NERC
NORTH AMERICAN ELECTRIC RELIABILITY CORPORATION

Winter Weather Preparation

2019 Webinar

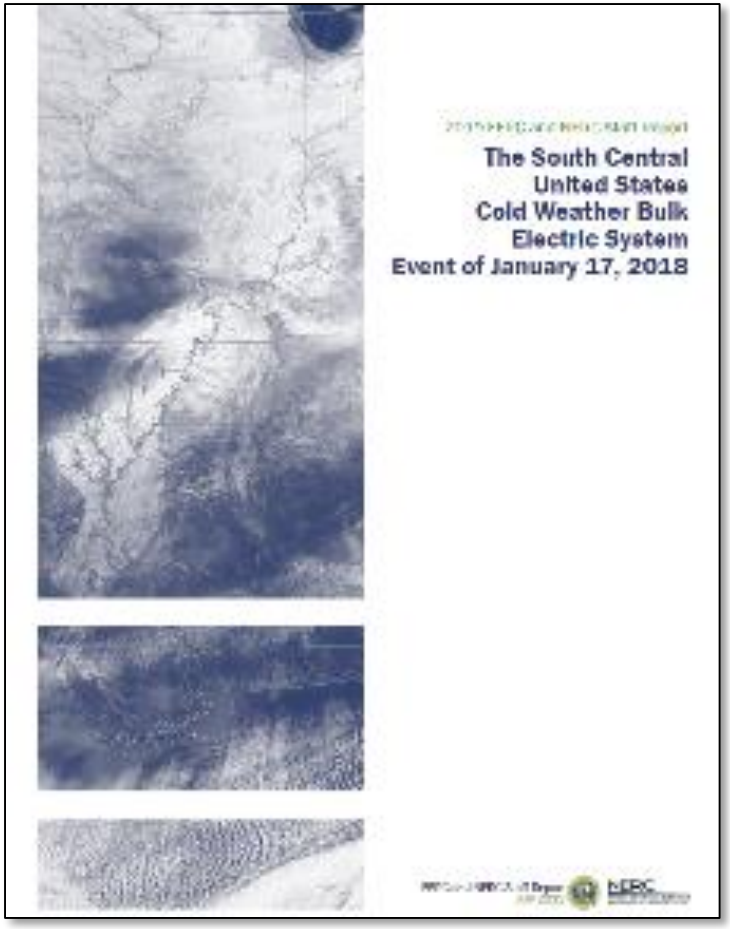
Richard Hackman, Sr. Event Analysis Advisor
September 5, 2019

RELIABILITY | RESILIENCE | SECURITY



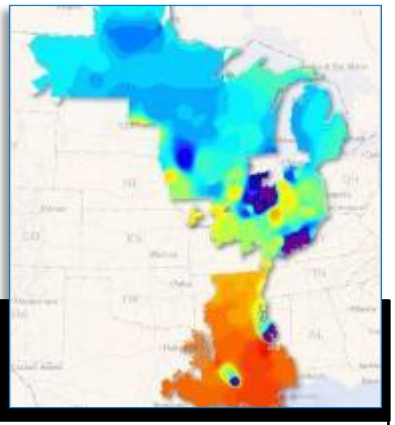

Recent Cold Event Experience

- January 30-31, 2019 – Extreme Cold Across North Central U.S.
- January 17, 2018 – Extreme Cold Across South Central U.S.
  - Note - There will be a webinar covering the FERC/NERC report on October 10, 2019 from 2:00-3:00 p.m. Eastern.



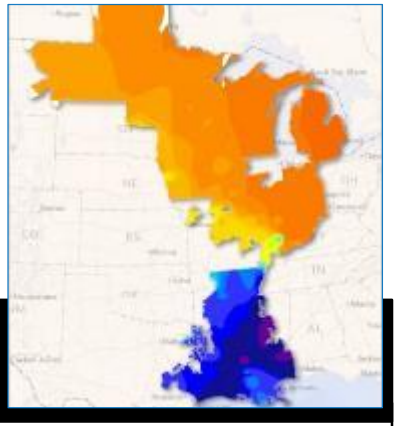
Recent Cold Event Experience

MISO North/Central region experienced extreme cold weather this January, similar to the extreme cold weather in the MISO South region last year



LMP RANGES ($/MWh)

- $300-$1000
- $100-$300
- $60-$100
- $40-$60
- $20-$40
- $(10)-$20
- $(1000)-$(10)

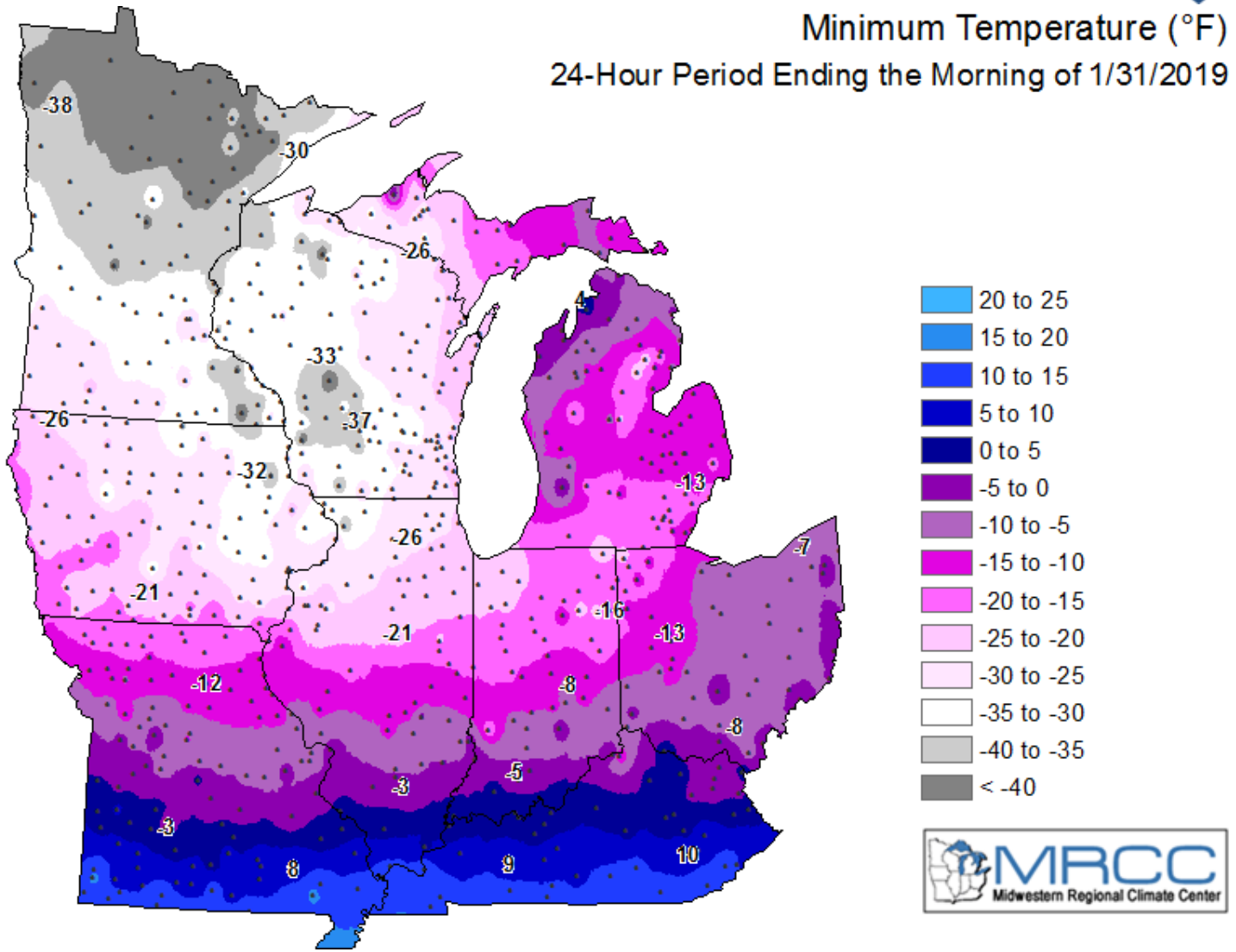


January 17, 2018 South Region	
Minimum Temperature	13°F
System Peak Load	106 GW
Unplanned Outages	13 GW
Scheduled LMRs*	0.9 GW
Emergency Purchases	1.2 GW
RDT** Flow & Direction	3.9 GW N-S

January 30-31, 2019 North/Central Region	
Minimum Temperature	-26°F
System Peak Load	101 GW
Unplanned Outages	29 GW
Scheduled LMRs*	2.5 GW
Emergency Purchases	Not Needed
RDT** Flow & Direction	2.2 GW S-N

*LMRs = Load Modifying Resources
**RDT = Regional Dispatch Transfer Maximum Unit Dispatch System

