# 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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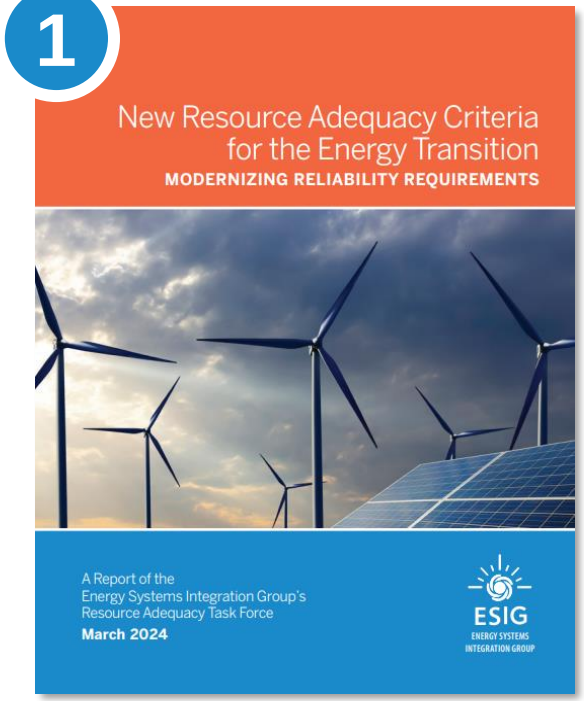


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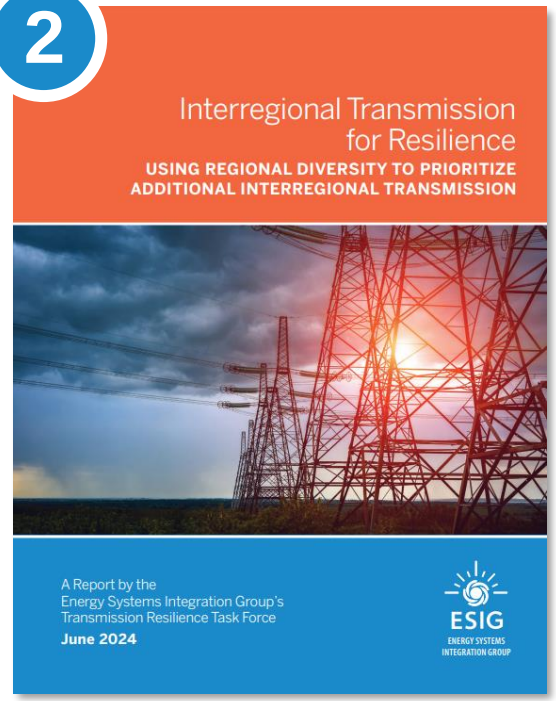


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**New approach to stress-testing for adequacy and wide-area assessments**

