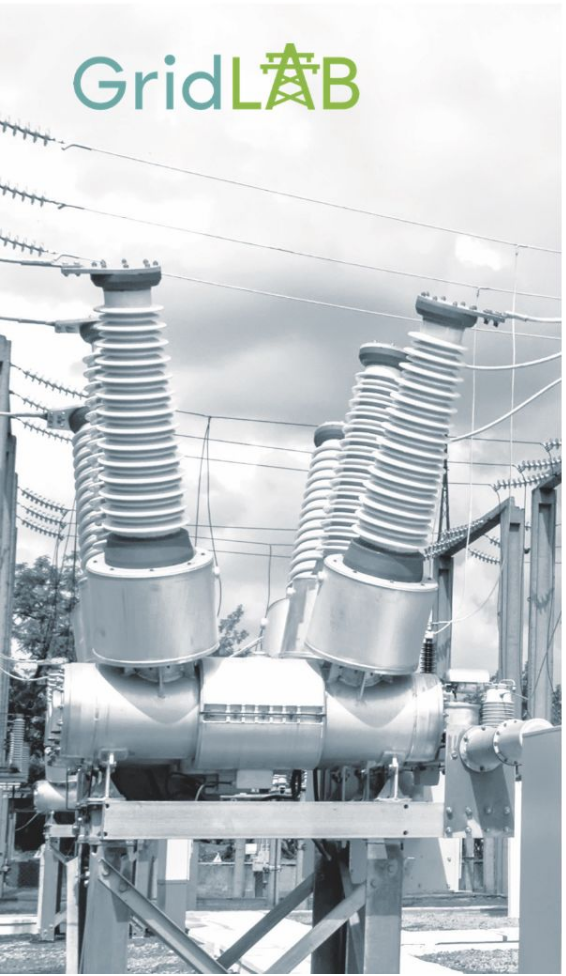
Advancing Electric Transmission

The Council of State Governments Midwest

Casey Baker
Cassady Craighill

GridLAB



Today's Talk

- State of the electric system
  - Reliability
  - Economics
  - Demand Growth
- Near Term Solutions -Advanced Transmission Technologies
- Long Term Solutions - Regional and Interregional Planning
  - FERC Order 1920

What is GridLab?

501(c)(3) providing technical support and research for a reliable and resilient clean energy grid

TECHNICAL ASSISTANCE

CONNECTIVITY PLATFORM

TRAINING

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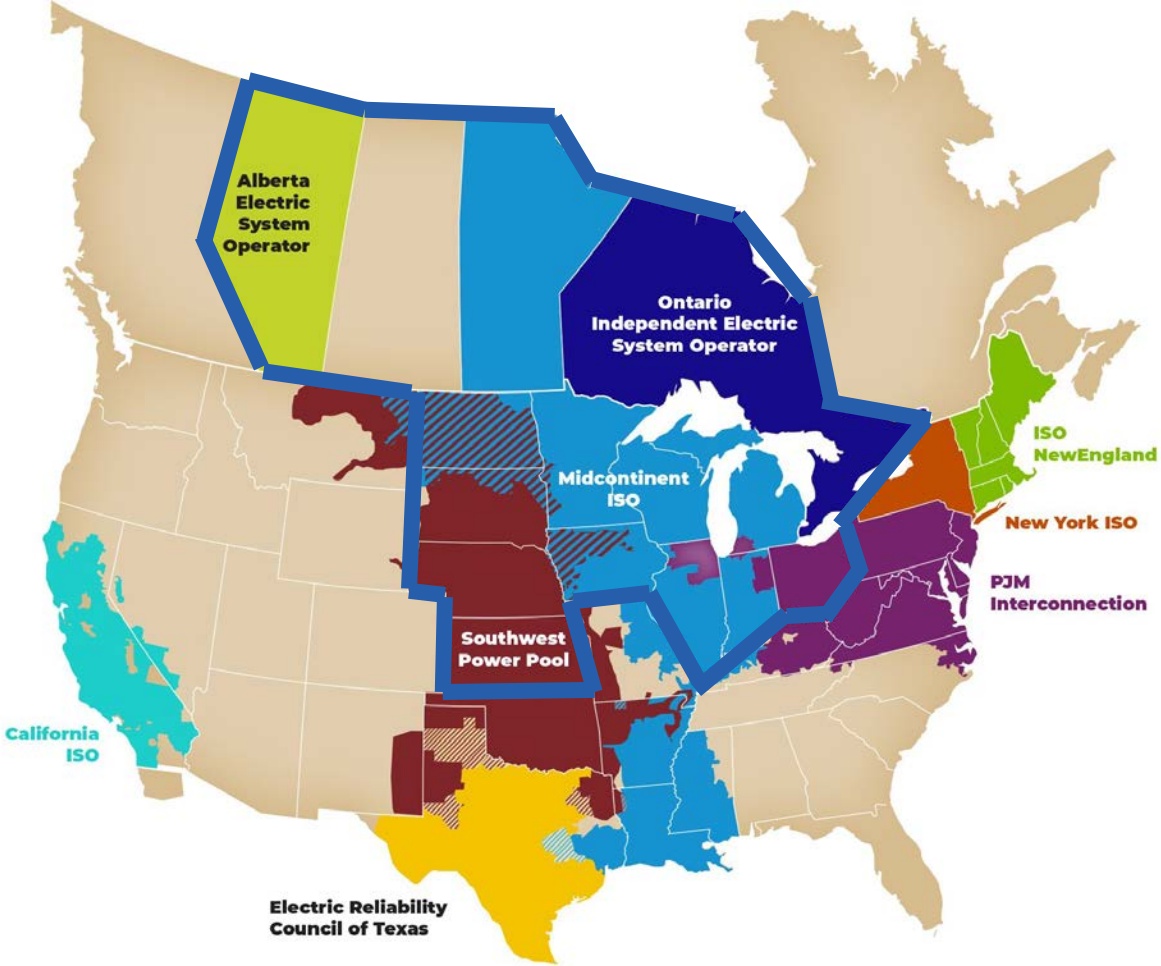
State of the Electric System



IRC
ISO/RTO COUNCIL

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Reliability

BREAKING: Emergency alert issued, Albertans asked to immediately reduce power to avoid rotating outages

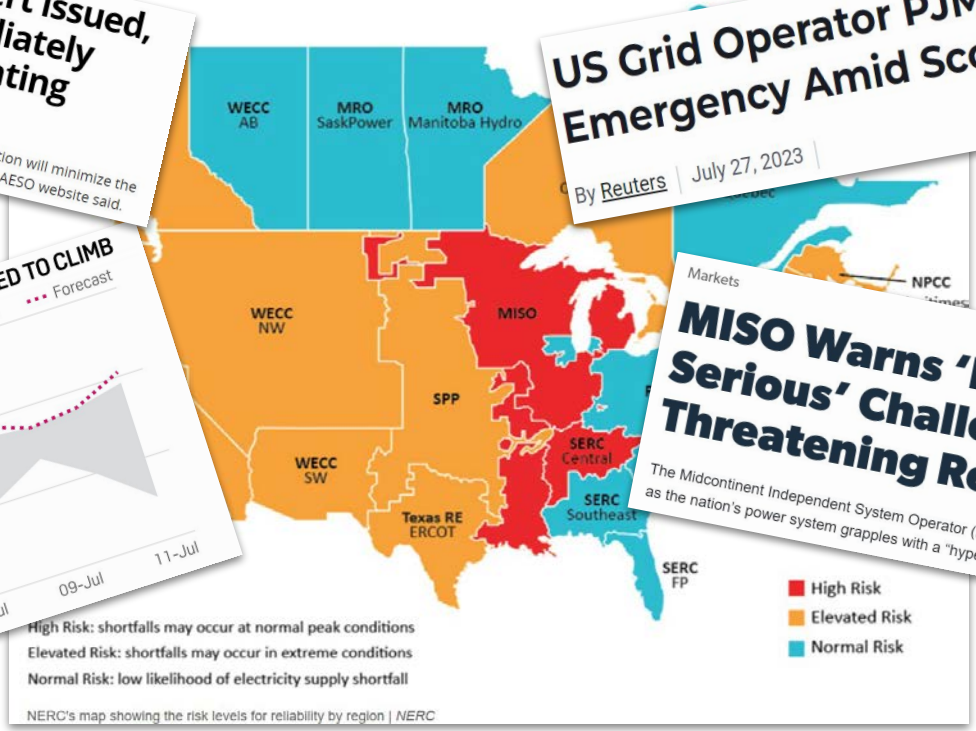
"Reducing peak electricity demand through province-wide conservation will minimize the high potential for rotating outages this evening," a statement on the AESO website said.