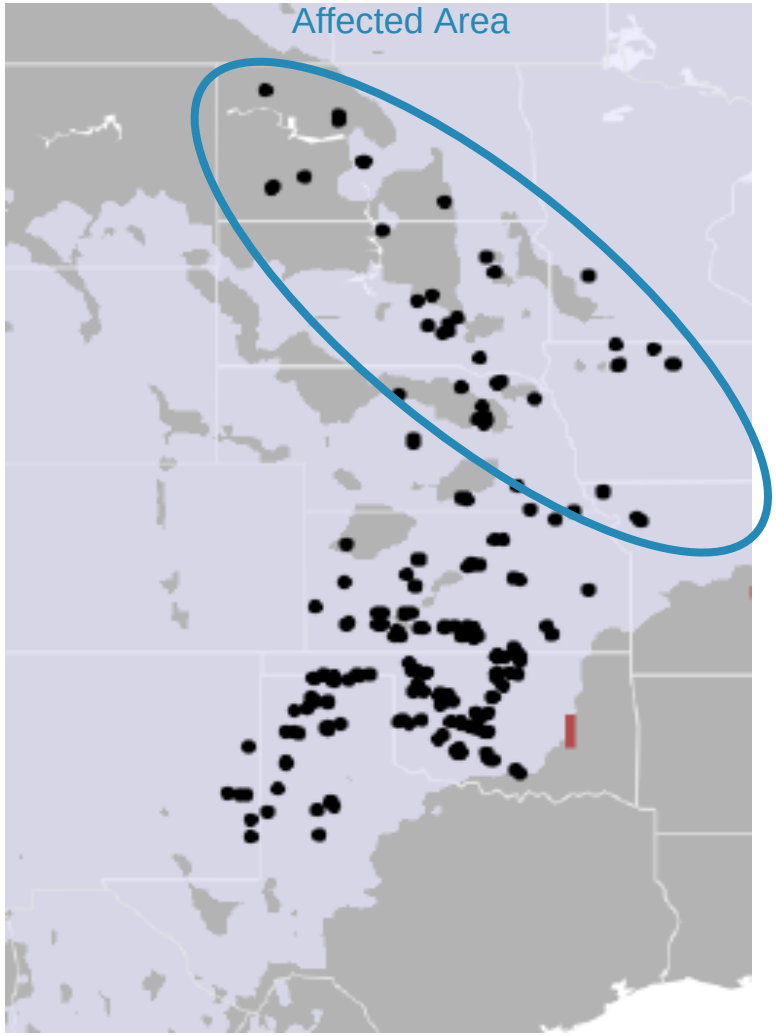
January 30-31, 2019 – Extreme Cold Across North Central U.S.



https://www.weather.gov/lot/RecordColdJan2019

Wind Turbine Temperature Limitations

SPP Wind Farms (2011)



- **Temperature at which SPP Turbines Turn Off**
  - -40˚C (-40˚F) only 320MW are able to run
  - -30˚C (-22˚F) 10GW are able to run
  - -20˚C (-4˚F) 17GW are able to run
  - >-10˚C (+14˚F) All 21.6GW are able to run
  - @-10˚C 1.6GW will shut down in SPP South, Texas/Oklahoma

Wind Turbine Temperature Limitations

- Some Wind Turbine temperature limits are based on greases and other lubricants, but these are generally specified for the expected temperature range the device should see in its location.
- Most Wind Turbines have both installed heaters and low temperature protective shutdown features.
- Below their shutdown temperature, Wind Turbines become load.
- Thumb rule - Roughly 2MW load for 100MW capacity

Inverter Temperature Limitations – Wind and Solar

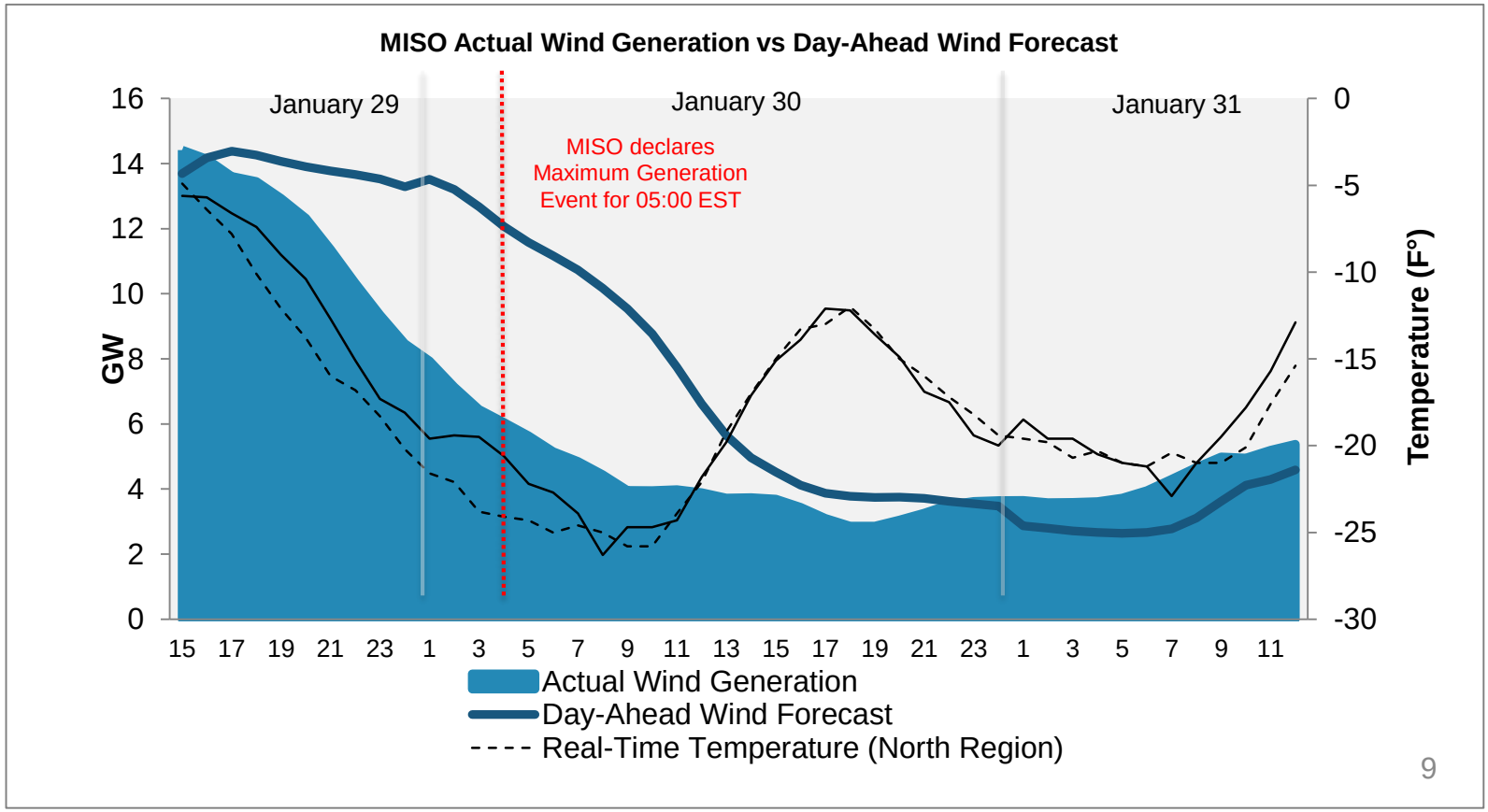
- Most of the more common inverters are able to operate down to -25˚C (-13˚F).
- Most can be exposed to temperatures down to -40˚C (-40˚F). Below that, damage will occur. The primary concern is the oil within large electrolytic capacitors freezes below -40˚C.
- This means active measures must be taken to keep the inverters above -40˚C to prevent damage, or above -25˚C to operate. These measures include enclosures designed with heat and snow drift abatement for most of the U.S. and Canada.

UPS Temperature Limitations – Wind and Solar

- Typical uninterruptible power supplies (UPS) in support systems for wind turbines or other outdoor installations have somewhat more restrictive cold temperature limits than inverters do.
- They are generally limited by the battery technology used. Few function below -10˚C (+14˚F) , some cannot handle <0˚C (32˚F), and most are damaged below -25˚C (-13˚F).
- Cabinet heaters or other temperature controls are necessary support across most of the U.S. and Canada.

