The Evolving Role of Extreme Weather Events in the U.S. Power System with High Variable Generation

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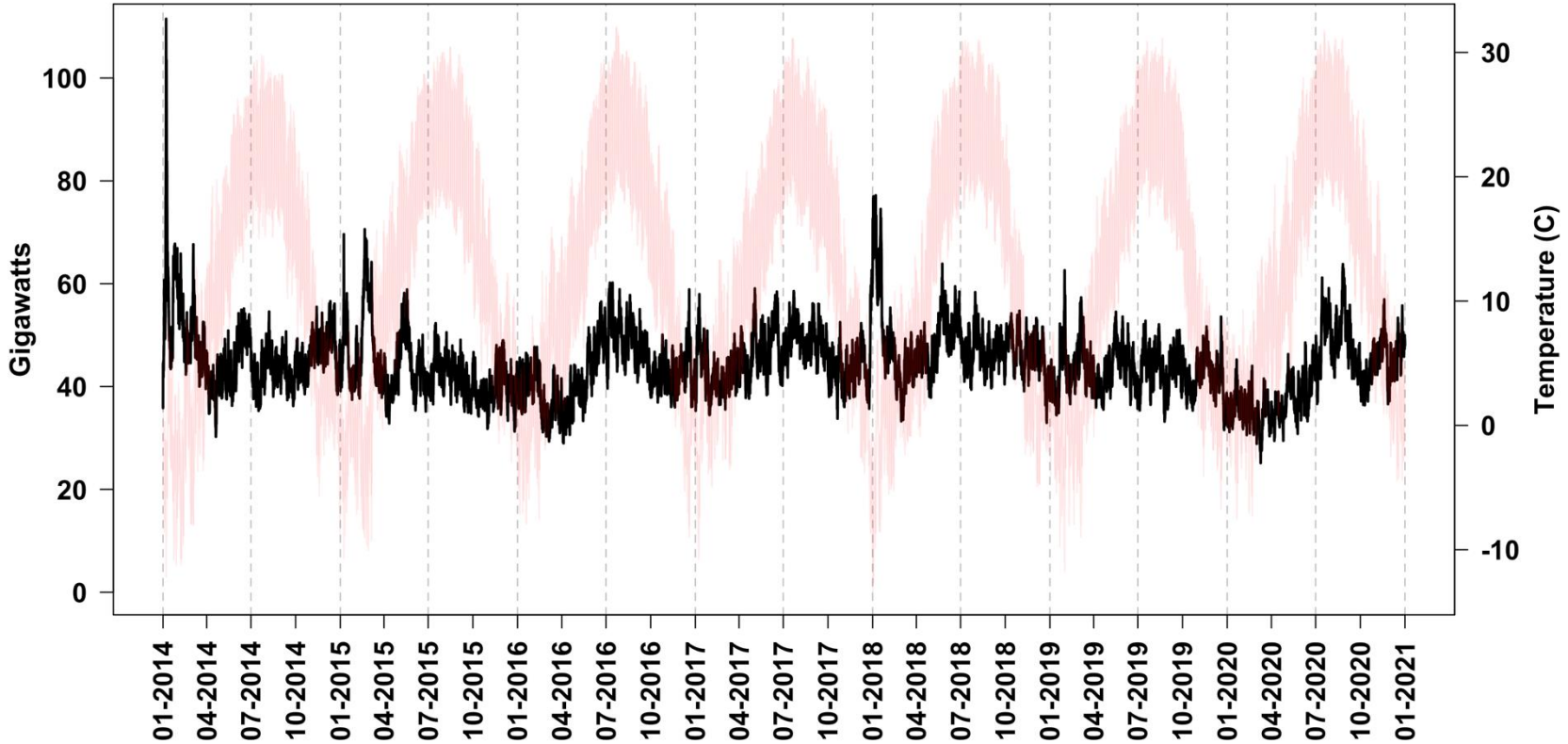
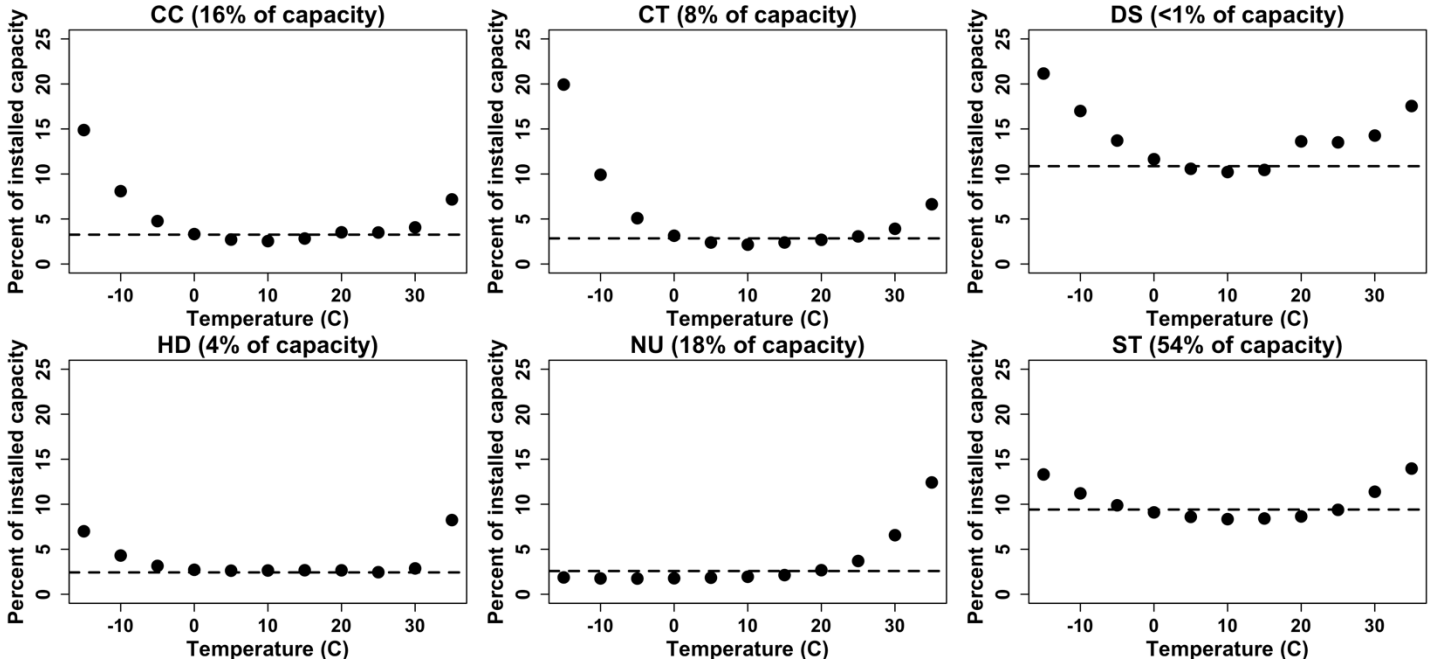
Living with Climate Change: The Polar Vortex
Anticipating Threats and Building Preparedness
Wednesday, April 13, 2022 12:00pm - 1:30pm EDT

