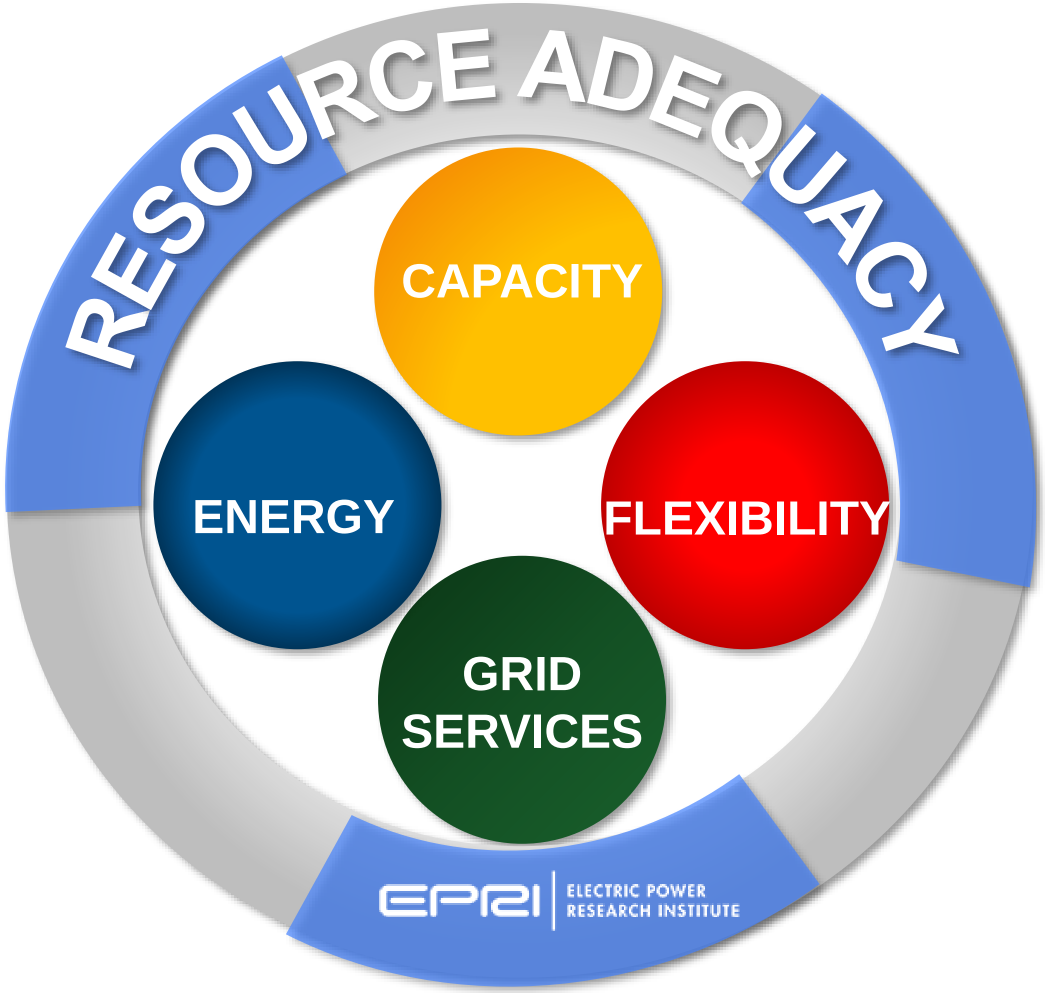
Resource Adequacy for a Decarbonized Future

ESIG Webinar

EPRI Transmission Operations and Planning
April 26, 2023

What is a Resource Adequacy (RA) Risk Assessment?



Can the resource mix meet projected customer energy needs at all times?

Traditional Modeling Process

Probabilistic across expected conditions with average generator outage rates

Traditional Metric

Loss of Load Expectation (LOLE):

Expected number of days per year with insufficient capacity to meet load

Traditional Criteria

LOLE less than 1 day every 10 years (LOLE < 0.1)

Resource Adequacy Initiative

Scope and Deliverables

RA Process

- Recommended Metrics and Criteria
- Future Scenario Database and Tool

Models and Data

- Emerging Resource & Demand Side Models
- Model Data Development Tools

Analysis Tools

- Existing RA Tool Capabilities
- New Algorithms and open-source code

Case Studies: Evaluation of existing and development of new capabilities based on 4-6 regional RA case studies covering differing RA issues and tools.

Tech Transfer: Reports and workshops to be conducted to disseminate results and to promote broad adoption in commercial tools.

25+ Participants

Partners

External Advisory: NARUC, NREL, ESIG, GridPath, RROs, DOE, ISOs/RTOs, G-PST, Consultants, Universities, etc.)

