Probabilistic Resource Adequacy Methods

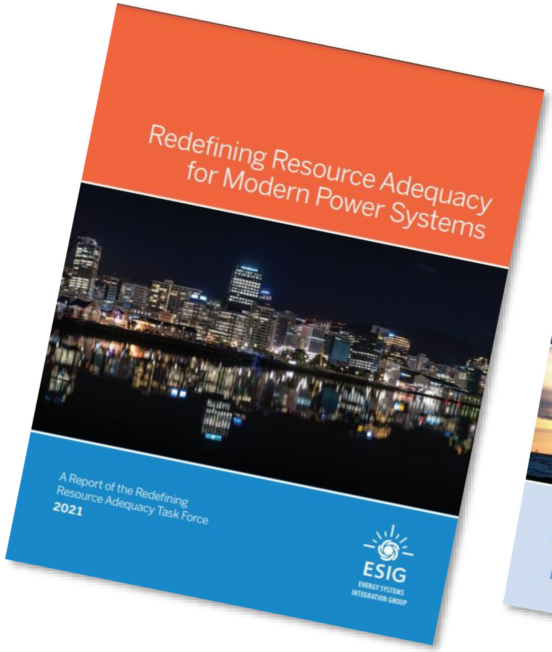
Best of 2022 Resource Adequacy Case Study Review

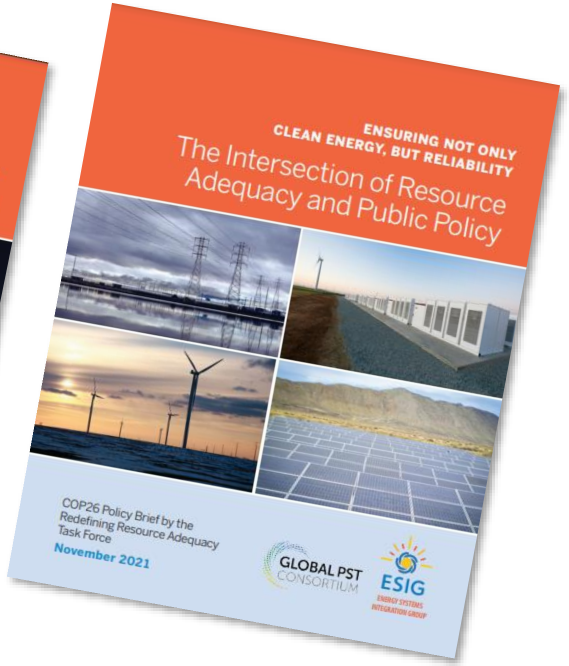
ESIG/GPST October Webinar
October 20, 2022

TELOS ENERGY

Redefining Resource Adequacy Task Force

ESIG



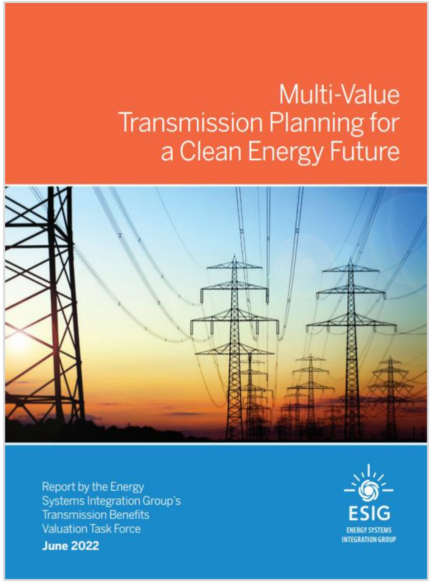


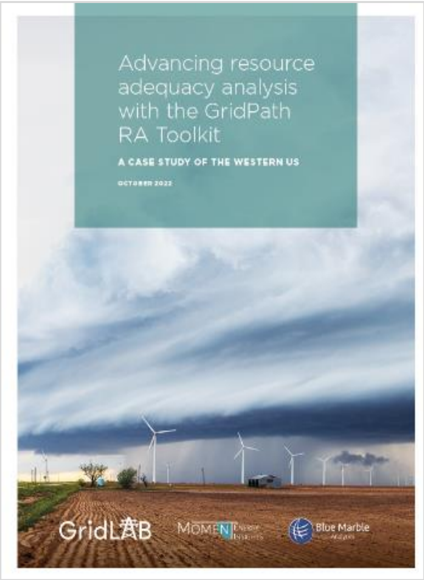
Coming soon! Redefining **capacity accreditation**

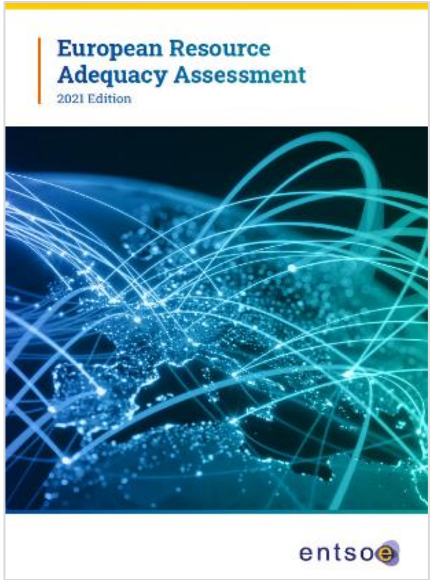
- **ESIG Whitepaper:** Redefining Resource Adequacy for Modern Power Systems
- **ESIG/GPST Policy Brief:** The Intersection of Resource Adequacy and Public Policy
- **ESIG Blog:** Five Principles of Resource Adequacy for Modern Power Systems
- **ESIG Webinar 2020:** Redefining Resource Adequacy for Modern Power Systems (part 1)
- **ESIG Webinar 2021:** Redefining Resource Adequacy for Modern Power Systems (part 2)
- Stenclik, et al., Beyond Expected Values Evolving Metrics for Resource Adequacy Assessment, CIGRE Session 2022

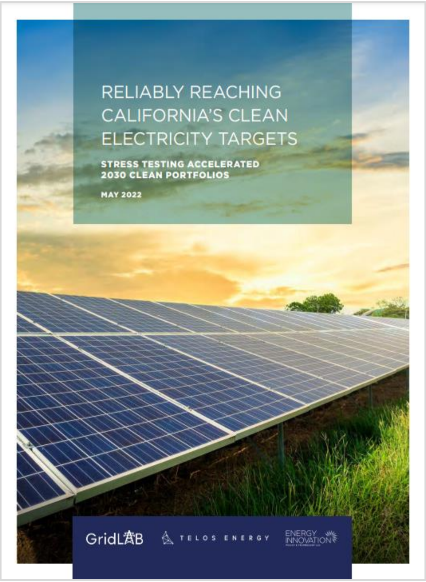
2022 Resource Adequacy

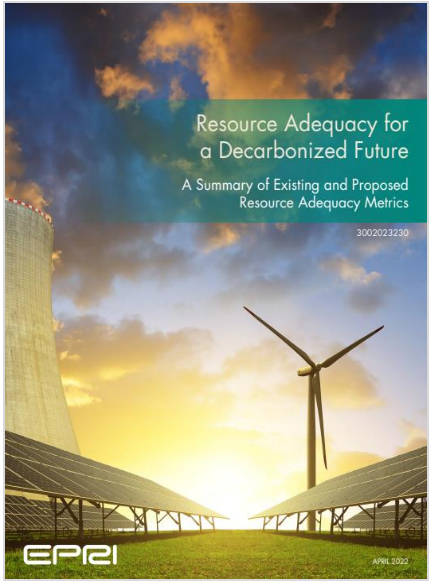
Case Study Review

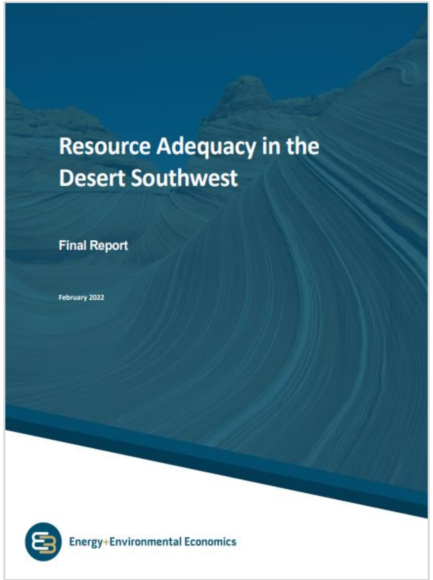


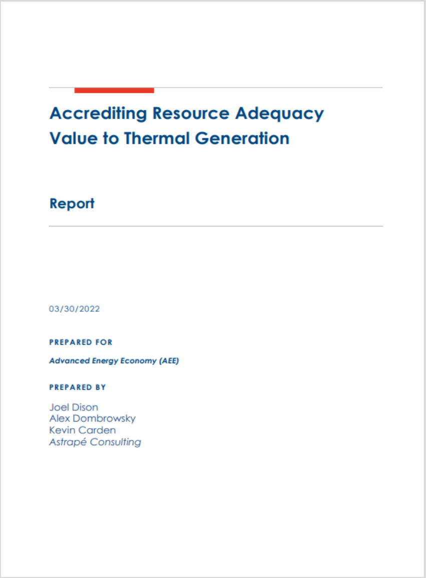












Sources

- **Energy and Environmental Economics, Inc. (E3),** *Resource Adequacy in the Desert Southwest*, February 2022, https://www.ethree.com/wp-content/uploads/2022/02/E3_SW_Resource_Adequacy_Final_Report_FINAL.pdf
- **Energy Systems Integration Group (ESIG),** *Multi-Value Transmission Planning for a Clean Energy Future,* June 2022, https://www.esig.energy/multi-value-transmission-planning-report/
- **Electric Power Research Institute (EPRI),** Resource Adequacy for a Decarbonized Future, ongoing, https://www.epri.com/resource-adequacy
- **Mid-Continent Independent System Operator (MISO)**, *2021 Regional Resource Assessment (RRA), https://cdn.misoenergy.org/2021%20Regional%20Resource%20Assessment%20Report606397.pdf*
- **European Network of Transmission System Operators for Electricity** (ENTSO-E), *2021 European Resource Adequacy Assessment (ERAA), https://www.entsoe.eu/outlooks/eraa/2021*
- **GridLab**, *Advancing resource adequacy analysis with the GridPath RA Toolkit: A case study of the Western US*, October 2022, https://gridlab.org/GridPathRAToolkit/
- **GridLab,** *Reliability reaching California's clean electricity targets: Stress testing an accelerated 2030 clean portfolio,* 2022, https://gridlab.org/california-2030-study/
- **Astrapé Consulting,** *Accrediting Resource Adequacy Value to Thermal Generation,* March 2022, https://info.aee.net/hubfs/Accrediting%20Resource%20Adequacy%20Value%20to%20Thermal%20Generation-1.pdf
- **Murphy, S., Sowell, F., Apt, J.,** *A time-dependent model of generator failures and recoveries captures correlated events and quantifies temperature dependence, Applied Energy, 253 (2019), https://www.sciencedirect.com/science/article/pii/S0306261919311870?via%3Dihub#f0005*

