Interregional Transmission for Resilience

Stress testing approach for ensuring adequacy

Derek Stenclik & Ryan Deyoe | October, 2024

ESIG Redefining Resource Adequacy and Transmission Resilience Task Forces

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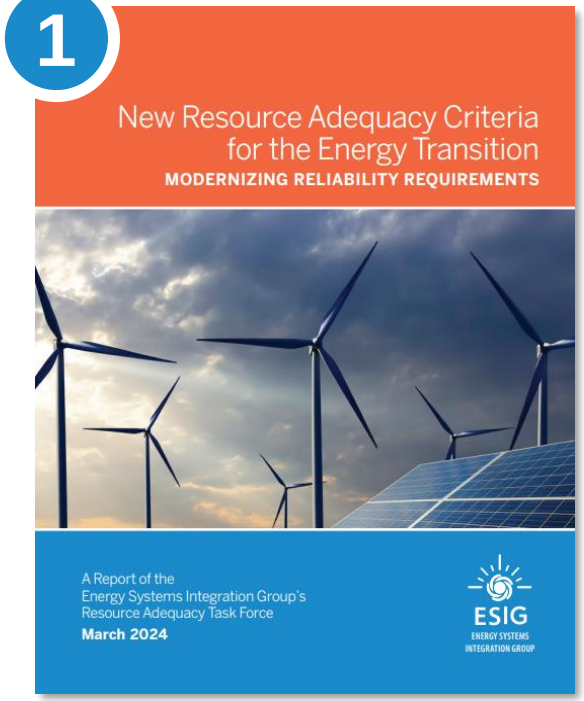

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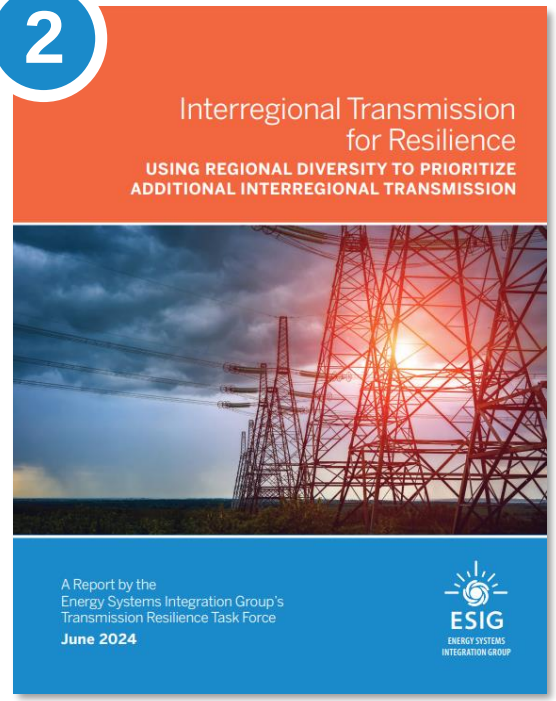

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New approach to stress-testing for adequacy and wide-area assessments