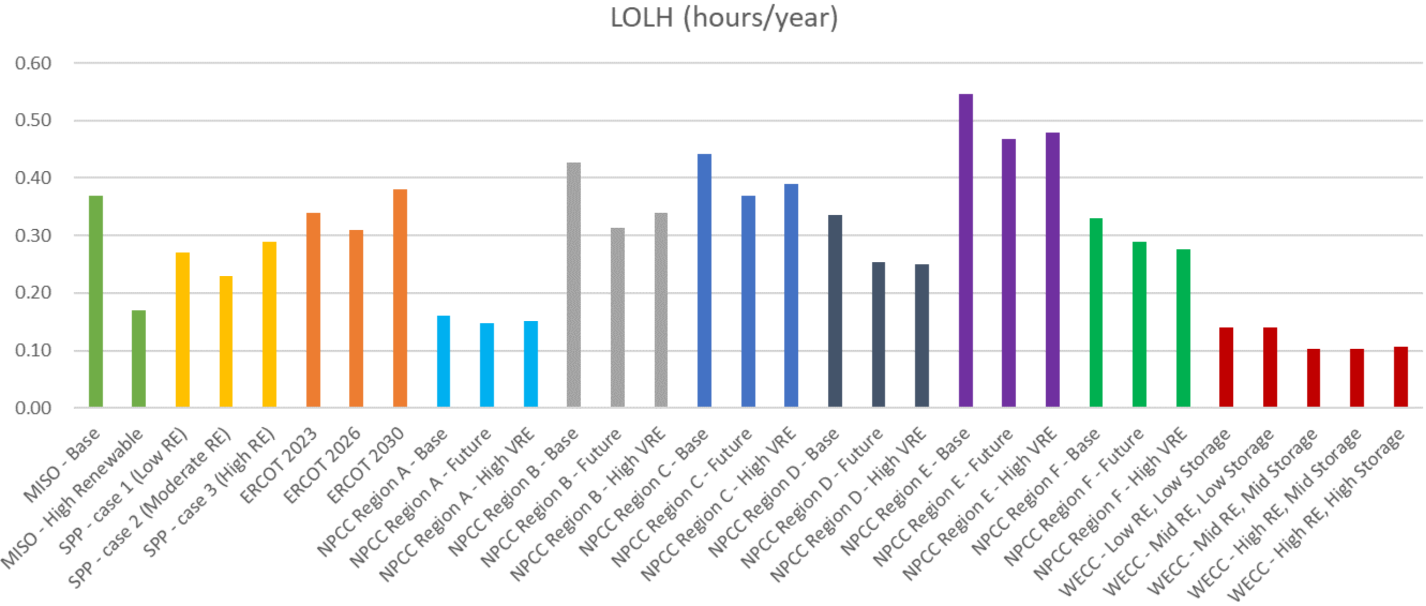
Foundational Case Studies

Six case studies of different views of future systems, in different climate and electrification contexts, used to assess a range of key questions and study tool capabilities.

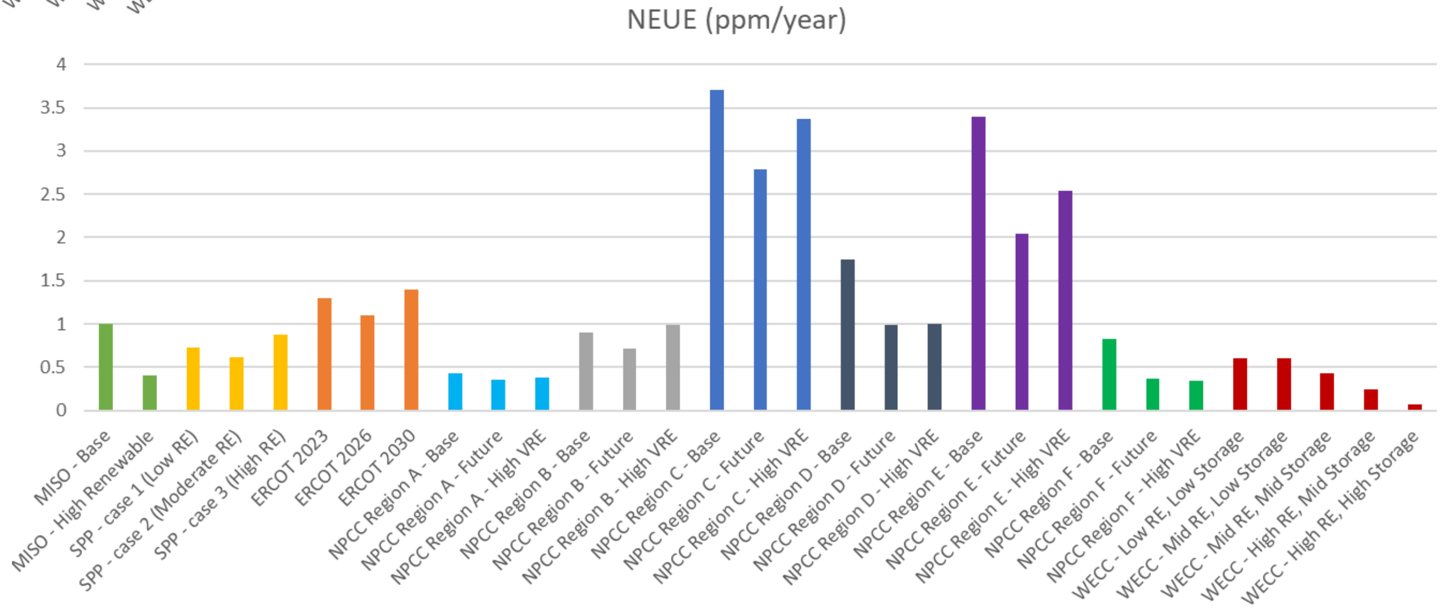
	WECC	TEXAS	SPP	MISO	Northeast	Southeast Utility
Metrics	●	●	●	●	●	●
WDO Modeling	○	●	●	●	●	○
Climate Impacts	○	○	○	○	●	○
Load Evolution	○	●	●	○	●	○
Storage	●	●	○	○	○	○
Transmission	○	○	○	●	●	○
Gas Electric	○	○	○	○	○	●