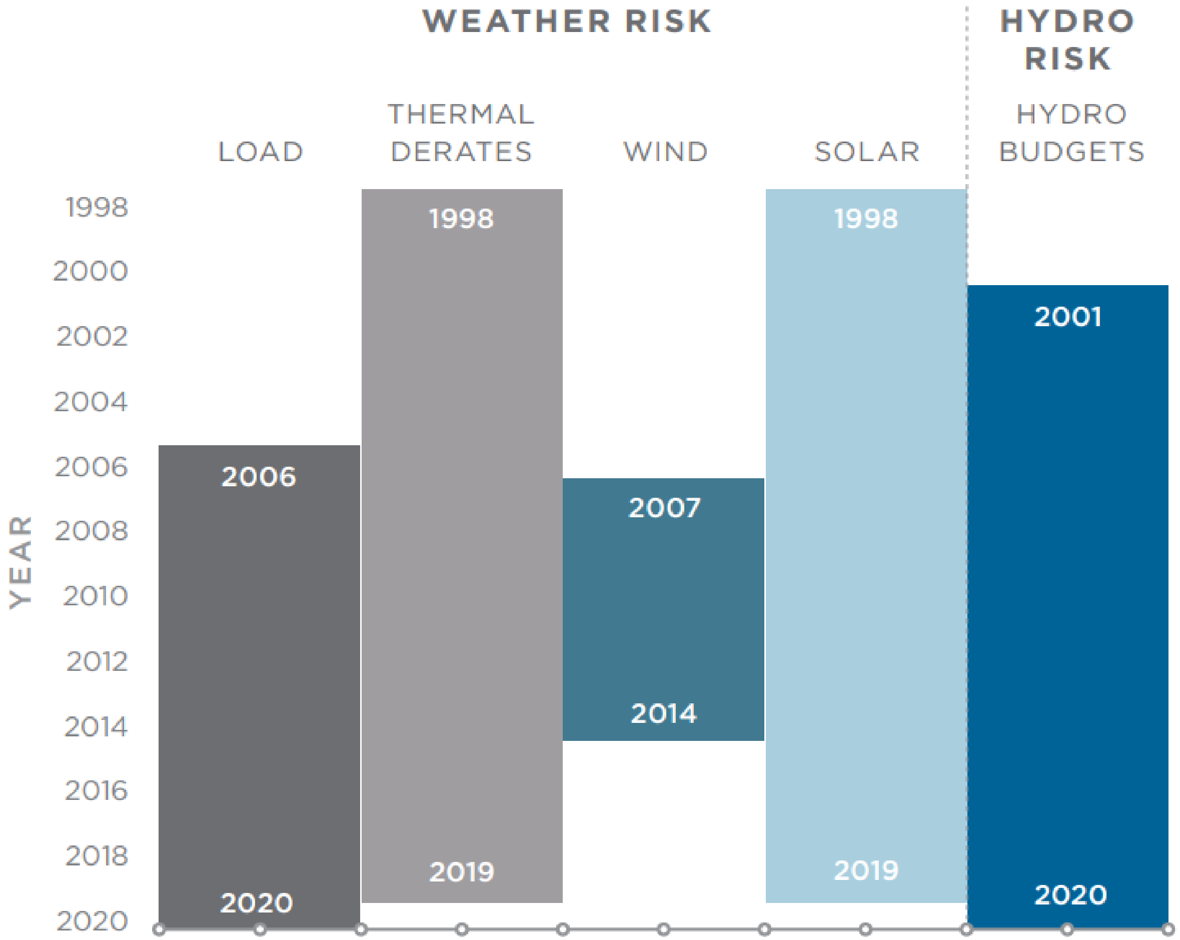
Recap from last year

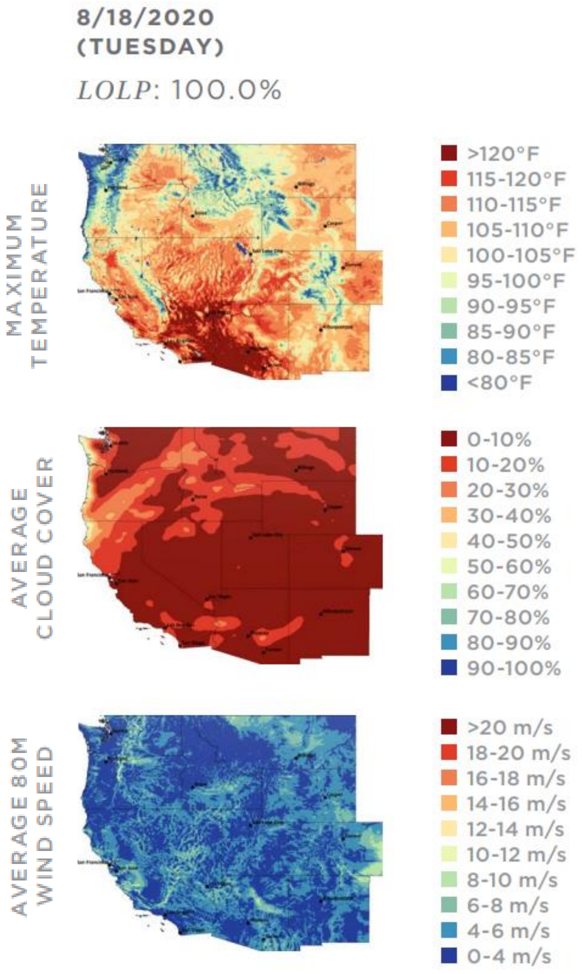
Six principles of resource adequacy for modern power systems

1. Chronological operations must be modeled across many weather years
2. Quantifying size, frequency, duration, and timing of capacity shortfalls is critical to finding the right resource solutions
3. Neighboring grids and transmission are a key part of the RA challenge
4. There is no such thing as perfect capacity.
5. Load participation fundamentally changes the resource adequacy construct.
6. Reliability criterion should not be arbitrary, but transparent and economic.

1. Chronological operations must be modeled across many weather years
2. Quantifying size, frequency, duration, and timing of capacity shortfalls is critical to finding the right resource solutions
3. Neighboring grids and transmission are a key part of the RA challenge
4. There is no such thing as perfect capacity.
5. Load participation fundamentally changes the resource adequacy construct.
6. Reliability criterion should not be arbitrary, but transparent and economic.

Resource transition is highlighting the importance of multi-year, correlated, interconnection-wide weather datasets

