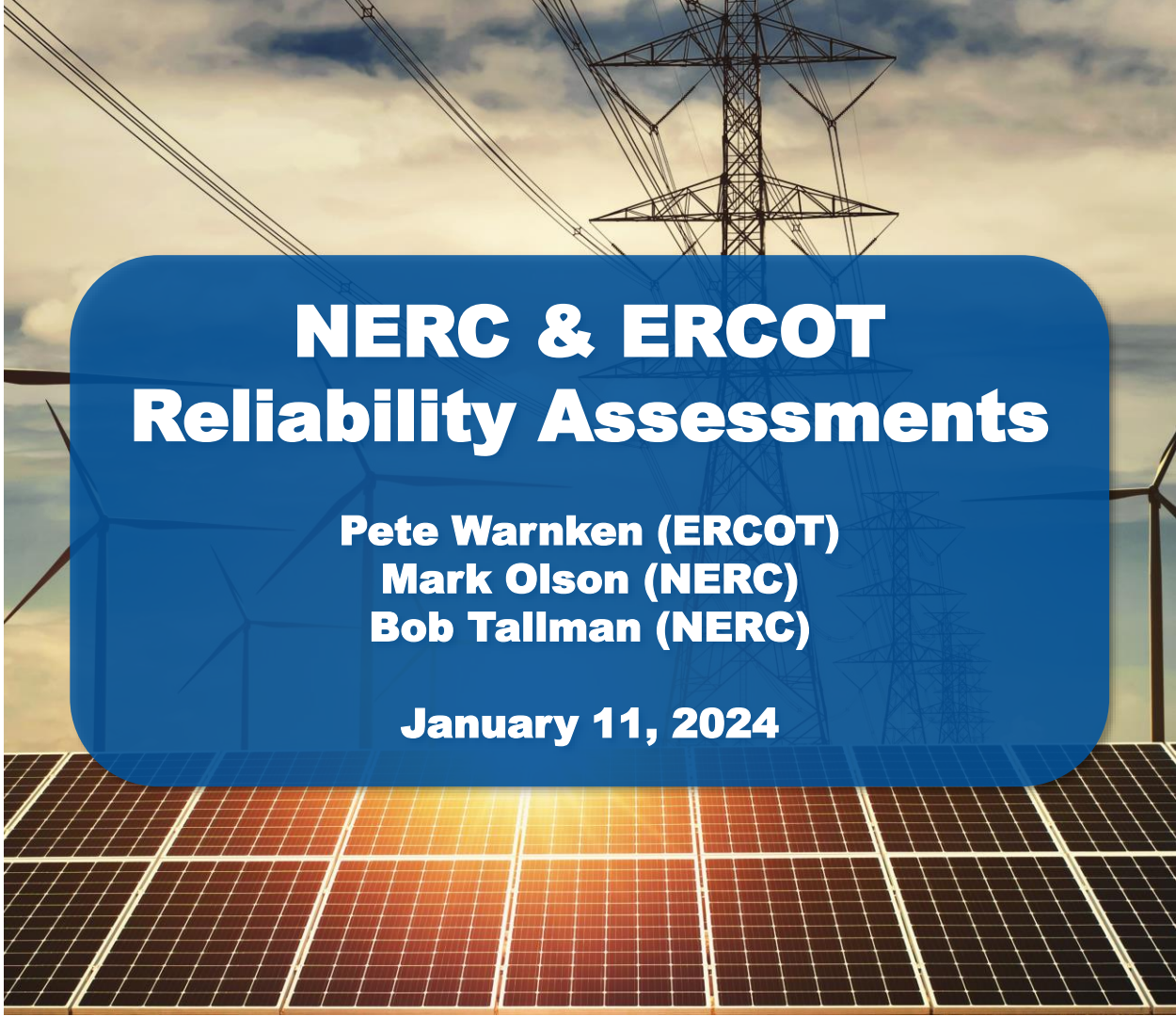
TEXAS RE



NERC & ERCOT Reliability Assessments

Pete Warnken (ERCOT)
Mark Olson (NERC)
Bob Tallman (NERC)

January 11, 2024

Antitrust Admonition

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Notice of this meeting was posted on the Texas RE website and this meeting is being held in public. Participants should keep in mind that the listening audience may include members of the press, representatives from various governmental authorities, and industry stakeholders.