US Grid Operator PJM Declares Level One Emergency Amid Scorching Heat

By Reuters | July 27, 2023

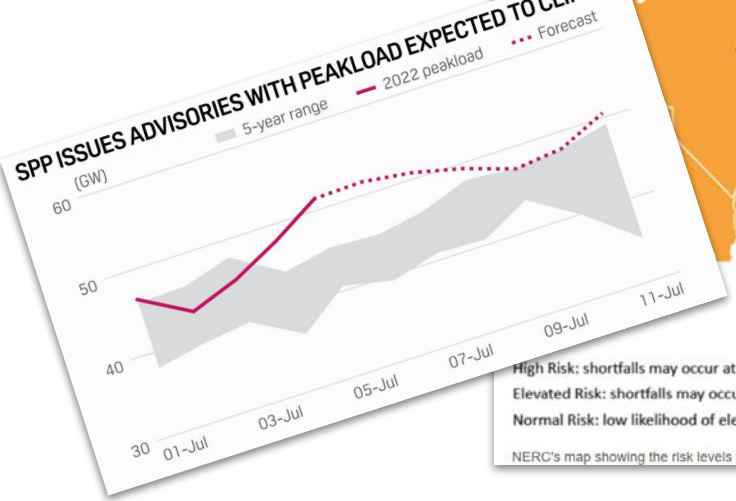
NERC: Growing Demand, Shifting Supply Mix Add to Reliability Risks

Long-Term Reliability Assessment Finds PJM Only RTO Without Elevated Risks



NERC's map showing the risk levels for reliability by region | *NERC*

SPP ISSUES ADVISORIES WITH PEAKLOAD EXPECTED TO CLIMB

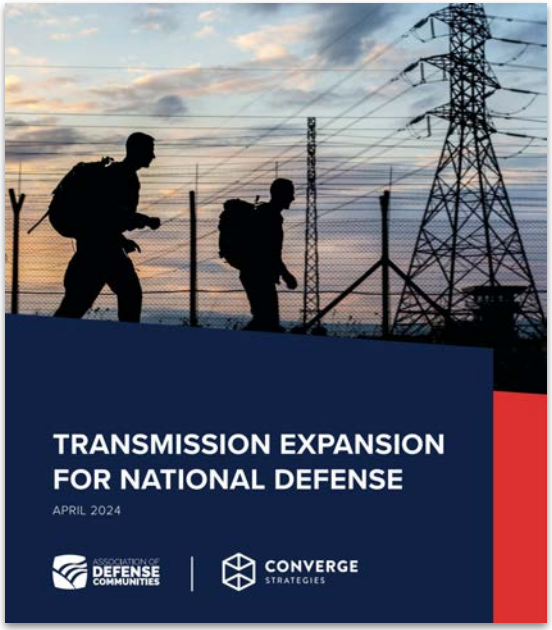


Markets

MISO Warns 'Immediate and Serious' Challenges Are Threatening Reliability

The Midcontinent Independent System Operator (MISO) is warning reliability challenges have grown urgent as the nation's power system grapples with a "hyper-complex risk environment."

Electric Reliability and National Defense



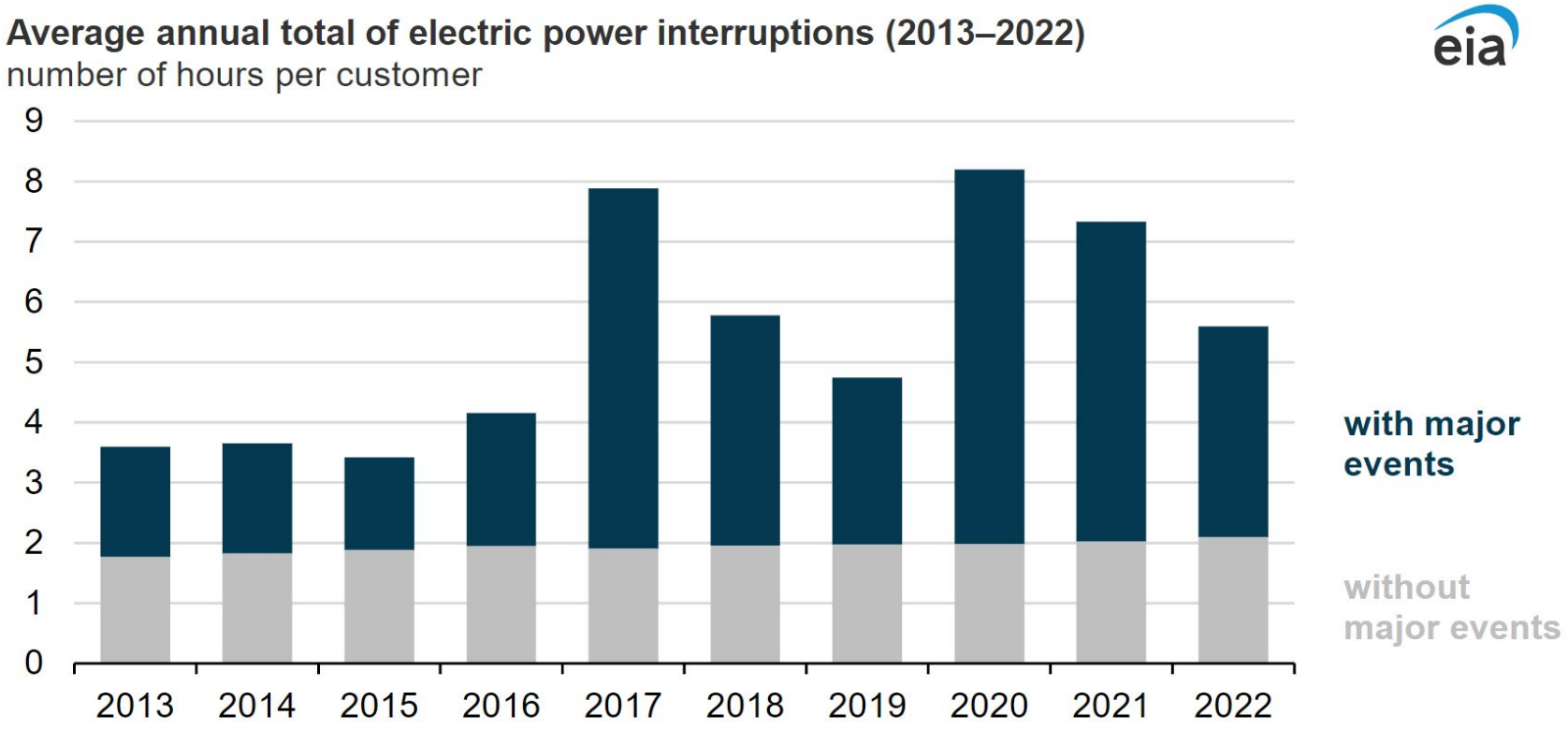
"As a result of Winter Storm Uri, DoD reported more than 1,000 hours of hours of unplanned outages at its installations."

"Twelve of the 15 military installations in the state experienced disruptions to their electricity service."

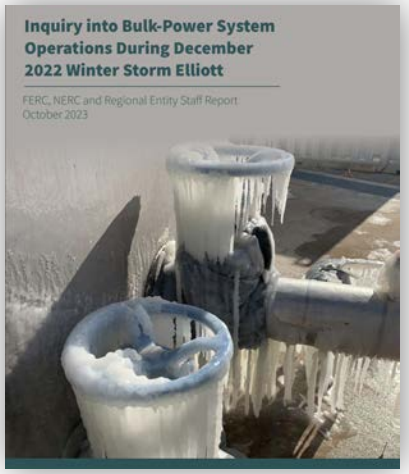
"ERCOT's inability to draw on interregional transmission as a source of backup power exacerbated the damage of the outages. Midcontinent Independent System Operator (MISO) and Southwest Power Pool (SPP) faced operating conditions similar to ERCOT, but they were able to access far more generation capacity through interregional transmission to avoid widespread outages."

https://defensecommunities.org/wp-content/uploads/2024/04/Converge-Stategies-Report-Final-ADC-Publications-April-2024.pdf

U.S. electricity customers averaged five and one-half hours of power interruptions in 2022



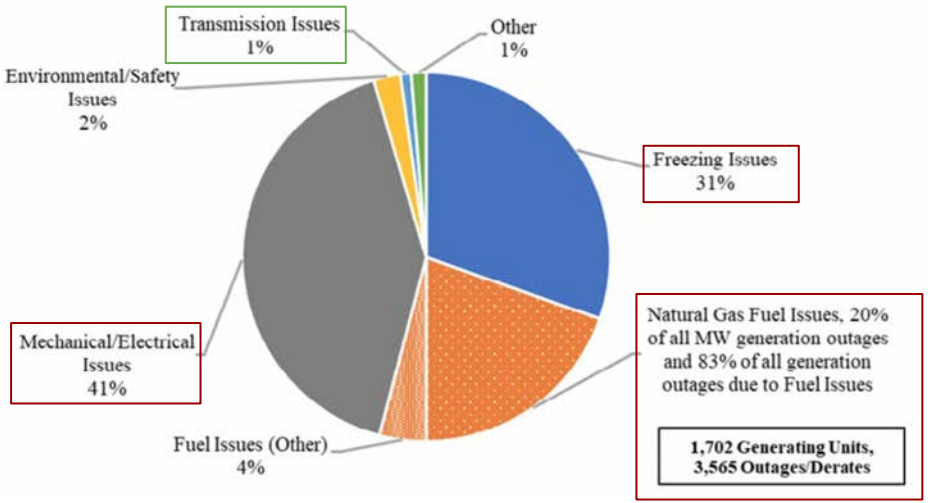
U.S. Energy Information Administration, *Annual Electric Power Industry Report*



Inquiry into Bulk-Power System Operations During December 2022 Winter Storm Elliott

FERC & NERC Staff

Figure 7: Incremental Unplanned Generating Unit MW Outages, Derates and Failures to Start, Total Event Area: by Cause