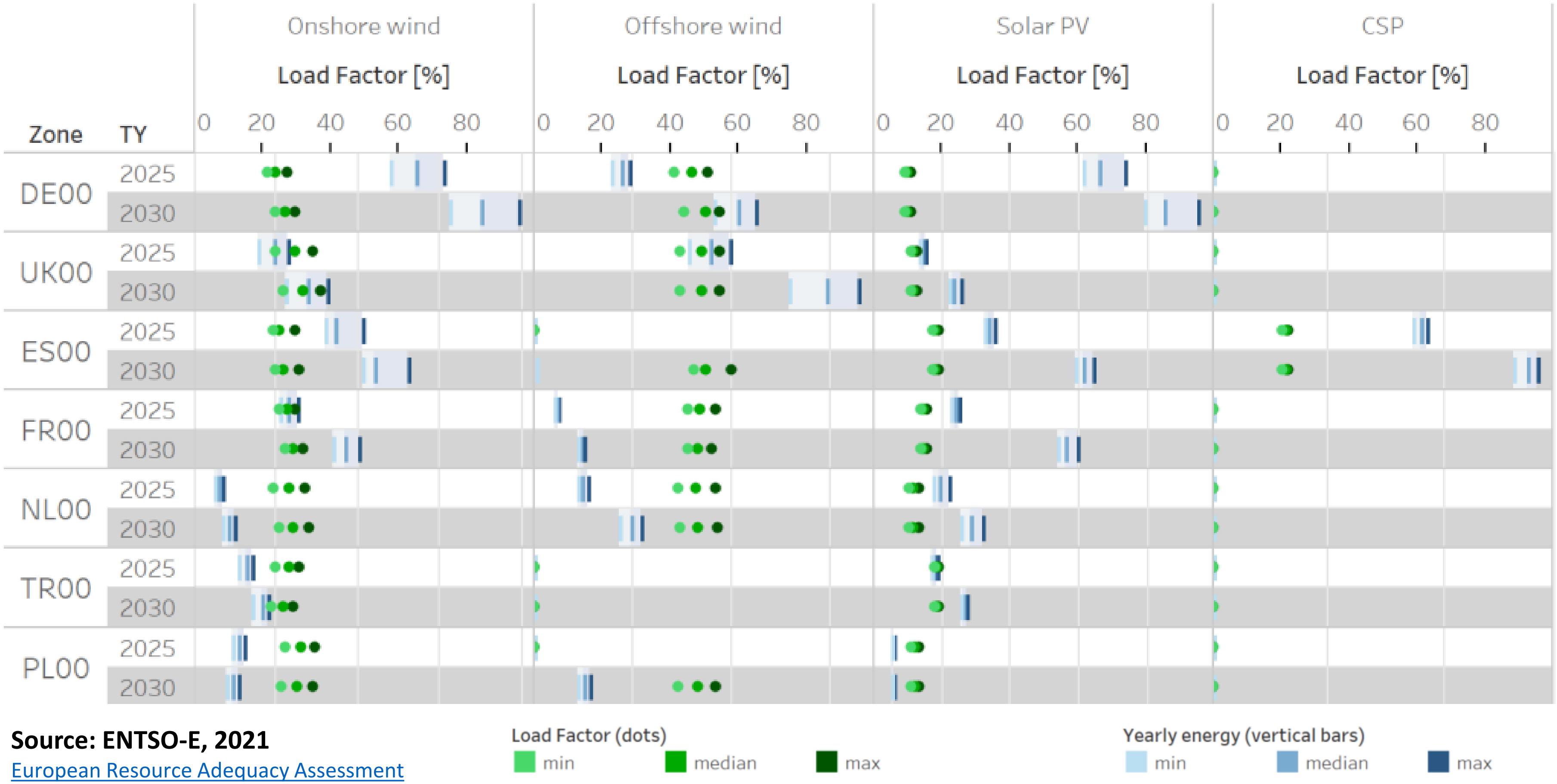




Source: GridLab, 2022,
[Advancing resource adequacy analysis with the GridPath RA Toolkit]

Best-practice in Europe… Pan-European climatological dataset across 35 weather years

Includes Climate Trends!



Source: ENTSO-E, 2021
European Resource Adequacy Assessment

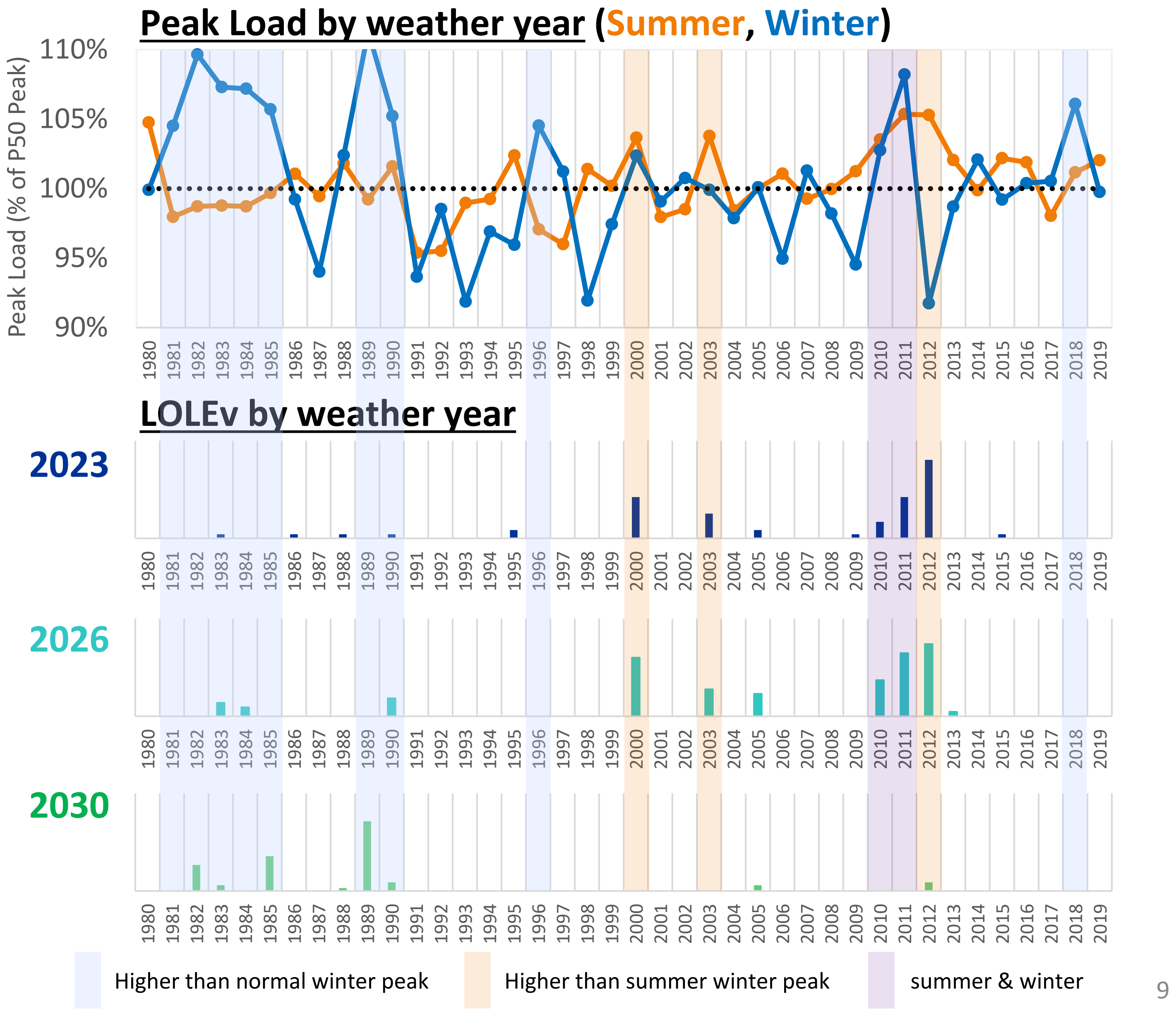
ESIG Task Force: new opportunity in North America – develop a consistent multi-weather year, continental dataset

ERCOT Case Study

Correlated weather impacts on renewable output and load response stresses the model in ways that expected profiles would not

- 40-year load dataset
- 40-year wind & solar dataset
  - Covers existing and potential future generators
  - Includes icing and cold weather impacts

High renewable system quantifies shifting risk to winter periods and different years of this historical record



Source: EPRI, Telos Energy, *forthcoming*
Resource Adequacy for a Decarbonized Future

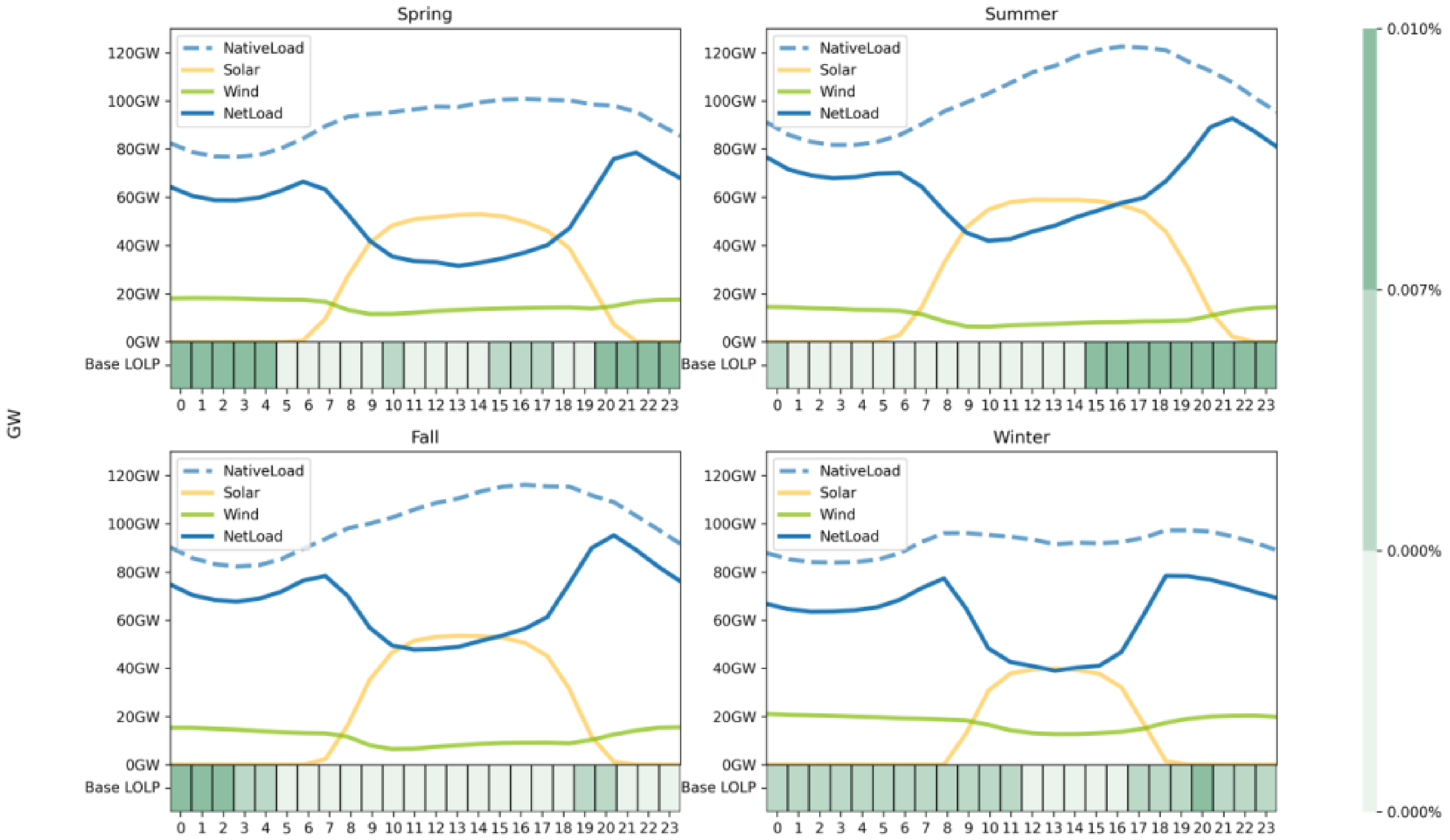
1. Chronological operations must be modeled across many weather years
2. **Quantifying size, frequency, duration, and timing of capacity shortfalls is critical to finding the right resource solutions**
3. Neighboring grids and transmission are a key part of the RA challenge
4. There is no such thing as perfect capacity.
5. Load participation fundamentally changes the resource adequacy construct.
6. Reliability criterion should not be arbitrary, but transparent and economic.