EPRI

Avoid relying on a single metric



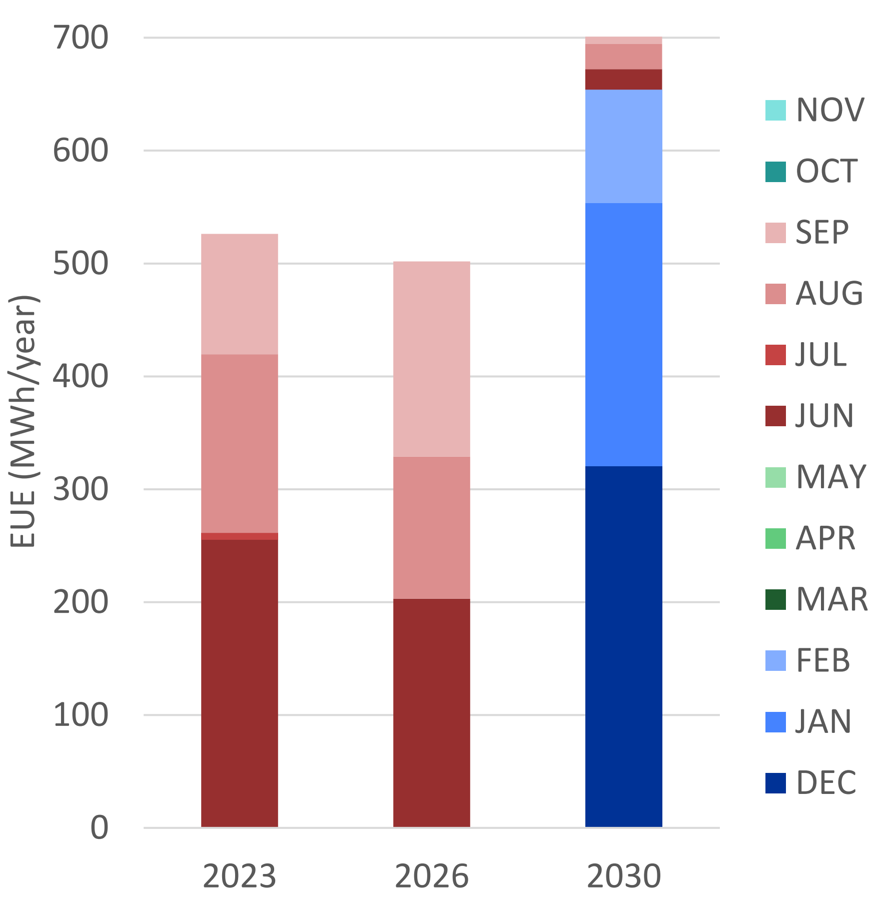
LOLE gives information of the expected number of days when a loss of load occurs but doesn't give information on the magnitude of that load loss.



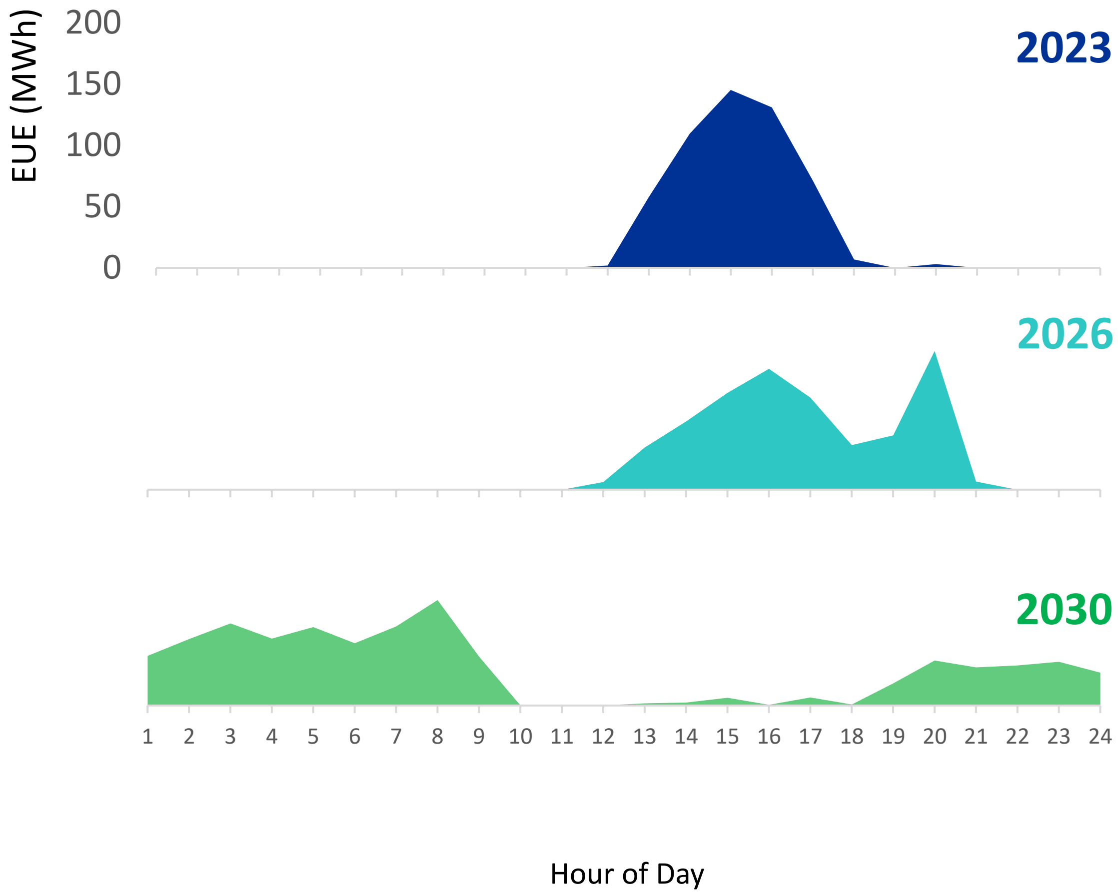
All case study portfolios shown here were brought to a LOLE of 0.1 days/year, and yet show different results for LOLH and EUE.