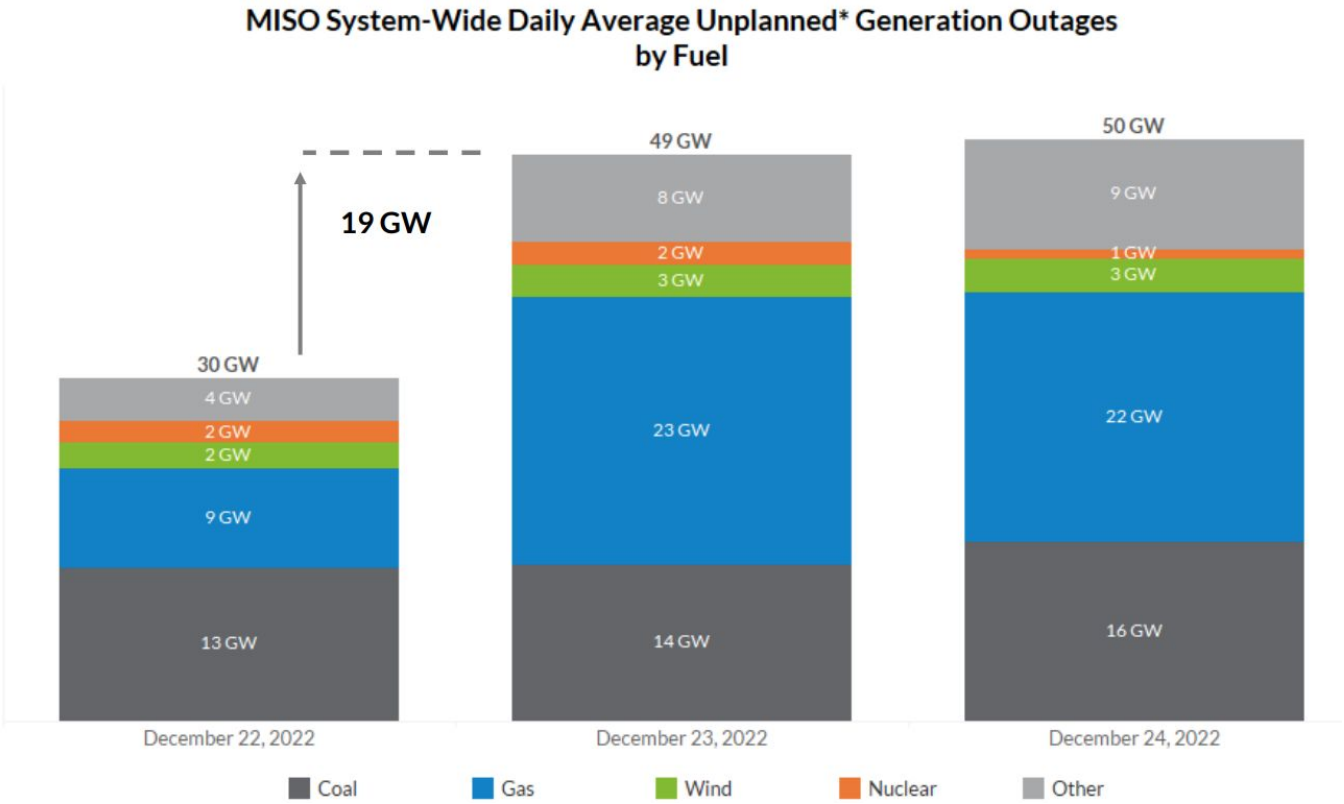


"planned and unplanned generating unit outages caused energy emergencies [that] in 2011, 2014 and 2021 triggered the need for firm load shed."

"Had Consolidated Edison Inc. (NY) not taken emergency action, gas heating could have been shut off for months in "all or portions" of its territory."

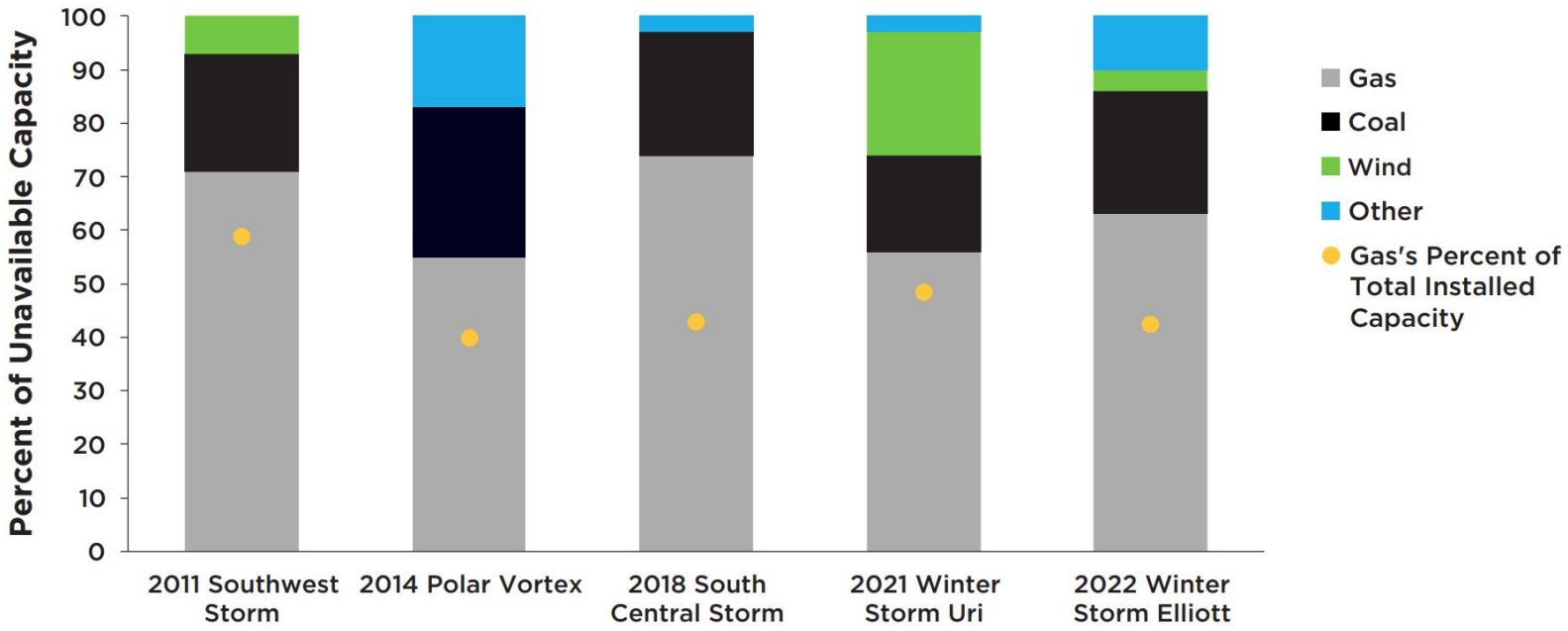
https://www.ferc.gov/sites/default/files/2024-02/24_Winter-Storm_Elliot_0207_UPDATE.pdf

Gas supply availability contributed to increased unplanned outages, particularly in the afternoon, that pushed MISO into emergency procedures



https://cdn.misoenergy.org/20230117%20RSC%20Item%2005%20Winter%20Storm%20Elliott%20Preliminary%20Report627535.pdf

Natural Gas Generation Failures Disproportionately Contributed to Capacity Shortfalls in Five Recent Cold Weather Events



https://www.ucsusa.org/sites/default/files/2024-01/gas-malfunction_summary.pdf

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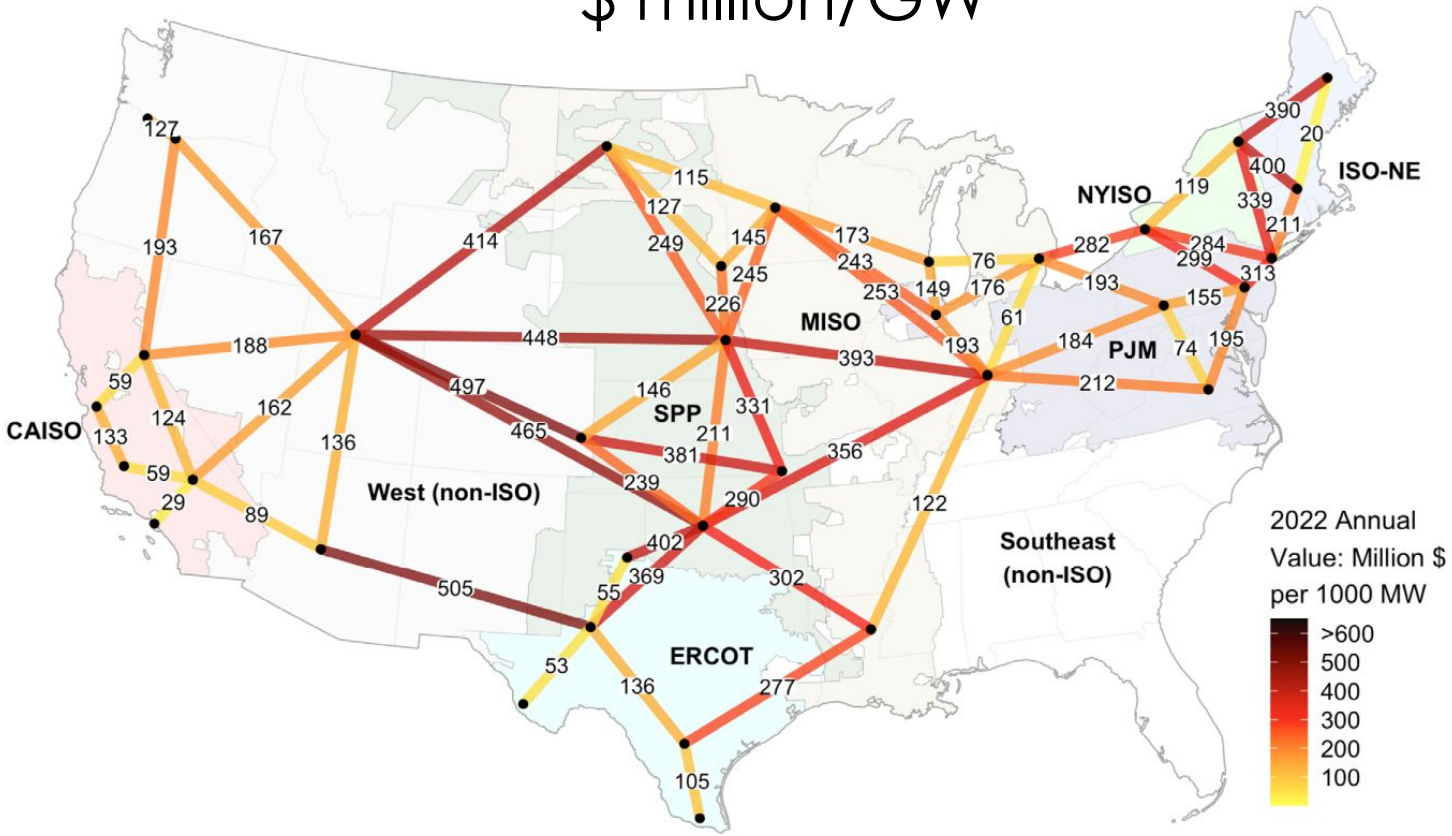
Economics

