Interregional Transmission for Resilience

Using Regional Diversity to Prioritize Additional Interregional Transmission

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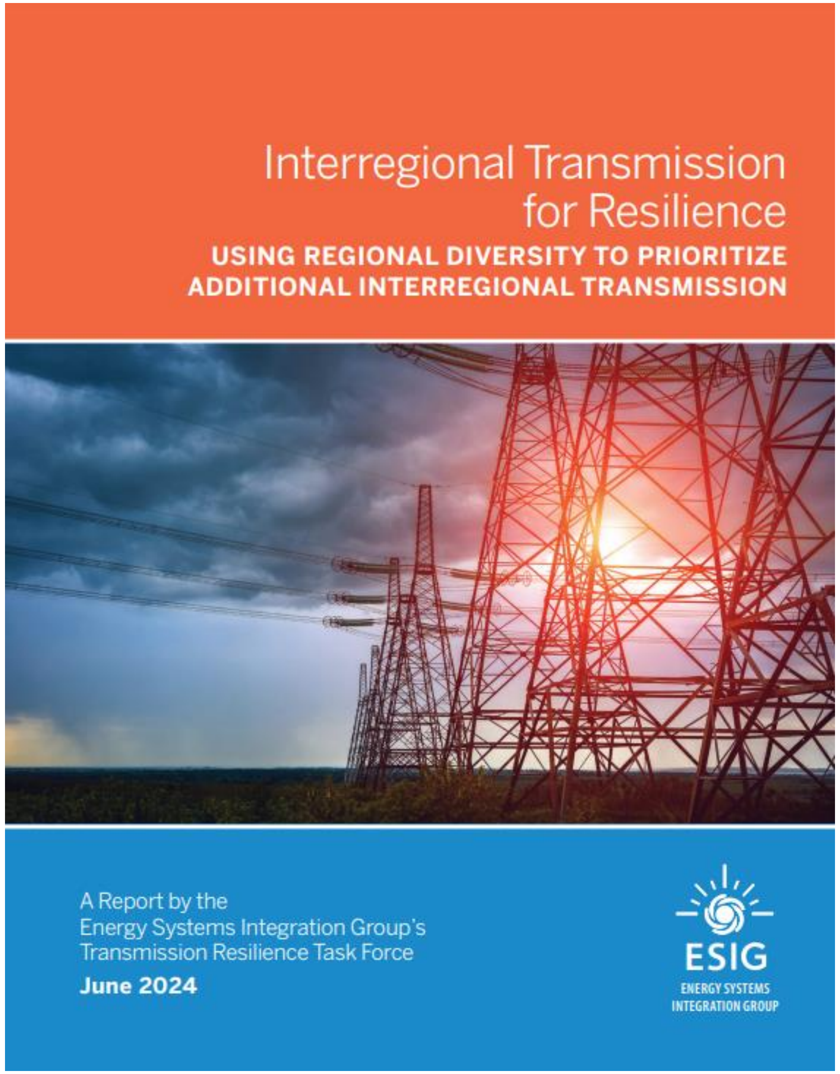
ESIG
ENERGY SYSTEMS INTEGRATION GROUP

New ESIG Report on Interregional Transmission for Resilience

Study Motivations

- Recent extreme weather events and load shedding raised attention towards interregional transmission
- BIG WIRES bill, FERC Order 1920, NERC ITCS, and other proposals related to interregional transfer capability
- Lack of national-level transmission assessments focused on reliability
- Desire to develop a method to consider the value of interregional transmission during resilience events



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Study Objectives & Key Findings

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Objectives

1. **Identify high priority, prudent additions to total transfer capability between regions to support reliability**

2. **Develop a weather dataset and regional energy margins (load, wind, solar, thermal outages) that can be used to represent neighboring regions within a probabilistic RA assessment**

Out of Scope

- ACPF transfer capability (used historical flows to inform interregional limits)
- Probabilistic Resource Adequacy analysis (intended to augment those studies with a better, yet simplified, view of interregional imports

Key Outcomes

A Framework for Planners
This methodology can be used to augment a region's probabilistic RA framework to investigate where their region may see the most resilience benefits for expanding interregional transmission capabilities.

Identification of Priority Lines
Planning transmission with regards to resilience should consider geographically diverse areas with complementary resource mixes, uncorrelated outage and load risks.

Data needs are critical
We have limited availability of consistent, correlated, hourly time series of load, wind, solar, and weather-dependent outages and we are missing extreme events.

Existing Interregional Transfer Limits

Study Approach:
Transfer limits for FERC Order 1000 planning regions based on **actual hourly EIA 930 data from 2019 – 2023.**