Aggregate unavailable generation capacity with temperature overlay

All plots are:
- Hourly time series
- Unscheduled events only
- CONUS generators only



Temperature dependence in PJM thermal/hydro generators

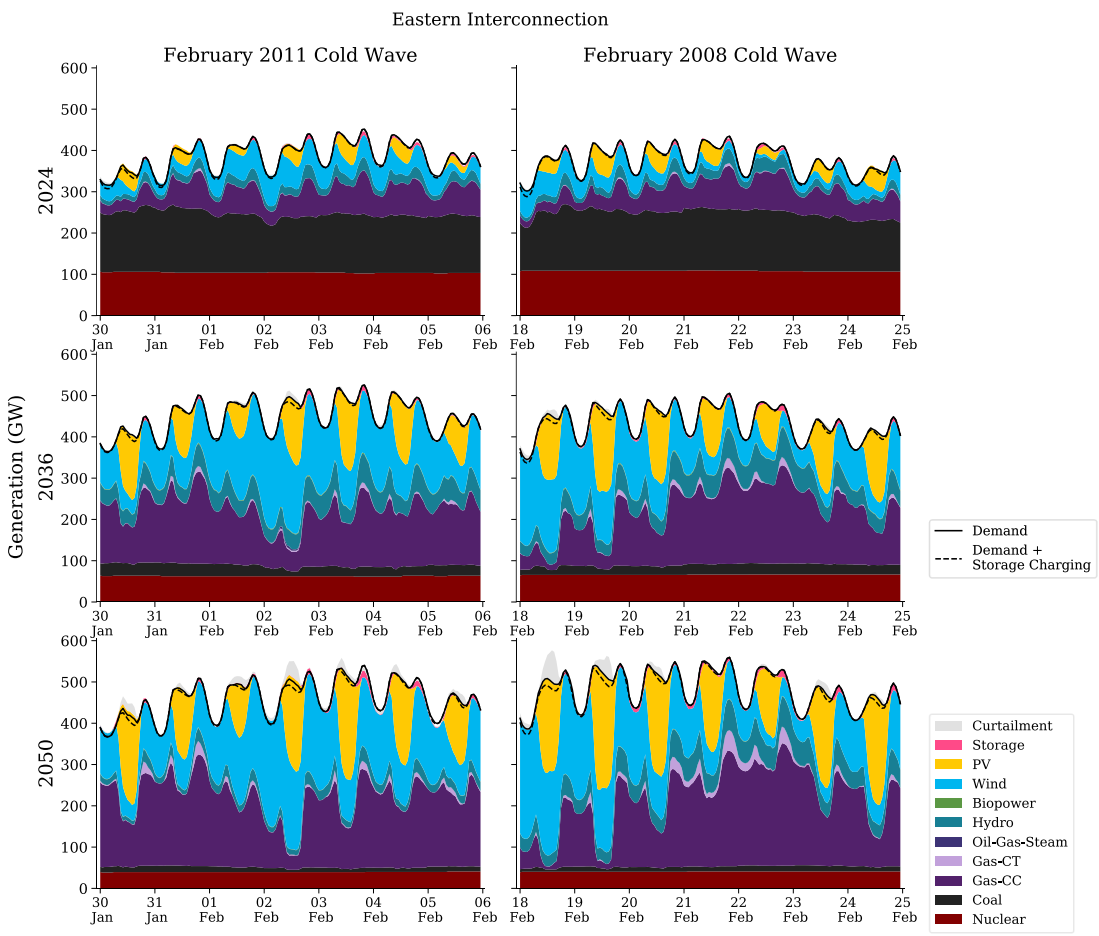


Murphy, S., Sowell, F., Apt J. "A time-dependent model of generator failures