Wind Generation Did Not Match Forecast

An earlier than expected drop in wind output increased insufficiency risk early on the morning of January 30 for MISO



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MISO End of January 2019 Unplanned Generation Outages

MISO North/Central Region Unplanned* Outages (GW)

	Coal	Gas	Wind	Other	Total
Installed Capacity	48.4	31.9	14.2	18.2	112.7
January 29	10.3 (21%)	6.3 (20%)	1.3 (9%)	2.2 (12%)	20.1 (18%)
January 30	10.3 (21%)	10.8 (34%)	4.0 (28%)	4.5 (25%)	29.6 (26%)
January 31	9.3 (19%)	11.9 (37%)	2.7 (19%)	5.0 (28%)	28.9 (26%)

*Unplanned = Forced plus derates

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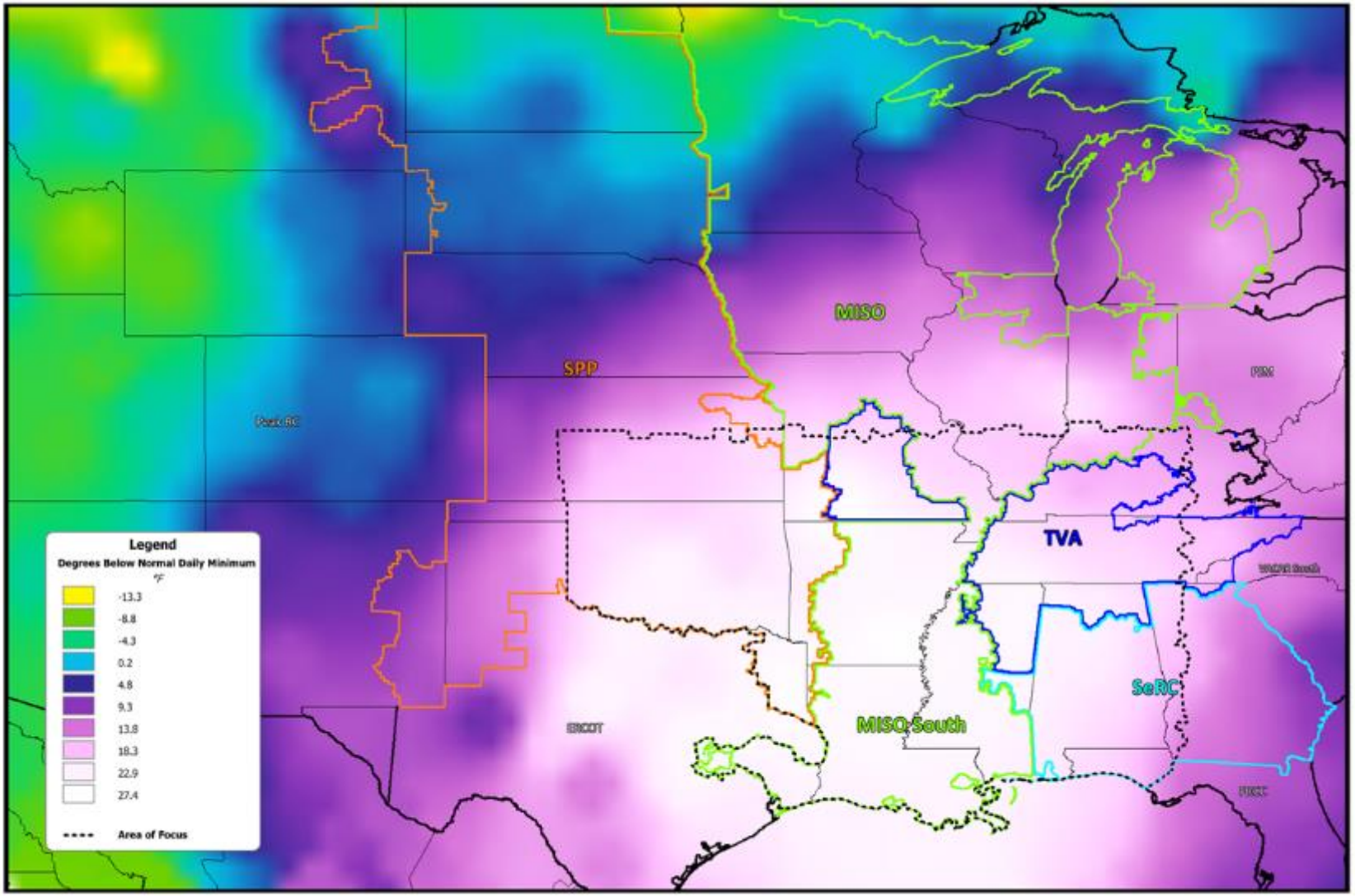
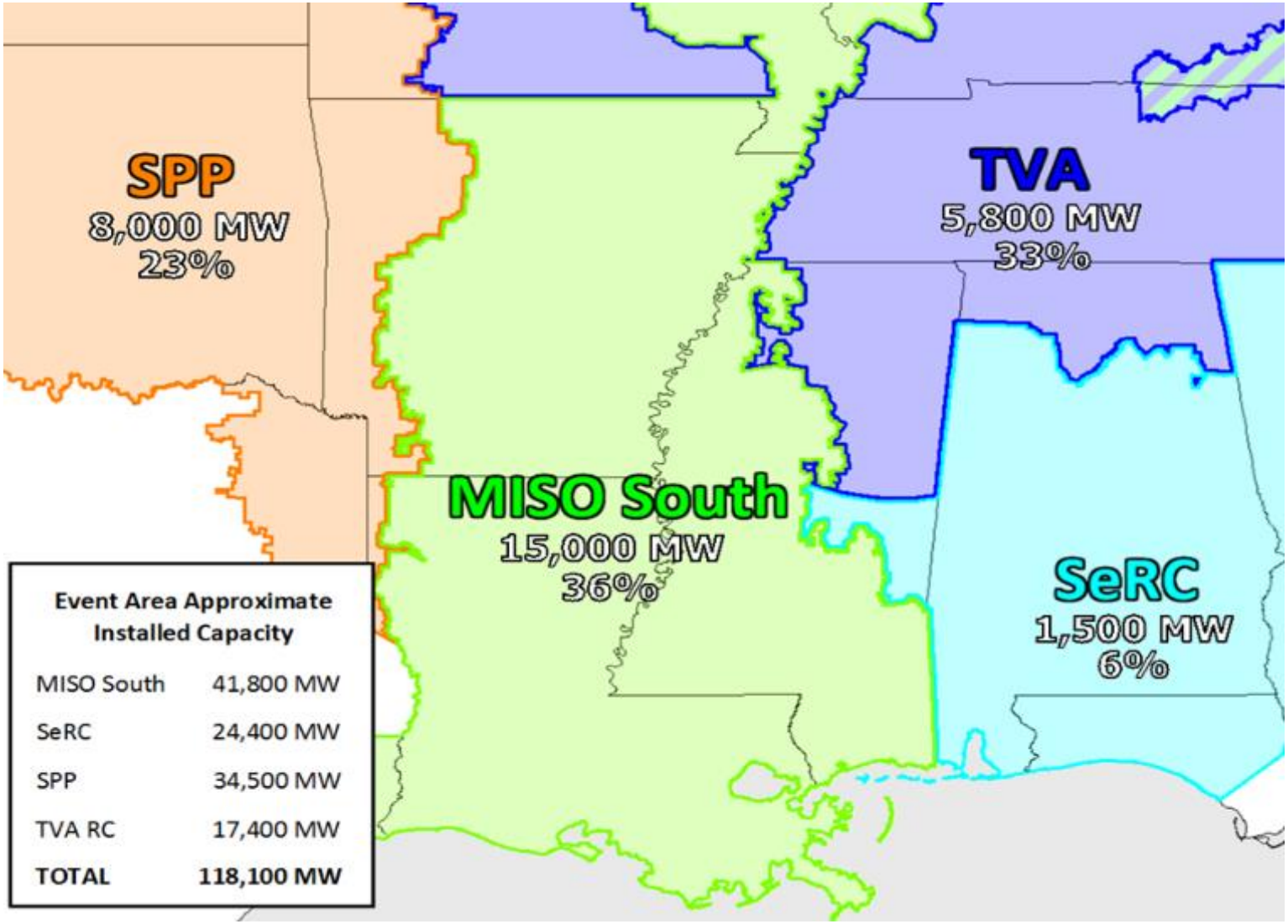
January 17, 2018 – Extreme Cold Across South Central U.S.