Upcoming Texas RE Events

January 30, 2024

FERC-NERC Blackstart Report

February 27, 2024

CSIRP Planning and Testing

March 5, 2024

Women's Leadership in Grid Reliability & Security Conference

Upcoming ERO Enterprise Events

January 17, 2024

TPL-001 Webinar

January 17, 2024

Extreme Weather Transmission Planning and Modeling Workshop

January 22, 2024

Technical Talk with RF

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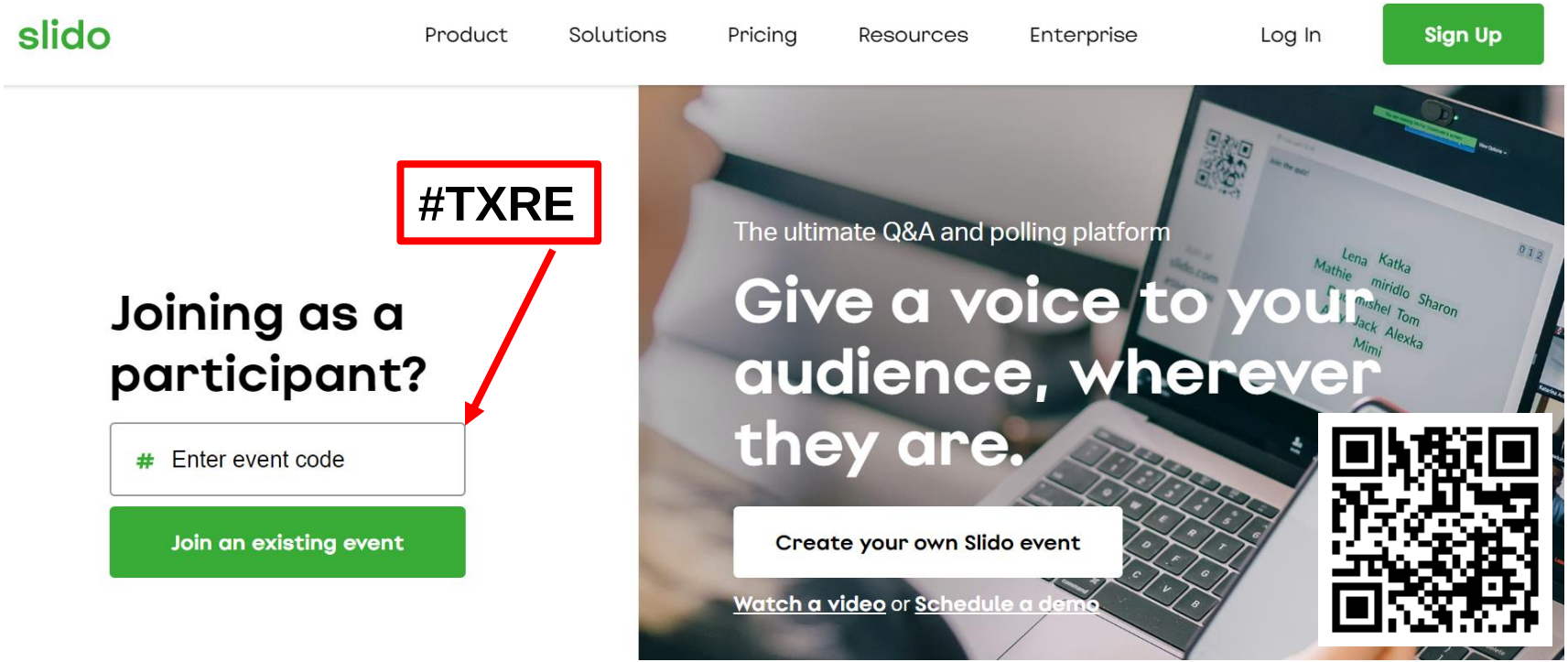
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ERCOT Resource Adequacy Reports Overview

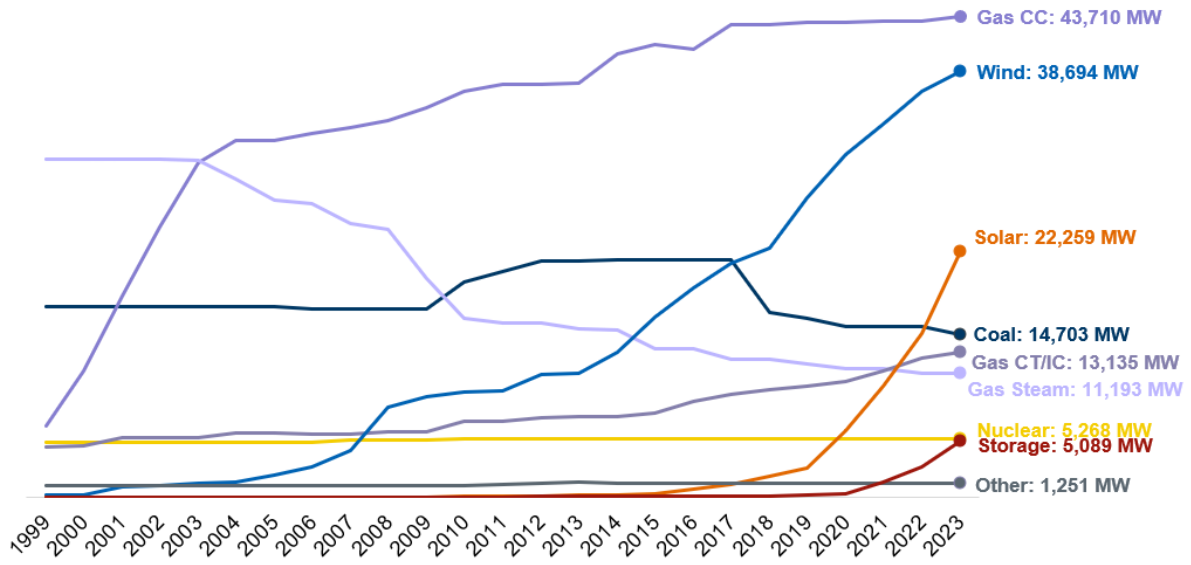
Pete Warnken
Resource Adequacy Dept.

January 11, 2024

December 2023 *Capacity, Demand and Reserves* Report

Installed Capacity Mix Trends, as of 1/8/2024

Includes Additions and Retirements



Notes: Capacity totals are based on the Installed Capacity Ratings for generating units. "Other" comprises of Biomass, Hydro, and Diesel.
- Planned generation projects are added to installed capacity after approval for synchronization to ERCOT Grid.
- Totals include Private-Use Network generators that export to the ERCOT grid, Distribution Generation Resources (DGRs), Settlement-Only Distribution Generators (SODGs), Unavailable Switchable Capacity, Extended Outage Units, and Mothballed Units.

CDR Summary, Summer (Condensed)

	2024	2025	2026	2027	2028
Firm Peak Demand, MW	**80,050**	**80,628**	**81,509**	**82,299**	**83,960**

Expected Capacity Available for Summer Peak Demands

Resources, MW:	**Cumulative Installed Capacity Ratings by 2027 (see Note)**	**2024**	**2025**	**2026**	**2027**	**2028**
Installed Summer-rated Capacity, Thermal	74,766	66,225	66,225	66,225	66,225	66,225
Hydroelectric	577	455	455	455	455	455
Switchable Generation Resources	2,441	2,335	2,184	2,335	2,948	2,948
Available Mothballed Capacity	145	136	136	136	136	136
Capacity from Private Use Networks	9,336	2,760	2,760	2,755	2,755	2,755
Wind	37,945	10,665	10,665	10,665	10,665	10,665
Solar Utility-Scale	19,851	14,976	14,976	14,976	14,976	14,976
Storage	4,100	0	0	0	0	0
Operational Generation Capacity, MW	**149,161**	**97,551**	**97,400**	**97,546**	**98,159**	**98,159**
Non-Synchronous Ties (Based on average net import contribution during summer 2019 EEA events)	1,220	850	850	850	850	850
Planned Resources (not wind, solar or storage) with Signed IA, Air Permits and Adequate Water Supplies	846	506	724	724	724	724
Wind	4,653	362	635	1,176	1,258	1,258
Planned Solar Utility-Scale	34,705	4,340	18,708	25,282	26,375	26,375
Planned Storage	15,780	0	0	0	0	0
Planned Generation Capacity, MW	**55,983**	**5,207**	**20,066**	**27,182**	**28,357**	**28,357**
Total Capacity, MW	**206,364**	**103,609**	**118,316**	**125,578**	**127,367**	**127,367**

	2024	2025	2026	2027	2028
Reserve Margin	**29.4%**	**46.7%**	**54.1%**	**54.8%**	**51.7%**

(Total Resources - Firm Load Forecast) / Firm Load Forecast

Note on Installed Capacities: Installed capacity ratings are based on the maximum power that a generating unit can produce during normal sustained operating conditions as specified by the equipment manufacturer.