Characterizing Risk in MISO

Seasonal assessment of LOLP by hour of day

Also incorporating what the wind, solar, and storage resources are performing during LOLP conditions

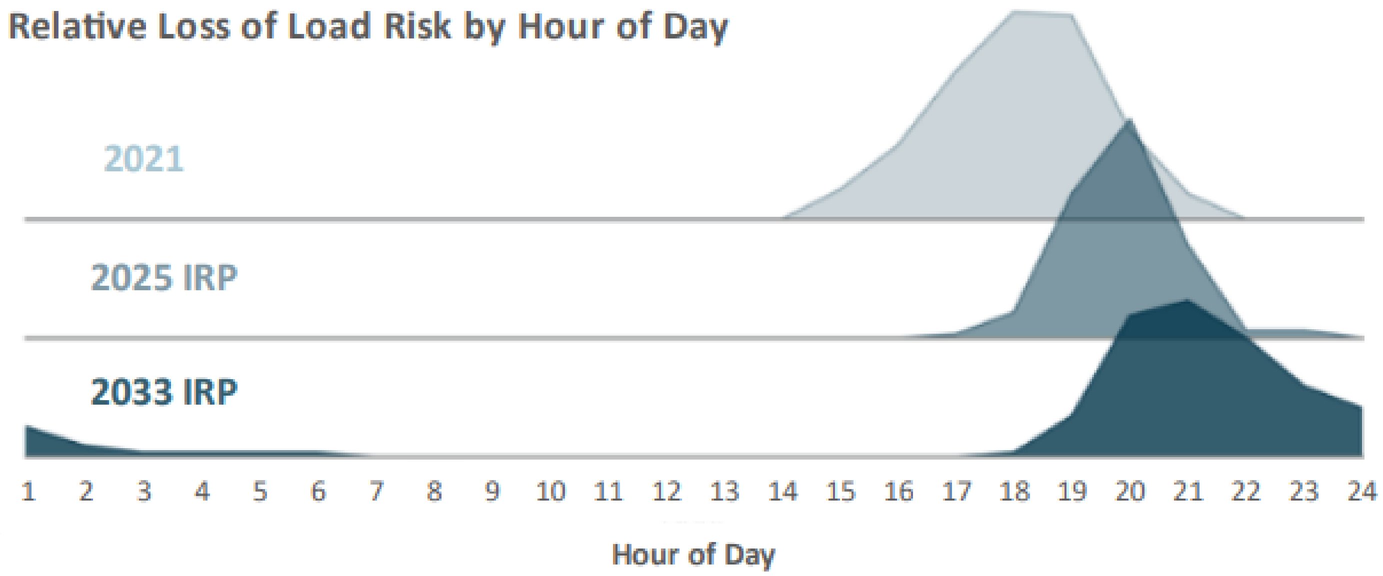
Diurnal Renewables, Load, Net Load and LOLP during EUE days in 2040

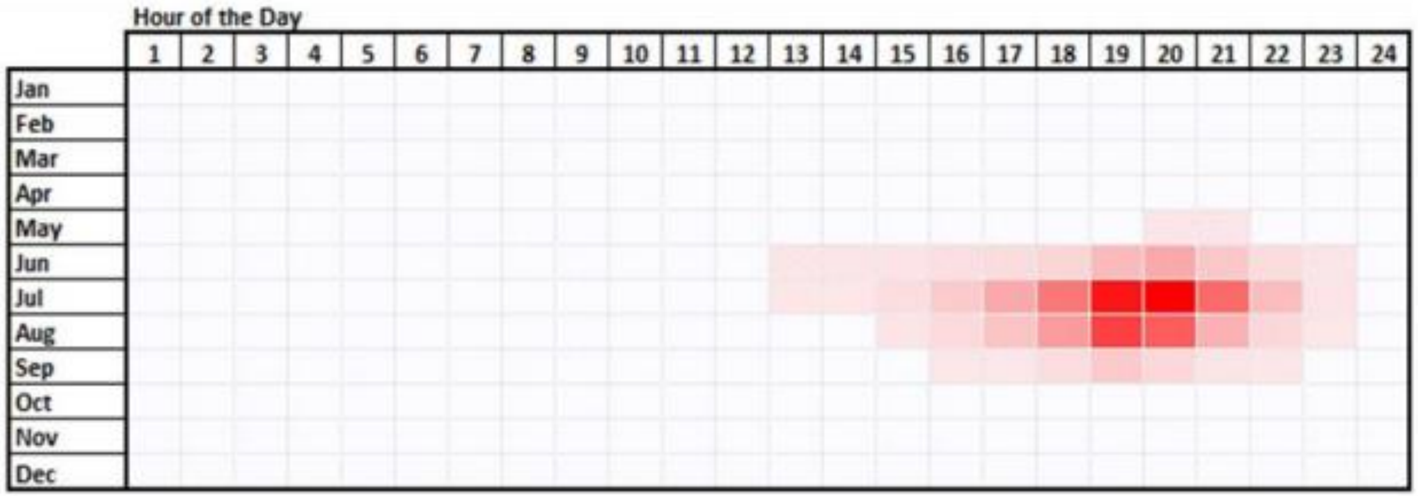


When are events occurring?

As the resource mix changes, risk will shift diurnally and seasonally

In many parts of the U.S. this will be into the later evenings and eventually into the winter season

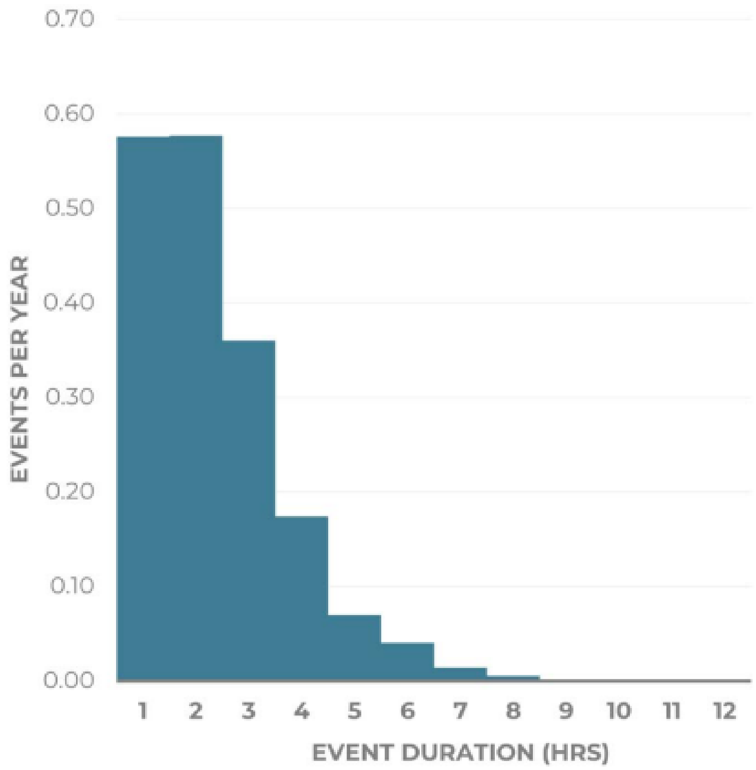




Source: E3, 2022,
[Resource Adequacy in the Desert Southwest]