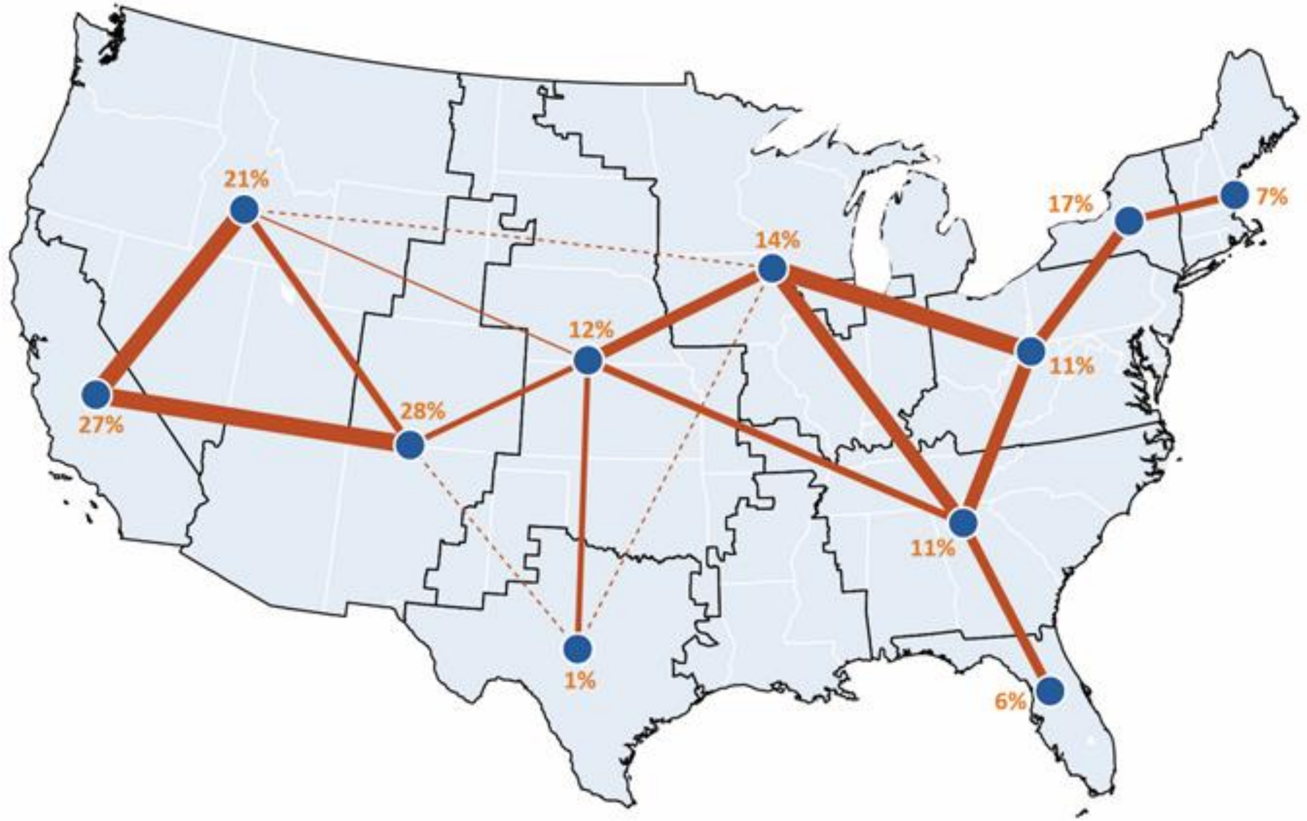
Data used 99th percentile of historical interchanges to control for outlier data.

<u>Embedded in these limits:</u>

- ✓ Assumption that each region hit a limit once in the past five years
- ✓ Physical infrastructure
- ✓ Resource deficiencies during times of risk
- ✓ Market rules and tariffs that could limit flow

***intentionally did *not* look at AC transfer capability**

Existing Interregional Transmission Paths Across the U.S., by FERC Order 1000 Region

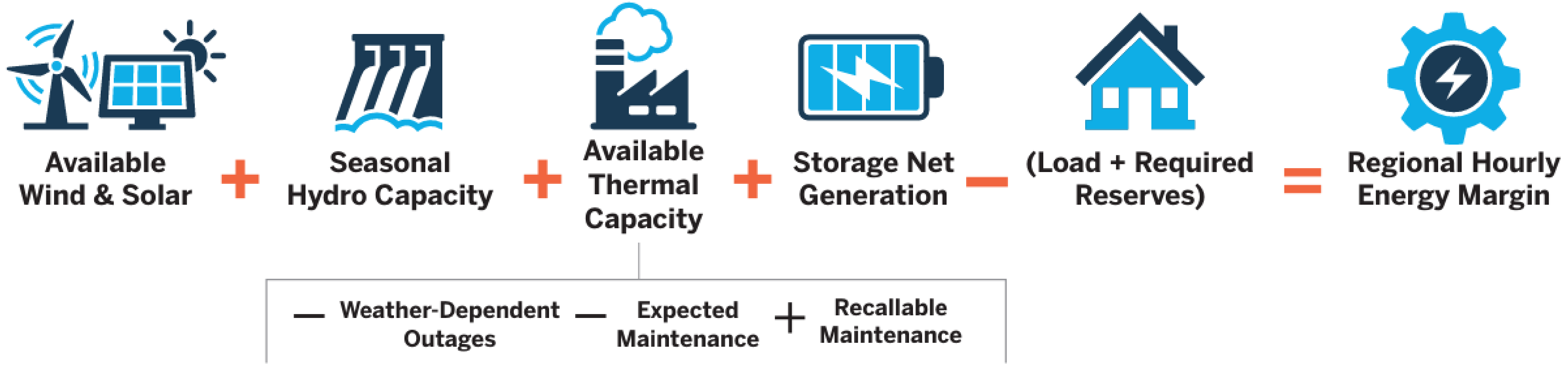


The blue dots represent the FERC Order 1000 regions, with orange lines showing the magnitude of the transfer capability between each pair of regions. Dotted lines represent no existing transfer capability, but the potential for immediate neighbors to create transfer capability. The thickness of the solid lines indicates the relative amount of transfer capability in each case. Note, transfer capabilities for U.S. regions with connections to Canadian regions are not included in these values.

Source: Energy Systems Integration Group; data from Energy Information Administration 930 Hourly Electric Grid Monitor.