Annual Transmission Congestion Costs
$ billions

https://gridstrategiesllc.com/wp-content/uploads/2023/07/GS_Transmission-Congestion-Costs-in-the-U.S.-RTOs1.pdf

The Value of Transmission
$ million/GW



https://eta-publications.lbl.gov/sites/default/files/lbnl-transmissionvalue-fact_sheet-2022update-20230203.pdf

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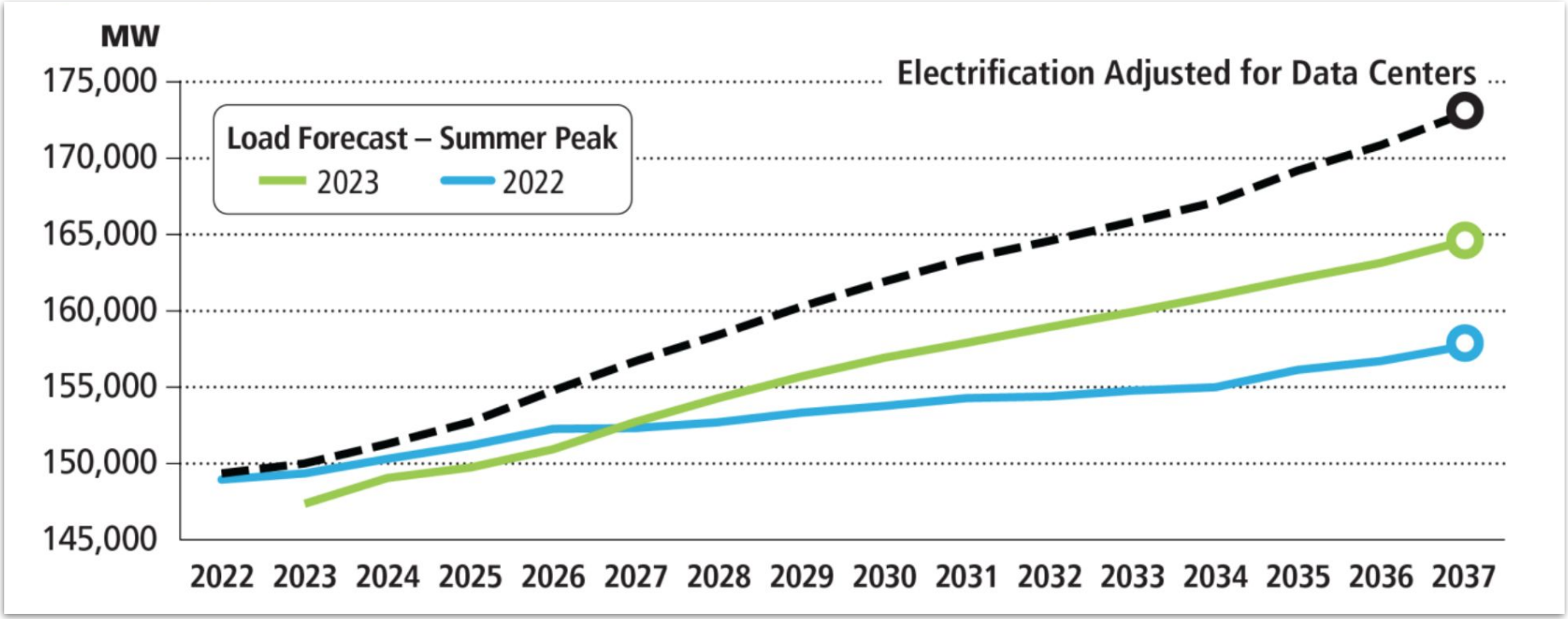
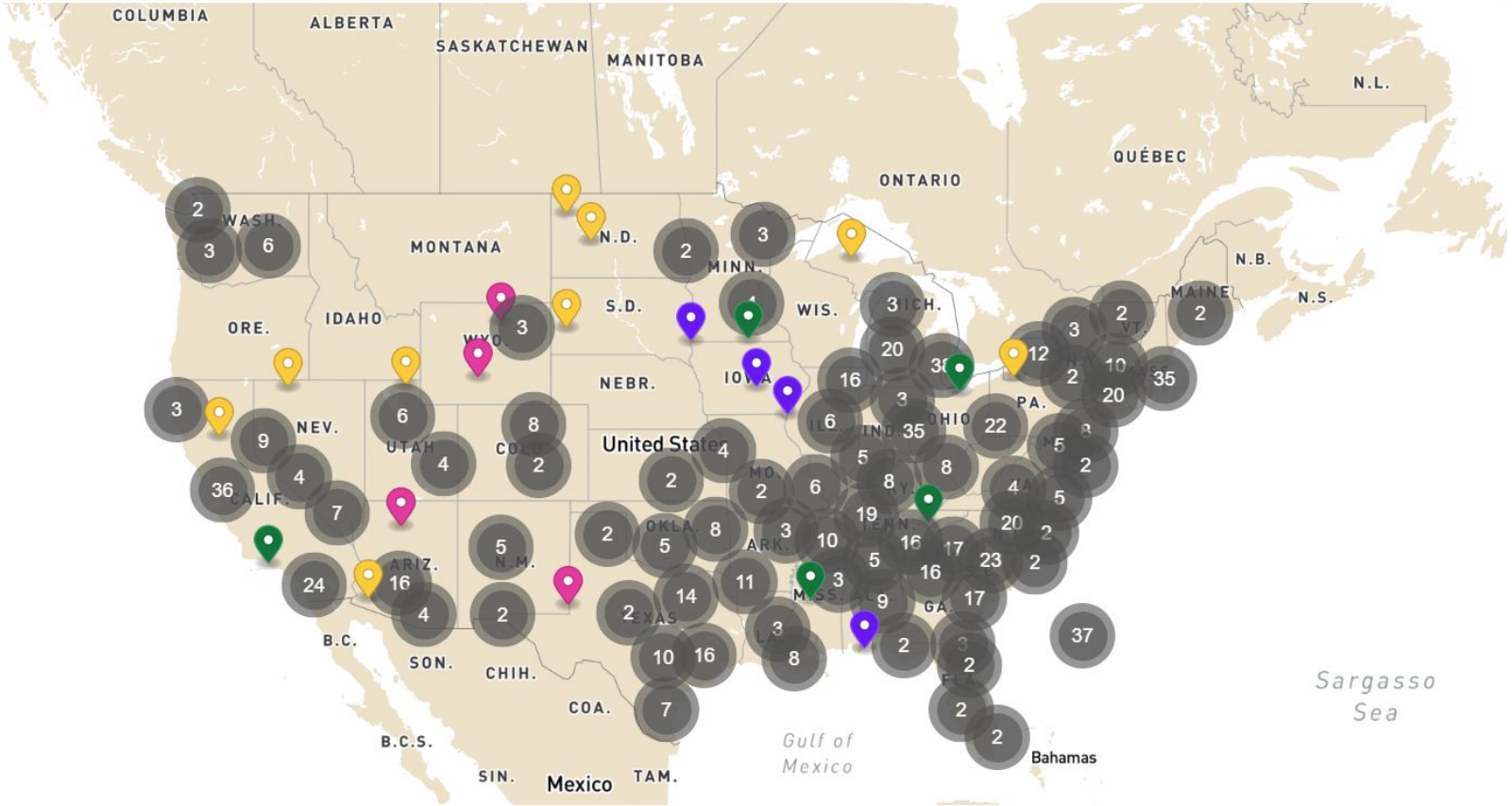
Demand Growth

Demand growth forecasts keep increasing…

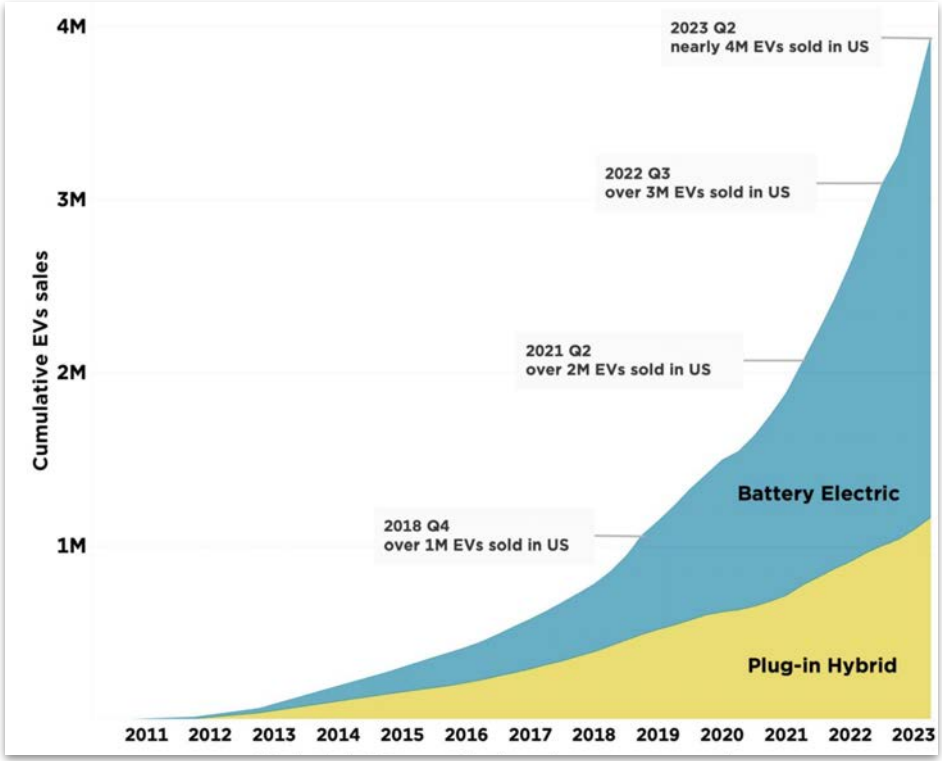


https://www.pjm.com/-/media/library/reports-notices/special-reports/2023/energy-transition-in-pjm-resource-retirements-replacements-and-risks.ashx