Widespread Generation Outages – January 17, 2019



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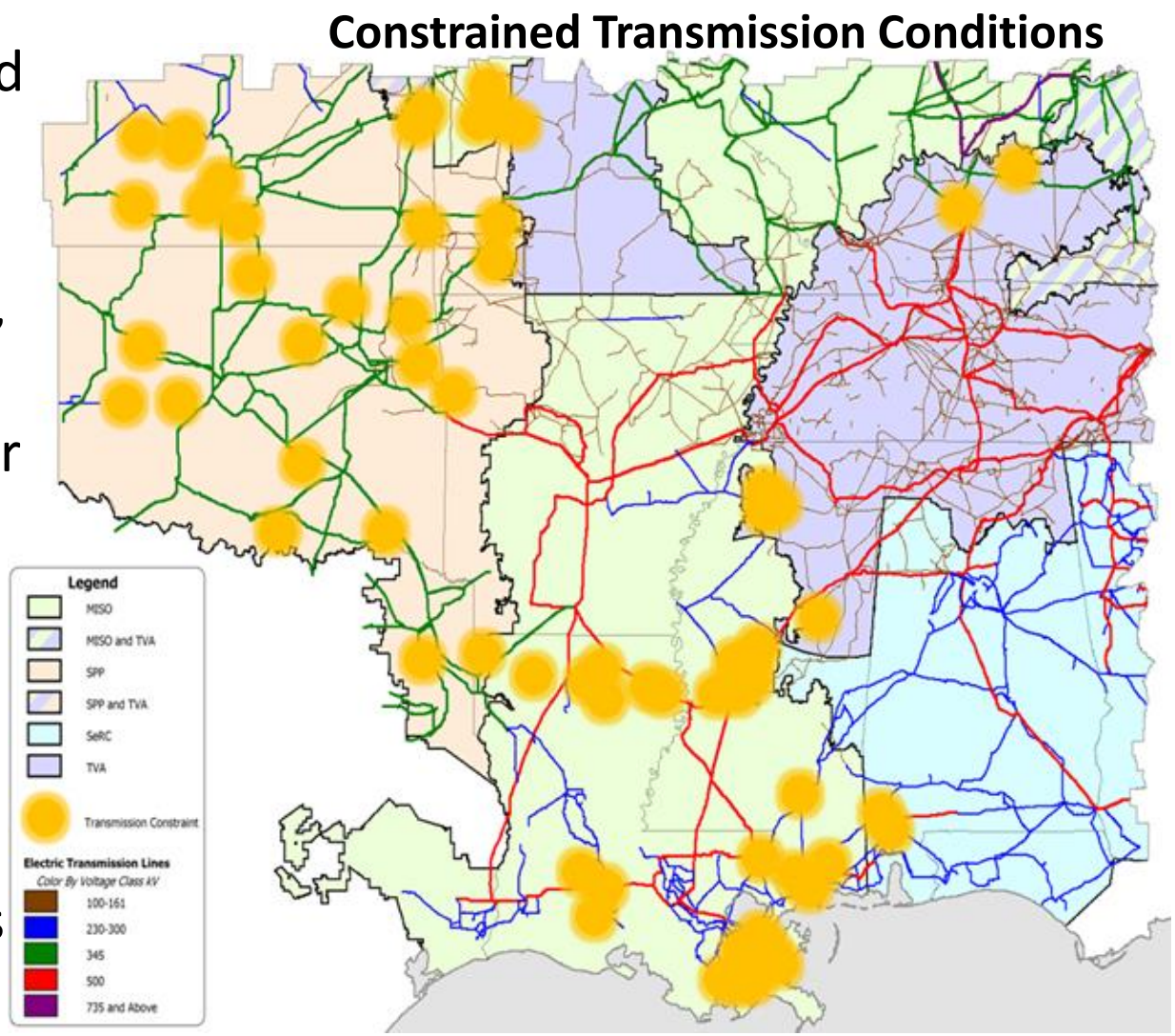
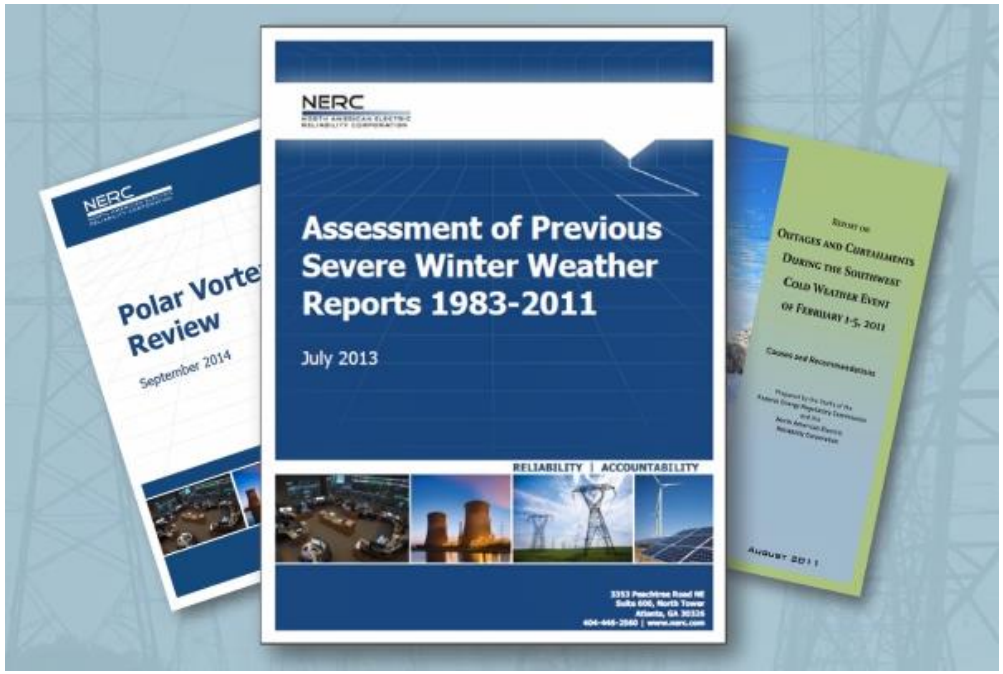
January 17, 2018 Extreme Cold Across South Central U.S.

- As temperatures decreased, unplanned outages increased
- 44% of outages were directly attributed to, or likely related to, extreme cold weather
- Gas supply issues contributed to the event
- Frozen moisture in control air and instrumentation lines still occurs



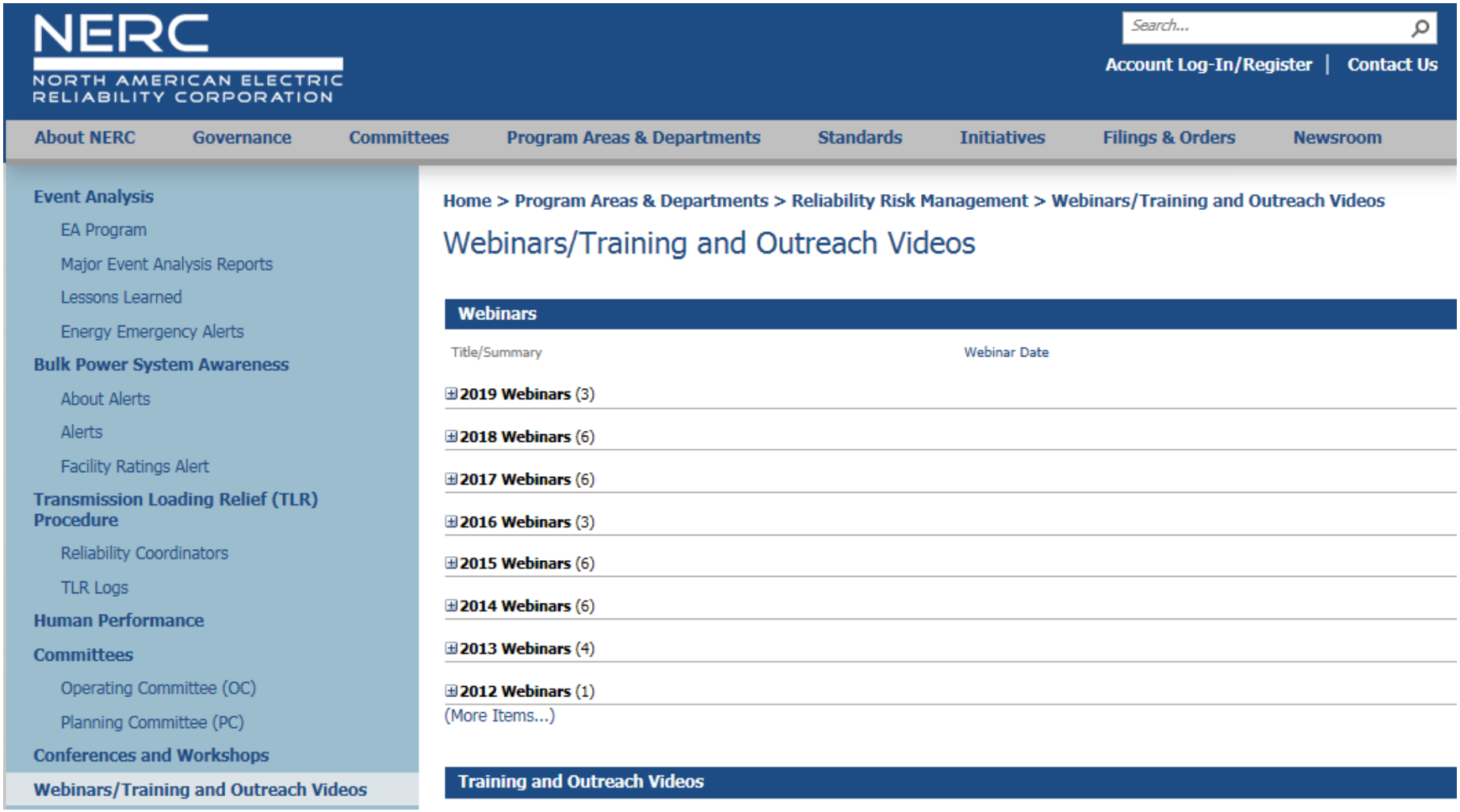
January 17, 2018 Extreme Cold Across South Central U.S.