and recoveries captures correlated events and quantifies temperature dependence." Applied Energy. November 2019. https://doi.org/10.1016/j.apenergy.2019.113513

Unit type key:

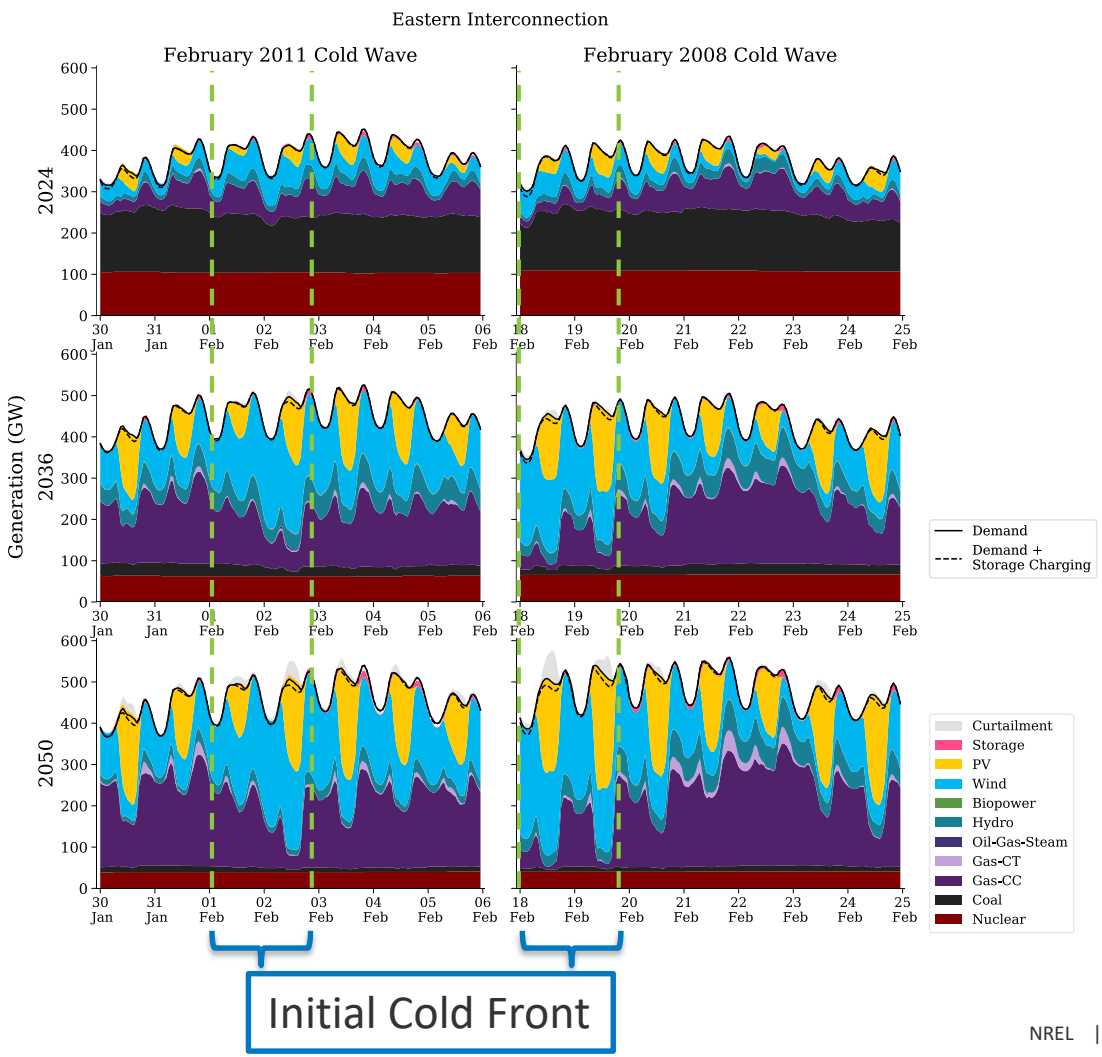
CC: combined cycle gas	HD: hydroelectric
CT: simple cycle gas	NU: nuclear
DS: diesel	ST: steam turbine (coal)