ESIG RA Task Force

New Reliability Criteria & Capacity Needs

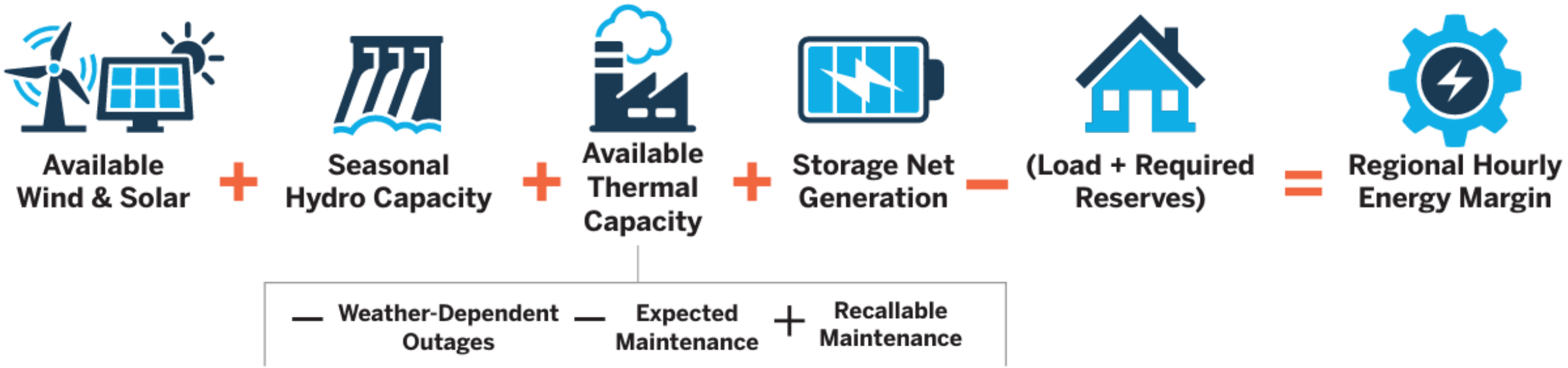
Moving beyond 1-day-in-10 LOLE

ESIG Transmission Resilience Task Force

Wide-area energy margin assessment

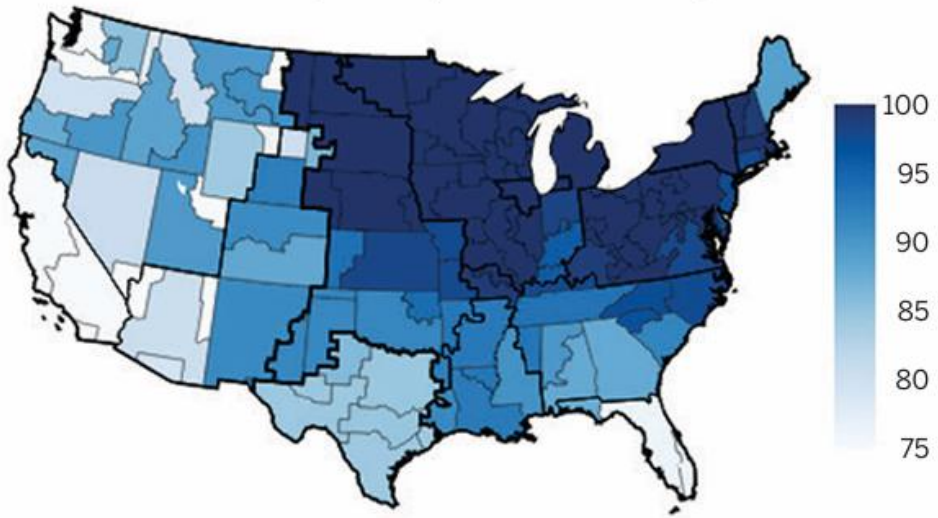
Geographic diversity and interregional transmission

Wide-area assessment approach for correlated, consistent, and time-synchronized energy margins

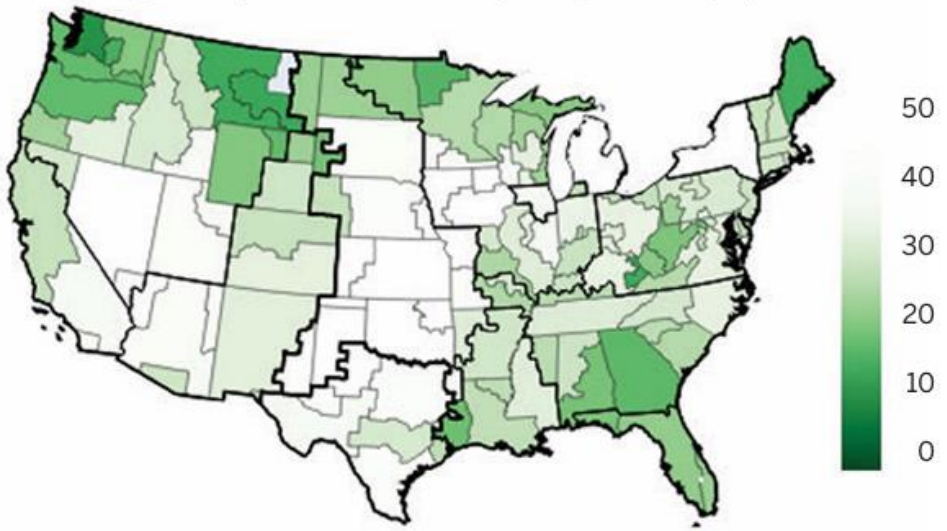


Maps Summarizing Major Factors in the Hourly Energy Margin for FERC 1000 Regions for July 17, 2012, Weather Data

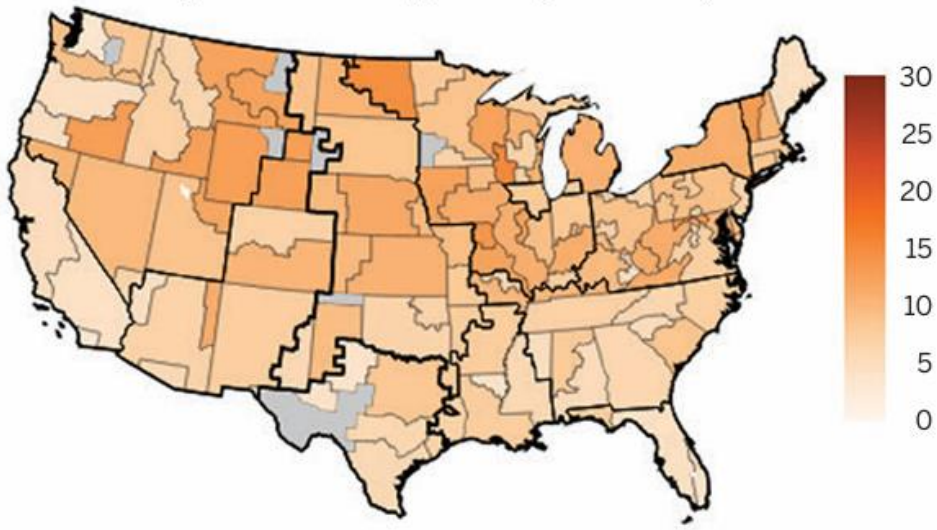
Maximum Daily Load (% of Annual Peak)