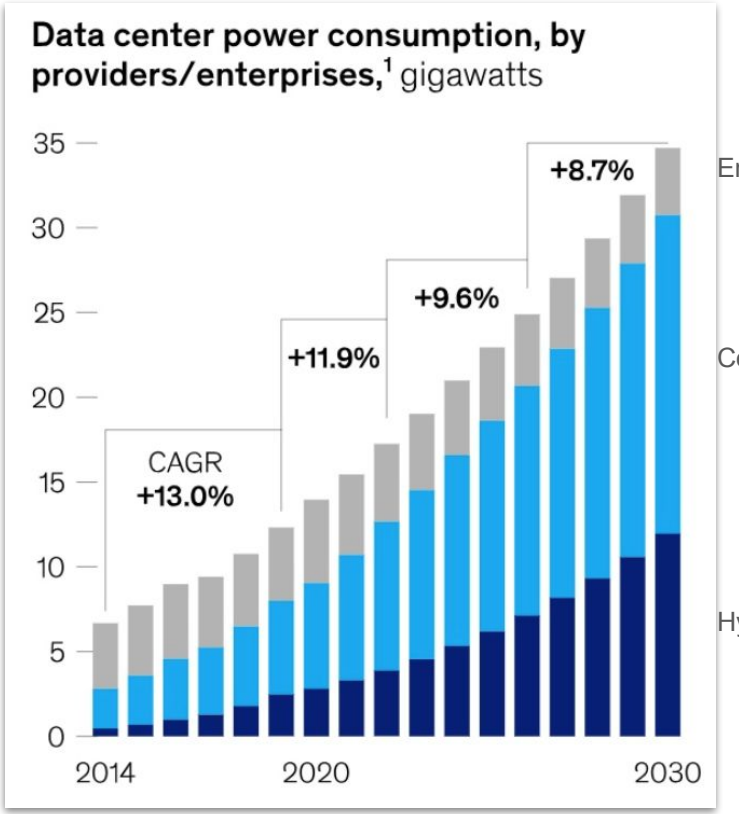
Manufacturing Facilities Announced since August 2022



https://www.energy.gov/invest



https://blog.ucsusa.org/dave-reichmuth/electric-vehicle-sales-in-us-hit-the-accelerator-pedal/



https://www.mckinsey.com/industries/technology-media-and-telecommunications/our-insights/investing-in-the-rising-data-center-economy

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Near Term Solutions: Advanced Transmission Technologies

GET more out of the existing system

Grid Enhancing Technologies - “GETS”

Squeeze more out of the existing system:

- Dynamic Line Ratings
  - Adjust system ratings in response to real weather conditions

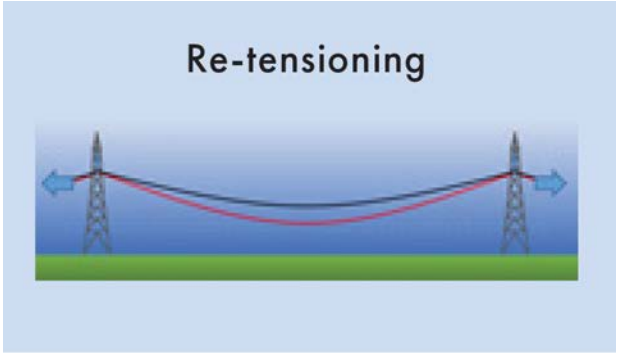
- Powerflow Controllers
  - Push power around more efficiently

- Topology Optimization
  - Switch lines in/out to avoid overloads

INCREASE THE CAPACITY
of the existing system

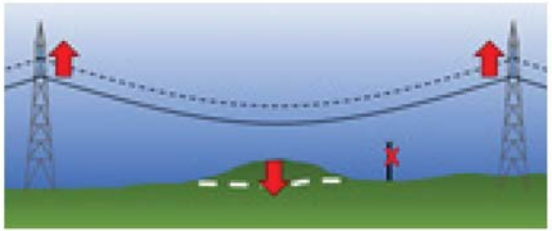
Advanced Tower Raising and Rehabilitation

- Power lines are often limited by their "sag"
- Raising or strengthening towers can increase capacity 10-40%
- New technologies and techniques allow towers to be raised while energized



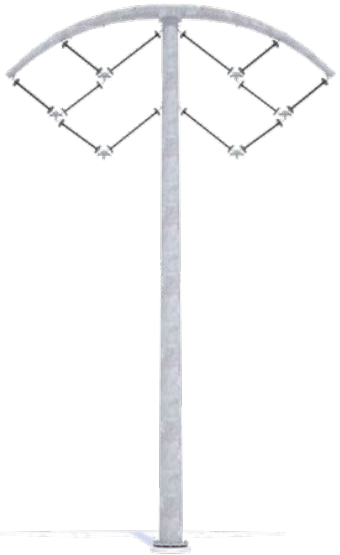
Traditional Lifting Method
(costly cranes and heavy footprint)

AMPJACK® Raise Method
(no cranes and minimal footprint)

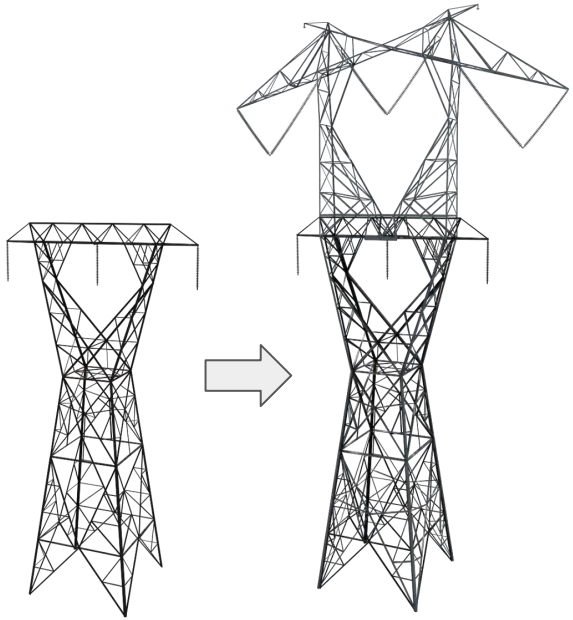


RECONDUCTORING, TENSIONING, AND ADVANCED CONDUCTOR TECHNOLOGIES FOR INCREASING THE CAPACITY OF TRANSMISSION LINES. April 2022. EPRI

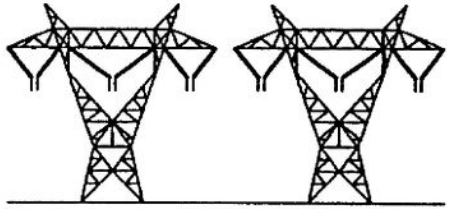
Advanced Tower Design



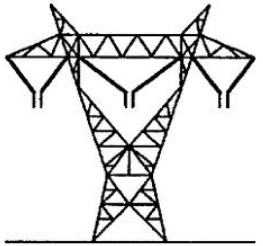
BOLD(R) Structure



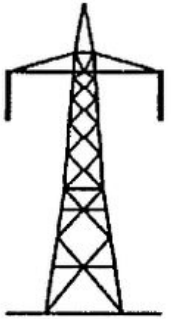
“ExoGrid”™ Structure



2 x 500 kV AC



800 kV AC



± 500 kV DC

HVDC Conversion

High Performance Conductors (a.k.a. "Advanced Conductors")

Conventional Conductor

"Aluminum Conductor Steel Reinforced" (ACSR)

High Performance or Advanced Conductors

"ACSS" Trapezoidal Wire

3M "ACCR"

CTC Global

"ACCC"