Resource Changes Relative to the May 2023 CDR

Resource Category	Summer Capacity Rating (MW)	Comments
Changes that Increase 2024 Summer Total Resources		
Planned solar additions	355	
Capacity contribution update to include summer 2023 data for Private-Use Networks (PUN), Hydro, Wind, Solar	117	
Planned wind additions	27	
Changes that Decrease 2024 Summer Total Resources		
COD delays for solar planned projects	(4,904)	
COD delays for wind planned projects	(112)	
Other changes to gas planned projects (Planned to Inactive)	(11)	
Other changes to wind planned projects (Planned to Cancelled)	(21)	
Other changes to solar planned projects (Planned to Cancelled, Planned to Inactive)	(550)	
New switchable capacity unavailable to ERCOT	(463)	Includes -152 MW TENASKA KIAMICHI STATION 2CT201 and -311 MW TENASKA KIAMICHI STATION 2ST both unavailable until summer 2028
New indefinite mothballed units	(144)	Lubbock Power and Light Units (125 MW), Wichita Falls STG 4 (17 MW), Texas Big Spring Wind (1.5 MW)
Rating changes to operational and planned units	(202)	
Net Change in Total Resources	**(5,907)**	

Monthly Outlook for Resource Adequacy: January, February, March 2023

January and February MORA Probabilistic Results

Riskiest hour for experiencing emergency conditions remains at 8 a.m., with February expected to have lower risk than January

January

Hour Ending	EMERGENCY LEVEL		
	Chance of Normal System Conditions	Chance of an Energy Emergency Alert	Chance of Ordering Controlled Outages
	Probability of CAFOR being above 3,000 MW	Probability of CAFOR being less than 2,500 MW	Probability of CAFOR being less than 1,500 MW
1 a.m.	98.53%	1.23%	1.10%
2 a.m.	98.67%	1.12%	1.02%
3 a.m.	98.73%	1.03%	0.97%
4 a.m.	98.67%	1.05%	1.00%
5 a.m.	98.54%	1.15%	1.04%
6 a.m.	97.79%	1.59%	1.38%
7 a.m.	94.43%	3.95%	3.35%
8 a.m.	89.54%	7.6%	6.70%
9 a.m.	93.26%	4.97%	4.29%
10 a.m.	97.11%	2.00%	1.77%
11 a.m.	98.53%	1.02%	0.90%
12 p.m.	99.15%	0.58%	0.47%
1 p.m.	99.55%	0.26%	0.23%
2 p.m.	99.74%	0.16%	0.14%
3 p.m.	99.84%	0.08%	0.07%
4 p.m.	99.79%	0.11%	0.10%
5 p.m.	99.47%	0.27%	0.20%
6 p.m.	97.82%	1.43%	1.27%
7 p.m.	96.33%	2.52%	2.14%
8 p.m.	96.18%	2.62%	2.19%
9 p.m.	97.93%	1.47%	1.19%
10 p.m.	98.33%	1.15%	0.97%
11 p.m.	98.91%	0.74%	0.67%
12 a.m.	99.16%	0.59%	0.53%

Note: Probabilities are not additive.

February

Hour Ending	EMERGENCY LEVEL		
	Chance of Normal System Conditions	Chance of an Energy Emergency Alert	Chance of Ordering Controlled Outages
	Probability of CAFOR being above 3,000 MW	Probability of CAFOR being less than 2,500 MW	Probability of CAFOR being less than 1,500 MW
1 a.m.	99.27%	0.62%	0.55%
2 a.m.	99.31%	0.58%	0.51%
3 a.m.	99.45%	0.44%	0.39%
4 a.m.	99.38%	0.46%	0.42%
5 a.m.	99.00%	0.73%	0.69%
6 a.m.	98.80%	0.82%	0.74%
7 a.m.	97.06%	2.21%	1.92%
8 a.m.	95.30%	3.2%	2.81%
9 a.m.	97.45%	1.96%	1.68%
10 a.m.	98.92%	0.82%	0.68%
11 a.m.	99.24%	0.52%	0.48%
12 p.m.	99.59%	0.26%	0.16%
1 p.m.	99.79%	0.17%	0.13%
2 p.m.	99.91%	0.05%	0.04%
3 p.m.	99.94%	0.03%	0.03%
4 p.m.	99.91%	0.03%	0.02%
5 p.m.	99.89%	0.07%	0.06%
6 p.m.	99.63%	0.21%	0.18%
7 p.m.	98.40%	1.16%	0.99%
8 p.m.	98.12%	1.17%	1.02%
9 p.m.	98.67%	0.91%	0.74%
10 p.m.	99.08%	0.56%	0.45%
11 p.m.	99.44%	0.41%	0.35%
12 a.m.	99.63%	0.29%	0.25%

Note: Probabilities are not additive.