**ESIG RA Task Force**

**New Reliability Criteria & Capacity Needs**

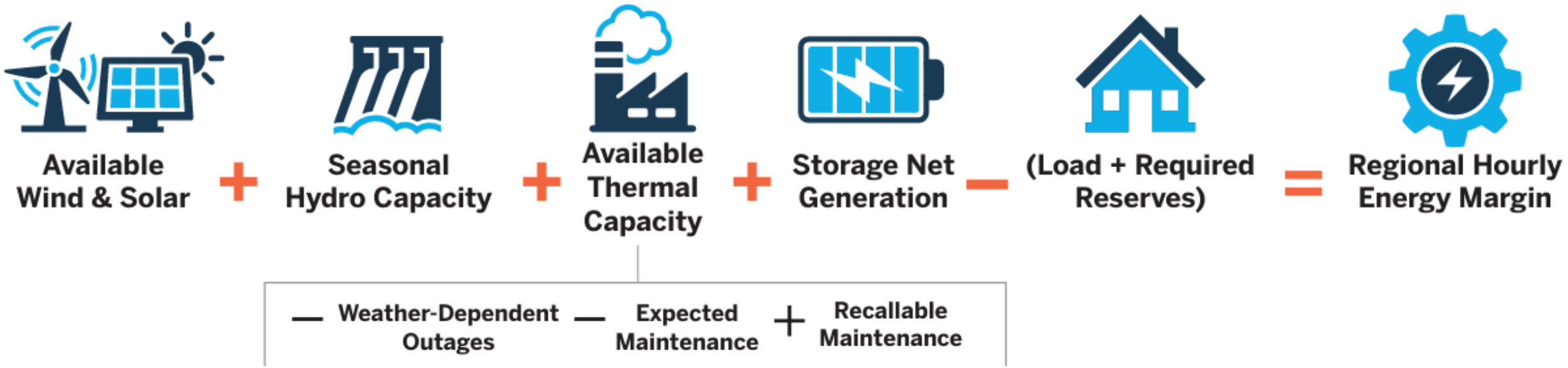
*Moving beyond 1-day-in-10 LOLE*

**ESIG Transmission Resilience Task Force**

**Wide-area energy margin assessment**

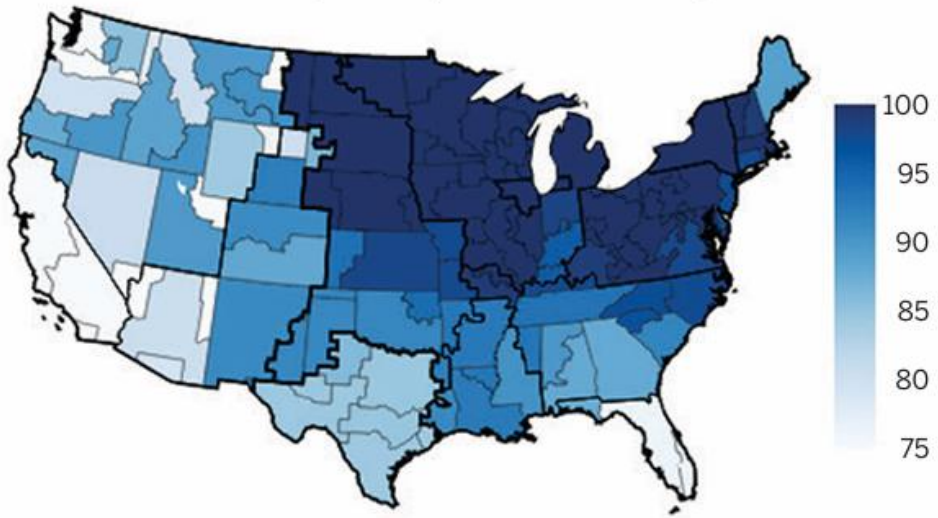
*Geographic diversity and interregional transmission*