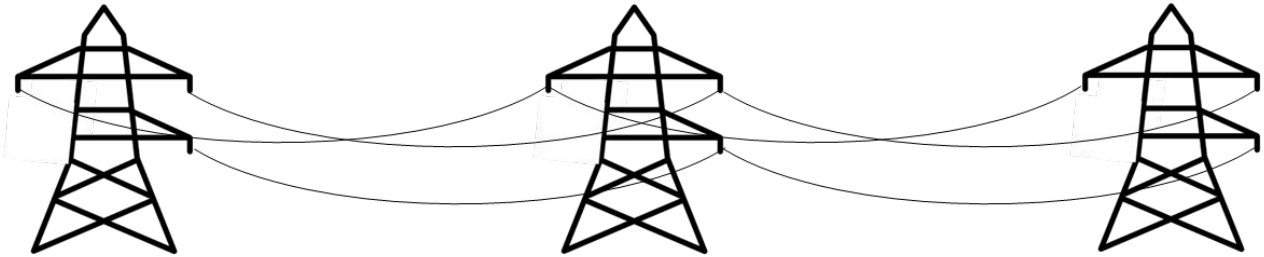
TS Conductor

- ☑ 2-3x Capacity
- ☑ Reduce Losses 10-40%
- ☑ Increase Resiliency

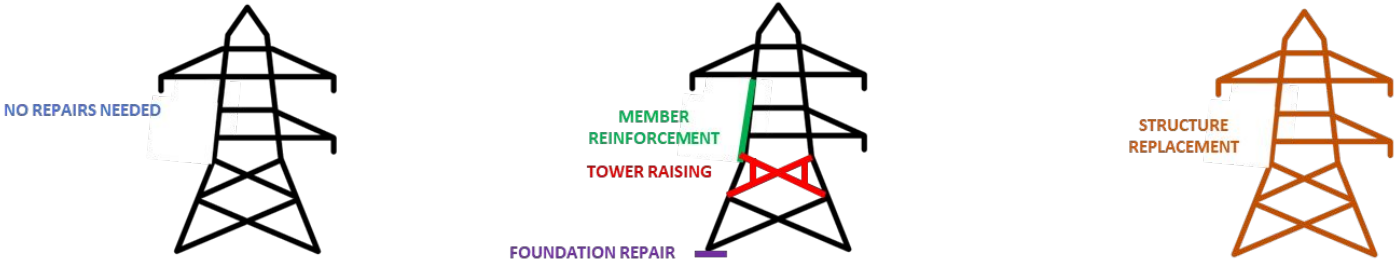
https://inl.gov/content/uploads/2024/02/23-50856_R8_-AdvConductorszScan-Report.pdf

Advanced Reconductoring

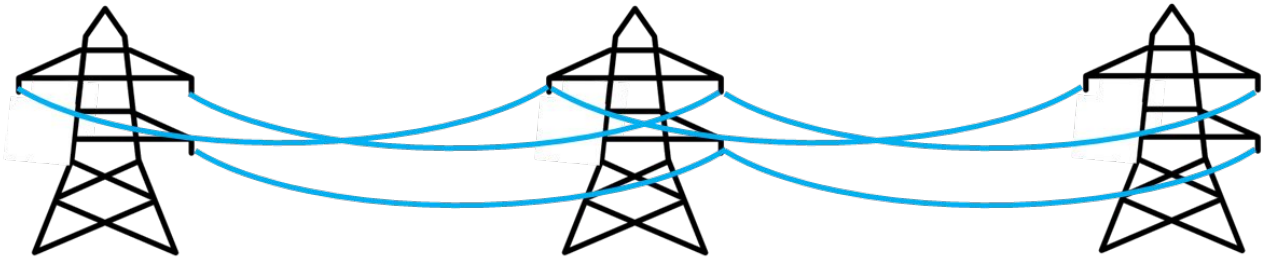
Existing powerline



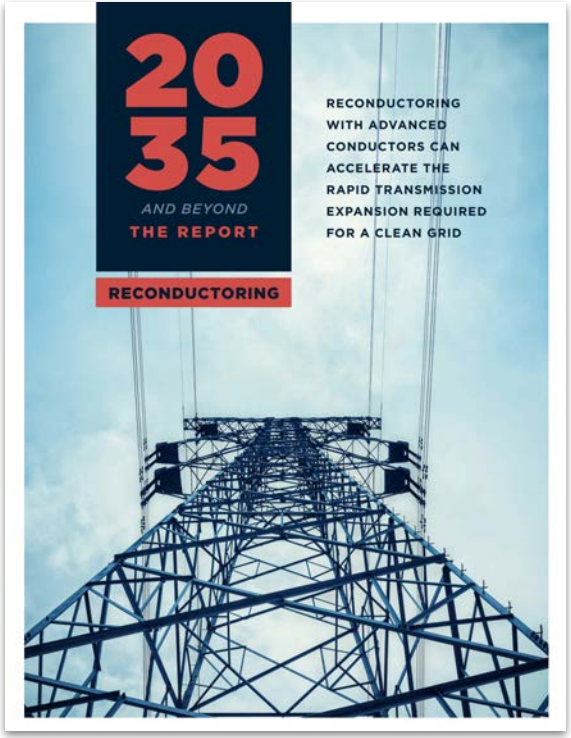
Remove Conductor, repair/replace structures

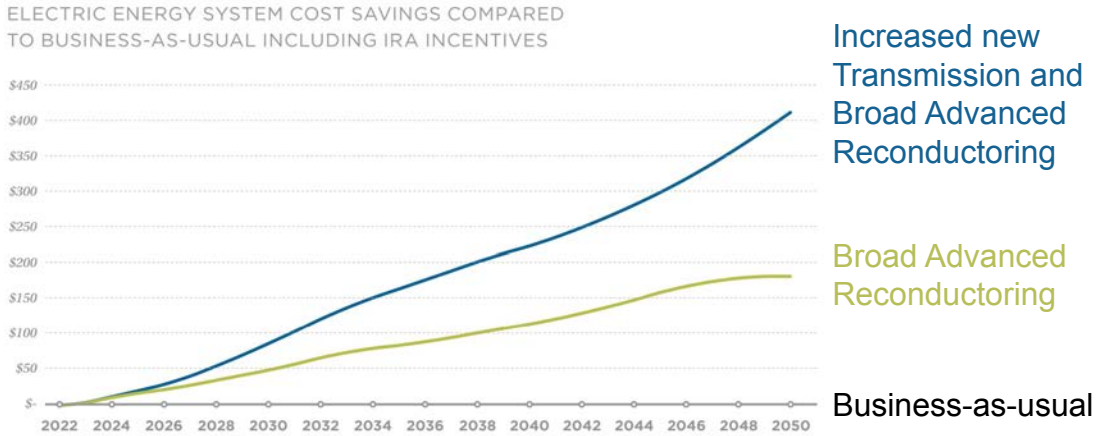


Install High Performance Conductor 2x capacity in same footprint



Reconductoring with High Performance Conductors (a.k.a. "Advanced Conductors")





Nearly $400 billion in savings by 2050

Where can legislators step in?

Case Study: Montana NW Energy

- Steel cables sag in heat, a fire hazard issue for MT's power lines that run through forests and connect with tree tops.
- Northwestern Energy upgraded a 105-mile line with advanced conductors, decreasing the risk and increase line capacity.
- MT Public Service Commissioner:

  "In some circumstances, switching to high-efficiency power line can cut line losses by a third, and with time, the upgrades can pay for themselves. Better efficiency also makes better use of base load power generation and reduces the need to purchase energy at peak market prices."

Case Study: Montana HB 729

- Successful NW Energy project and PSC proceeding provided proof of concept for legislation in 2023.

- HB 729 (Rep. Steve Galloway (R)) provided financial incentive for utilities by allowing utilities to rate base advanced conductor installation.
    - Advanced conductors eligible for cost recovery when tested against "cost effectiveness criteria: "decreased electrical losses and any other relevant consumer, environmental, and system benefits provided by advanced conductors."3

- Passed *nearly* unanimously

Case Study: Virginia, IRPs

- Critical for existing transmission to updated as Virginia is at center of massive load growth from data center expansion in Northern Virginia
- Virginia utilities file Integrated Resource Plans (IRPs) every other year and plans are subject to approval by VA State Corporation Commission.
- Regulated IOU monopoly market in Virginia, Dominion Energy serves 2 out of 3 customers

Case Study: Virginia, HB 862

- Sponsored by freshman Del. Phil Hernandez (D), passed on bipartisan lines and signed by Republican Gov.
- Razor-thin Democratic majorities in House and Senate, Republican Gov. Agreement on energy-related issues is EXTREMELY rare!
- 862 requires Virginia utilities to consider GETs and advanced conductors in their IRPs
- Dominion Energy did not oppose the bill and was just awarded nearly $35 million in federal funding for grid modernization efforts, lightening load on ratepayers

Barriers

- High upfront costs
- Utilities are incentivized towards major infrastructure projects, upgrades and improvements on existing infrastructure are less attractive
- Utilities are intentionally slow to adopt new technologies to avoid risks on cost recovery
- Operational and engineering changes are required

Legislative Solutions

- Require utilities to **consider new technologies** like GETS and High Performance Conductors in IRPs
- Create **shared savings mechanisms** where utilities and customers share the savings
- "de-risk" or **provide incentives** for utilities to test out new technologies
- Require **multiple benefit streams** to be included in IRPs including savings, resiliency, reliability evaluated over 20+ years
- **Energy efficiency standard** for transmission lines

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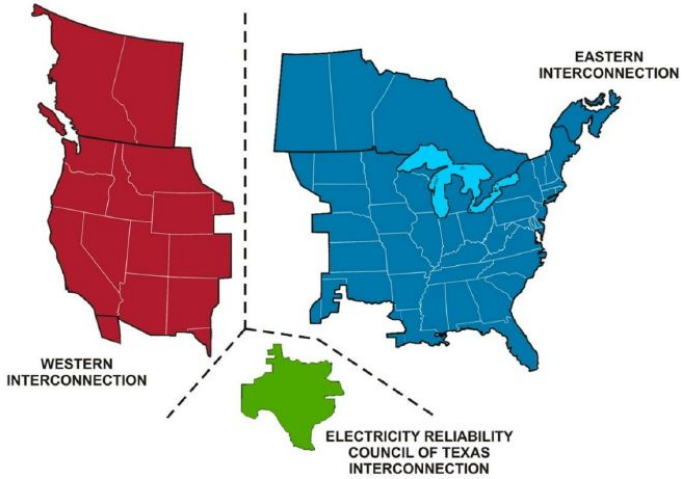
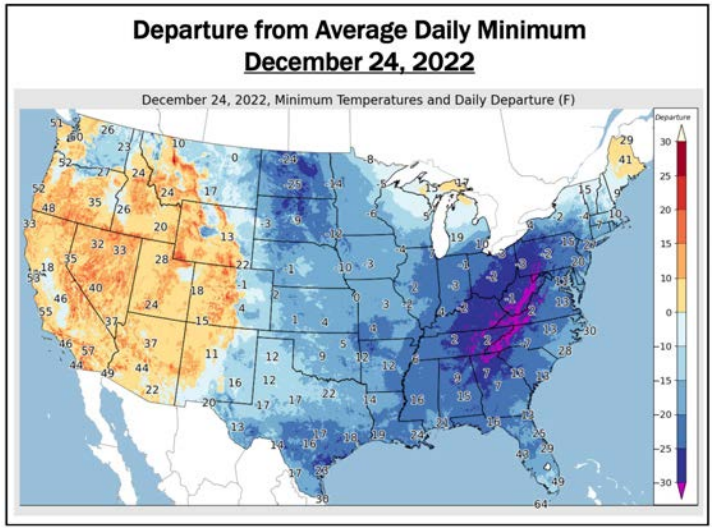
Long Term Solutions: Regional and Interregional Planning