January and February MORA Scenario Comparison

A WS Elliott scenario fixes peak load to a value reflecting weather comparable to that experienced during the storm; risk for emergency conditions increases

January

Hour Ending	EMERGENCY LEVEL: Chance of Normal System Conditions — Probability of CAFOR being above 3,000 MW	Chance of an Energy Emergency Alert — Probability of CAFOR being less than 2,500 MW	Chance of Ordering Controlled Outages — Probability of CAFOR being less than 1,500 MW
1 a.m.	99.59%	0.27%	0.23%
2 a.m.	99.66%	0.20%	0.14%
3 a.m.	99.67%	0.16%	0.13%
4 a.m.	99.68%	0.22%	0.12%
5 a.m.	99.67%	0.24%	0.16%
6 a.m.	99.53%	0.26%	0.18%
7 a.m.	87.64%	5.70%	3.36%
8 a.m.	70.15%	20.6%	16.77%
9 a.m.	84.25%	7.49%	4.93%
10 a.m.	97.80%	0.65%	0.36%
11 a.m.	99.81%	0.06%	0.03%
12 p.m.	99.98%	0.00%	0.00%
1 p.m.	100.00%	0.00%	0.00%
2 p.m.	100.00%	0.00%	0.00%
3 p.m.	100.00%	0.00%	0.00%
4 p.m.	100.00%	0.00%	0.00%
5 p.m.	100.00%	0.00%	0.00%
6 p.m.	99.77%	0.09%	0.04%
7 p.m.	96.97%	0.35%	0.21%
8 p.m.	95.56%	0.94%	0.41%
9 p.m.	99.77%	0.06%	0.03%
10 p.m.	99.86%	0.06%	0.02%
11 p.m.	99.94%	0.01%	0.00%
12 a.m.	99.98%	0.00%	0.00%

Note: Probabilities are not additive.

February

Hour Ending	EMERGENCY LEVEL: Chance of Normal System Conditions — Probability of CAFOR being above 3,000 MW	Chance of an Energy Emergency Alert — Probability of CAFOR being less than 2,500 MW	Chance of Ordering Controlled Outages — Probability of CAFOR being less than 1,500 MW
1 a.m.	89.07%	3.56%	1.68%
2 a.m.	88.53%	3.39%	1.74%
3 a.m.	89.79%	2.88%	1.31%
4 a.m.	90.67%	2.50%	1.23%
5 a.m.	87.82%	4.69%	2.65%
6 a.m.	84.75%	6.90%	4.37%
7 a.m.	80.08%	11.35%	8.24%
8 a.m.	71.92%	18.3%	14.66%
9 a.m.	86.55%	6.12%	3.98%
10 a.m.	94.38%	2.25%	1.18%
11 a.m.	97.62%	0.65%	0.20%
12 p.m.	99.82%	0.02%	0.00%
1 p.m.	100.00%	0.00%	0.00%
2 p.m.	100.00%	0.00%	0.00%
3 p.m.	100.00%	0.00%	0.00%
4 p.m.	100.00%	0.00%	0.00%
5 p.m.	100.00%	0.00%	0.00%
6 p.m.	100.00%	0.00%	0.00%
7 p.m.	90.65%	1.69%	0.56%
8 p.m.	92.06%	1.66%	0.69%
9 p.m.	93.31%	1.39%	0.59%
10 p.m.	95.79%	0.64%	0.18%
11 p.m.	99.04%	0.04%	0.02%
12 a.m.	99.72%	0.00%	0.00%

Note: Probabilities are not additive.

March MORA Probabilistic Results

Hour Ending	EMERGENCY LEVEL		
	Chance of Normal System Conditions	Chance of an Energy Emergency Alert	Chance of Ordering Controlled Outages
	Probability of CAFOR being above 3,000 MW	Probability of CAFOR being less than 2,500 MW	Probability of CAFOR being less than 1,500 MW
1 a.m.	99.99%	0.00%	0.00%
2 a.m.	99.99%	0.00%	0.00%
3 a.m.	100.00%	0.00%	0.00%
4 a.m.	100.00%	0.00%	0.00%
5 a.m.	99.99%	0.00%	0.00%
6 a.m.	100.00%	0.00%	0.00%
7 a.m.	99.97%	0.00%	0.00%
8 a.m.	99.96%	0.03%	0.03%
9 a.m.	99.98%	0.00%	0.00%
10 a.m.	100.00%	0.00%	0.00%
11 a.m.	100.00%	0.00%	0.00%
12 p.m.	100.00%	0.00%	0.00%
1 p.m.	100.00%	0.00%	0.00%
2 p.m.	100.00%	0.00%	0.00%
3 p.m.	100.00%	0.00%	0.00%
4 p.m.	100.00%	0.00%	0.00%
5 p.m.	100.00%	0.00%	0.00%
6 p.m.	99.89%	0.03%	0.02%
7 p.m.	98.97%	0.26%	0.12%
8 p.m.	99.45%	0.12%	0.05%
9 p.m.	99.85%	0.03%	0.00%
10 p.m.	99.98%	0.00%	0.00%
11 p.m.	100.00%	0.00%	0.00%
12 a.m.	99.99%	0.00%	0.00%

Note: Probabilities are not additive.

Scenario Assuming Extreme Low Wind Generation

Hour Ending	EMERGENCY LEVEL		
	Chance of Normal System Conditions	Chance of an Energy Emergency Alert	Chance of Ordering Controlled Outages
	Probability of CAFOR being above 3,000 MW	Probability of CAFOR being less than 2,500 MW	Probability of CAFOR being less than 1,500 MW
1 a.m.	99.79%	0.08%	0.06%
2 a.m.	99.79%	0.08%	0.06%
3 a.m.	99.80%	0.09%	0.05%
4 a.m.	99.83%	0.09%	0.05%
5 a.m.	99.79%	0.08%	0.07%
6 a.m.	99.75%	0.12%	0.09%
7 a.m.	99.69%	0.19%	0.14%
8 a.m.	99.70%	0.16%	0.11%
9 a.m.	99.93%	0.04%	0.04%
10 a.m.	99.96%	0.03%	0.03%
11 a.m.	99.97%	0.02%	0.00%
12 p.m.	99.99%	0.00%	0.00%
1 p.m.	100.00%	0.00%	0.00%
2 p.m.	100.00%	0.00%	0.00%
3 p.m.	99.98%	0.00%	0.00%
4 p.m.	99.87%	0.00%	0.00%
5 p.m.	99.58%	0.06%	0.02%
6 p.m.	97.90%	0.33%	0.17%
7 p.m.	80.66%	6.67%	3.80%
8 p.m.	85.43%	3.73%	1.53%
9 p.m.	87.15%	3.12%	1.13%
10 p.m.	97.04%	0.11%	0.00%
11 p.m.	99.97%	0.00%	0.00%
12 a.m.	99.99%	0.00%	0.00%

Note: Probabilities are not additive.