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

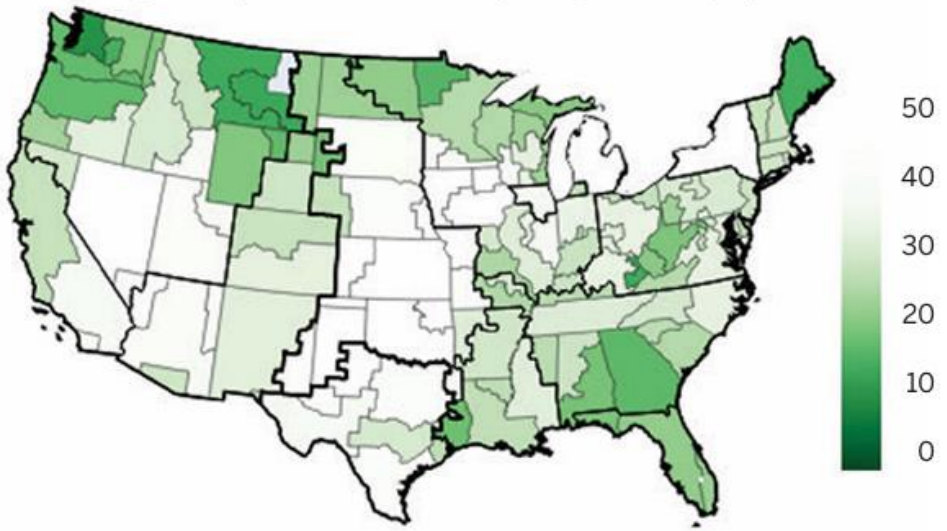


# Maps Summarizing Major Factors in the Hourly Energy Margin for FERC 1000 Regions for July 17, 2012, Weather Data

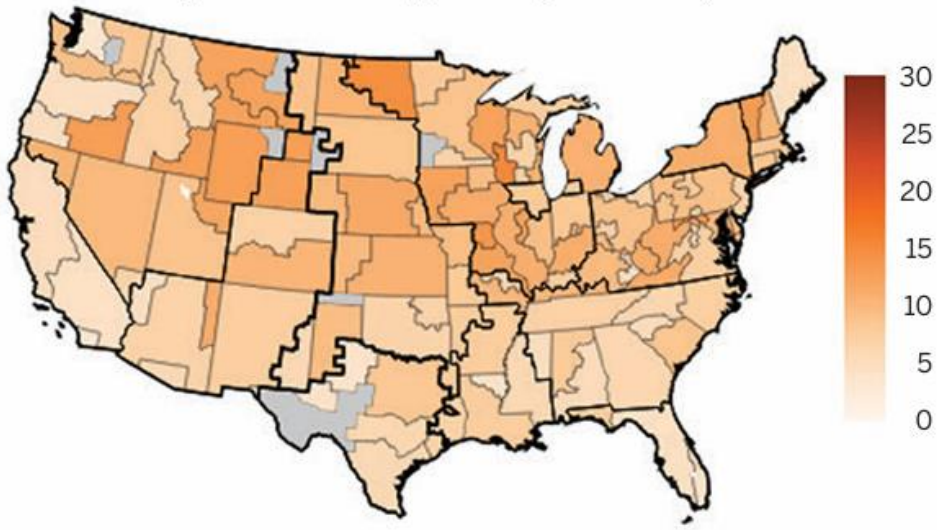
**Maximum Daily Load (% of Annual Peak)**