Evolution of operations during cold waves driven by wind dynamics



Evolution of operations during cold waves driven by wind dynamics

In both cold waves, wind and solar generation provide >80% of generation in the EI even as load increases as the cold front moves across the continent.



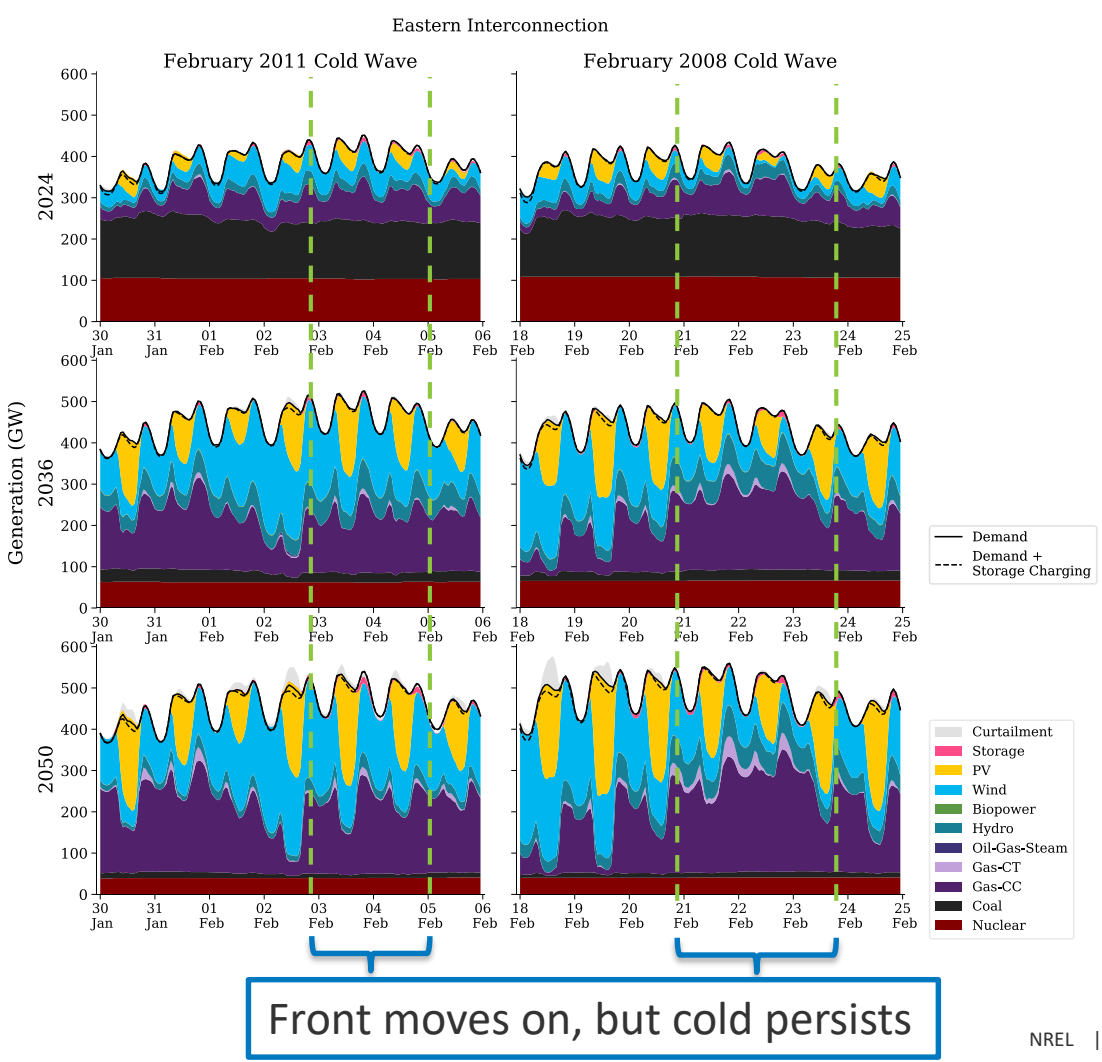
Evolution of operations during cold waves driven by wind dynamics