Hourly Regional Margin Approach

Regional Hourly Energy Margin Formula Used in This Study



Pros and Cons of the Hourly Energy Margin Analysis Developed in this Study

Method Pros	Method Cons
✓ Allows for quick regional assessments of expected resource availability ✓ Captures hourly variability in wind and solar output against thermal availability ✓ Incorporates multiple weather years of temperature data into resource availability ✓ Allows for easy variation for levels of reserve require-ments to assess more conservative operations	x Does not assess actual system dispatch of economic transfers x Hydro uses a simplified availability based on seasonal capacity ratings, which does not capture energy limitations of hydro x Storage resources are dispatched to net load within a 24-hour period as an aggregated capacity/energy pool

Example of Hourly Energy Margin Results

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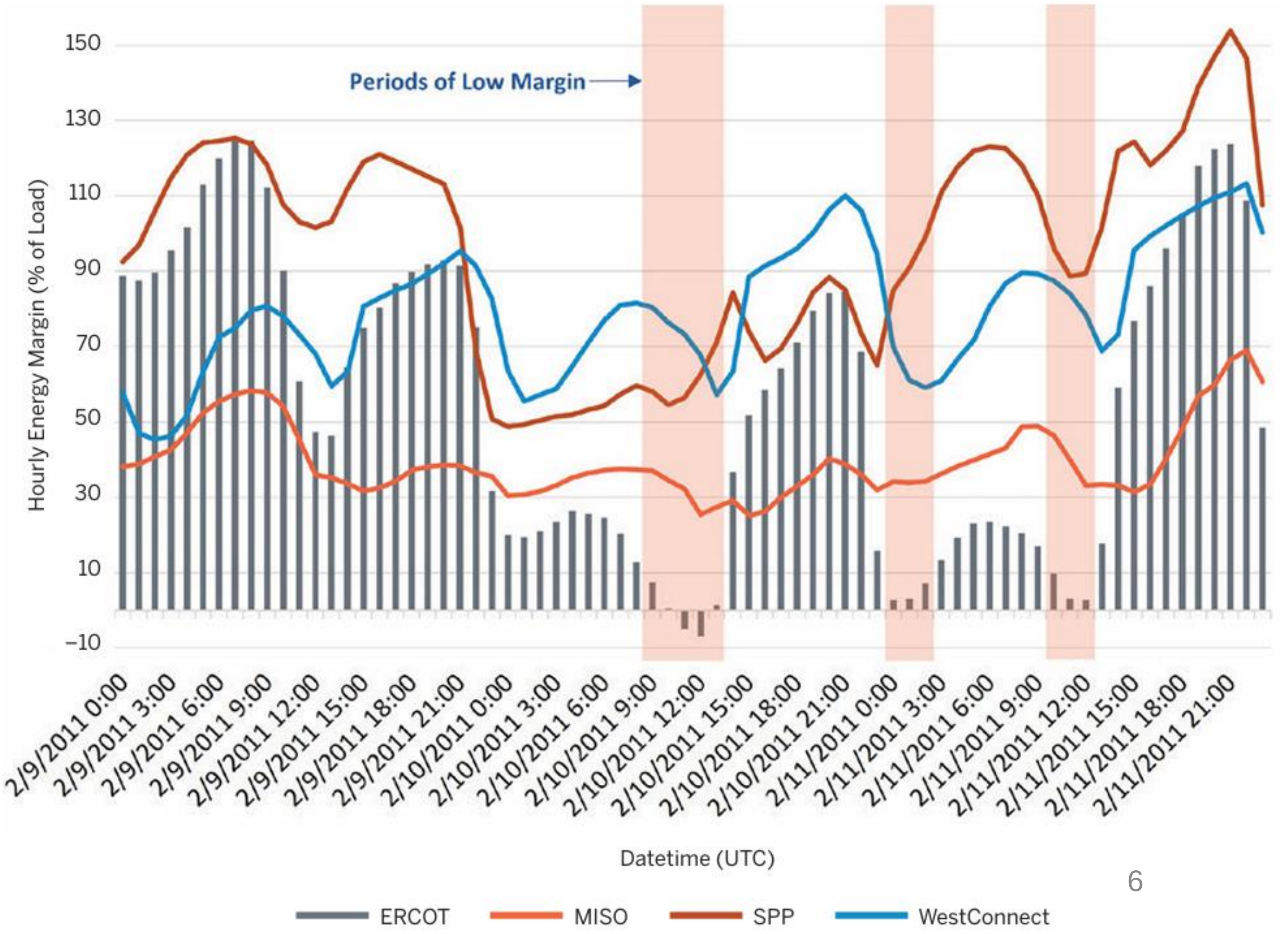
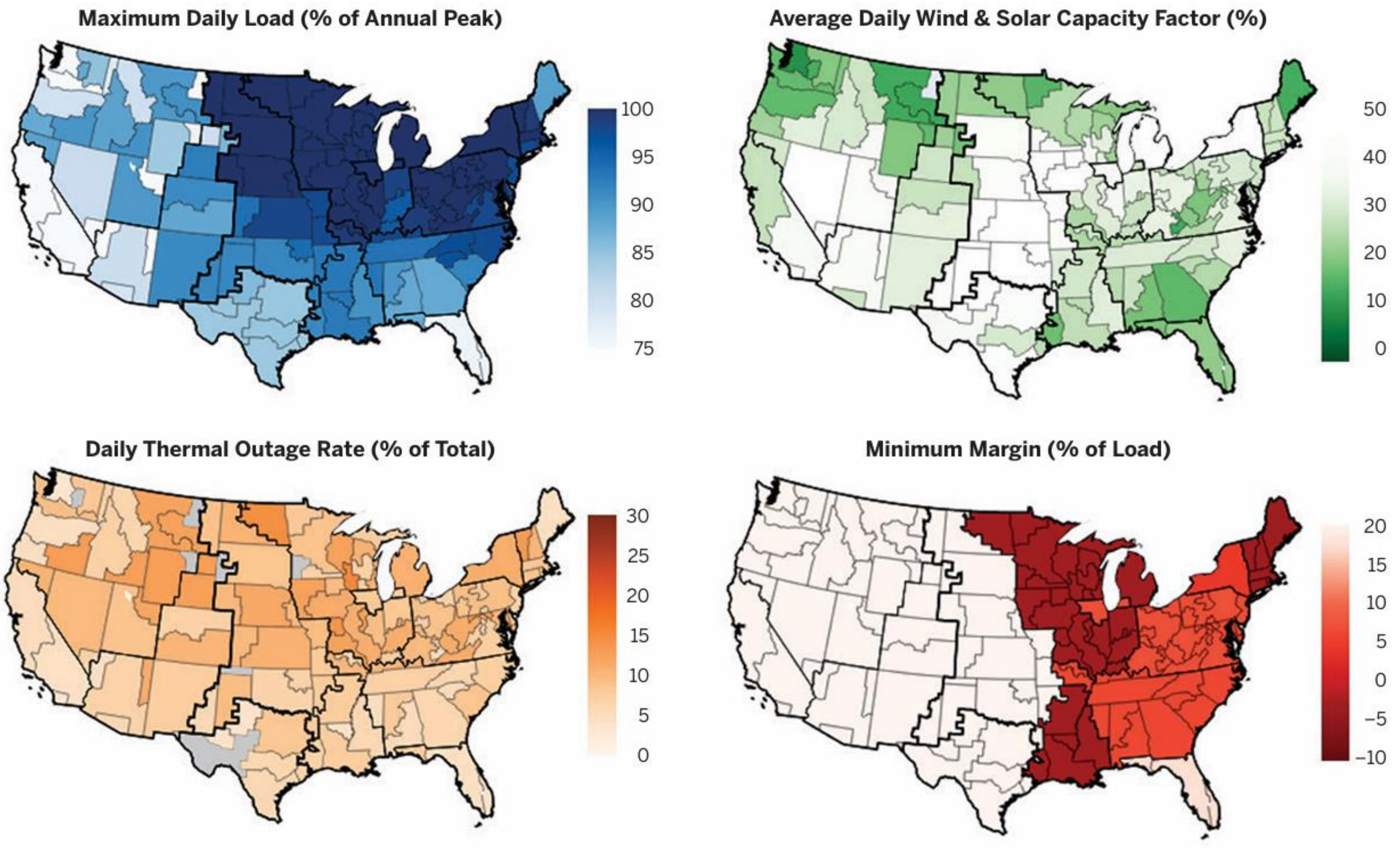
The value of evaluating regional resources in a consistent, synchronized method