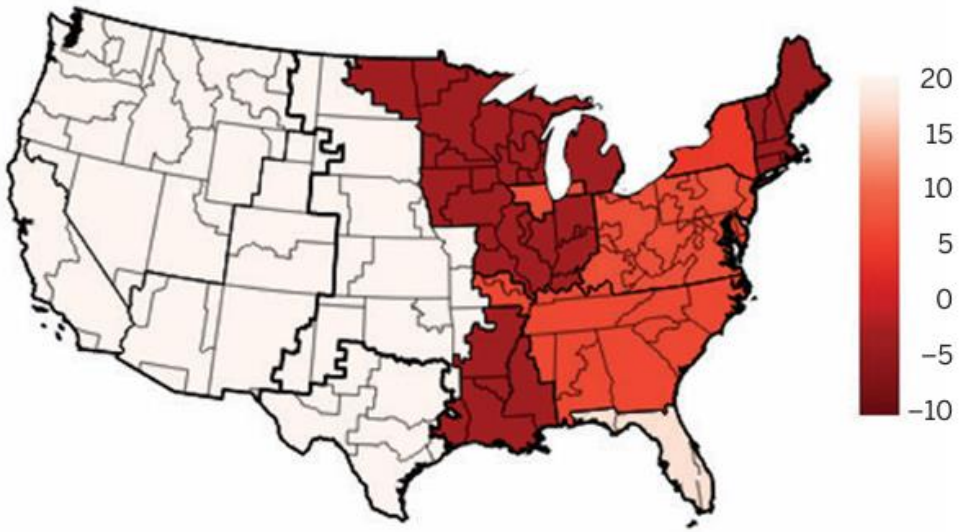

**Average Daily Wind & Solar Capacity Factor (%)**




**Daily Thermal Outage Rate (% of Total)**

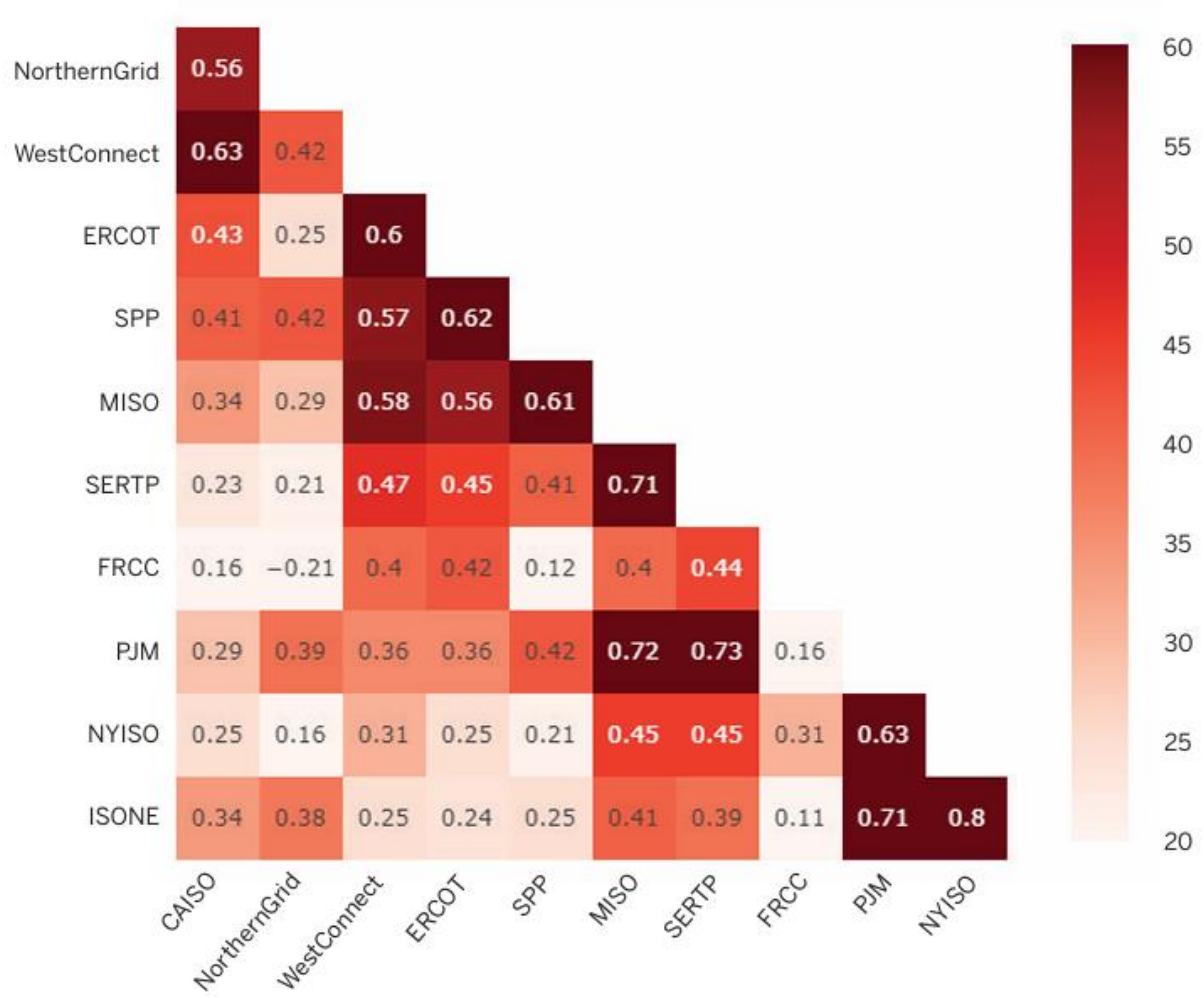



**Minimum Margin (% of Load)**

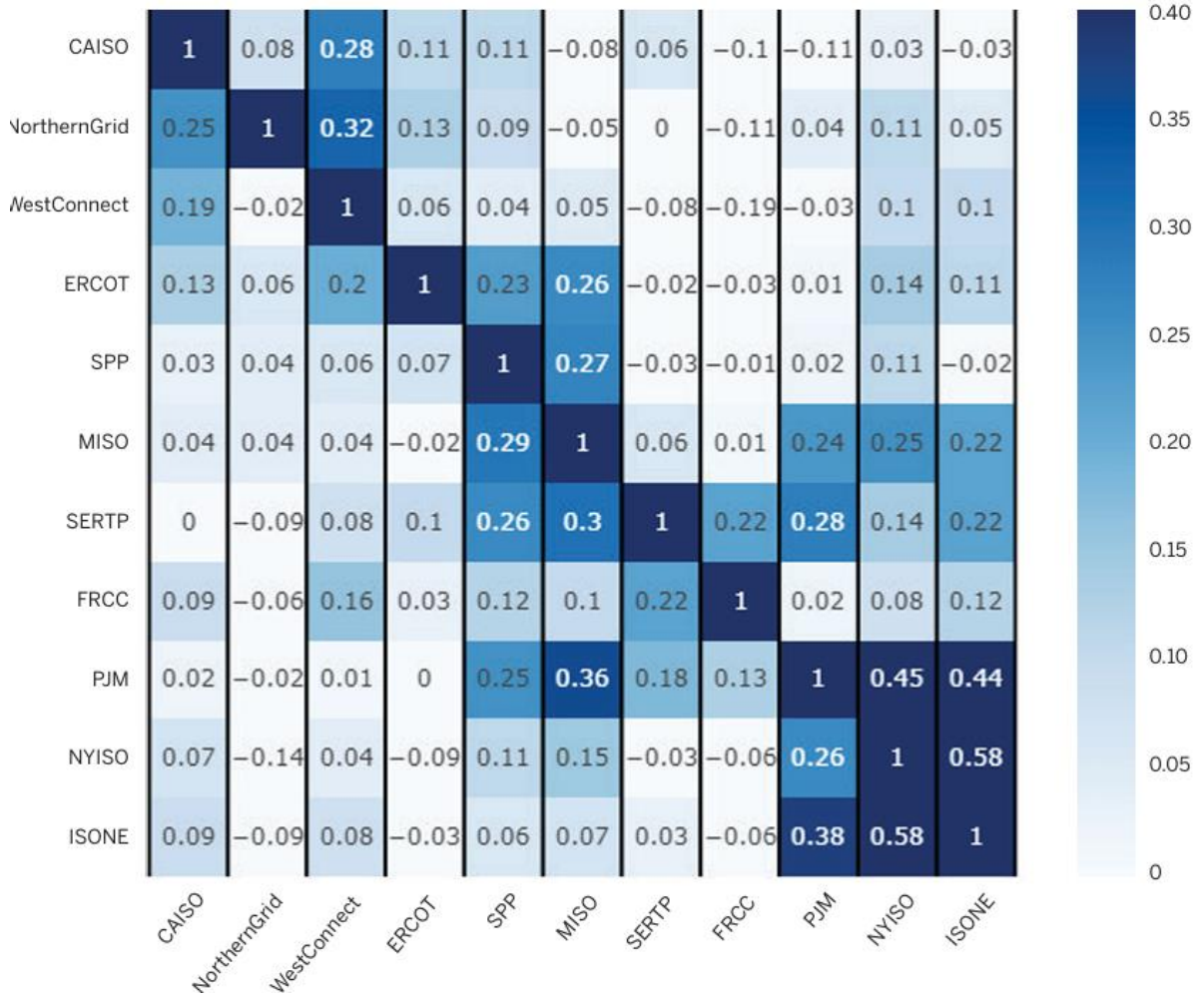


# Correlations in Regional Risk and Geographic Diversity

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



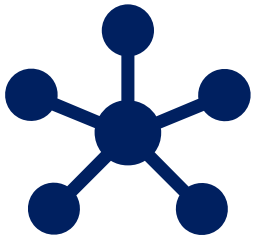