2011 Extreme Cold Wave

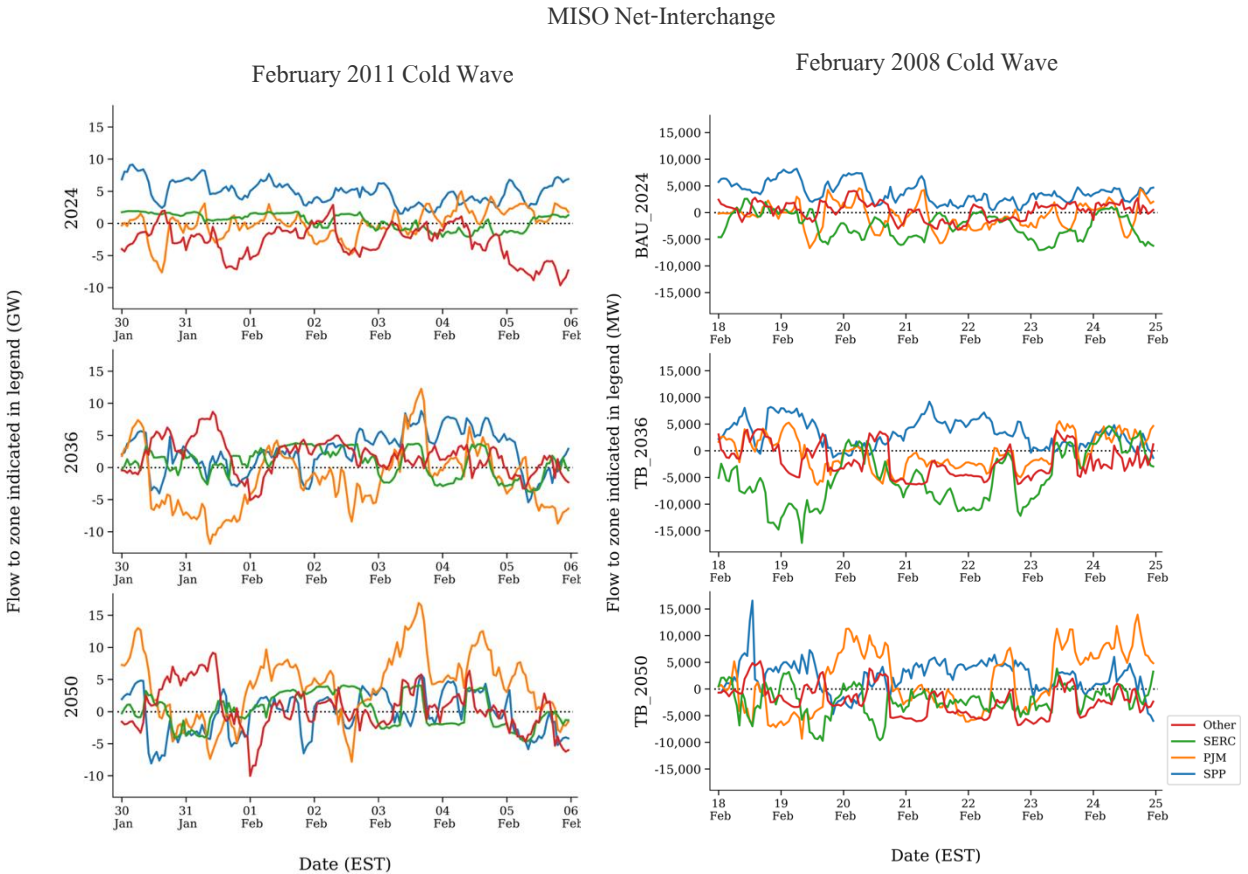
Wind and solar continues to serve ~50% of load after front moves through and load is elevated.

2008 Milder Cold Wave

Overnight wind penetrations drops below 10% of all generation. Offline thermal reserves drop in MISO and SPP.