- Regional energy margins vary hourly due to load, renewable output, storage, and daily thermal generator availability.
- Periods of low margin (high potential grid stress) across regions are evaluated on a synchronized basis across multiple regions.
- Enables evaluating resource availability for interregional transmission to support neighbors.

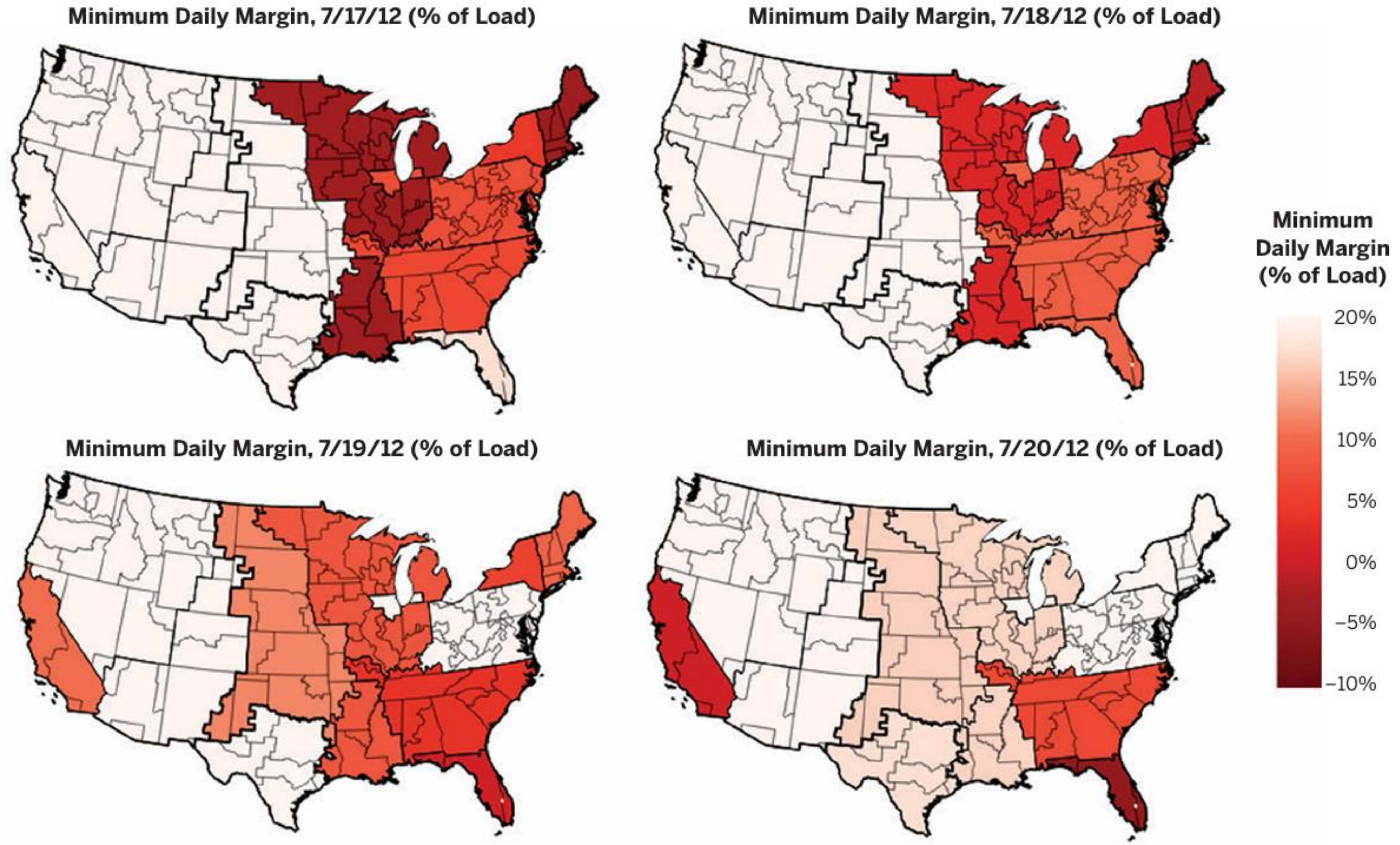
Hourly Energy Margin for ERCOT, SPP, MISO, and WestConnect for 2/9/2011– 2/11/2011 Weather Data