## Correlation Between FERC 1000 Regions During Hours with Low Margin (Lowest 1,400 Hours)



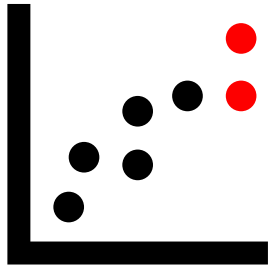
# How can we combine wide-area assessments with region-specific stress-testing and resilience analysis?

ESIG
ENERGY SYSTEMS INTEGRATION GROUP

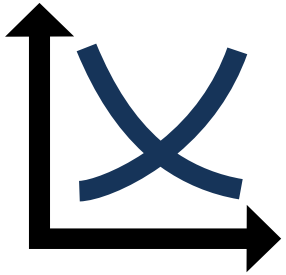
# Final Recommendations from the Task Force



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



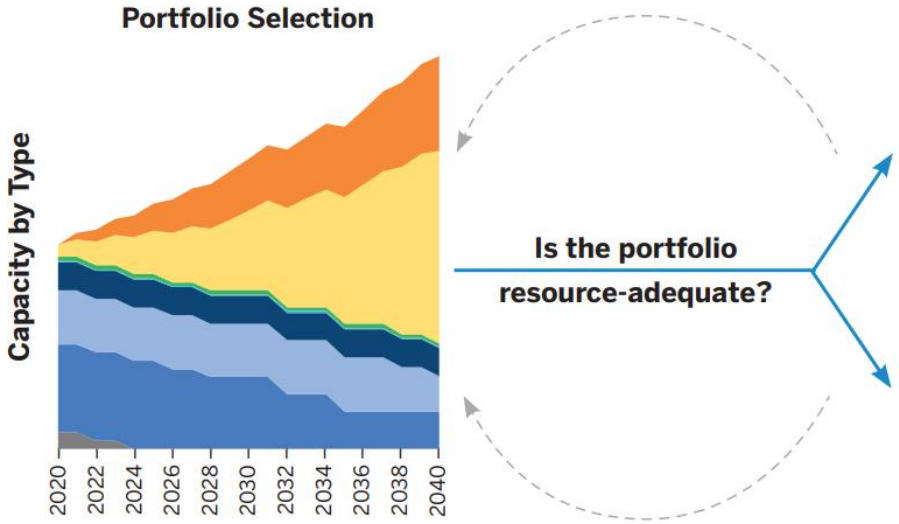
2. **Specifically consider extreme events**