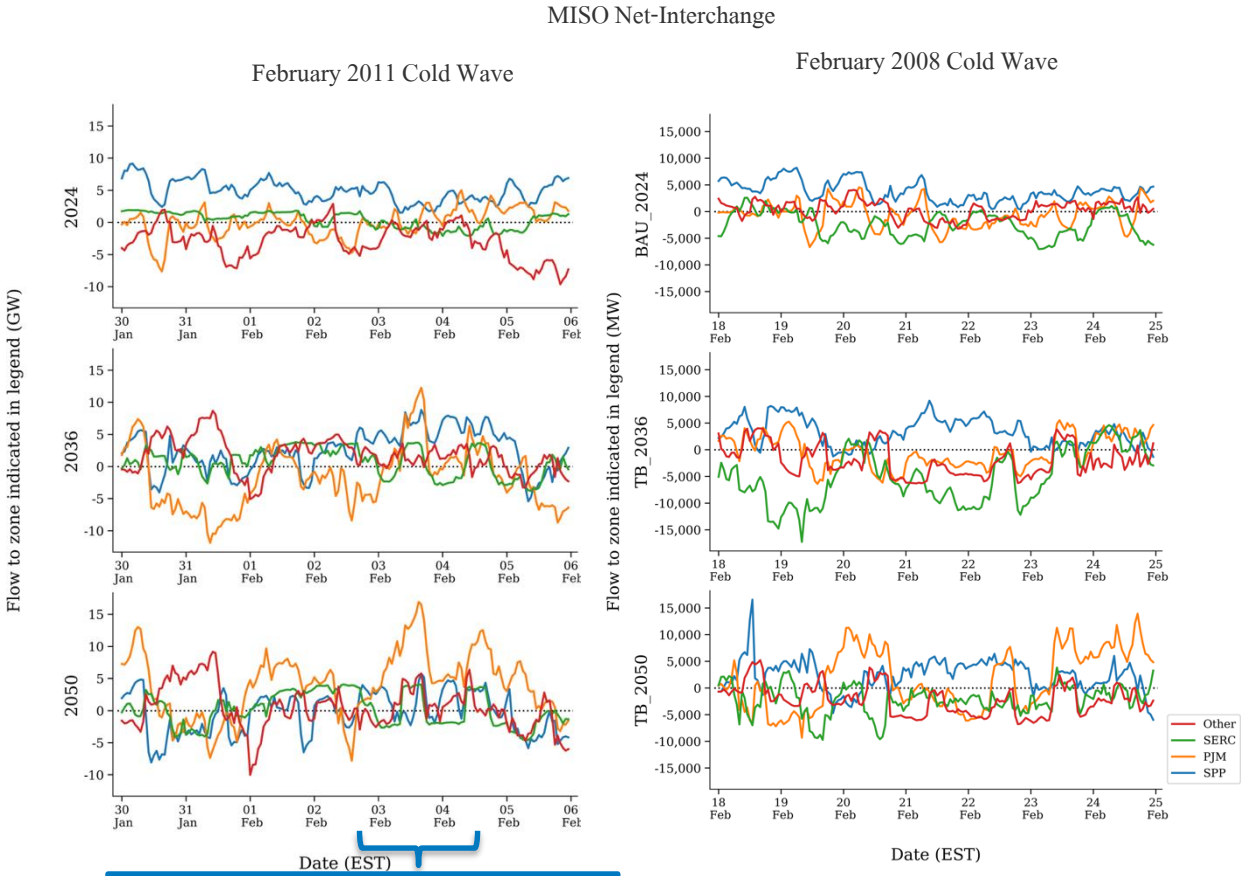
Evolution of operations during cold waves driven by wind dynamics



Evolution of operations during cold waves driven by wind dynamics

2011 Extreme Cold Wave

Transmission enables usage of geographic diverse wind and solar resources.