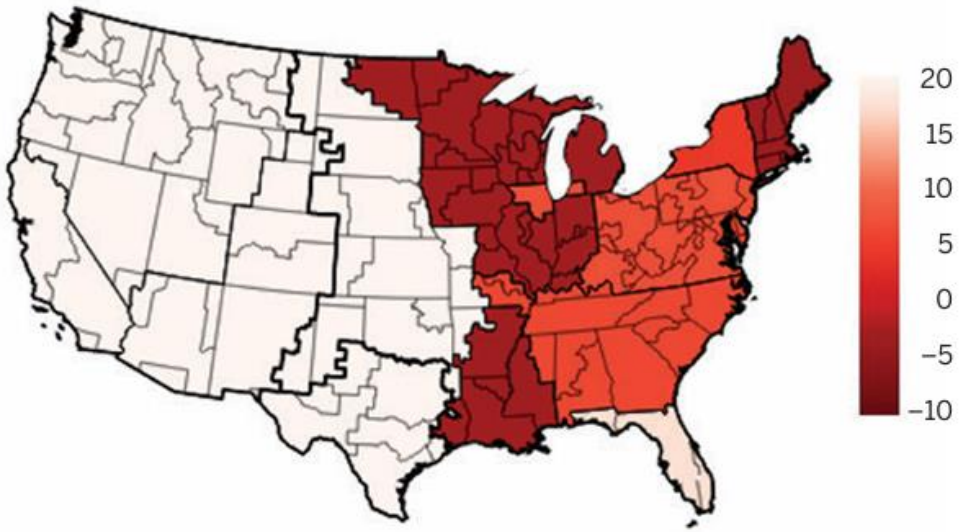
Average Daily Wind & Solar Capacity Factor (%)



Daily Thermal Outage Rate (% of Total)