Better leverage existing metrics

Unserved Energy by Month



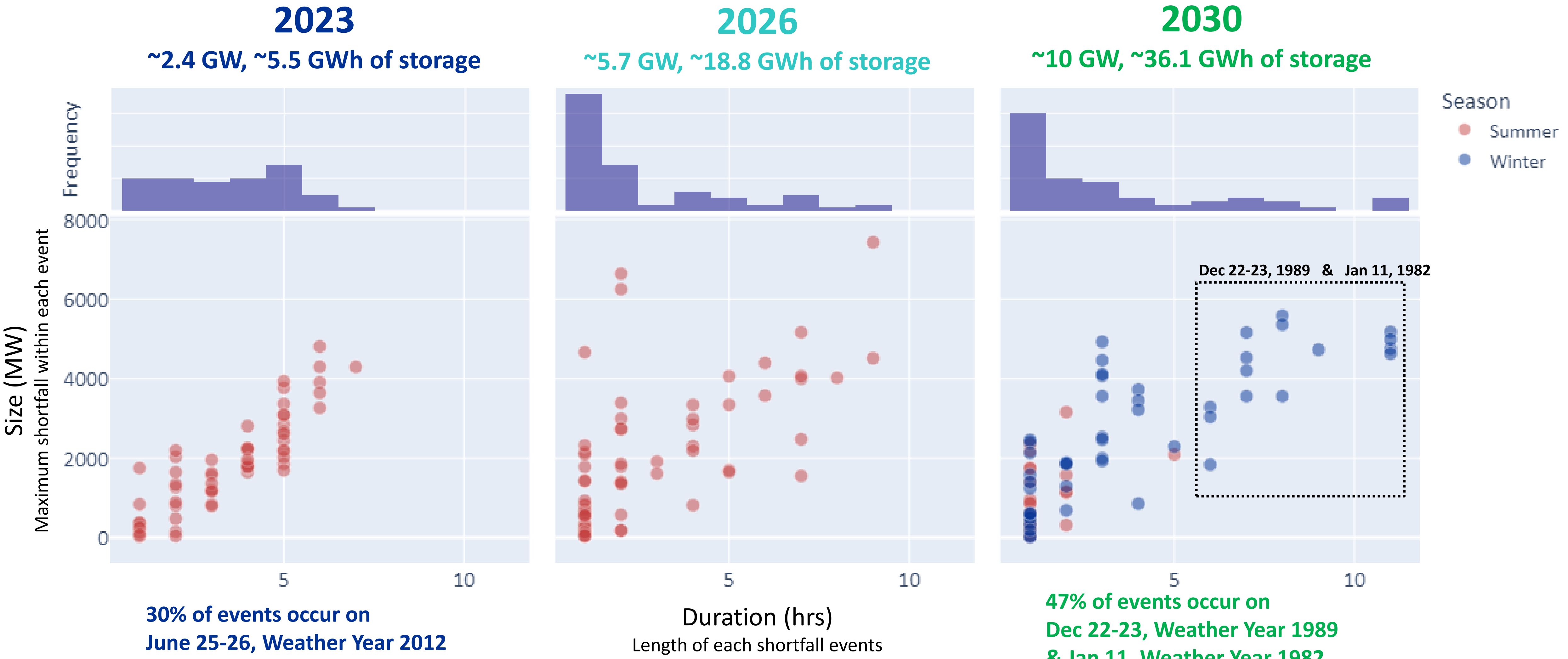
Unserved Energy by Hour of Day



ERCOT case study results

Existing metrics can be reported by hour of day or by month to provide additional information.

Characterize event size, frequency, and duration



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

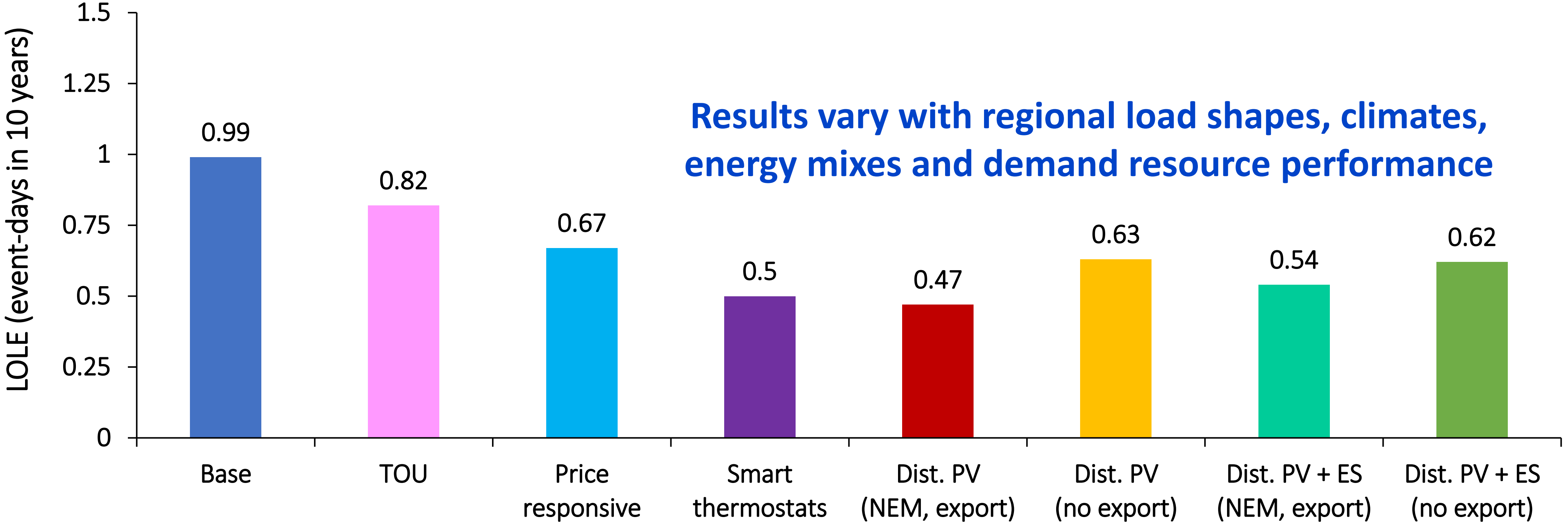
47% of events occur on Dec 22-23, Weather Year 1989 & Jan 11, Weather Year 1982