Characterizing event size is necessary to properly size mitigations

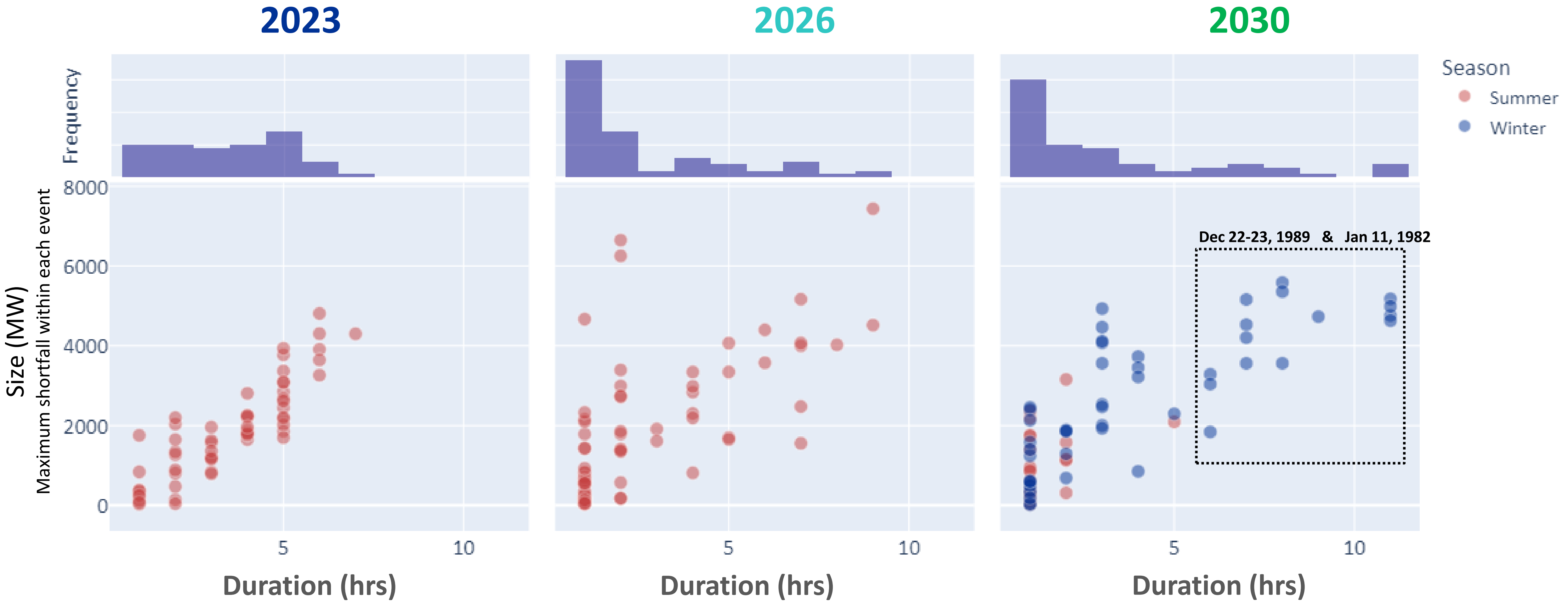
EVENT DURATION DISTRIBUTION



EXPECTED DAYS OF LOST LOAD IN 10 YEARS

Source: GridLab, 2022,
[Advancing resource adequacy analysis with the GridPath RA Toolkit]

Characterizing individual events for further insights help understand risks and potential mitigations



30% of events occur on June 25-26, Weather Year 2012

47% of events occur on Dec 22-23, Weather Year 1989 & Jan 11, Weather Year 1982

Source: EPRI, Telos Energy, *forthcoming*
[Resource Adequacy for a Decarbonized Future]

1. Chronological operations must be modeled across many weather years
2. Quantifying size, frequency, duration, and timing of capacity shortfalls is critical to finding the right resource solutions
3. **Neighboring grids and transmission are a key part of the RA challenge**
4. There is no such thing as perfect capacity.
5. Load participation fundamentally changes the resource adequacy construct.
6. Reliability criterion should not be arbitrary, but transparent and economic.

Resource adequacy studies should span large geographies to capture benefits of load and renewable diversity

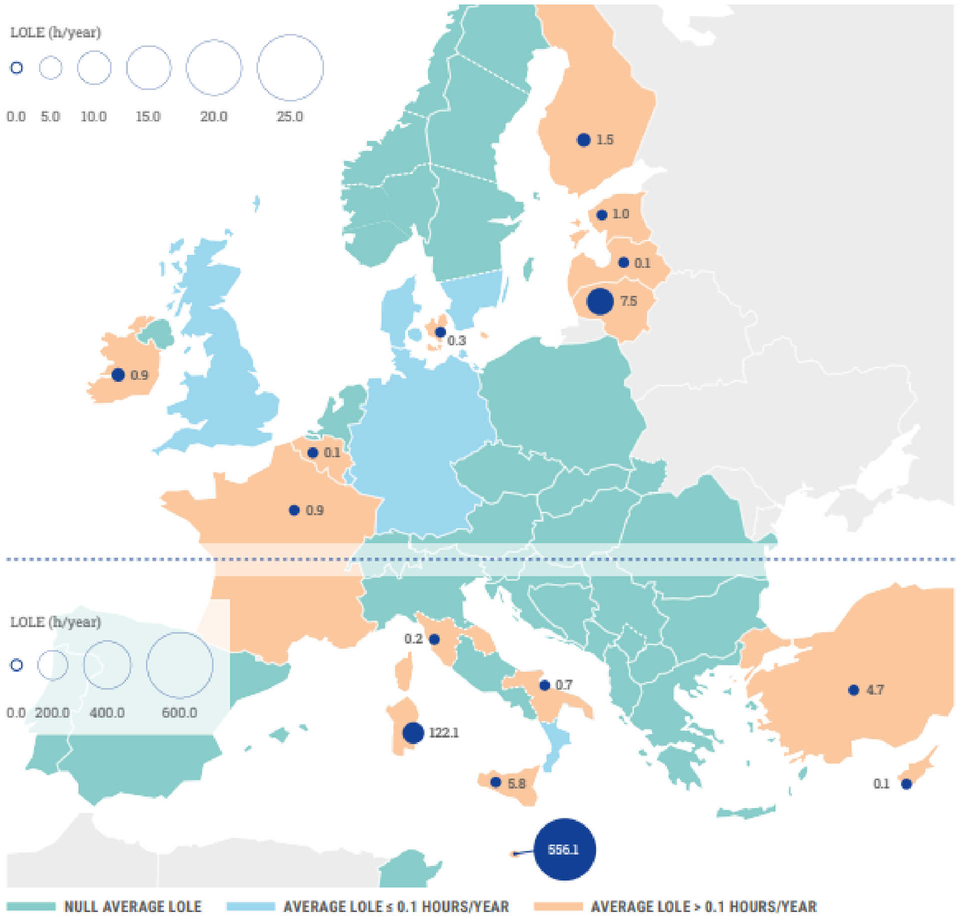


Figure 3: LOLE values for the scenario "National Estimates 2025". Circles for bidding zones with LOLE values smaller than 0.1 hours/year are not represented.

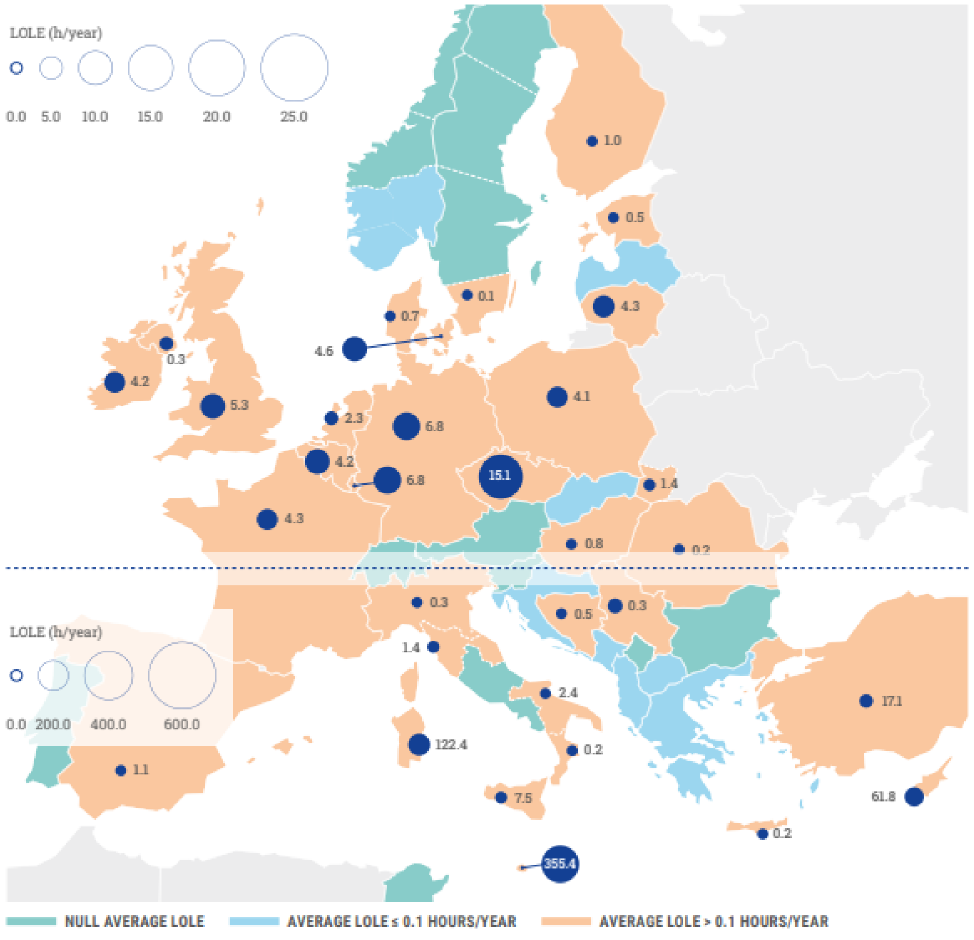


Figure 5: LOLE values for the scenario "EVA without CM 2025". Circles for bidding zones with LOLE values equal or smaller than 0.1 hours/year are not represented.

Source: ENTSO-E, 2021
[European Resource Adequacy Assessment]

There's large opportunities for capacity sharing, but this requires new regulatory frameworks

	2025 IRP Portfolios	
Metric	Base Case	Regional Support
LOLE (days/yr)	0.04	0
LOLH (hrs/yr)	0.07	0
Normalized EUE (ppm)	0.34	0
Effective Capacity Surplus (Shortfall) (MW)	**760**	**2,139**

"while this analysis presents a view of the level of reliability that might be achieved across the region, **each utility remains responsible** for planning a portfolio of resources to meet the reliability needs of its own customers' loads. In the absence of a **formalized protocol for sharing of capacity** resources among entities within the Southwest, utilities plan for the resource adequacy of their own systems in a way that may not harvest the full physical load and resource diversity of the region."