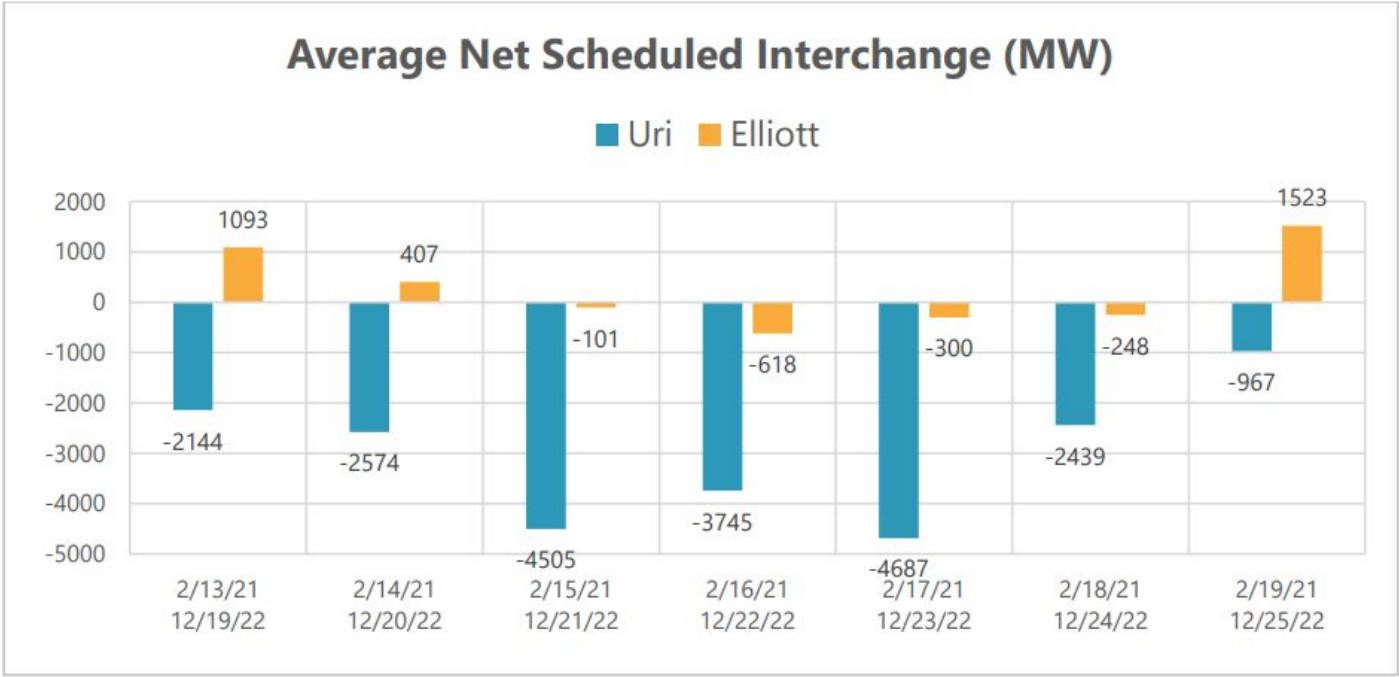
We need a system bigger than the weather

"This is a come to Jesus moment for a lot of market operators and planners. It's like, 'Wow, everything we had available is not enough,' it's one of those examples of how you need to build a grid that's bigger than the weather."

- Jonathon Monken, a former senior official at PJM Interconnection, the nation's largest grid operator.

"Interchange" = Trading energy between regions using electric transmission

Figure 7 – Comparison of average net scheduled interchange between Winter Storms Uri and Elliott



"SPP's largest neighbors – the Electric Reliability Council of Texas (ERCOT) and MISO – did not experience as many system challenges during Elliott as they did during Uri. They were able to provide more generation, in the form of interchange schedules, to SPP during and following the worst timeframes of Elliott."

https://www.spp.org/documents/69218/review%20of%20spp's%20response%20to%20the%20dec.%202022%20winter%20storm.pdf

The value of transmission during Winter Storm Elliot

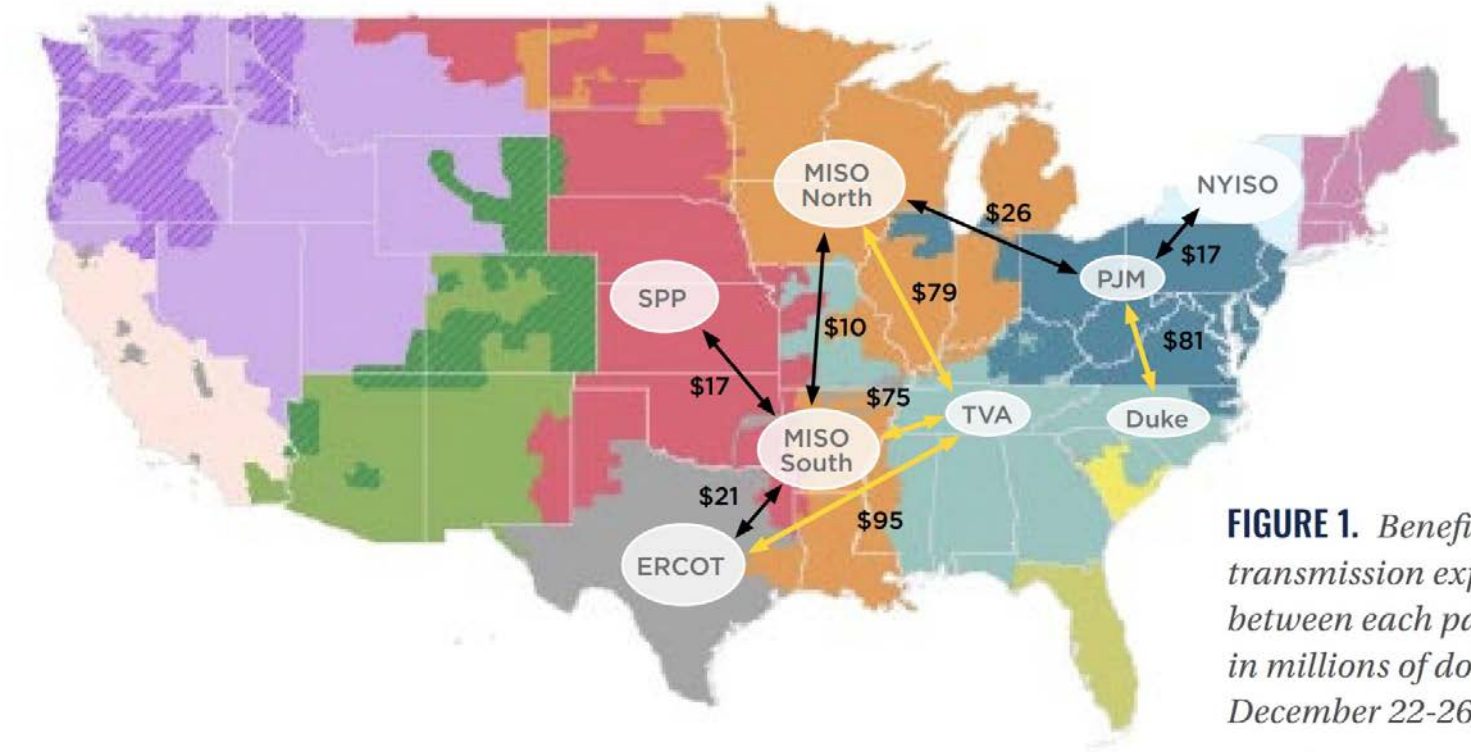


FIGURE 1. *Benefit of 1 GW transmission expansion between each pair of regions, in millions of dollars, December 22-26, 2022*

https://acore.org/wp-content/uploads/2023/02/The-Value-of-Transmission-During-Winter-Storm-Elliott-ACORE.pdf

"only 5% of hours contribute to 50% of transmission's value"

https://emp.lbl.gov/publications/empirical-estimates-transmission

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FERC Order 1920

FERC Order 1920

FERC Jurisdictional Transmission Operators Must:

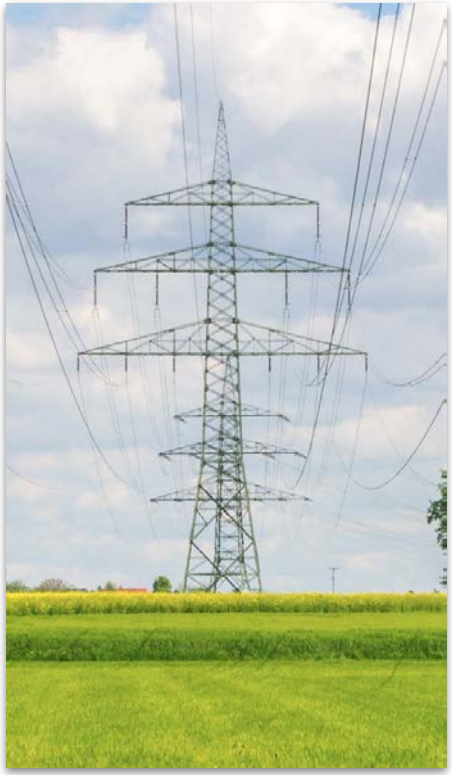
- Produce a regional transmission plan of at least 20 years to identify long-term needs and the facilities to meet them.
- Conduct this long-term planning at least once every five years using a plausible and diverse set of at least three scenarios that incorporate specific factors and use best available data.
- Apply seven specific benefits to determine whether any identified regional proposals will efficiently and cost-effectively address long-term transmission needs.
- Include an evaluation process to identify long-term regional transmission facilities for potential selection in the regional plan.
- Include a process giving states and interconnection customers the opportunity to fund all, or a portion, of the cost of a long-term regional transmission facilities that otherwise would not meet the transmission provider's selection criteria.
- Consider the use of Grid Enhancing Technologies such as dynamic line ratings, advanced power flow control devices, advanced conductors and transmission switching.

https://ferc.gov/news-events/news/fact-sheet-building-future-through-electric-regional-transmission-planning-and

FERC Order 1920

The grid rule requires transmission providers to:

- Be transparent regarding local transmission planning information and conduct stakeholder meetings during the regional transmission planning cycle about the local process.
- Identify opportunities to modify in-kind replacement of existing transmission facilities to increase their transfer capability, known as "right-sizing," when needed.
- Give incumbent transmission owners a right of first refusal to develop these "right-sized" replacement facilities.
- Revise existing interregional transmission coordination processes to reflect the new long-term regional transmission planning reforms.



https://ferc.gov/news-events/news/fact-sheet-building-future-through-electric-regional-transmission-planning-and

FERC Order 1920

The grid rule contains these cost-allocation provisions:

- Before applicants submit compliance filings, they must open a six-month engagement period with relevant state entities.
- Applicants must propose a default method of cost allocation to pay for selected long-term regional transmission facilities.
- Applicants may propose a state agreement process that lasts for up to six months after a project is selected for participants to determine, and transmission providers to file, a cost allocation method for the selected facilities.

https://ferc.gov/news-events/news/fact-sheet-building-future-through-electric-regional-transmission-planning-and

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State's Role in Transmission

States have a large role to play in transmission!

- Empower your regulators
  - Is resiliency spend being adequately allocated?
  - Are there new technologies that should be studied?
  - Do defense communities in your state have adequate representation in this process?
  - Is interregional transmission considered in utility integrated resource plans?
- Should your state adopt a consolidated transmission plan?
  - One Model: Minnesota Biennial Transmission Projects Report - http://www.minnelectrans.com
- Should your state adopt an Electric Transmission Authority?
  - One Model: Colorado Transmission Authority https://www.cotransmissionauthority.com/
- Should your state be proactive in establishing transmission corridors?
- How can your state engage in transmission planning for Order 1920?
  - Organization of MISO States
  - SPP Regional State Committee
  - Organization of PJM States

Thank You

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APPENDIX

NERC

NORTH AMERICAN ELECTRIC RELIABILITY CORPORATION

Essential Actions to Industry

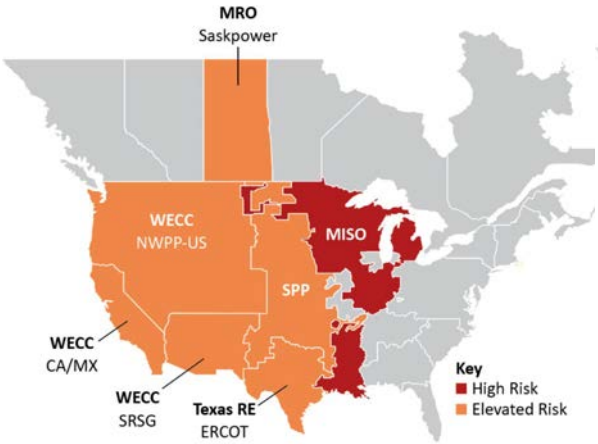
Cold Weather Preparations for Extreme Weather Events III

Initial Distribution: May 15, 2023

NERC is issuing this Level 3 Alert: Essential Actions for Cold Weather Preparations for Extreme Weather Events to increase the Reliability Coordinators' (RC), Balancing Authorities' (BA), Transmission Operators' (TOP), and Generator Owners' (GO) readiness and enhance plans for, and progress toward, mitigating risk for the upcoming winter and beyond.

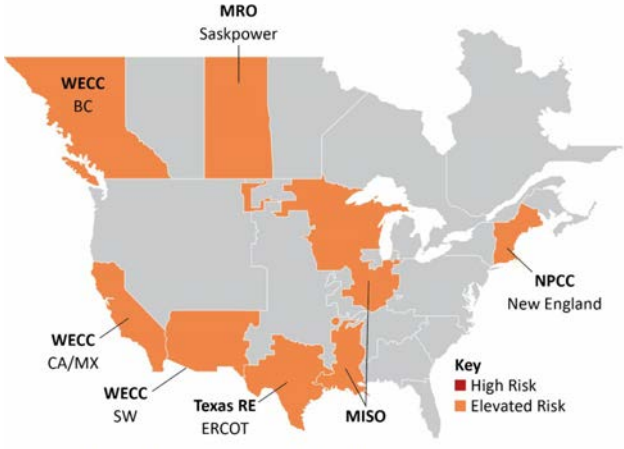
Recent NERC Summer Reliability Assessments

2022



2023

2024



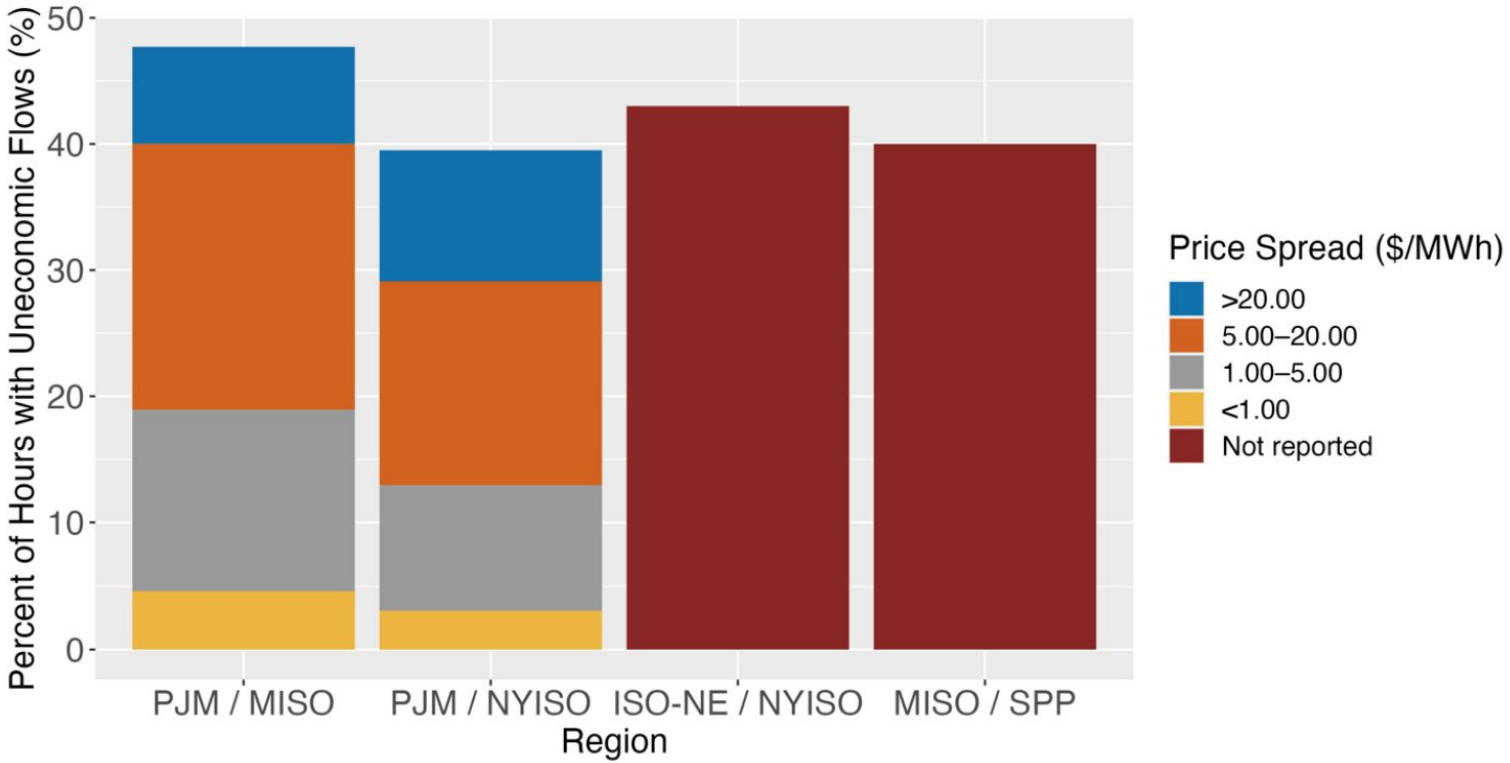


Figure 2. Hours with uneconomic power flow across major interregional seams in 2022

https://www.nrel.gov/docs/fy24osti/89363.pdf?utm_medium=email&utm_source=govdelivery