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

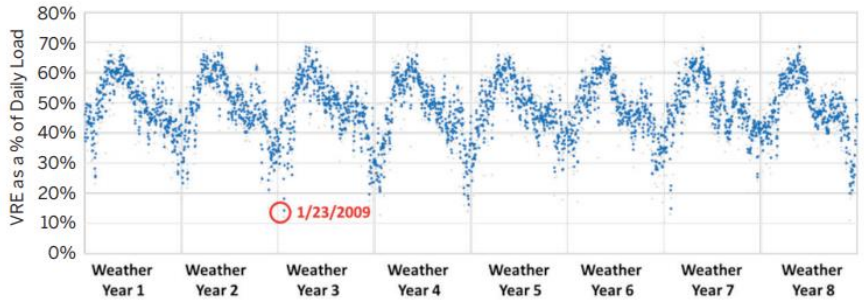
## Probabilistic Resource Adequacy Analysis

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



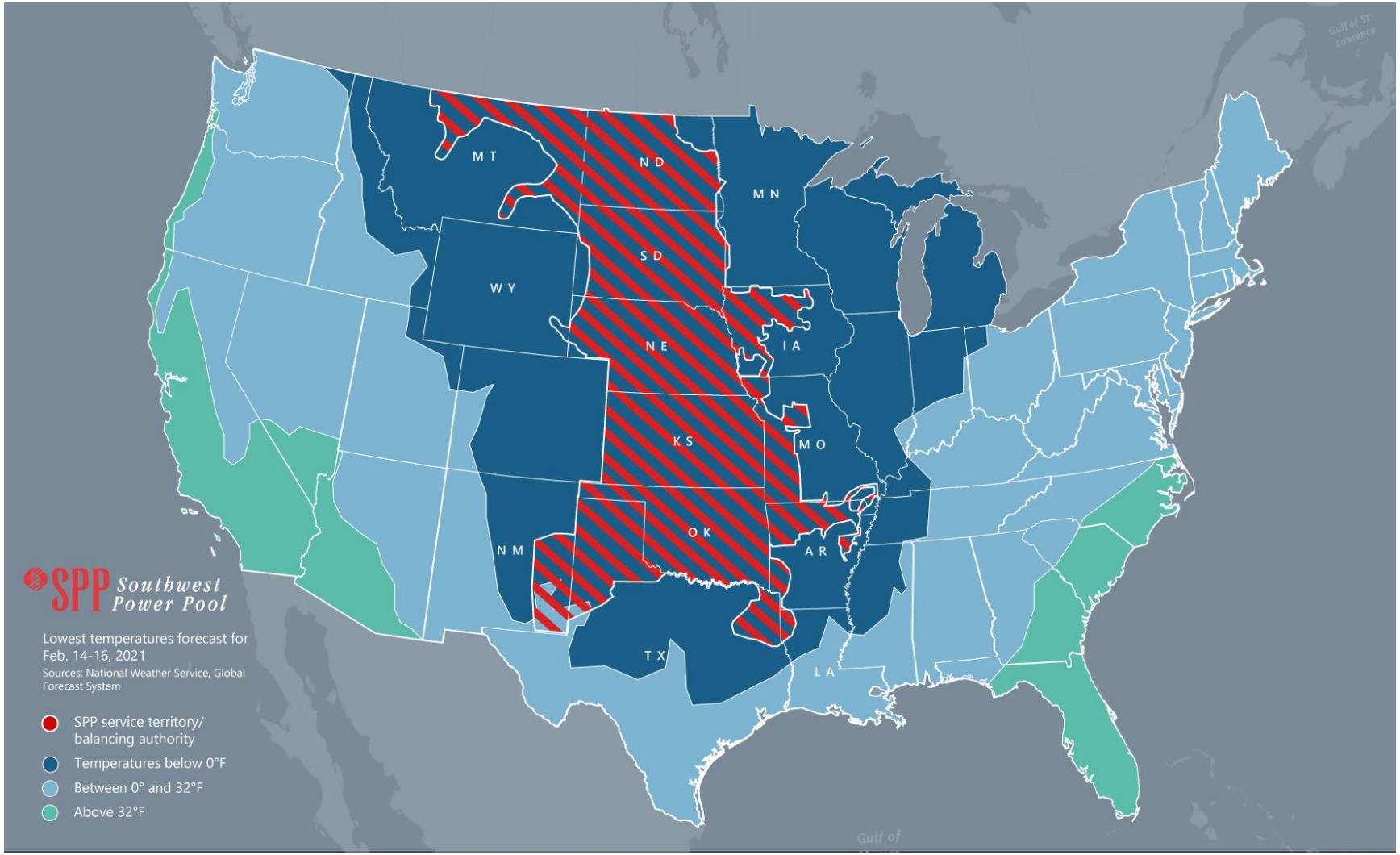

- Detailed stress tests of specific conditions
- Deeper insights into specific weather events
- Additional information in availability of imports and region-wide analysis