- One-third of Generator Owner/Operators who had outages/derates/failures to start did not have winterization procedures
- This should not be the case given the number of prior cold weather events that have been analyzed, lessons learned, and preventive actions reported to the industry.



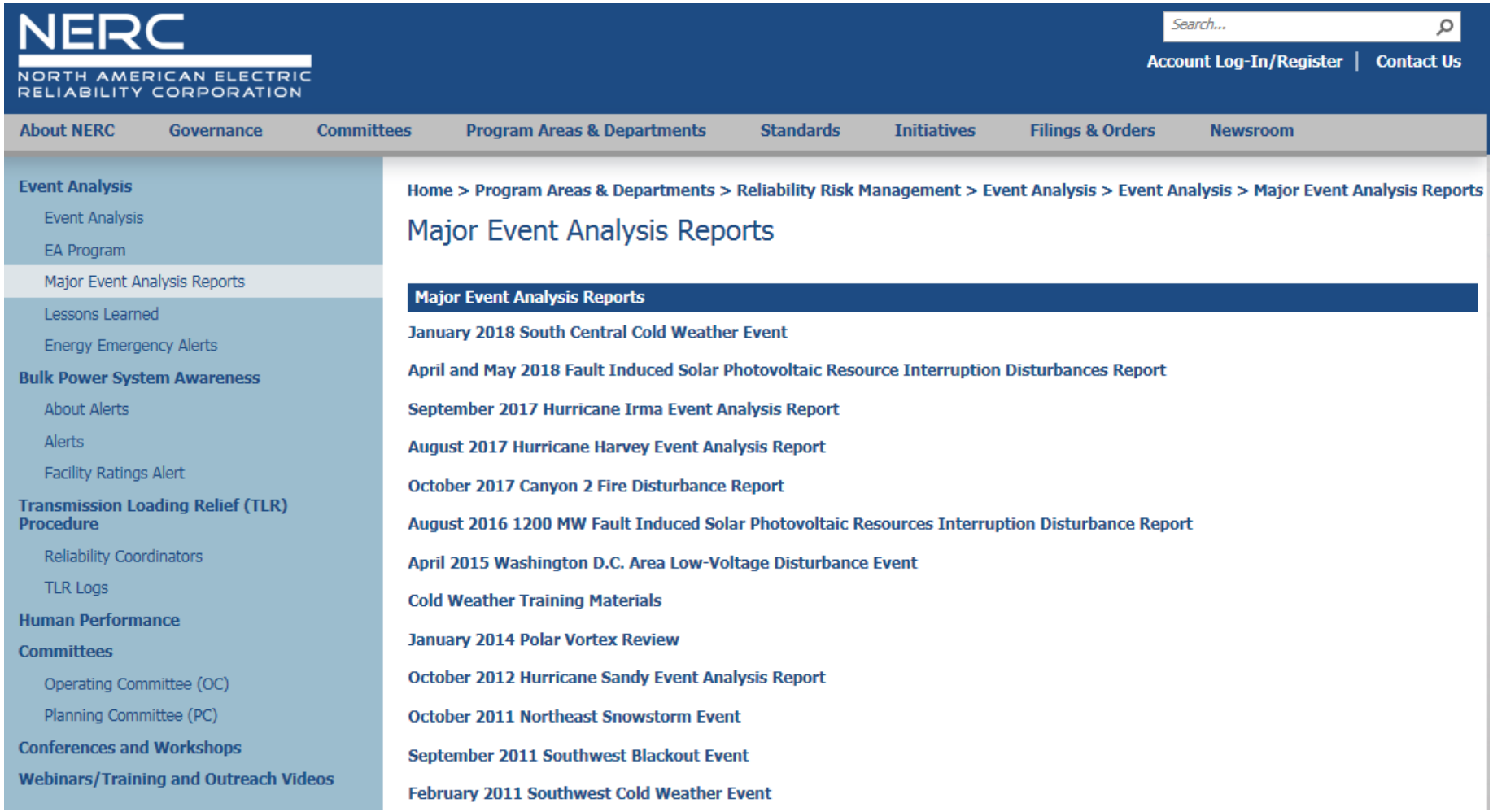
NERC Annual Winter Webinars

https://www.nerc.com/pa/rrm/Pages/Webinars.aspx



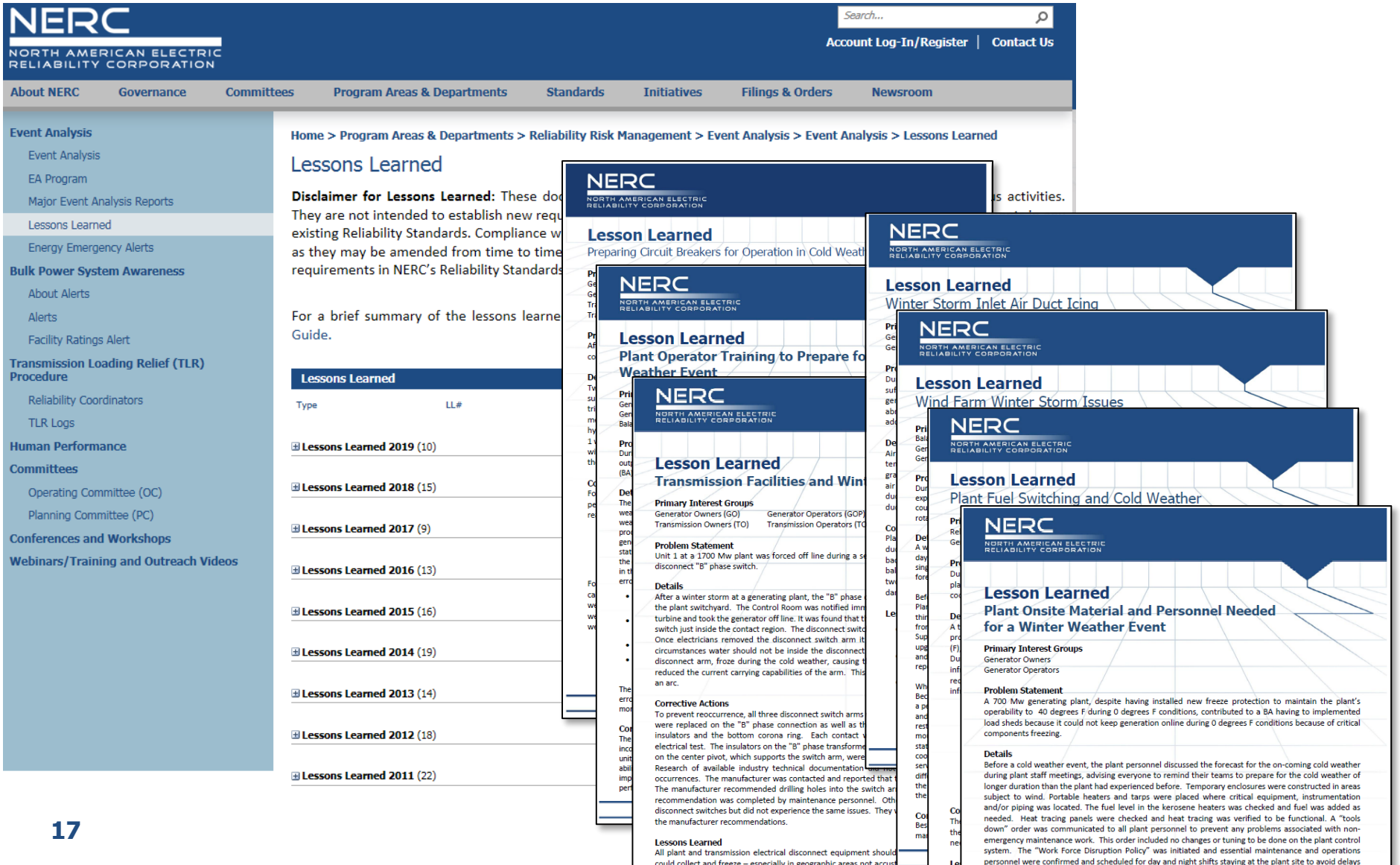
NERC Cold Weather Reports

https://www.nerc.com/pa/rrm/ea/Pages/Major-Event-Reports.aspx

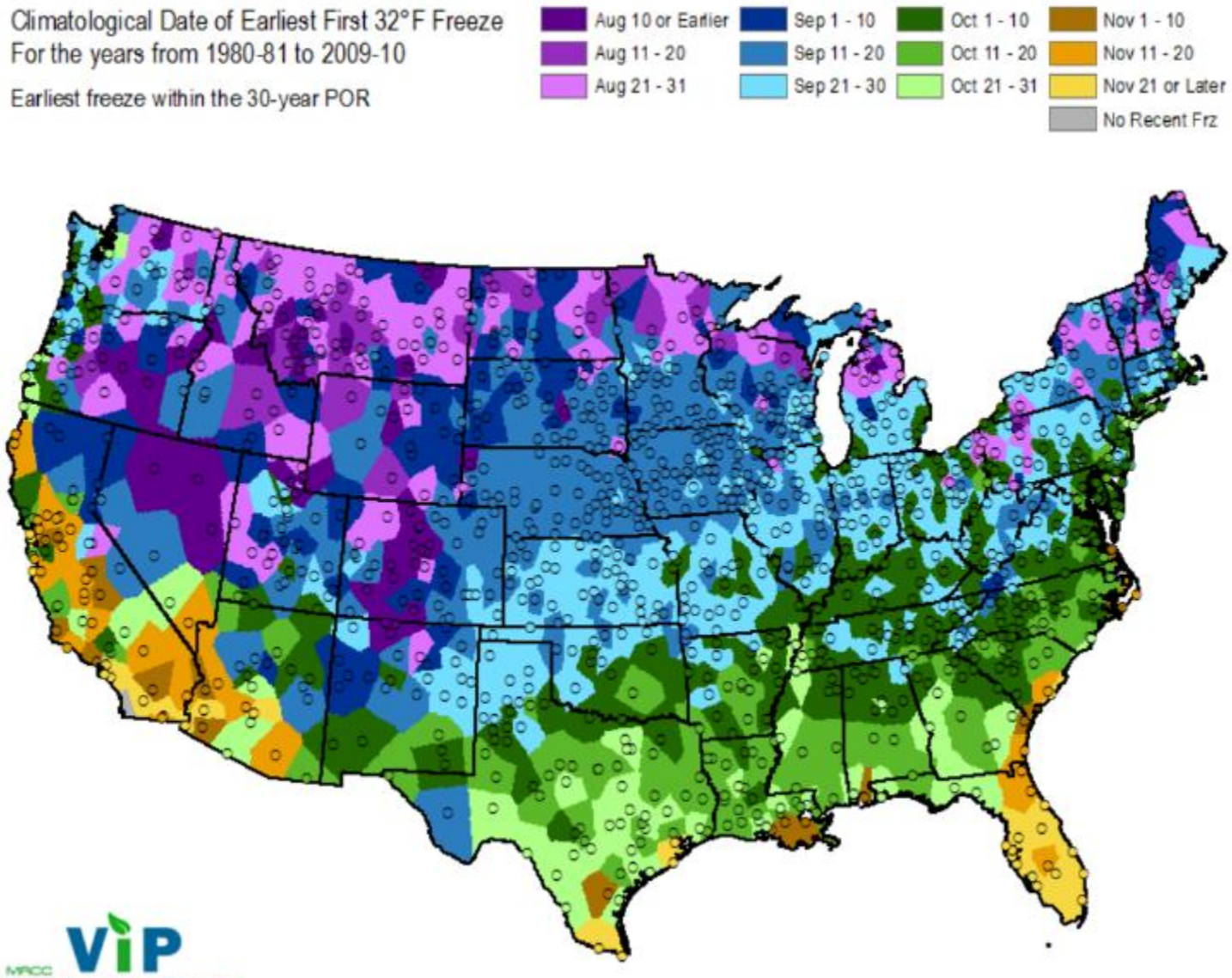


NERC Cold Weather Lessons Learned