As system transitions to higher renewable and increased storage, duration of shortfalls get longer as the system becomes more energy limited

ERCOT case study results

Resource Models: Demand Flexibility Potential Value

Potential reduction in LOLE from 900 MW (3% peak demand) of various distributed resource types (technology and tariff) for specific utility system



EPRI RAI provides methodology for modeling flexible demand contributions to RA

Examine consequences of extremes

- With the same expected LOLE, replication results vary. The highest result from all replications varies from 5.89 days/year to 0.3 days/year.
- When high top replications are observed, the lower replications have much lower loss of load than the rest.
- P50 for Region B in the base case is down at 0.01 days/year where Region A VRE is at the average LOLE of 0.1 days/year.

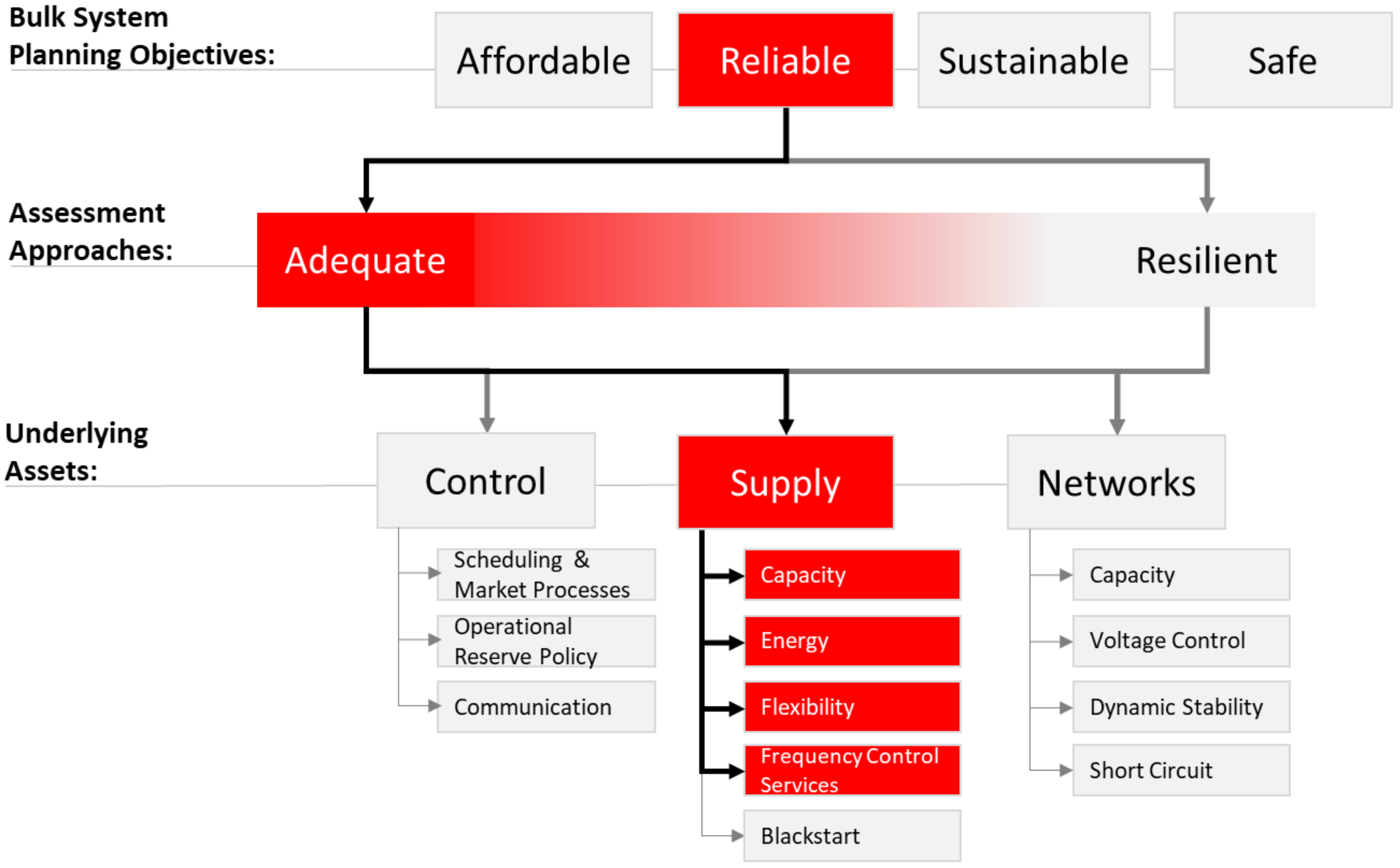
LOLE95 is already in use in Belgium

		Daily LOLE [days/year]					
Region	Case	Average LOLE	p50	p90	p95	p99	Top
A	Base	0.10	0.10	0.17	0.18	0.24	0.41
	Future	0.10	0.09	0.17	0.17	0.19	0.34
	VRE	0.10	0.10	0.18	0.18	0.21	0.30
B	Base	0.10	0.01	0.22	0.46	1.50	5.89
	Future	0.10	0.07	0.25	0.37	0.69	1.38
	VRE	0.10	0.07	0.21	0.36	0.66	1.50
C	Base	0.10	0.08	0.19	0.21	0.29	0.51
	Future	0.10	0.08	0.18	0.21	0.25	0.38
	VRE	0.10	0.09	0.18	0.21	0.26	0.41
D	Base	0.10	0.09	0.17	0.19	0.25	0.44
	Future	0.10	0.06	0.22	0.29	0.40	0.60
	VRE	0.10	0.09	0.19	0.31	0.42	0.68
E	Base	0.10	0.09	0.18	0.25	0.41	0.78
	Future	0.10	0.06	0.22	0.30	0.60	1.26
	VRE	0.10	0.07	0.20	0.29	0.59	1.14
F	Base	0.10	0.10	0.16	0.19	0.25	0.44
	Future	0.10	0.06	0.19	0.25	0.41	0.75
	VRE	0.10	0.06	0.19	0.22	0.44	0.76

Northeast case study results

For a same expected LOLE of 0.1 days/year, significant differences between cases and regions exist when considering percentile results.

Stress testing: Adequacy and Resilience



Adequate

Philosophy: Determine the expected performance of a system over the range of foreseeable conditions.

Assessment Metrics:
Expected frequency, duration, energy lost margins, pass/fail tests

Resilient

Philosophy: Identify how a system anticipates, absorbs, adapts to, and/or rapidly recovers from extreme scenarios