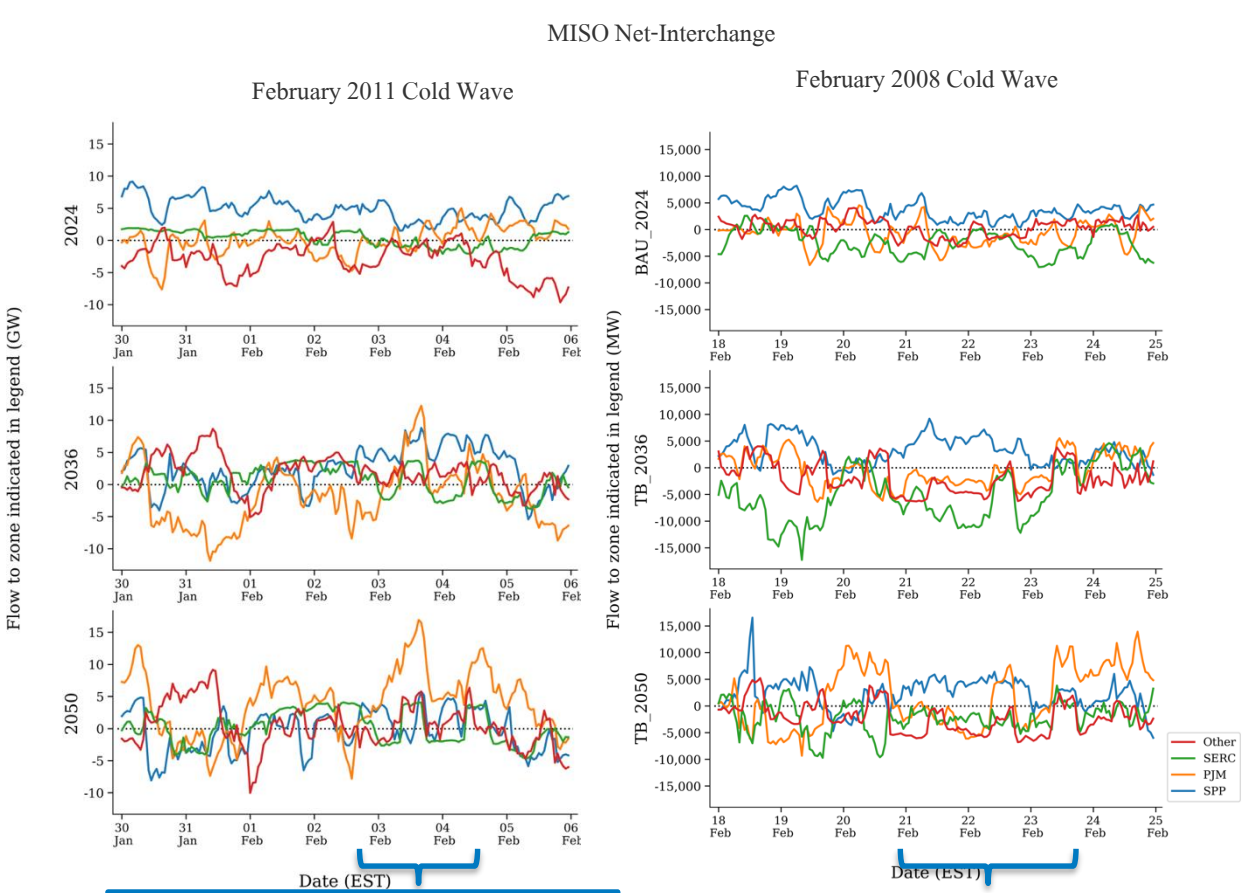


Swing in MISO exports to PJM used to serve SERC and NYISO

Evolution of operations during cold waves driven by wind dynamics

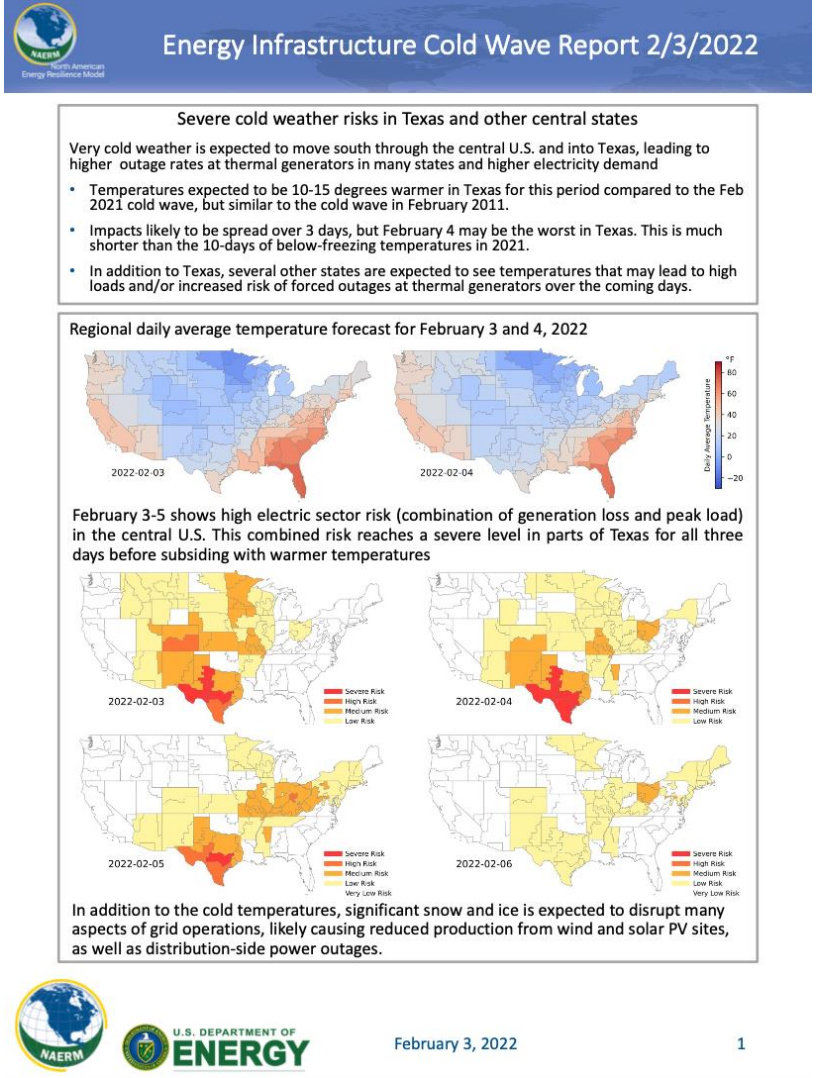
2011 Extreme Cold Wave
Transmission enables usage of geographic diverse wind and solar resources.