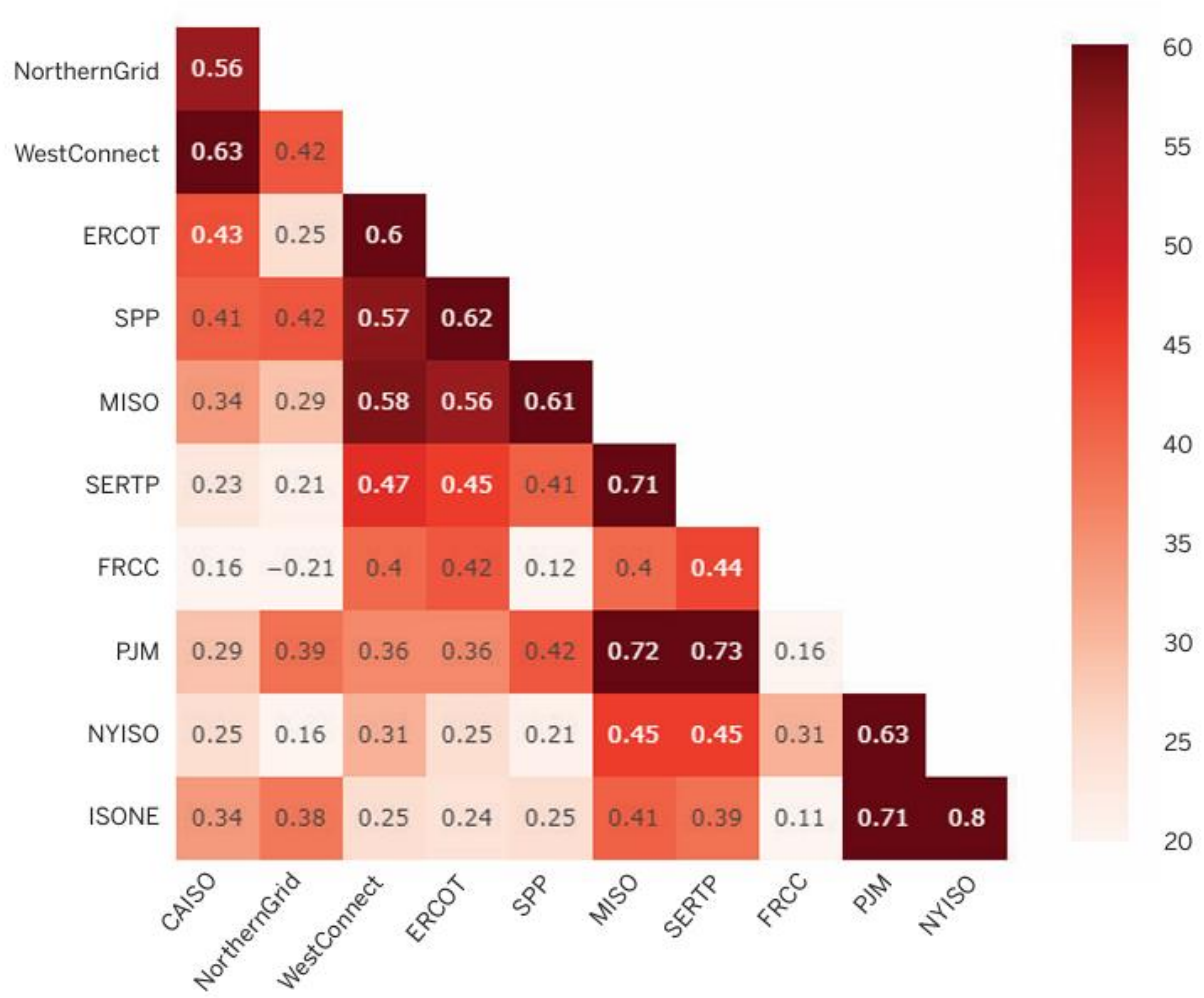


Minimum Margin (% of Load)