**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%**

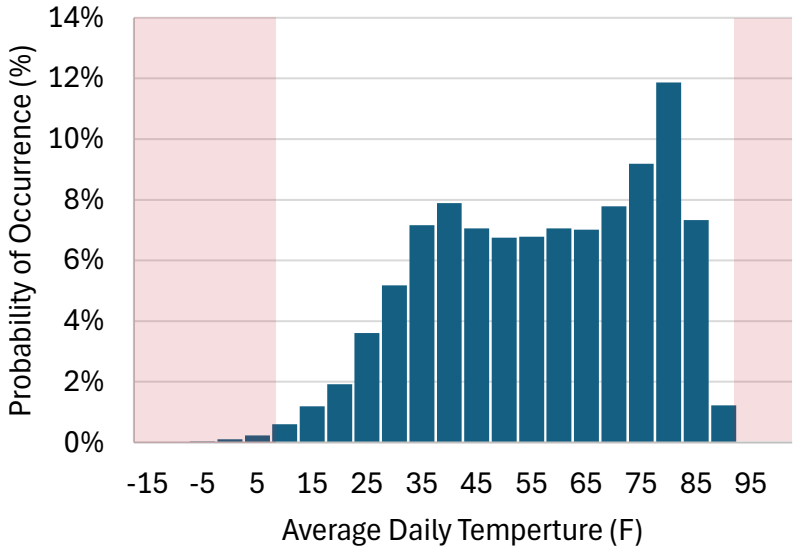
***= 450 Stress Conditions, each evaluated across different import representations***

# How extreme are our stress periods?

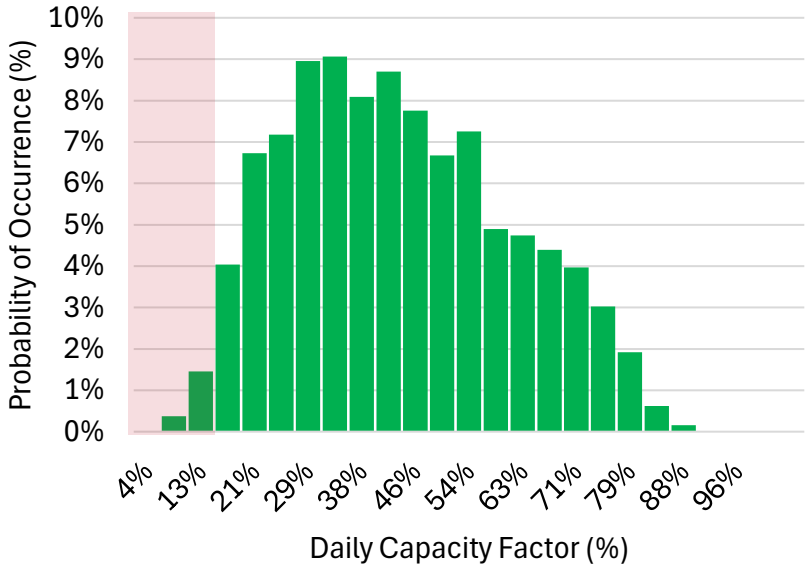
Selected stress periods are very extreme events based on the 43 years of data from SPP and recent historical outage data. We are focused on the extreme tails.