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NORTH AMERICAN ELECTRIC RELIABILITY CORPORATION

2023 Winter and Long-Term Reliability Assessments

Mark Olson, Manager, Reliability Assessment
Bob Tallman, Senior Engineer, Reliability Assessment
Talk with Texas RE
January 11, 2024

RELIABILITY | RESILIENCE | SECURITY




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NORTH AMERICAN ELECTRIC RELIABILITY CORPORATION

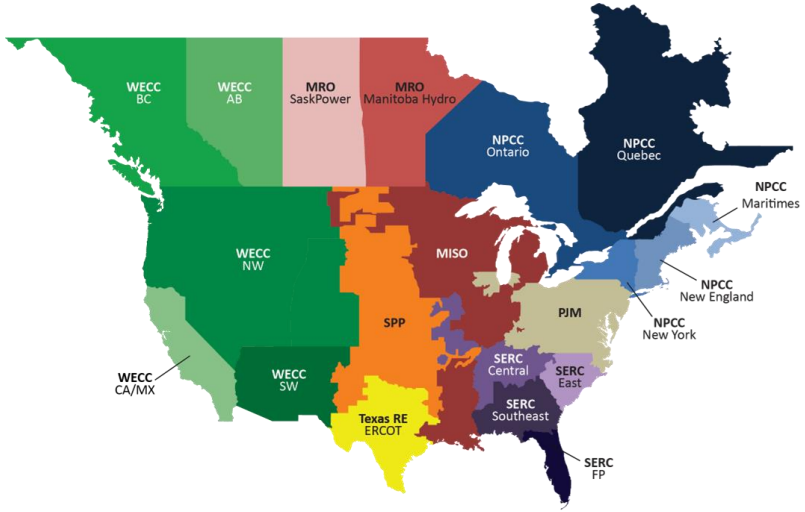
2023 Long-Term Reliability Assessment

RELIABILITY | RESILIENCE | SECURITY




LTRA Summary

- 10-year assessment of resource capacity and energy risks
- Uses industry's demand and generation forecasts and transmission projections
- Coordination and Review with Regions and Stakeholders
- Includes emerging issues that can impact future reliability



MISO *(Midcontinent Independent System Operator)*
PJM

MRO – Midwest Reliability Organization
- MRO-Manitoba Hydro
- MRO-SaskPower
- SPP

NPCC – Northeast Power Coordinating Council
- NPCC-Maritimes
- NPCC-New England
- NPCC-New York
- NPCC-Ontario
- NPCC-Québec

SERC – SERC Reliability Corporation
- SERC-East
- SERC-Central
- SERC-Southeast
- SERC-Florida Peninsula

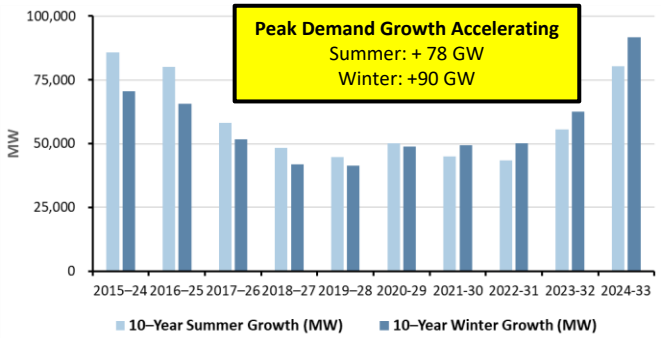
Texas RE – Texas Reliability Entity
- Texas RE-ERCOT *(Electric Reliability Council of Texas)*

WECC
- WECC-CA/MX *(California/Mexico)*
- WECC-AB *(Alberta)*
- WECC-BC *(British Colombia)*
- WECC-NW *(Northwest)*
- WECC-SW *(Southwest)*

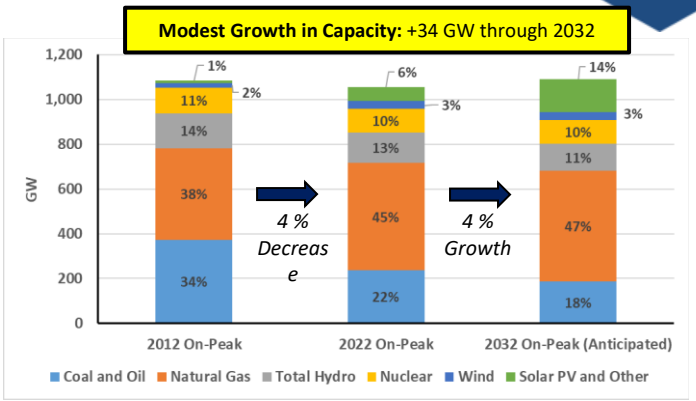
2023 LTRA Overview

- Demand and Resources: Past…Present…Future
- Capacity and Energy Risk Assessment 2024-2032
- Changing Resource Mix
- Demand and Energy Trends
- Transmission Development Trends
- Emerging Risks
- Recommendations

Past…Present…Future



10-year Peak Demand Growth Projection



Generation On-Peak Capacity

Demand

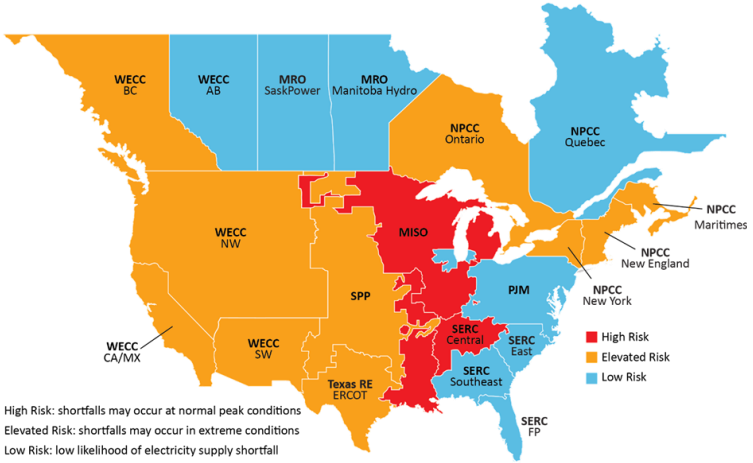
- Highest demand and energy growth rates in recent years
- Northeast and Southeast become winter peaking in late years
- New load behavior is changing daily load profile, challenges operational forecasting