Assessment Metrics:
An array of case specific metrics that can include load and energy not served.

Stress Test Study Approach

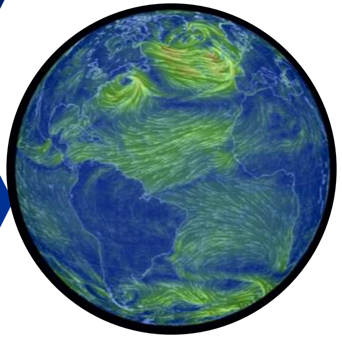
High Level Overview

Power System Information
e.g. generators, demand

Weather Data
Historical & Climate Model

Asset Risk Profiles
e.g. normal operating ranges

Project Future Weather
Historical weather overlaid on climate model projections



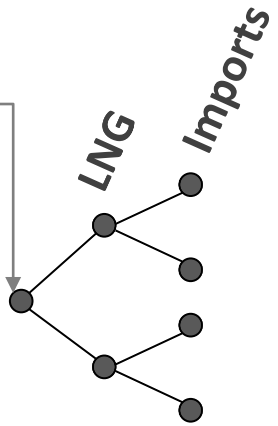
Identify High Risk Events
Screen weather for periods of potential high risk

Cold Snap

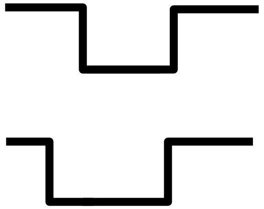
Severe Storm

Heatwave

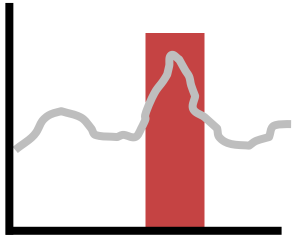
Event Scenarios
Identify potential non-weather scenarios



Weather Dependent Outages
Simulate outages of thermal plant



Operational Simulation
Simulate how the system operates through events



Source: https://gcaptain.com/earth-weather-visualized/

Severity Scale

- New tool to support adequacy assessment
- Case studies will benchmark and provide insight into value of tool
- Beyond using different metrics, allows for greater insight into challenges future system will face

Category	Description	Impact			Operational Actions	Condition
		Economic	Reliability	Public Safety		
Category 1	Region dependent on imports to meet operating reserve requirement	Low	Med	Low	Deployment of demand response	In-region resources cannot meet demand + reserve requirement
Category 2	All available resources cannot meet load and operating reserve requirement	Med	Med	Low	EEA1, public conservation	All available resources cannot meet demand + reserve requirement
Category 3	Minor firm load interruption in progress	Med	High	Med	EEA2, operational reserve deficiency, CVR	Involuntary load shedding is experienced (not greater than 5% in any interval)
Category 4	Significant firm Load interruption in progress	High	V. High	High	EEA3, active load shedding	Involuntary load shedding is experienced (not greater than 10% in any interval)
Category 5	Extensive firm load interruption with catastrophic effect	V. High	V. High	V. High	Rolling Load Shedding	Involuntary load shedding is experienced (greater than 10% in any interval)