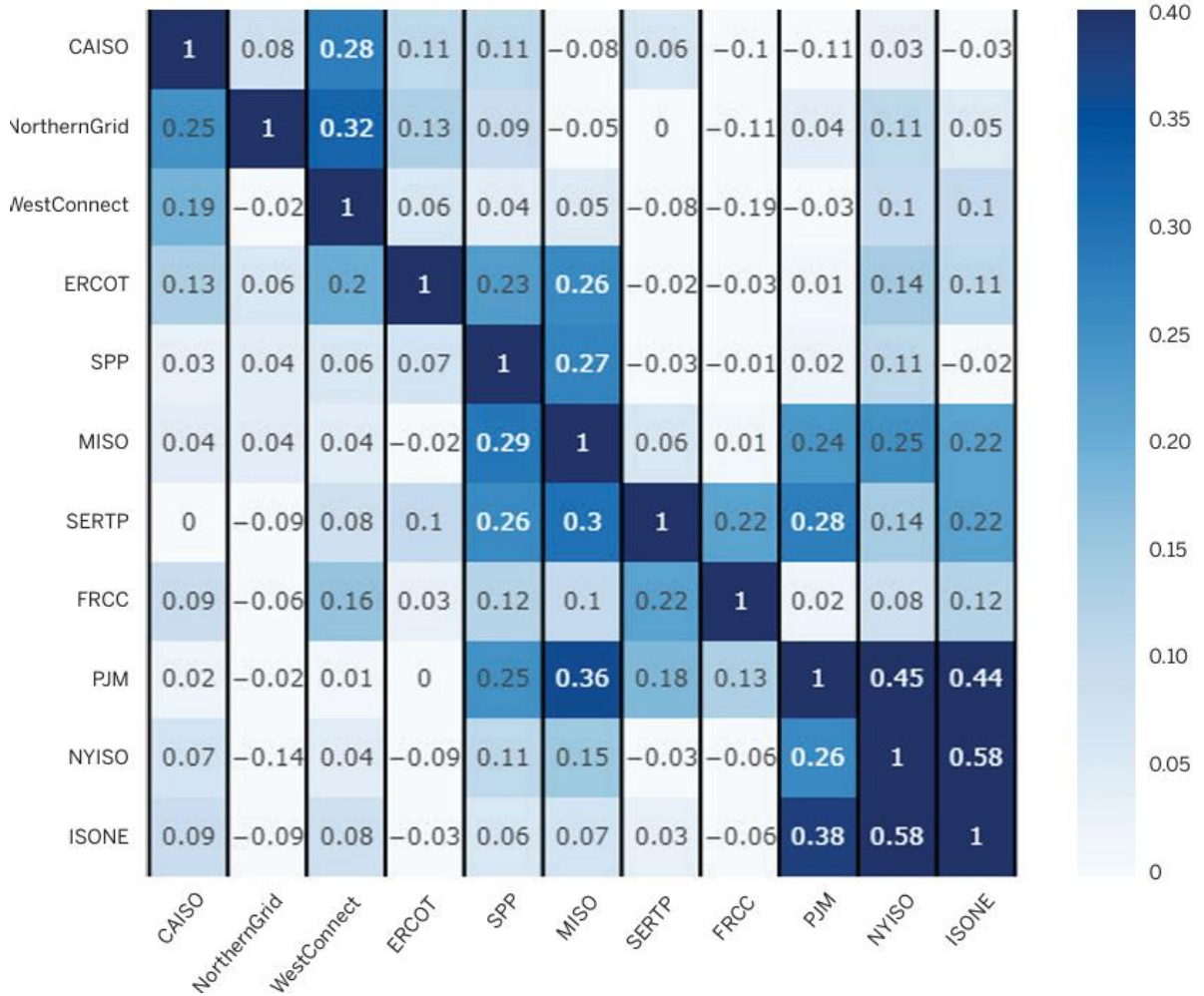


Correlations in Regional Risk and Geographic Diversity

Minimum Daily Energy Margin Correlations Between FERC 1000 Regions for 2007–2013, All Hours



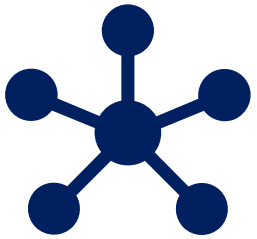
Correlation Between FERC 1000 Regions During Hours with Low Margin (Lowest 1,400 Hours)



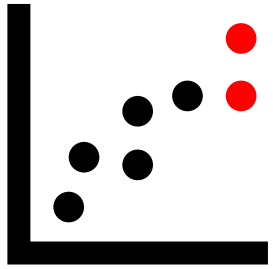
How can we combine wide-area assessments with region-specific stress-testing and resilience analysis?

ESIG
ENERGY SYSTEMS INTEGRATION GROUP

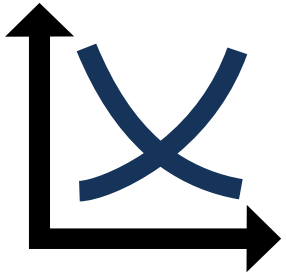
Final Recommendations from the Task Force



1. **Transition to a multi-metric criteria**



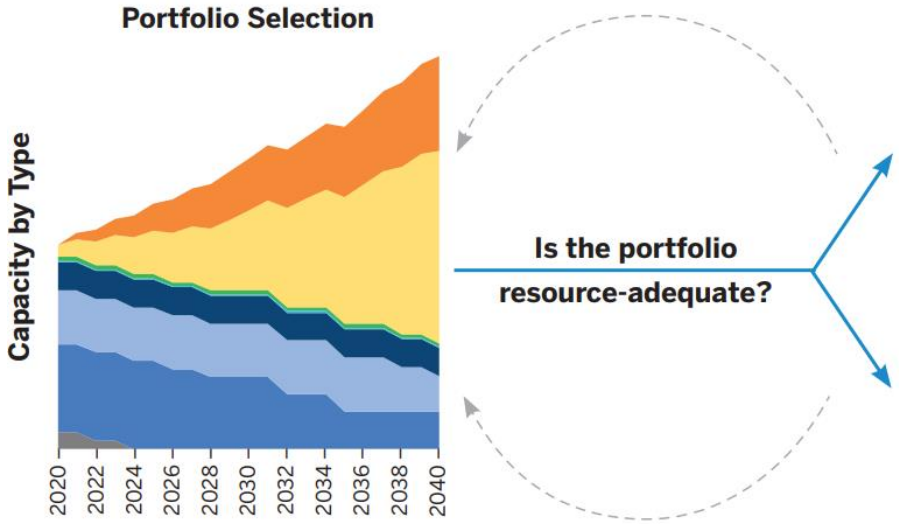
2. **Specifically consider extreme events**



3. **Incorporate economics**

Specifically consider extreme events

Limited data are available to determine with confidence the probability of extreme events. This reality may require discrete analysis or stress-testing



Source: GridLab, Telos Energy

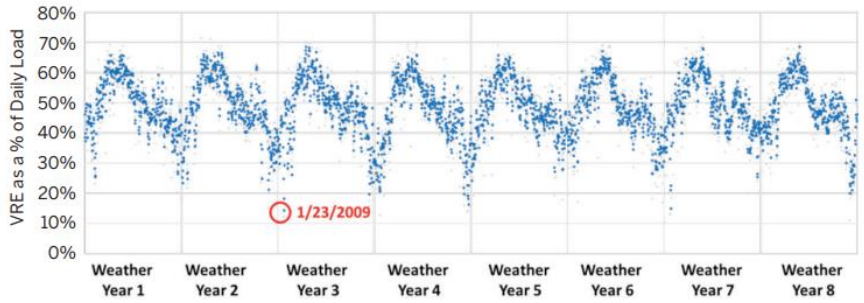
Probabilistic Resource Adequacy Analysis

Many years weather data X Random outage draws = 1000s of Monte Carlo samples

Key Outputs
Probability and expected value metrics (LOLE, LOLP, EUE)

- Probabilistic assessment of weather and random outage draws
- Simplified model for hundreds or thousands of samples
- Aggregated results for probabilities, but limited specific insights