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



Progression of Minimum Daily Energy Margin for FERC 1000 Regions for July 17–20, 2012, Weather Data



Correlations in Regional Risk

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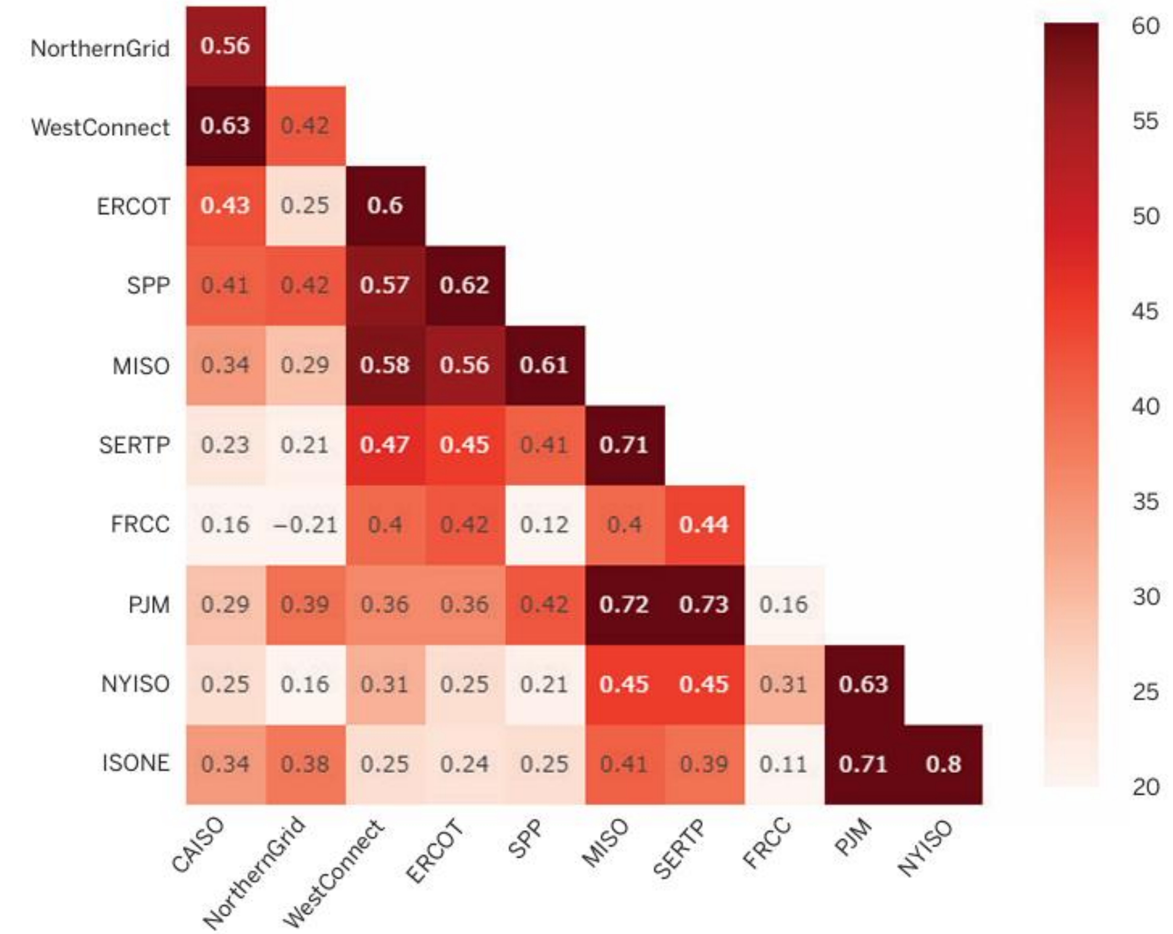
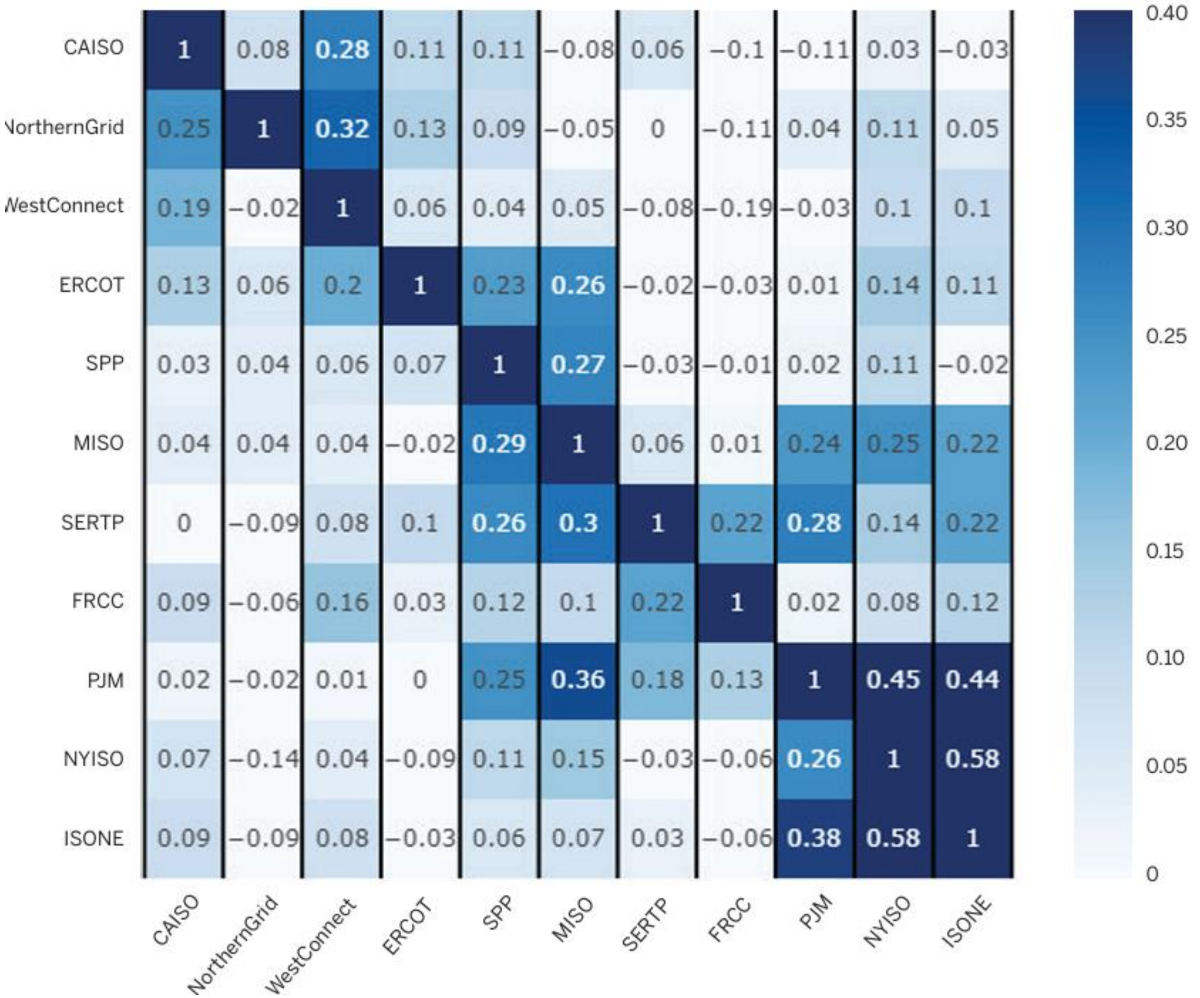
Minimum Daily Energy Margin Correlations Between FERC 1000 Regions for 2007–2013, All Hours



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



Where to prioritize transfer capability to meet 20% of peak demand?