Risk is shifting seasonally, from summer to winter

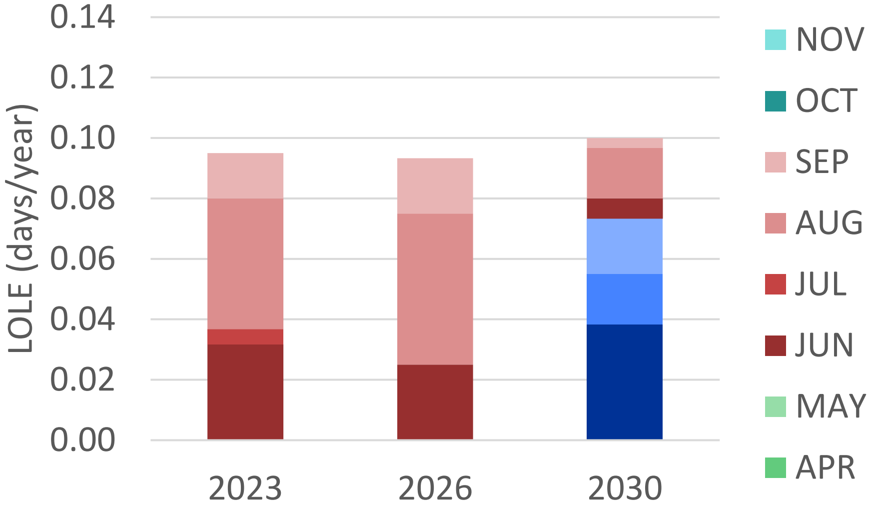
ERCOT case study results

Methodology

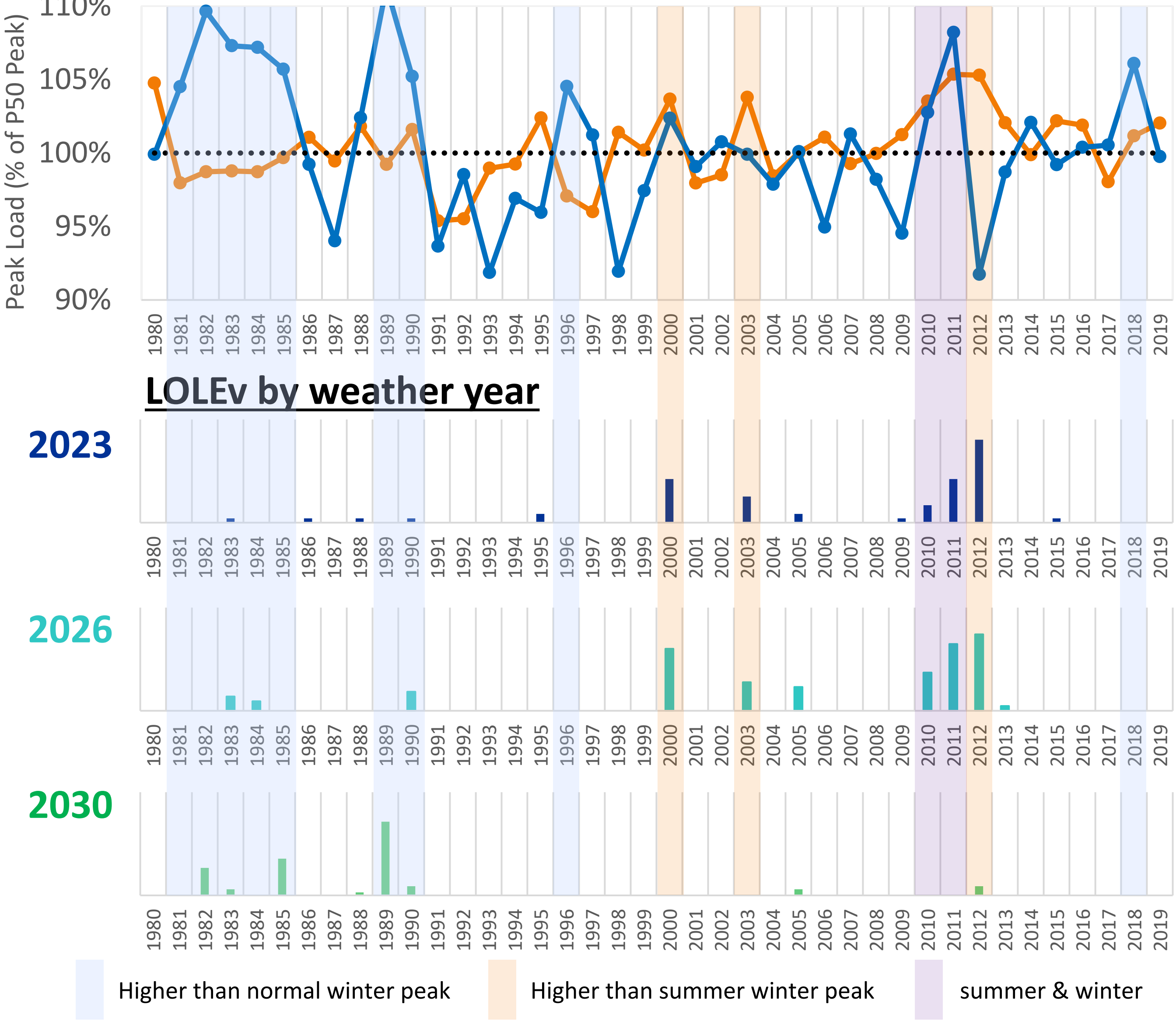
3 study years (2023, 2026, 2030)
with increasing variable renewables, storage, and thermal retirements