Stress-Testing Specific Conditions



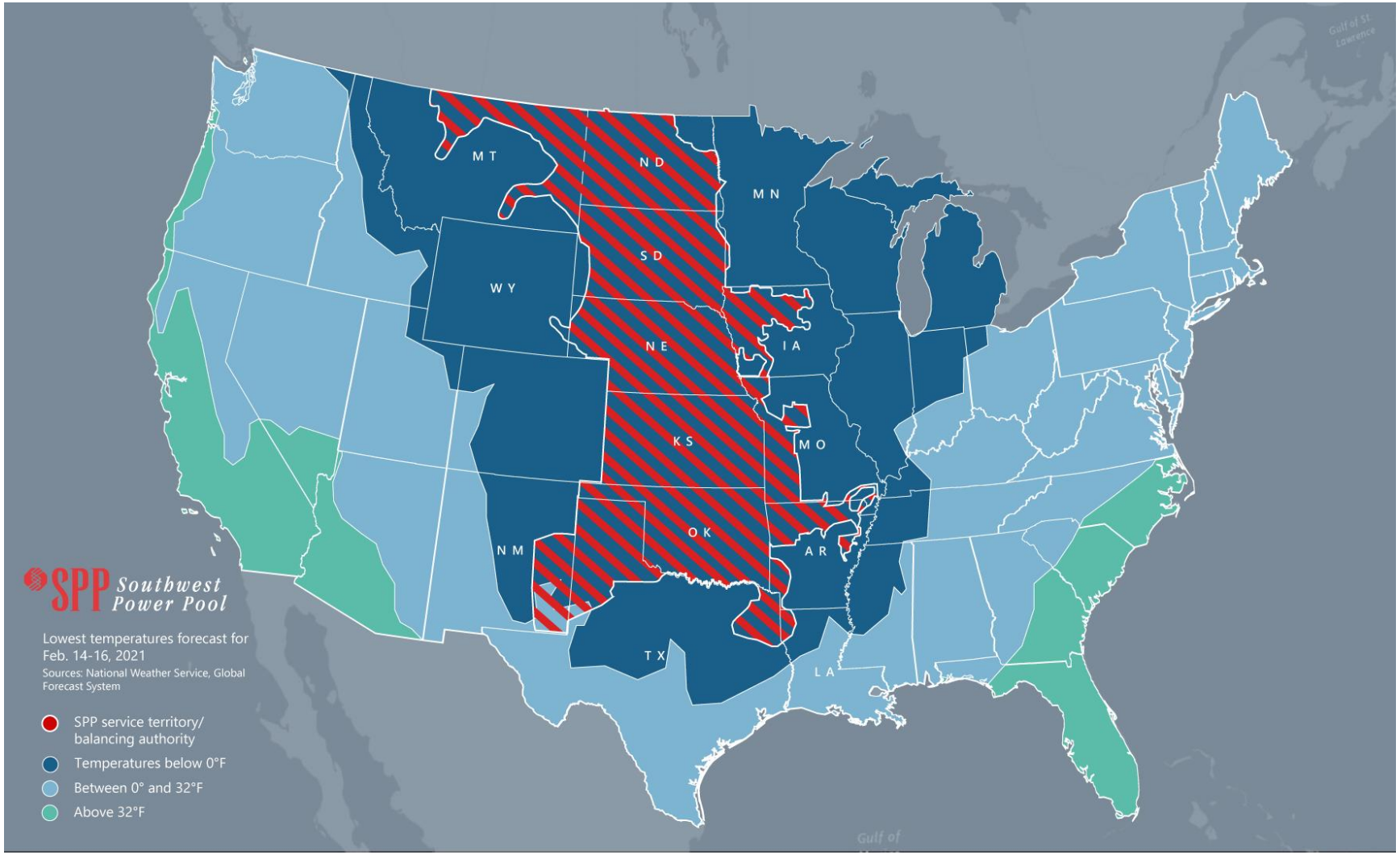
- Detailed stress tests of specific conditions
- Deeper insights into specific weather events
- Additional information in availability of imports and region-wide analysis

Key Outputs
- Unserved energy margin (close calls)
- Reliance on imports
- Key stressors

Common Pitfalls of Stress Testing

- **Limited or no consideration of external regions and resource availability**
- **Artificially conservative assumptions on wind and solar availability, "doomsday scenario"**
- **Not accounting for weather dependent outages of thermal resources**
- **Only considering a single combination of stressors**

SPP Case Study
for Interregional Transmission Resilience



How can we combine a **detailed representation of SPP**, with a simplified representation of the North American system?