Supply

- Total capacity growth of 34 GW over next 10 years (Tier 1 additions – retirements)
- Most additions are Solar (69 GW)
- Retirements: 83 GW through 2033
- New emissions regulations likely to prompt additional retirements

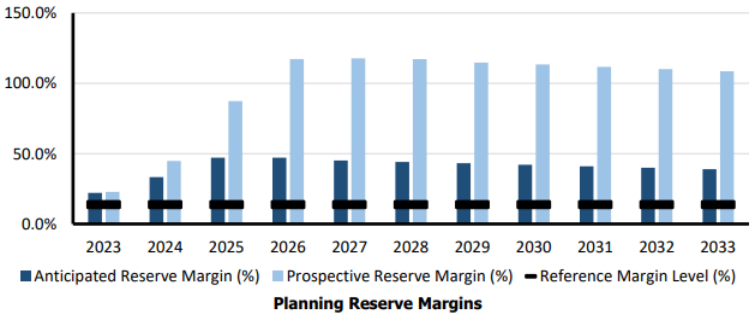
2023 LTRA Findings

- Growing number of areas face capacity and energy risks in the next 10 years
  - Generator retirements expected before sufficient replacement resources will be in service
  - Energy risks identified in areas where future resource mix is not balanced between dispatchable and variable energy resources
- **Higher demand forecasts, additional generator retirements, and changing resource mix contribute to expanding risk area**

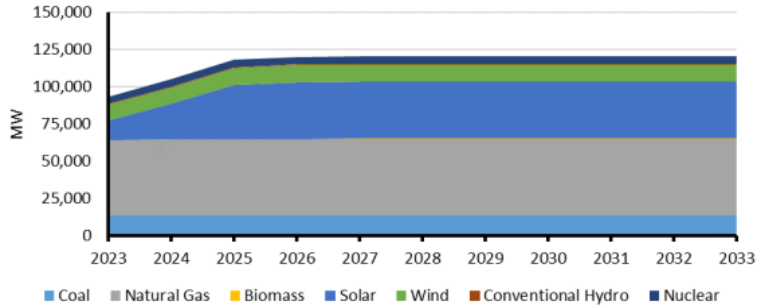


Risk Area Summary 2024-2033

Texas RE-ERCOT



Planning Reserve Margins



Existing and Tier 1 Resources

- Robust demand growth is forecasted over the 2024-2033 period
- Summer ARM is above the RML (13.75%) for all 10 years (2024–2033)
- ARM peaks at 47% by summer 2025, reflecting the expected addition of 25,802 MW of Tier 1 capacity, most of which is solar PV
- Energy risks increase as demand growth outpaces available dispatchable generation
- Currently, there are $10.26 billion of transmission improvement projects that are expected to be put in service between 2023 and the end of 2028

Neighboring Assessment Areas

WECC-SW

(2026 and later)

- Declining dispatchable resource levels and generators retire
- Risk of insufficient supplies in wide-area, prolonged heat

SPP

(2024 and later)

- Surplus capacity falls sharply over the next five years as generators retire and reliability margin levels increase
- Risk of insufficient supplies in extreme heat, cold, or low wind conditions

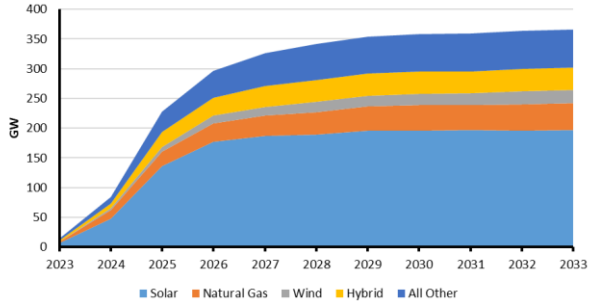
MISO

(2028 and later)

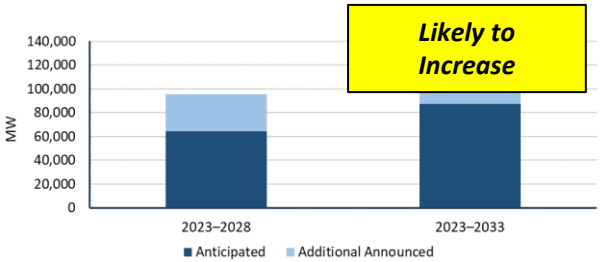
- Expected retirements result in 4.7 GW shortfall starting in 2028 despite 12 GW of new resources
- Delayed generator retirements and new resources have improved overall outlook since 2022 LTRA

Changing Resource Mix

- Wind, solar, and battery additions drive continued energy transition as older thermal resources retire
- 83 GW of fossil-fired and nuclear generator retirements are anticipated through 2033
- EPA rules could heighten the risk of thermal unit retirements before solutions to resource adequacy & system planning issues are in place.
- **Generator retirements challenge the ability to serve growing electricity demand and maintain grid reliability**



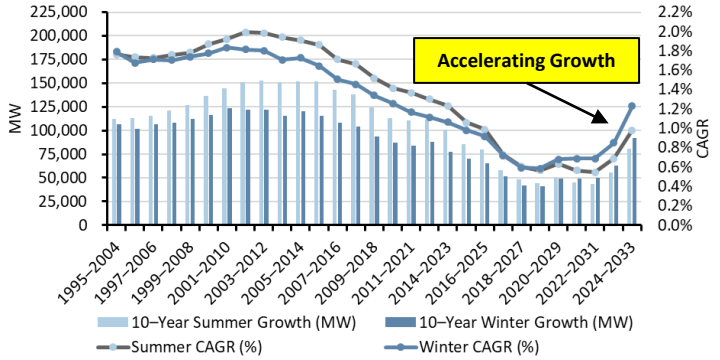
Tier 1 and 2 Resource Additions Through 2033