Risks of dependence on neighboring regions

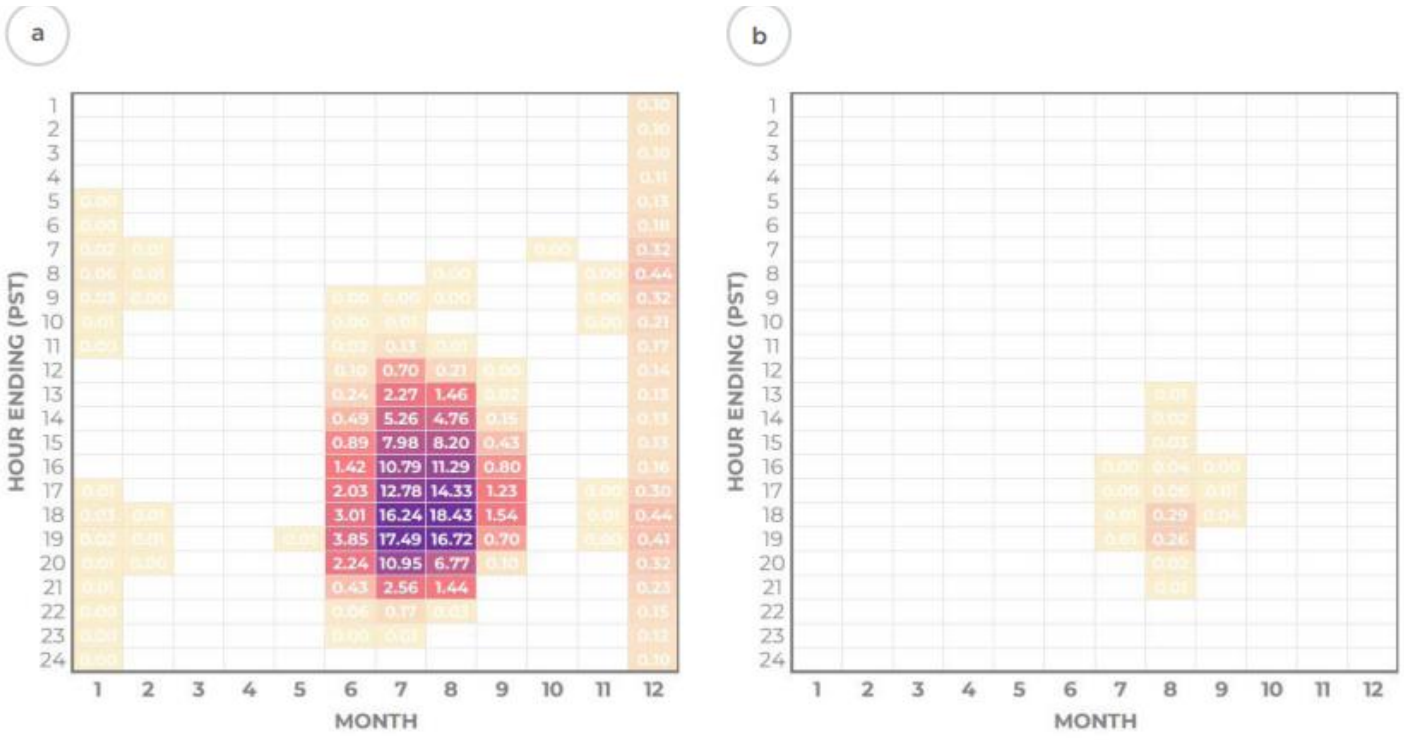
- Development risk in neighboring regions
- Operational risks of energy-limited resources
- Institutional risks

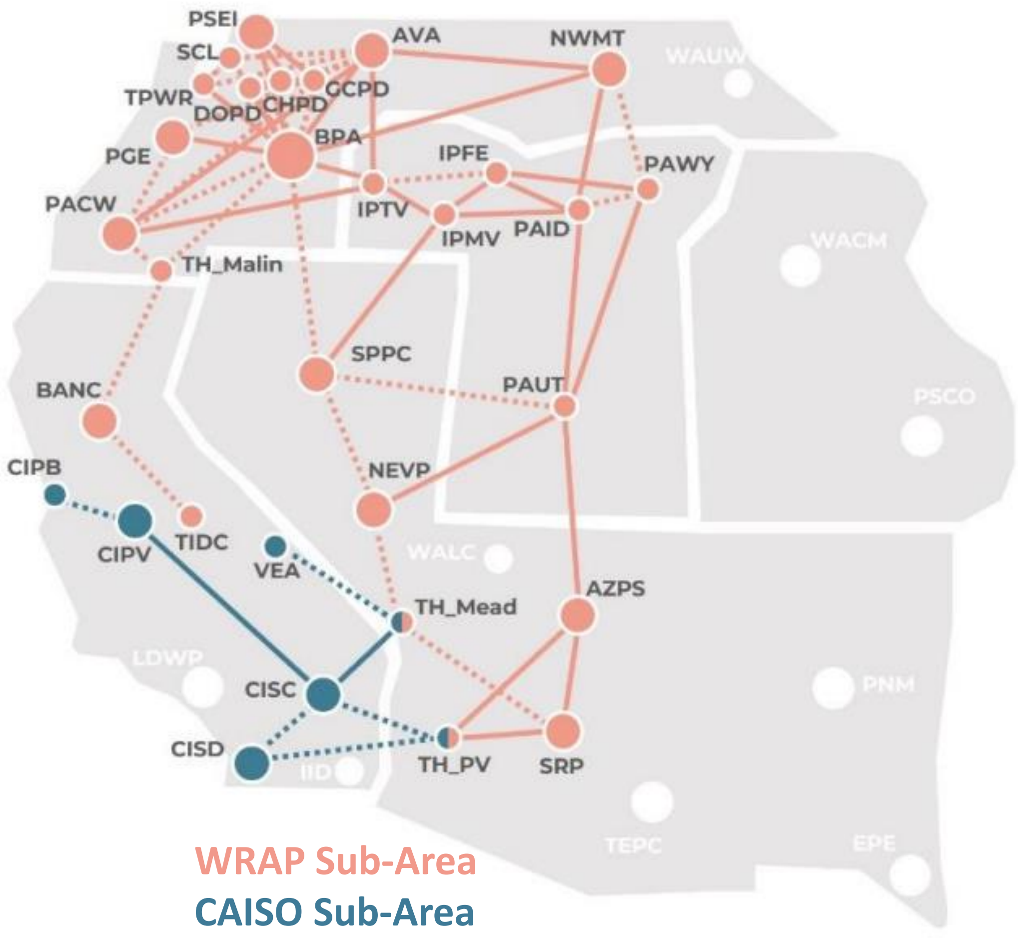
How can the policy & regulatory framework overcome these?

Source: E3, 2022,
Resource Adequacy in the Desert Southwest

Interregional coordination and transmission can be a capacity resource, but only if we evaluate it

Loss of load hours per year for the WRAP subarea in the Less Coal Scenario when (a) the subarea is modeled as an island and (b) the subarea has access to imports.

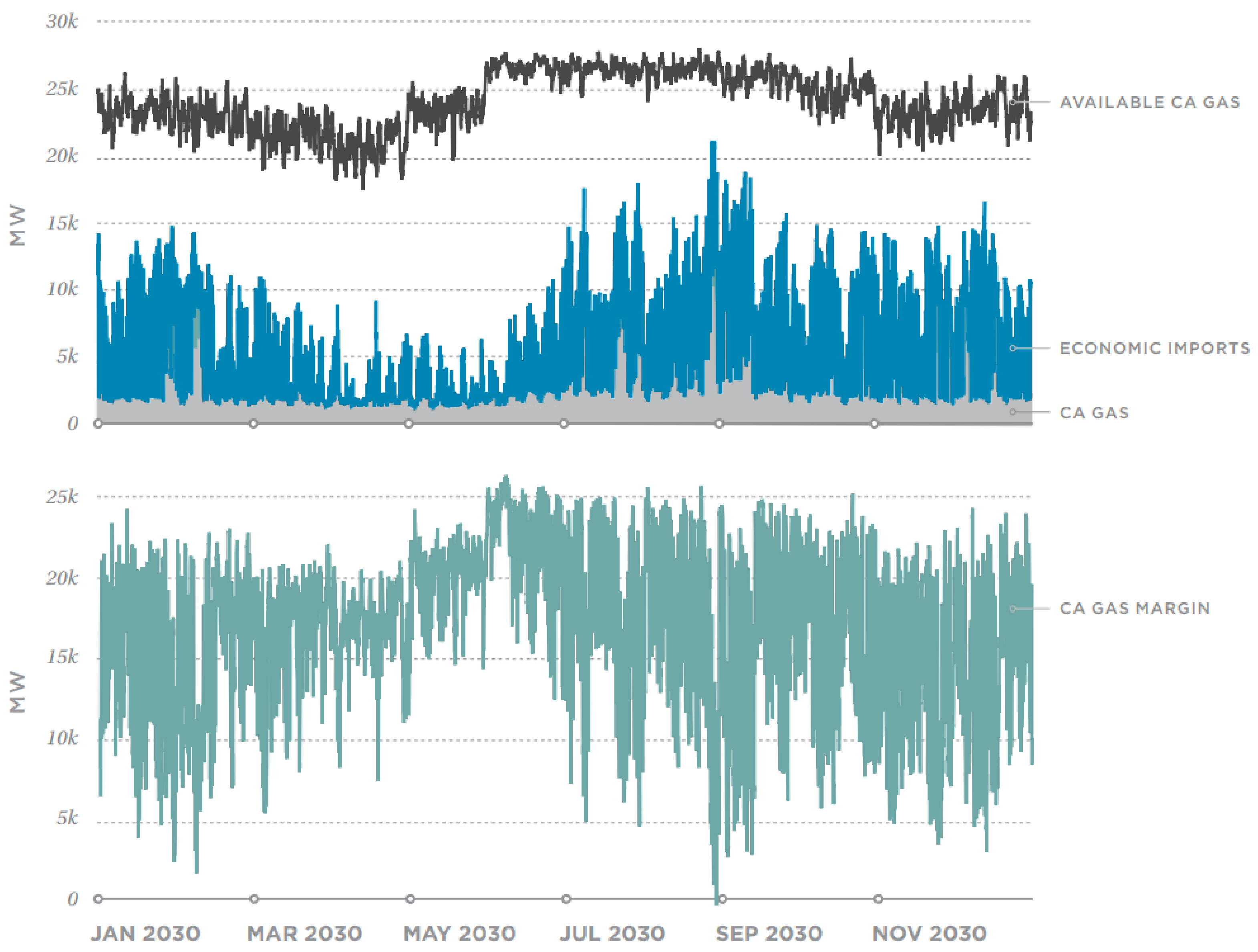




Source: GridLab, 2022,
[Advancing resource adequacy analysis with the GridPath RA Toolkit]