2008 Milder Cold Wave
Transmission **also** enables geographic diverse thermal fleet.



Swing in MISO exports to PJM used to serve SERC and NYISO

Thermal, wind, and PV less impacted in Atlantic states

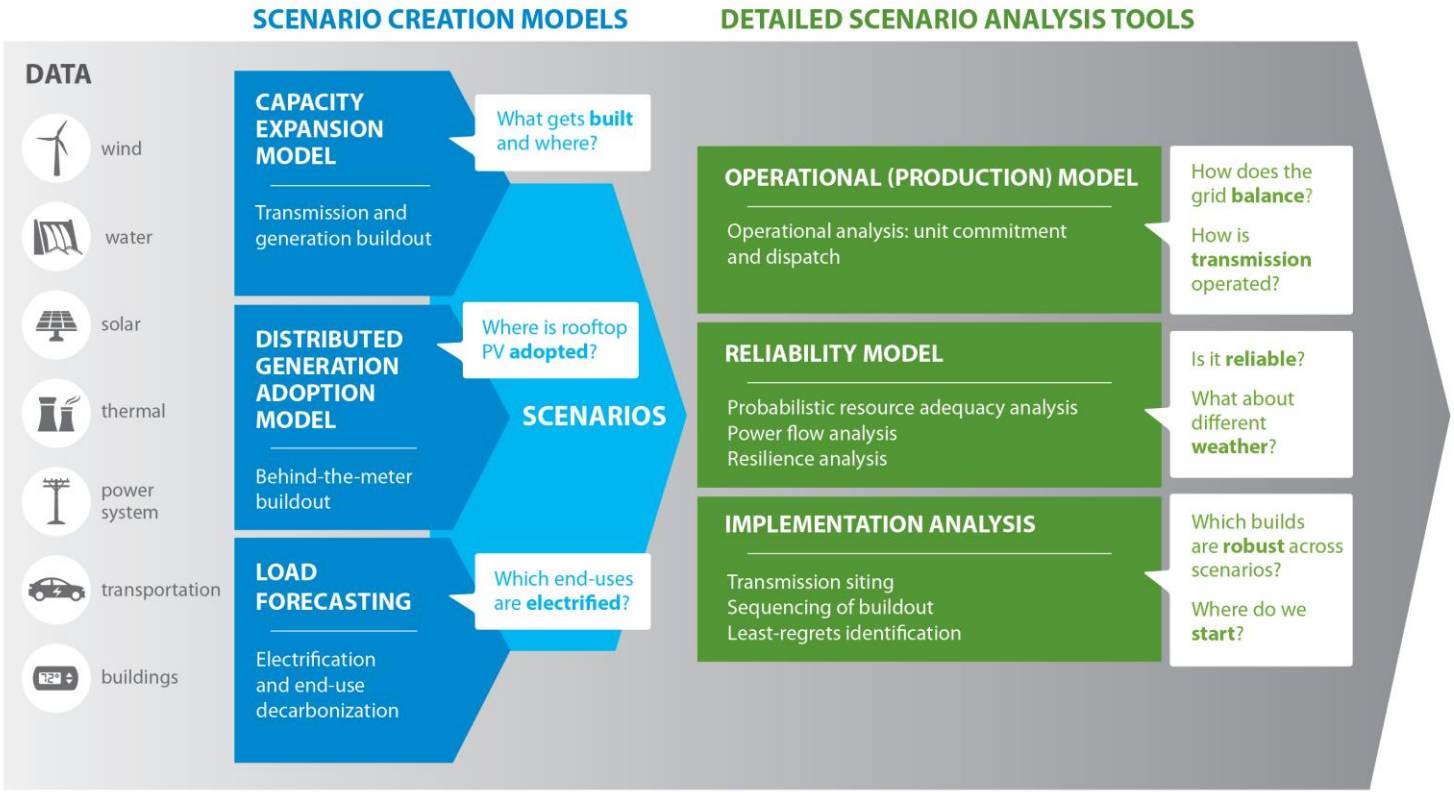


NAERM Cold Wave Report

The North American Energy Resilience Model (NAERM) is a multi-lab effort to identify resilience risks across the energy sector. NAERM is developing a beta version of a **cold wave report** to provide system operators awareness of forecasted cold weather and winter storms and the associated power system risks.

- Increased generator outage
- Regions with above normal forecasted load
- Snow and ice impacts on T&D infrastructure, wind power, and solar power

National Transmission Plan and NAERM



Key Takeaways

- Corelated Modeling
- Planning
- Operational Forecasts vs. Resource Adequacy
- Transmission Flexibility
- Longer Duration Storage (day long or multi-day storage)

Thank you

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