https://www.nerc.com/pa/rrm/ea/Pages/Lessons-Learned.aspx



What is your Winterization Procedure Schedule Date?



MRCC VIP Vegetation Impact Program

https://www.weather.gov/iwx/fallfrostinfo

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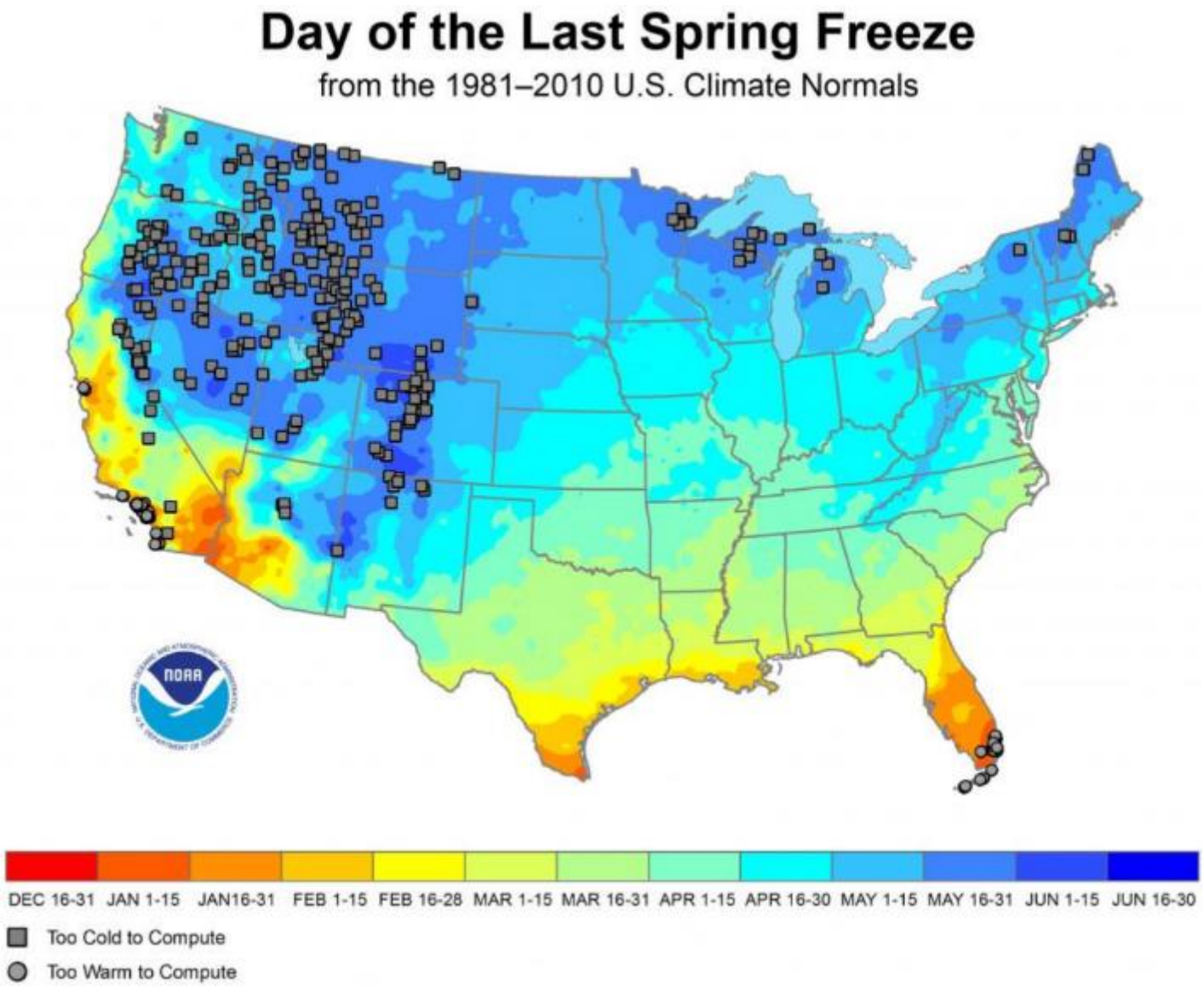
When Can You De-Winterize?
(Begin "Summerization" Procedure)



https://www.ncdc.noaa.gov/file/day-last-spring-freeze-mapjpg

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NERC Winter Reliability Assessment

Mark Olson, Senior Engineer Reliability Assessments
Winter Readiness Webinar
September 5, 2019