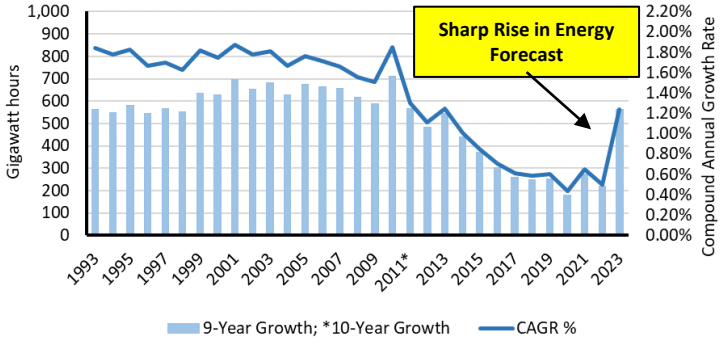
Projected Generation Retirement Capacity

Rising Demand and Energy Needs

- Sharp Rise in Demand and Energy Growth Forecasts since *2022 LTRA*
- Forecasts are being shaped by electrification and growth in electric vehicles (EV) and data centers
- Resource and transmission system planners must **anticipate potential for accelerating growth**



10-year Summer and Winter Peak Demand Growth



Net Energy for Load Growth

Emerging Issues

- Cryptocurrency mining is raising policy, market, operational, and planning issues in areas experiencing growth
- Growth in large industrial loads (data centers, smelters, manufacturing) can have implications for system reliability
  - Requires careful planning, operational coordination, and infrastructure
- Distribution transformer backlog and supply chain issues challenge storm restoration and response planning
- Planners have fewer blackstart resource options as current blackstart generators retire

Recommendations

The *2023 LTRA* contains actionable recommendations to meet accelerating demand growth as grid transformation continues

1. Add new resources with needed reliability attributes, manage retirements, and make existing resources more dependable
2. Expand the transmission network to deliver supplies from new resources and locations to serve changing loads
3. Adapt BPS planning, operations, and resource procurement markets and processes for a more complex power system
4. Strengthen relationships among policymakers and reliability stakeholders

NERC
NORTH AMERICAN ELECTRIC RELIABILITY CORPORATION

2023-2024 Winter Reliability Assessment

RELIABILITY | RESILIENCE | SECURITY

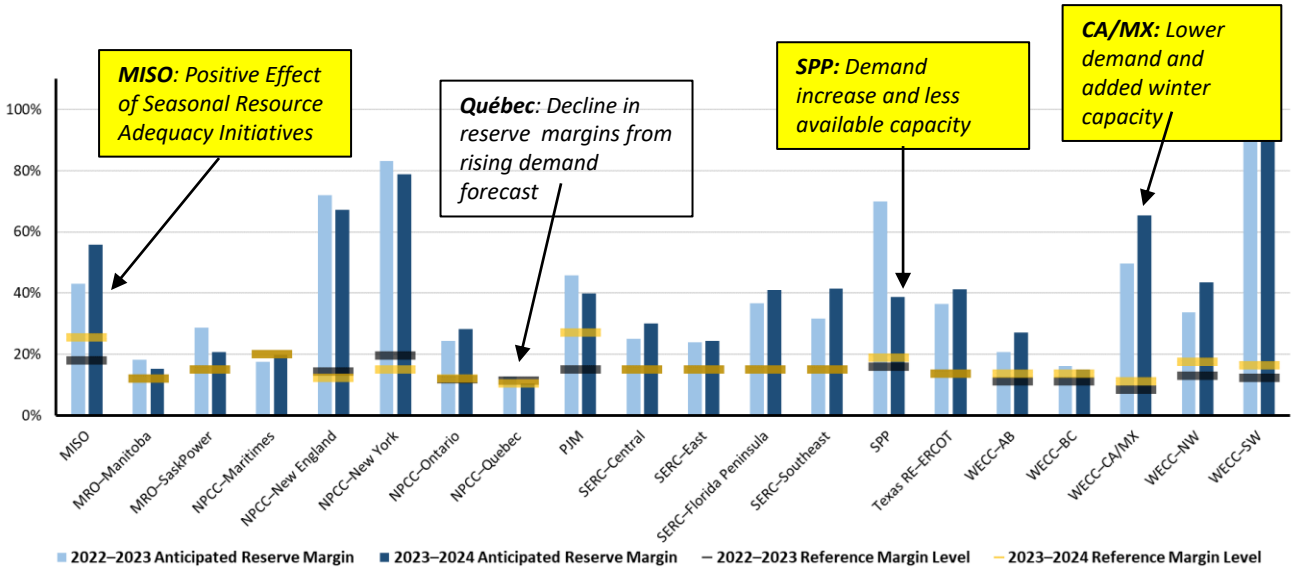



Key Takeaways

- A large portion of North America remains at risk of insufficient electricity supplies during extreme winter conditions
  - Adequate resources for normal winter peak demand
- Factors contributing to reliability risks in affected areas include:
  - Higher peak-demand projections and added load forecasting complexity
  - Generator and fuel supply vulnerabilities to extreme weather
  - Interconnected natural gas and electric systems
- Industry cold weather preparations are on a positive trend but generators and fuel supplies in warmer zones could have performance issues in freezing temperatures

Reserve Margin Changes

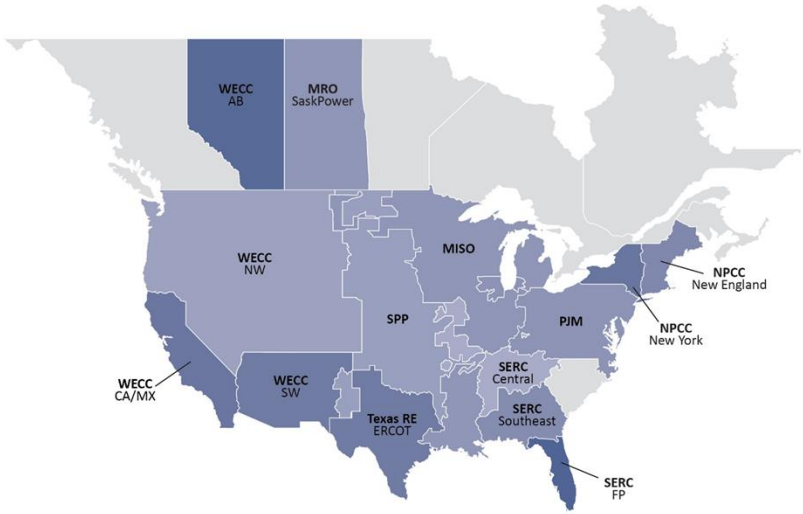
- Changes in available winter capacity are having a strong affect on reserve margins in MISO, SPP, and California-Mexico



Winter 2022–2023 and Winter 2023–2024 Anticipated Reserve Margins Year-to-Year Change

Interconnected Natural Gas and Electric Systems

- Natural gas fuel is essential for winter reliability
- Weather related generator and fuel supply failures widen the reliability impact of extreme winter events



All other assessment areas have less than 35% natural gas fired generation contribution to winter resource mix.