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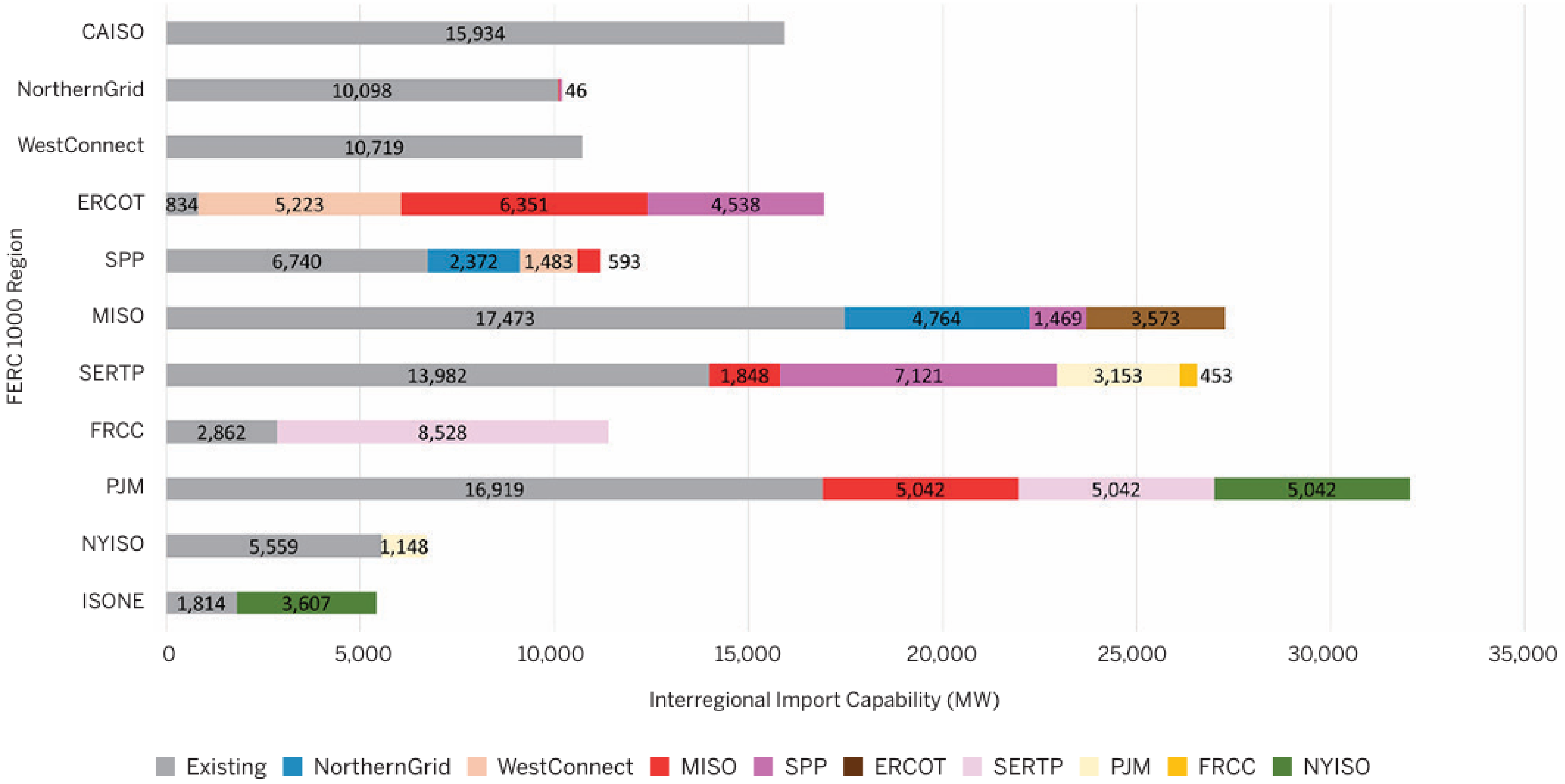
Interregional Non-Coincident Import Capability Added by the Model, by FERC Order 1000 Region, to Allow Each Region to Import 20% of Its Peak Load