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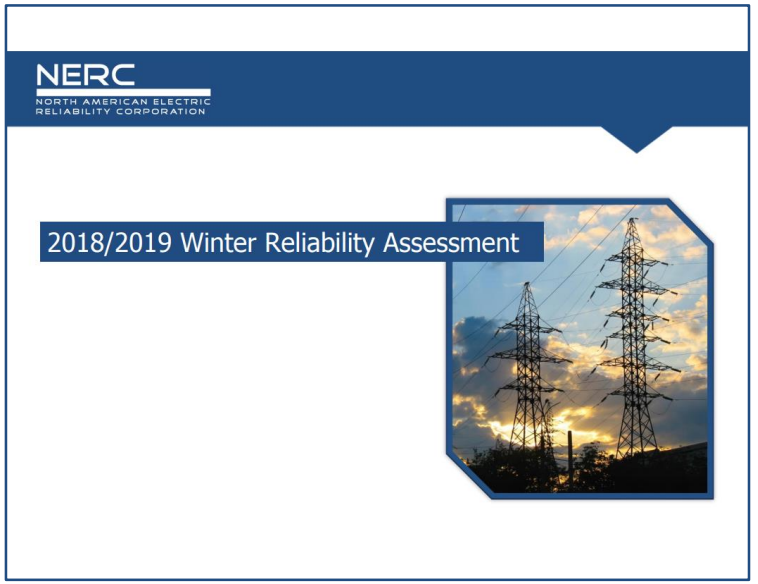
About the Report

- NERC's Winter Reliability Assessment (WRA) examines potential regional resource deficiencies and operating reliability concerns
  - Describes industry preparations to manage seasonal risks
- Developed with the Reliability Assessment Subcommittee (RAS) and reviewed by the NERC technical committees
- Published annually



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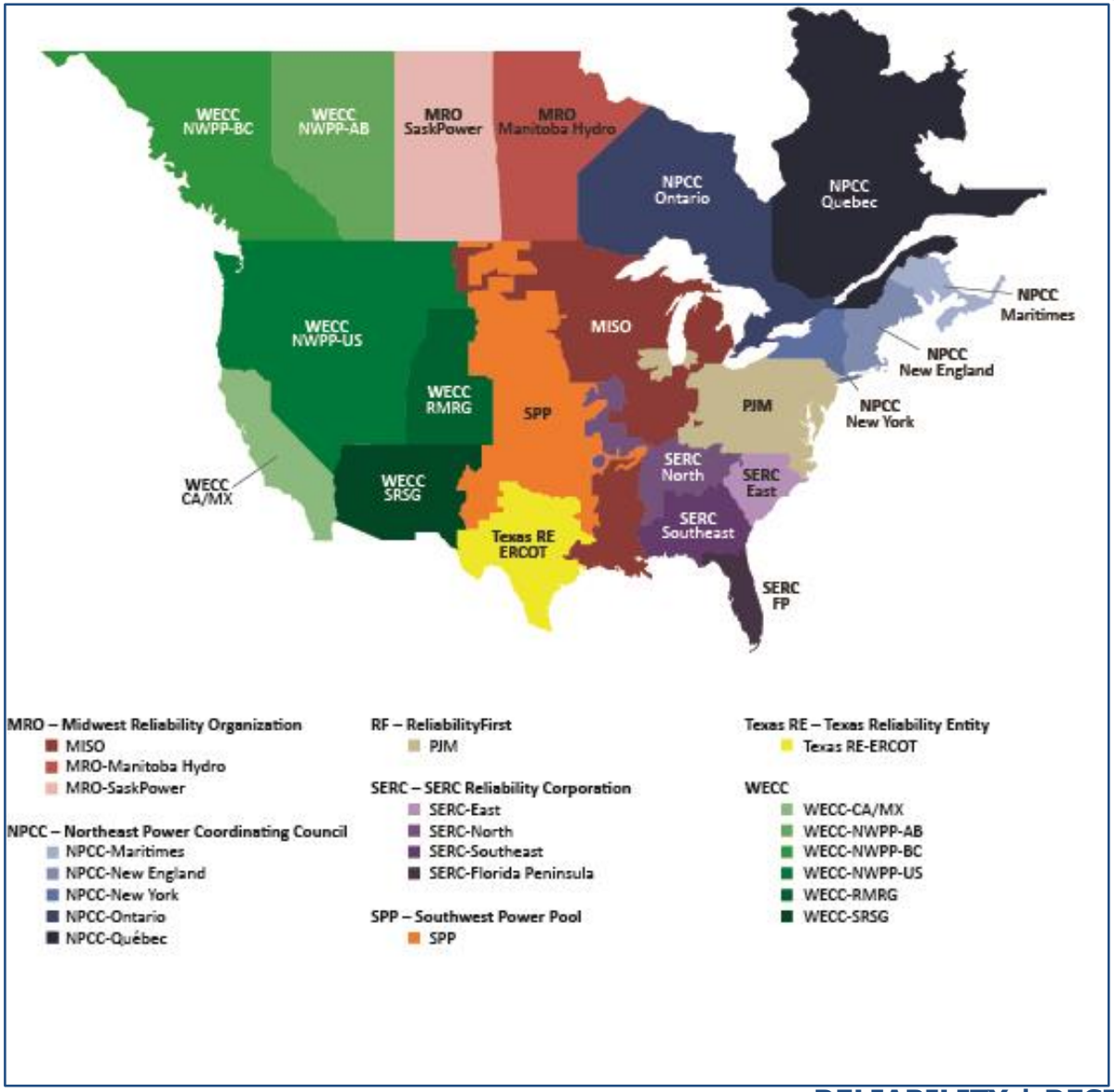
NERC Assessment Areas