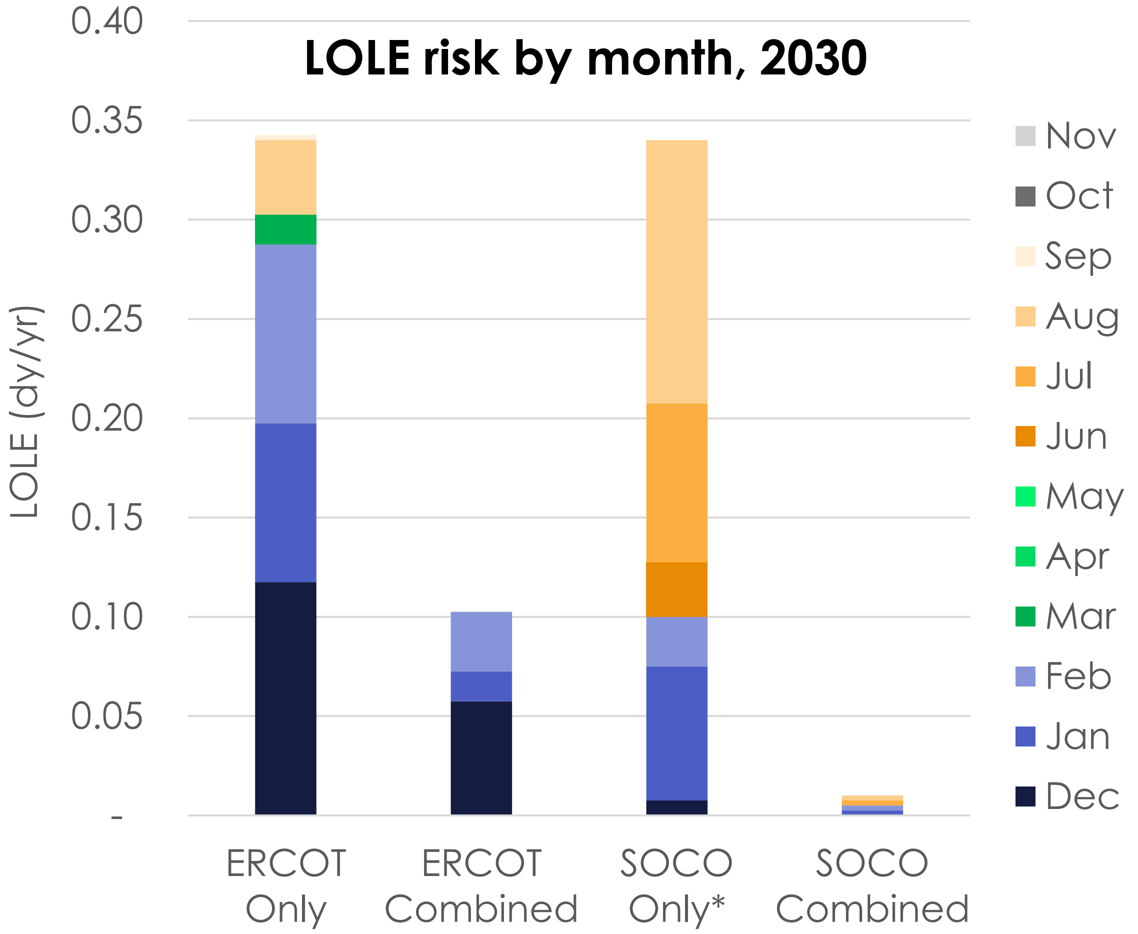
How can we disaggregate reliance on imports?

GridLab California study evaluated the interrelationship between economic (non-dedicated) imports and in-state gas availability to better capture reliance on imports



Evaluating capacity contributions of new transmission

- **With additional Southern retirements, the connected system sees RA benefits at both ends of the HVDC line *without adding any new resources***
- Interregional transmission accesses load diversity and renewable resource diversity
- Improves ERCOT resource adequacy and enables deferral of new gas capacity and additional coal retirements in southeastern US
- Intereregional transmission can have a
  200% Capacity Credit
  a 2 GW line can improve resource adequacy similar to 4 GW of new natural gas capacity
  [2 GW in ERCOT + 2 GW in Southern Company]



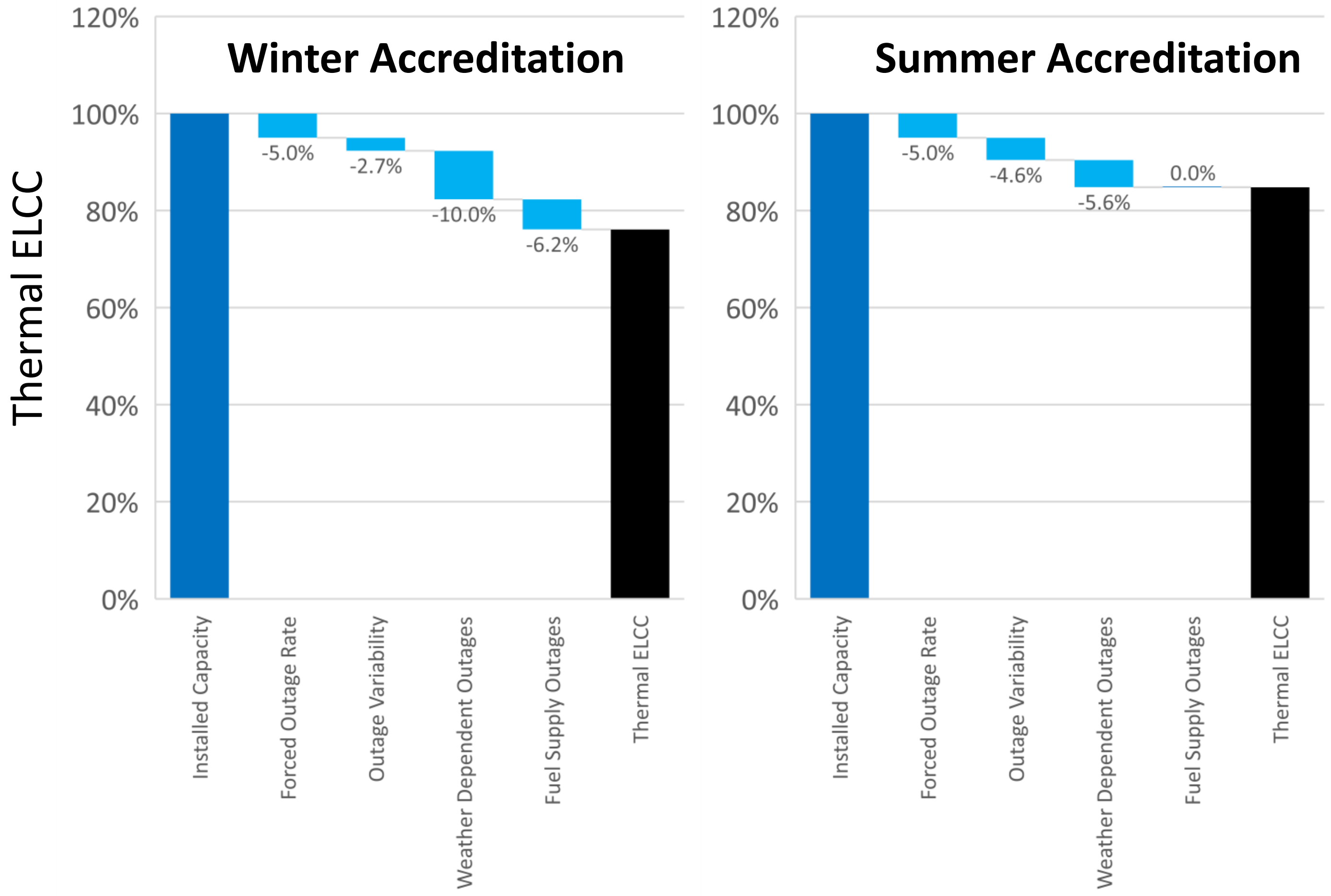
1. Chronological operations must be modeled across many weather years
2. Quantifying size, frequency, duration, and timing of capacity shortfalls is critical to finding the right resource solutions
3. Neighboring grids and transmission are a key part of the RA challenge
4. **There is no such thing as perfect capacity.**
5. Load participation fundamentally changes the resource adequacy construct.
6. Reliability criterion should not be arbitrary, but transparent and economic.