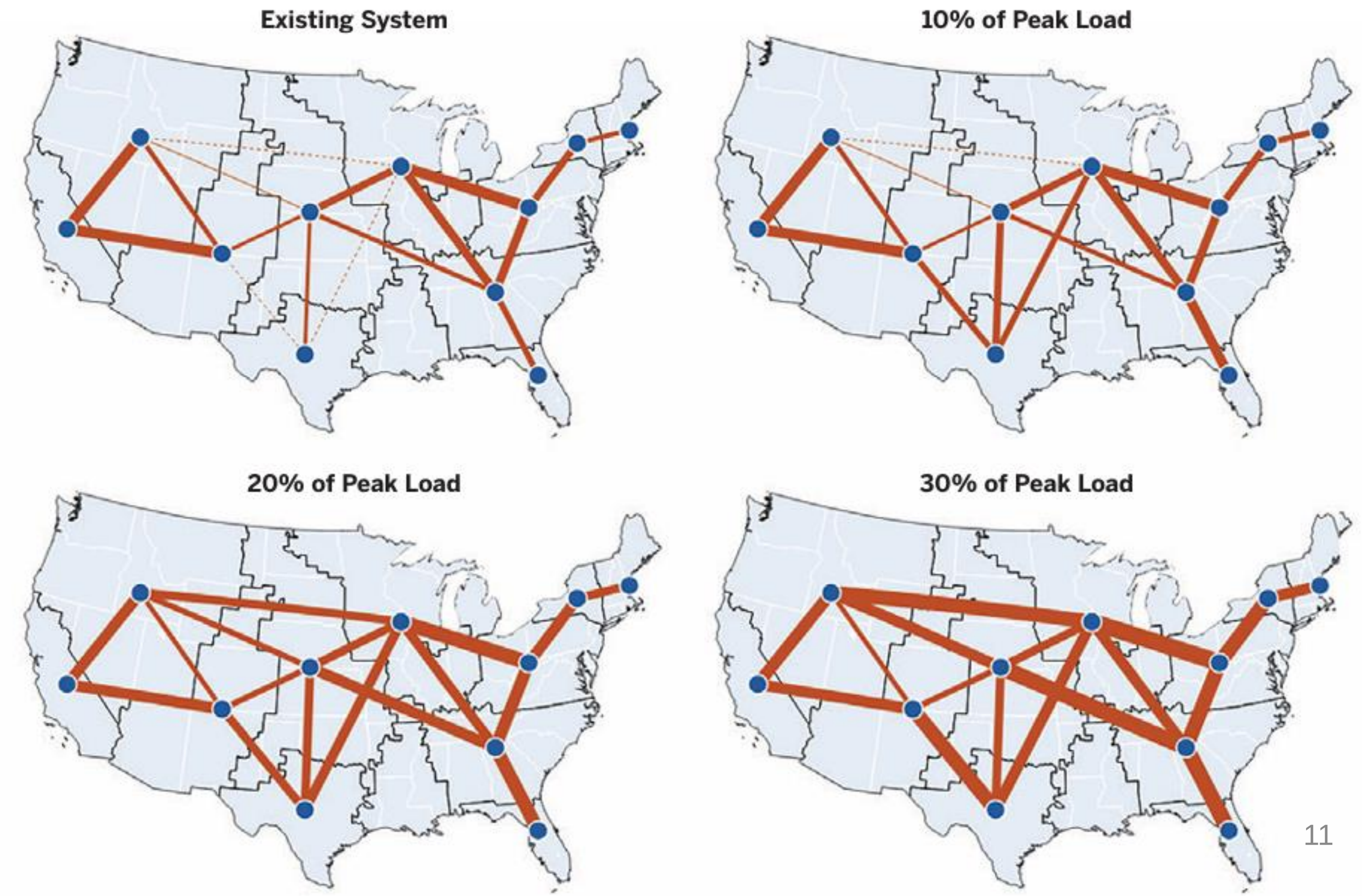


Scale of Additional Transmission Capability

Existing U.S. Interregional Transfer Capability Between FERC 1000 Regions, and the Size of Connections Needed for 10%, 20%, and 30% Minimum Transfer Capability

Results of Increasing Transmission Capability for all regions:
By the 20% of peak load import case, every potential connection (dotted lines) between regions is added relative to today's system.

Notably, increased connections between the Eastern, Western, and ERCOT interconnections is valuable to mitigate risks based on differences in hourly energy margins.



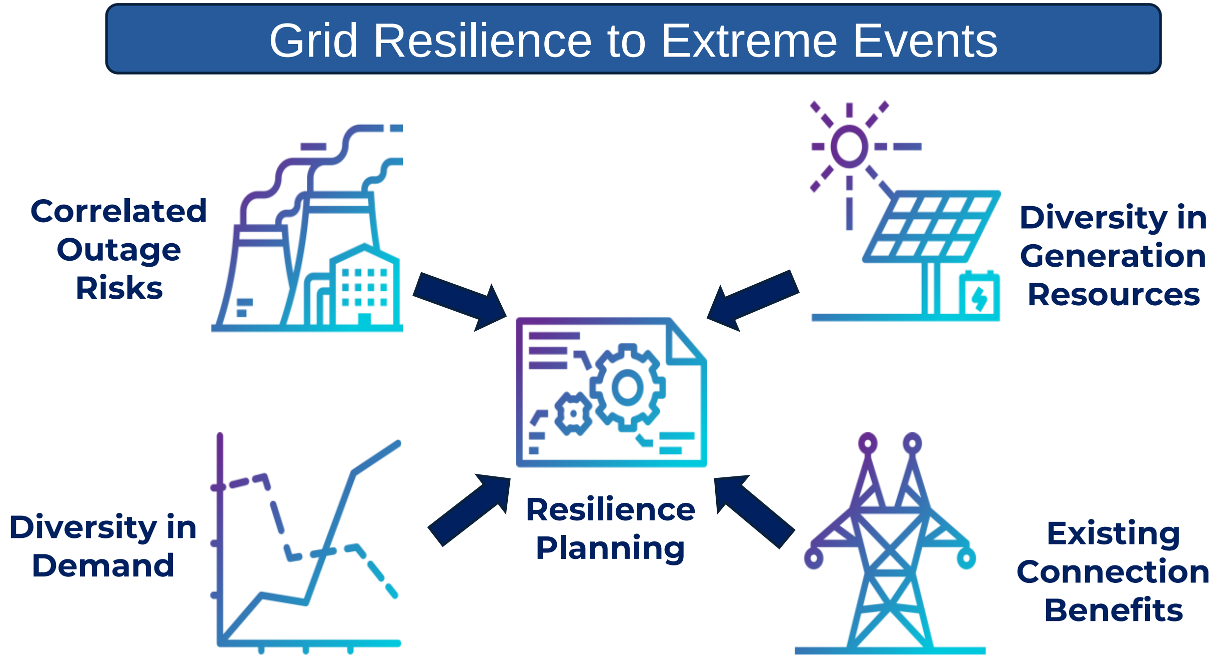
Key Practices for Interregional Transmission Planning

Prioritize regions with less existing transfer capability
There may be a quantifiable minimum transfer capability that all regions can meet to improve resilience

Prioritize transfer capability that increases imports from regions with uncorrelated risks
Assessing hourly variations in surplus and deficits for all regions allows prioritizing those with uncorrelated risks

Focus on immediate neighbors
Increasing interregional transmission focused on connections between geographically closer regions can minimize costs

Allow for power to flow from a neighbor's neighbor
Adequate evaluation needs to represent a region's access to load and resource diversity beyond its immediate neighbors



Next Steps

Improve Data: increase availability of consistent, correlated, hourly time series of load, wind, solar, and weather-dependent outages … specifically for extreme events.

Refine regional topologies: incorporate sub-regional topology, beyond FERC Order 1000 regions

Corroborate historical transfer limits: compare historical flows to engineering analysis and ACPF transfer capabilities

Coordinate with industry: socialize method and coordinate with other studies at DOE, NERC, and ISO/RTOs

Utilize method in future work: expand on energy margin assessment to represent neighbors in regional transmission planning