Stress testing approach including 450 potential stress conditions

3 Stress Tests

Extreme Cold
Feb 2021

Extreme Heat
July-Aug 2011

Wind Drought
Sept 2011

50 Stress Samples

Stress Variable	Stress Testing Approach
Thermal Forced Outages	50 Random Daily Samples Correlated to Temp
Renewable Generation	50 Random Daily Samples Correlated to Load
Thermal Maintenance	50 Samples Scheduled for 1 year by Model
Transfer Capability Levels	50 Randomly Generated Outage Samples or based on published data

3 Load Levels

+/- 2%,
4%,
6%

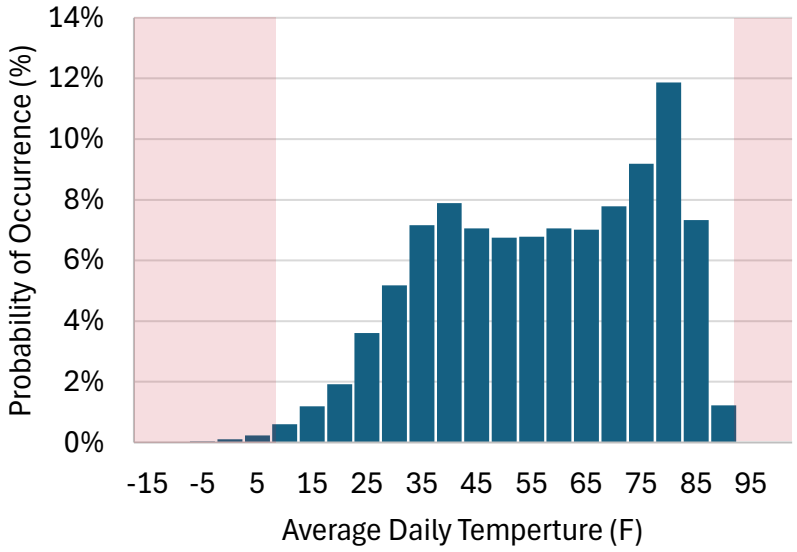
= 450 Stress Conditions, each evaluated across different import representations

How extreme are our stress periods?

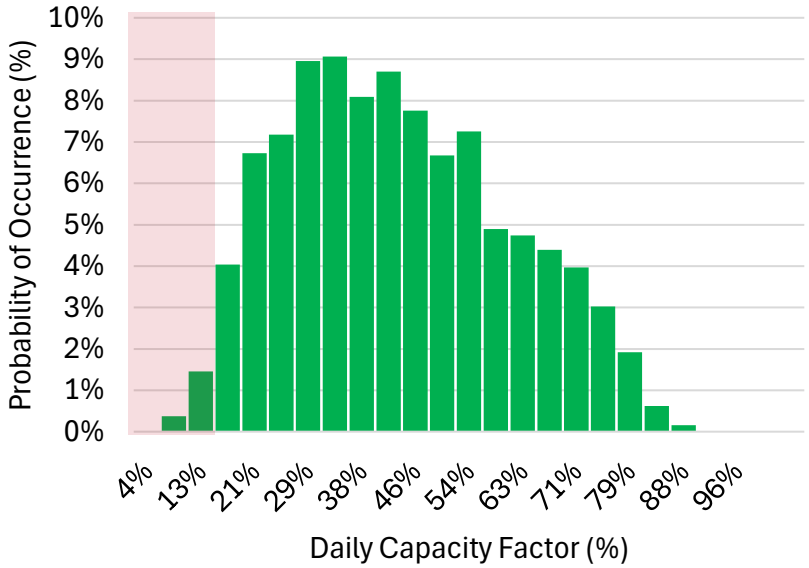
Selected stress periods are very extreme events based on the 43 years of data from SPP and recent historical outage data. We are focused on the extreme tails.

Stress Period Type	Stress Period Dates	Notable Extreme Factors	Event Description
Extreme Cold	February 11 – 25, WY 2021	99.85% of days are warmer	Freezing temps, high load, high outage levels, low wind
Extreme Heat	July 13 – August 10, WY 2011	99.99% of days are cooler	Extreme heat, high summer load
Wind Drought	August 29 – September 18, WY 2011	0.23% probability of 5+ day drought occurring in summer/fall months	5-day consecutive low wind period