Capacity Accreditation for All

UCAP accreditation may not be a good proxy for perfectly available capacity when accounting for fleet wide interactions of thermal resources

Key fleet wide interactive outage effect categories include:

- Outage variability
- Common mode failures
- Weather dependent outages
- Fuel availability outages



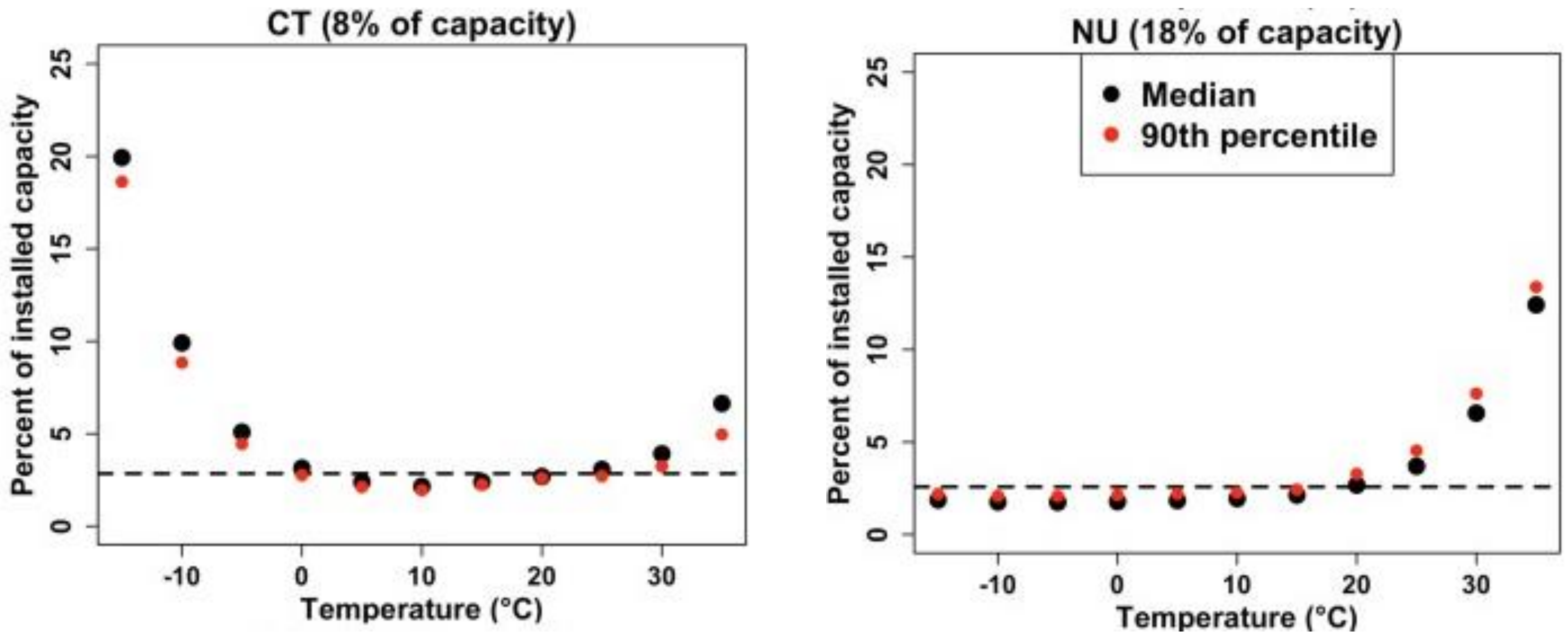
Data Source: Astrape, 2022 (Chart by Telos Energy)
[Accrediting Resource Adequacy Value to Thermal Generation]

We need more granular forced outage data

To capture weather dependencies by generating units

GADS+ could include anonymized:

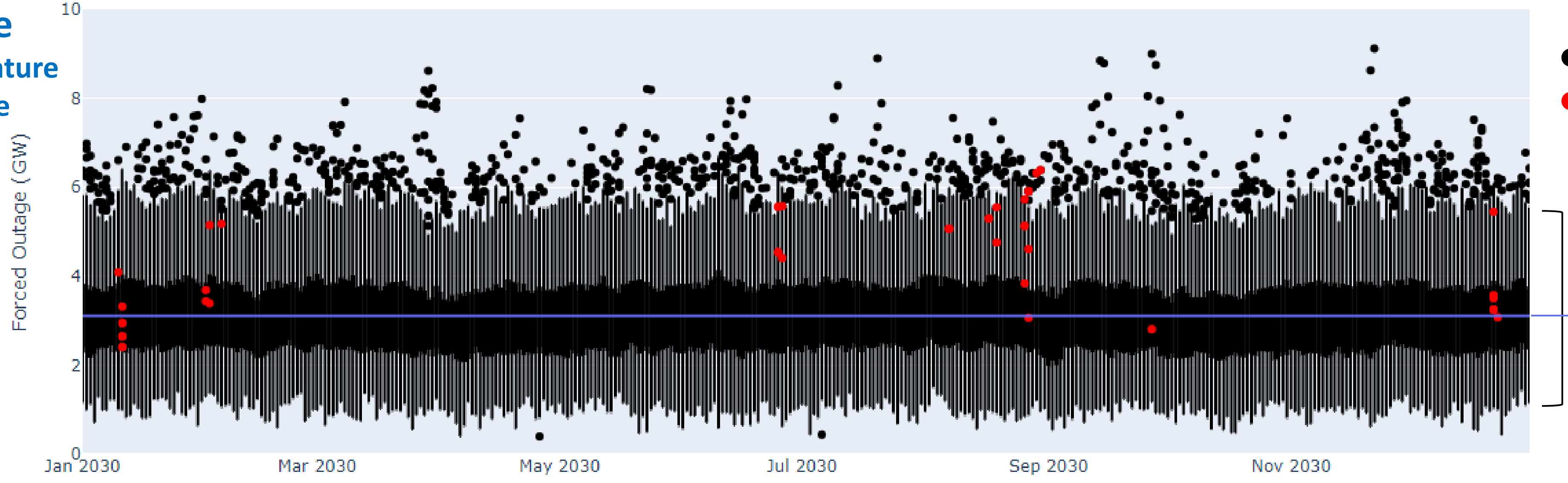
- Daily outage rates by unit
- Locational outage rates (by weather zone)
- Long historical record to include outlier weather conditions
- Simulated performance during weather events
- Control equipment (weatherization, chillers, etc.)



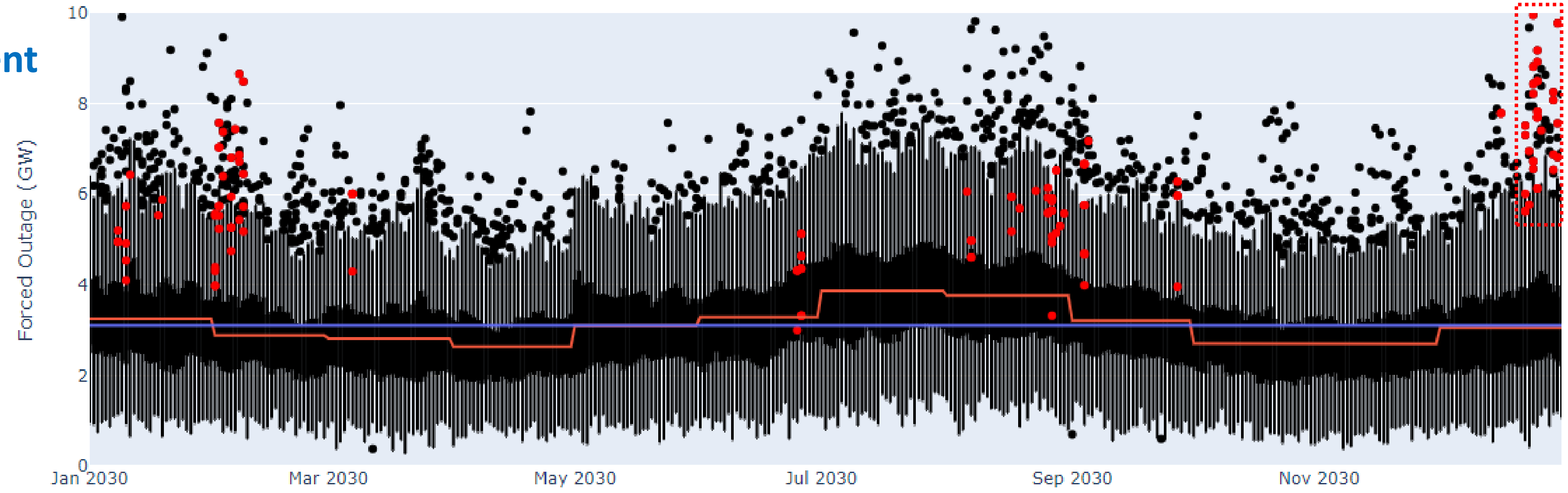
Source: Murphy, S., et al, 2022
[A time-dependent model of generator failures and recoveries captures correlated events and quantifies temperature dependence]

Evaluating system risk with weather dependent outages

Base Case
No Temperature Dependence



Weather Dependent Outages



*note: ERCOT does not see an increase in average forced outage rates in the summer, but that may be due to faster repair times
Source: ERCOT Annual Reports 2012-2020

Source: EPRI, *forthcoming*
Resource Adequacy for a Decarbonized Future

What comes next?

There's more work to be done, especially to evaluate load flexibility and to establish the reliability criteria for the future

1. Chronological operations must be modeled across many weather years
2. Quantifying size, frequency, duration, and timing of capacity shortfalls is critical to finding the right resource solutions
3. Neighboring grids and transmission are a key part of the RA challenge
4. There is no such thing as perfect capacity.
5. Load participation fundamentally changes the resource adequacy construct.
6. Reliability criterion should not be arbitrary, but transparent and economic.

Thank You!

Questions?

Derek Stenclik
derek.stenclik@telos.energy
Telos Energy