| 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 |

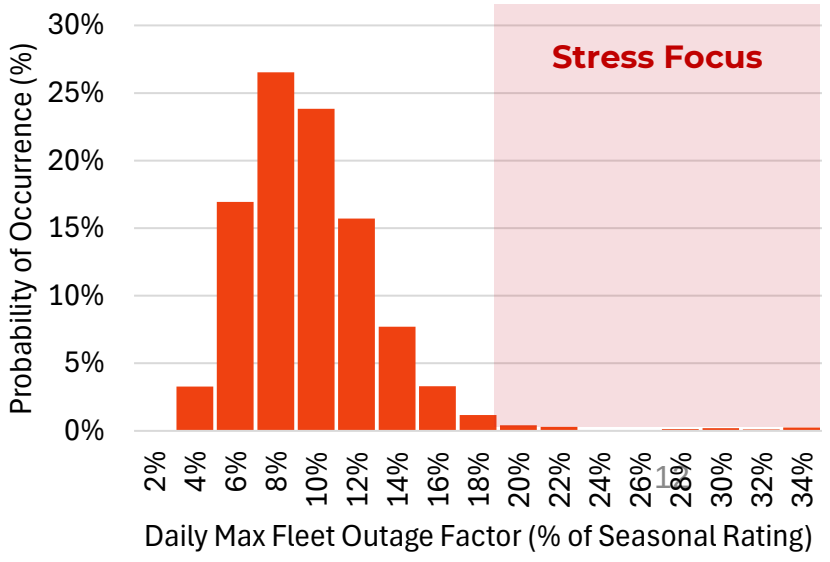
**SPP Wide Avg Daily Temp Probability (1980-2022)**




**SPP Wide Daily Wind Output Probability (1980-2022)**

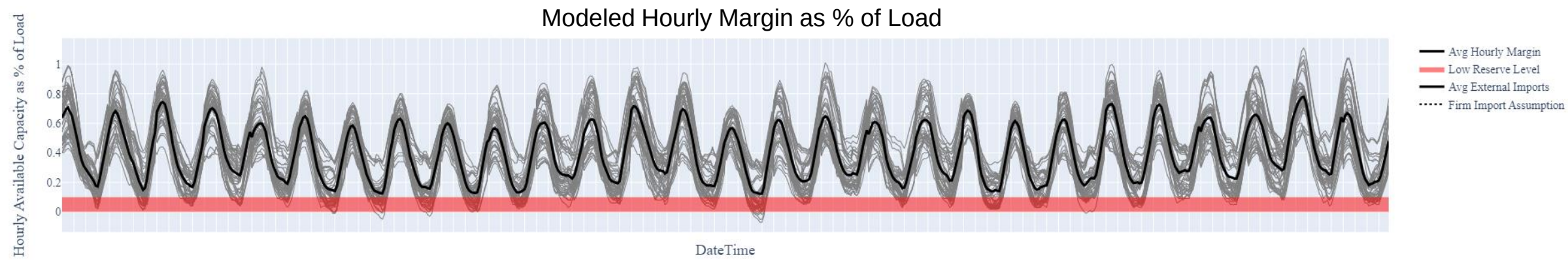


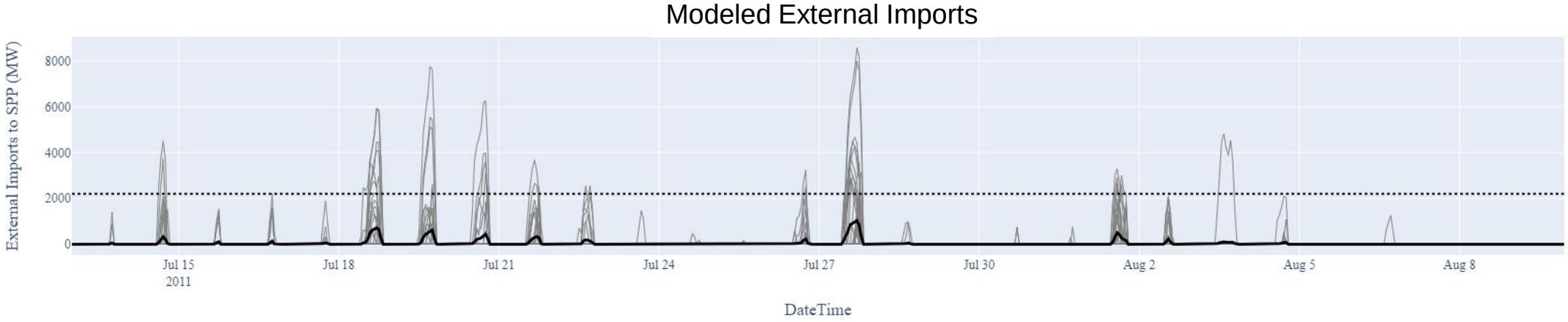

**SPP Daily Gas Fleet Outage Factor (2016-2023)**



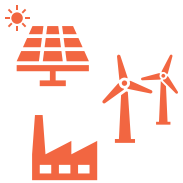
# Preliminary Results for 50 Stress Samples

## 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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