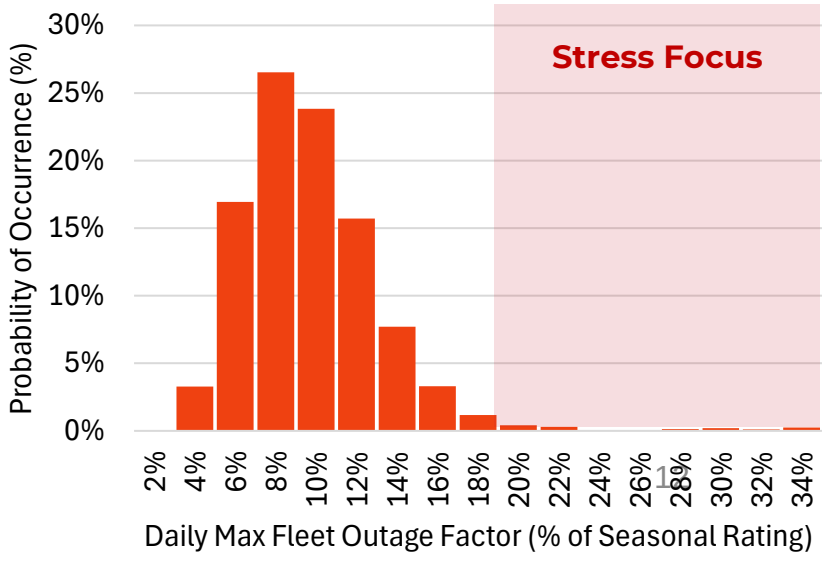
SPP Wide Avg Daily Temp Probability (1980-2022)



SPP Wide Daily Wind Output Probability (1980-2022)

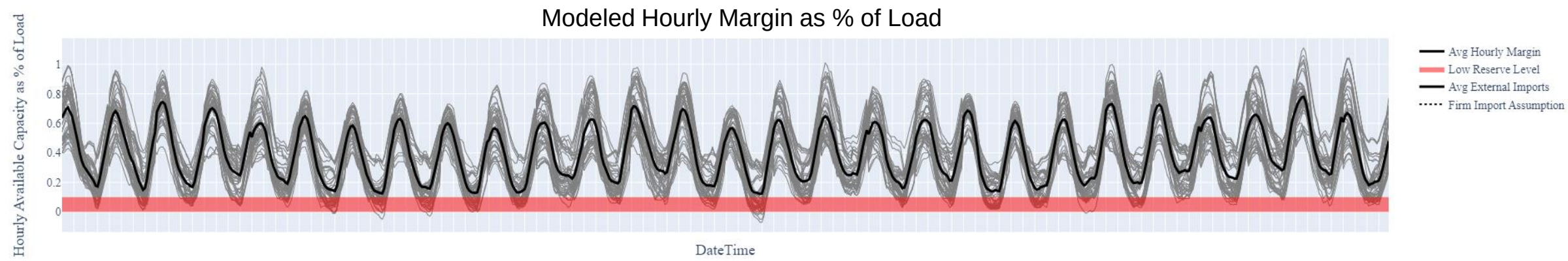


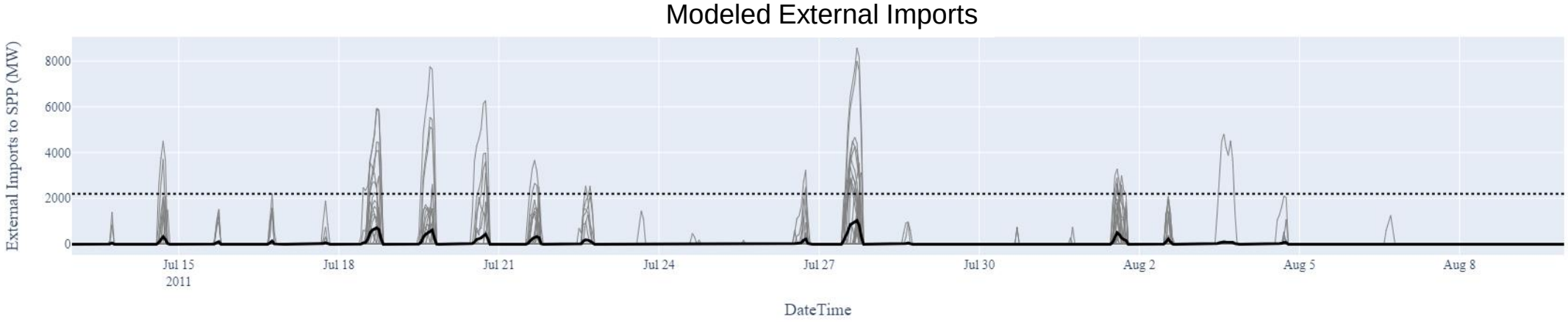
SPP Daily Gas Fleet Outage Factor (2016-2023)



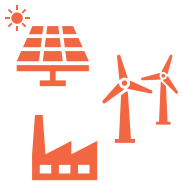
Preliminary Results for 50 Stress Samples

July 13th – August 9th, 2011, Heat Event SPP Wide Hourly Margin and External Imports





Next Steps



Finalize Stress Test Conditions: Develop consistent, correlated, hourly time series of load, wind, solar, and weather-dependent outages … specifically for extremes

Evaluate Interregional Transmission Options: quantify the availability of external assistance and compare it to in-region resources

Consider Future Systems: Evaluate future resource mixes and electrification levels

Conduct transfer analysis on extreme conditions: evaluate interregional transfer capability under extreme events

THANK YOU

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