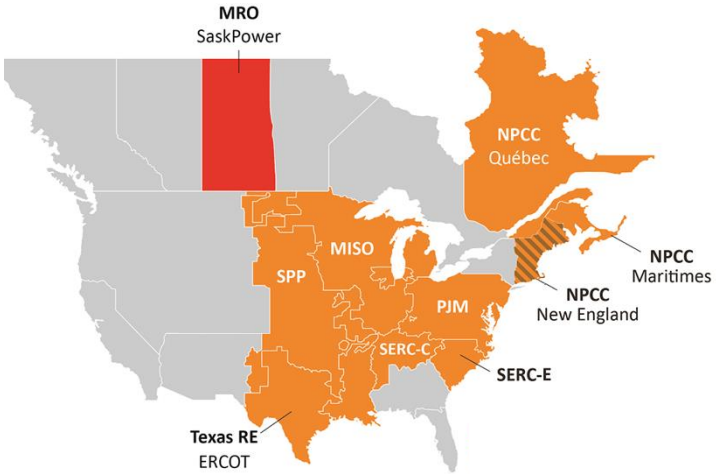
	Natural-Gas-Fired Generation	
	Peak Winter Capacity	Contribution to Total Winter Resource Mix
MISO	67.5 GW	46%
MRO-SaskPower	2.1 GW	46%
NPCC-New England	17.3 GW	54%
NPCC-New York	24.5 GW	66%
PJM	84.9 GW	47%
SERC-Central	22.7 GW	44%
SERC-Florida Peninsula	50.6 GW	79%
SERC-Southeast	31.5 GW	51%
SPP	27.4 GW	41%
Texas RE-ERCOT	54.2 GW	62%
WECC-AB	11.4 GW	75%
WECC-CA/MX	39.9 GW	65%
WECC-NW	31.0 GW	39%
WECC-SW	18.2 GW	62%

Natural-Gas-Fired Generation Capacity Contributions to 2023–2024 Winter Generation Mix

2023-2024 Winter Reliability Assessment Highlights

Wide area cold events pose risk to reliability

- Capacity and Energy Risk Assessment inputs
  - On-peak reserve margins
  - Operational risk analysis
  - Probabilistic energy metrics
- Generator availability assessed for extreme winter scenarios



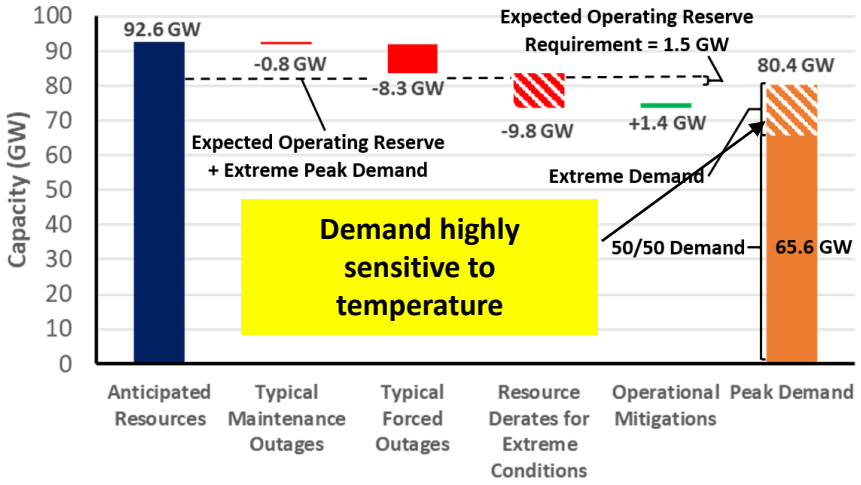
2023-2024 Winter Reliability Risk Map

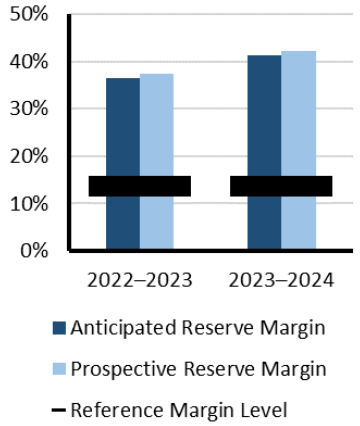
Seasonal Risk Assessment Summary	
High	Potential for insufficient operating reserves in normal peak conditions
Elevated	Potential for insufficient operating reserves in extreme conditions
Low	Sufficient operating reserves expected

Extreme conditions include 90/10 demand scenarios, historical high generator outage rates, and low variable energy resource scenarios

Texas Risk Assessment

- Reserve scarcity risks greater than last winter due to robust load growth & limited dispatchable resources
- Wind energy and dispatchable generation are critical to meeting peak demand





- Above-normal demand, generator outages, and fuel vulnerability in extreme cold weather can result in energy emergencies

2023-2024 Winter Reliability Assessment Recommendations

- **Cold Weather Preparations** – Implement *Essential Actions* in NERC Level 3 Alert (May 2023) and winter operating plans
- **Fuel** –Reliability Coordinators and Balancing Authorities should implement fuel surveys and monitor fuel supply adequacy
- **Load Forecasting** – Anticipate potential for underestimating load in extreme cold and take early action to reduce the risk of reserve shortfall
- **State regulators and policy makers** – Support public appeal for reduced electricity and natural gas use and be prepared to handle requests for environmental and transportation waivers when needed for reliability

Questions and Answers