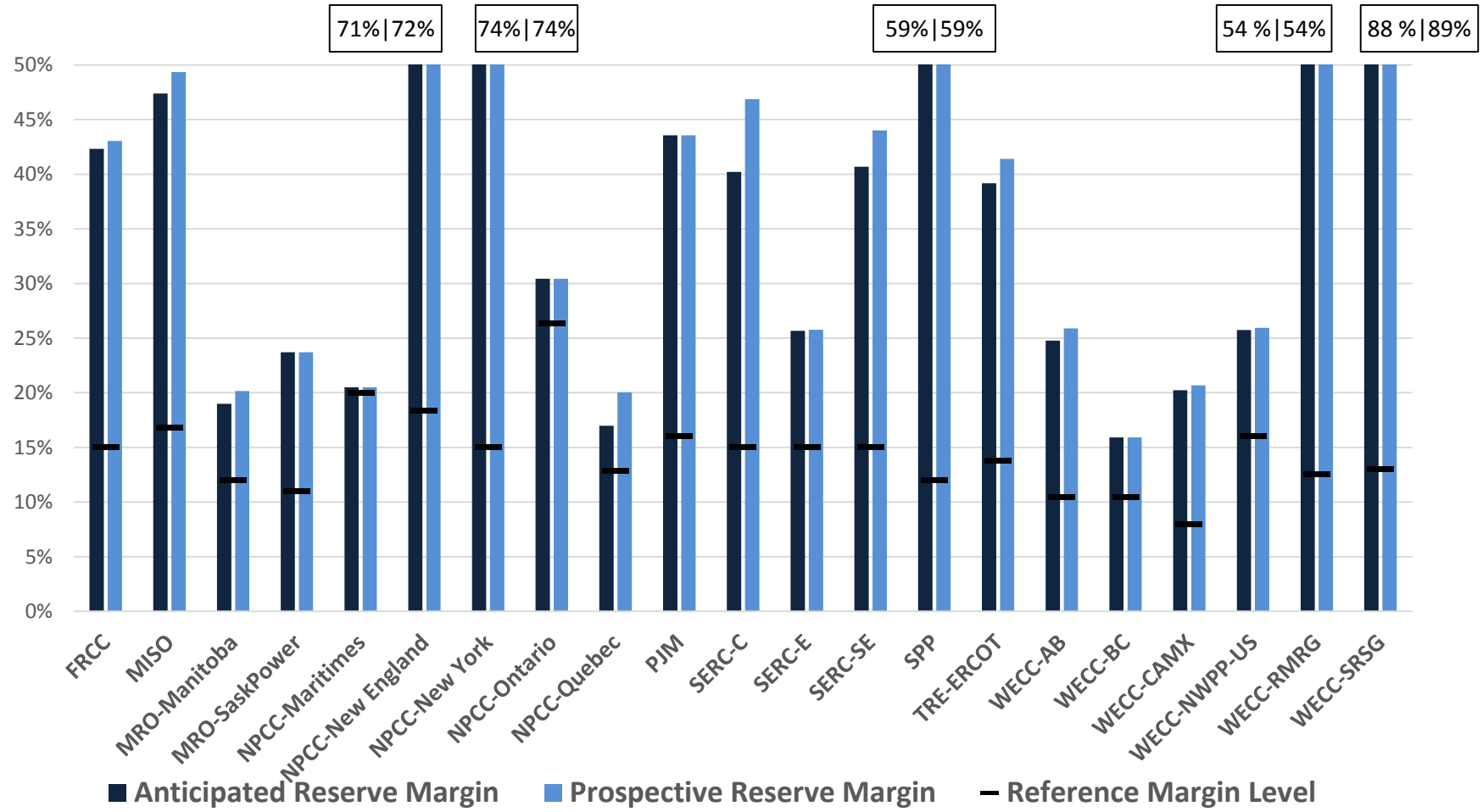


Key Findings from 2018-2019 WRA

Released December 12, 2018

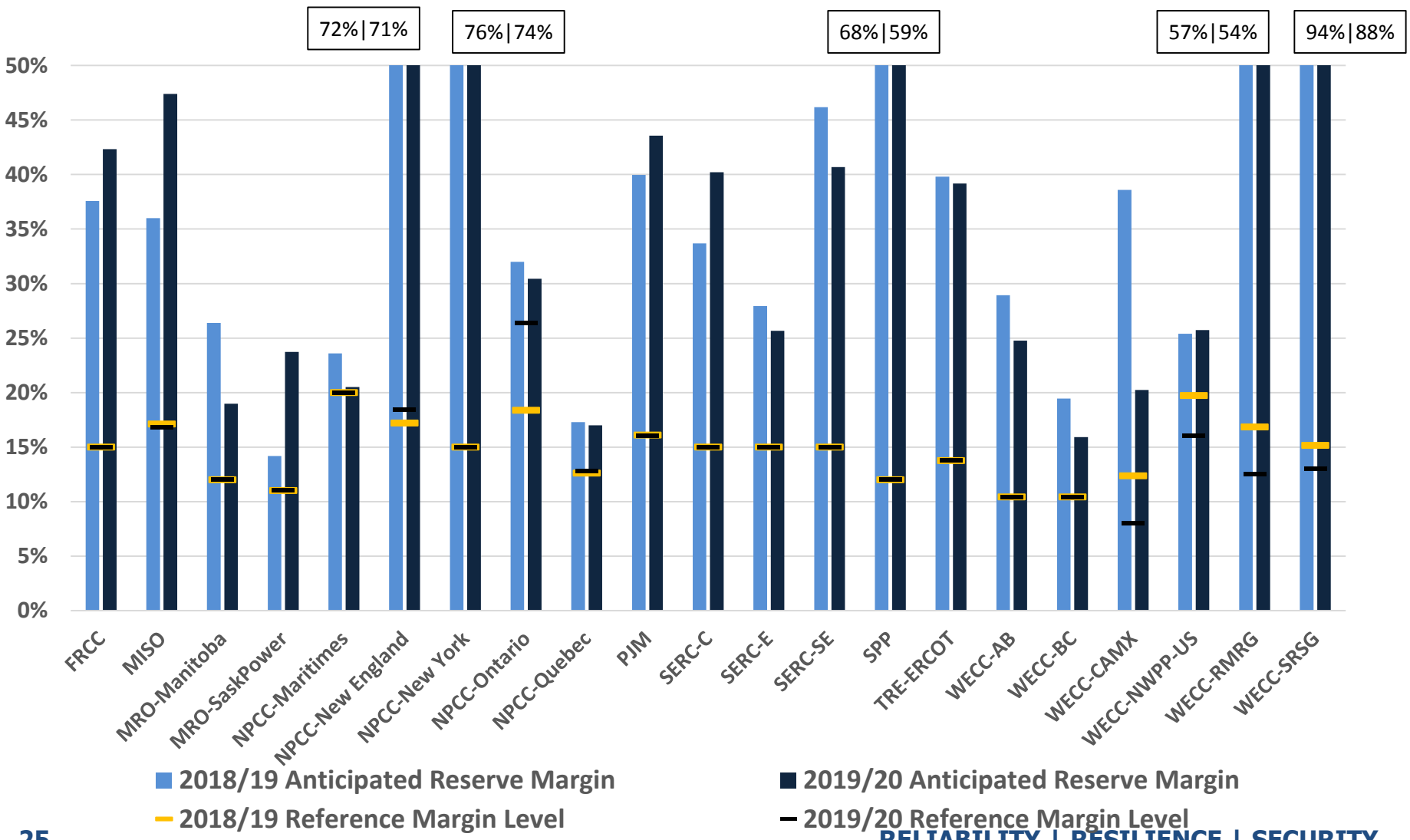
- All assessment areas had adequate resources for December 2018-19 winter season
- Incentives for generator performance in market areas are aimed at mitigating winter reliability risks
  - PJM Capacity Performance Initiative
  - ISO-NE Pay for Performance
- Entities are implementing processes and strategies to reduce risks of generator fuel supply issues
- Continuing natural gas storage and transportation limitations associated with Aliso Canyon could impact Southern California generators

2019-20 Winter Reserve Margins



Preliminary Data Shows Capacity Resources are Adequate for Winter

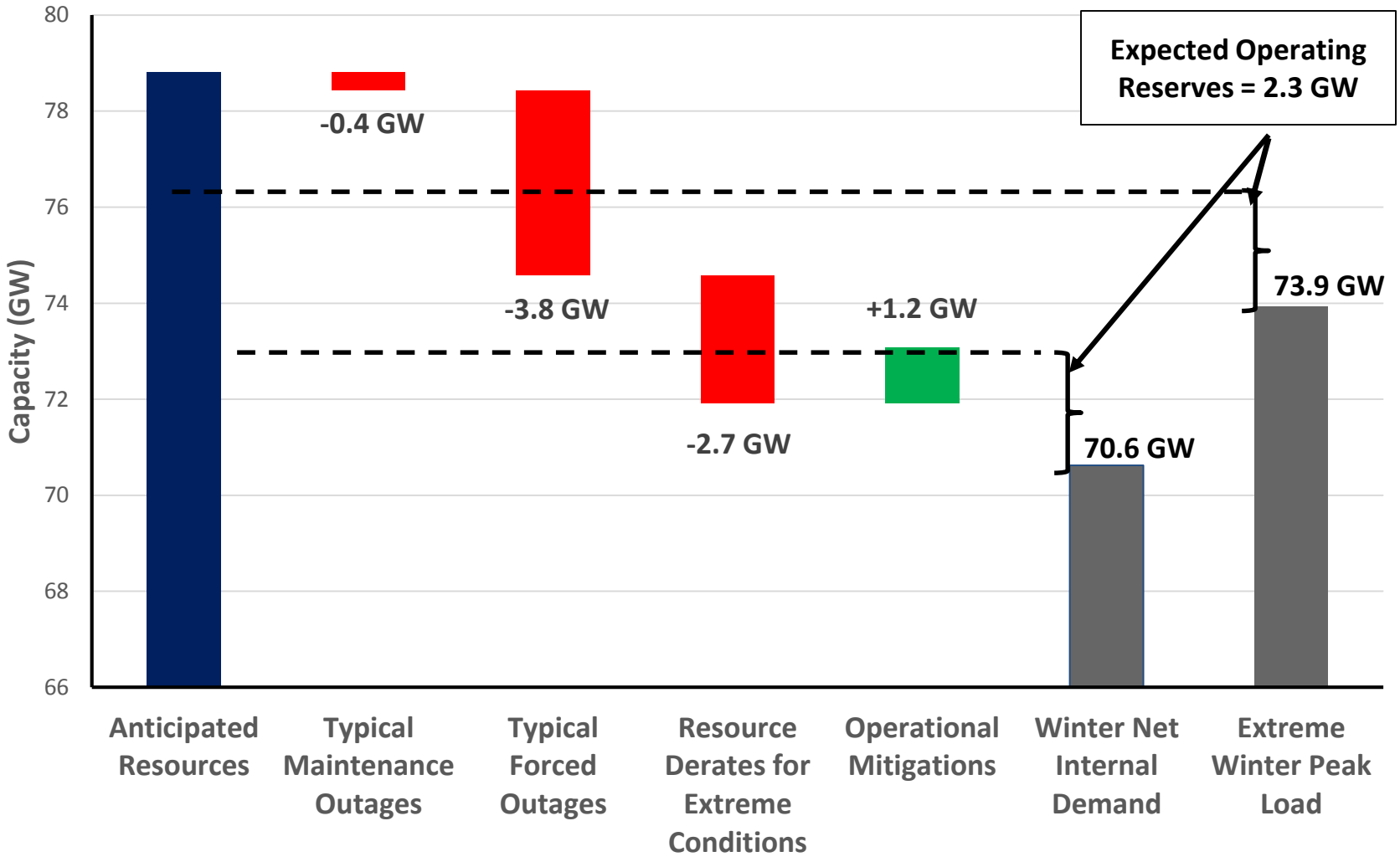
Preliminary Reserve Margin Year-on-Year Comparison



WRA Will Examine Extreme Weather Event Risks

- Each assessment area is providing data for operational risk scenario
- Scenarios provide additional insight into winter reliability risks
  - Consider extreme winter peak loads
  - Account for **resource derates and outages due to extreme winter conditions**
  - Compare resources with expected operating reserve requirements provided by NERC assessment areas
- Data can be used for an operational risk waterfall chart

Example Area Risk Scenario



Questions and Answers