40 years of time synchronized weather data for load, solar, and wind profiles

each study year evaluated to ~0.1 days/year LOLE for comparison purposes

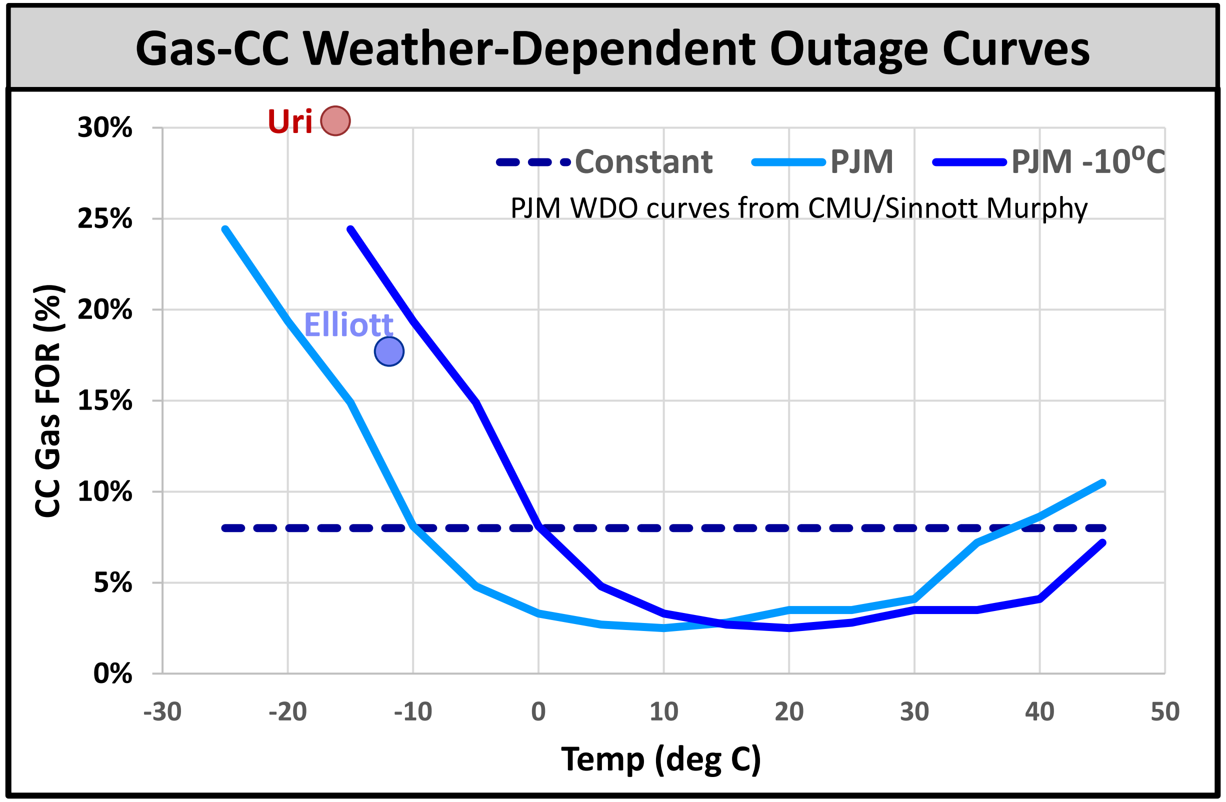


Peak Load by weather year (Summer, Winter)

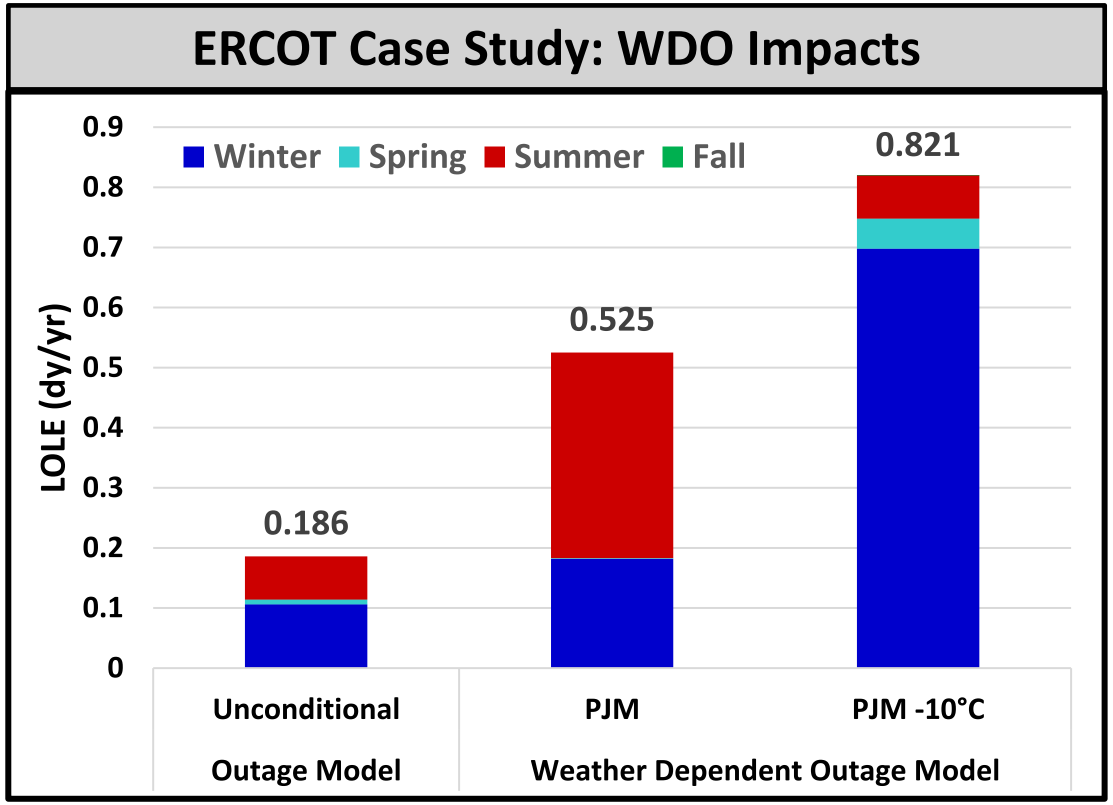


Resource Models: Weather Dependent Outages (WDO)

ERCOT case study results



Extreme temperature impacts generator forced outage rates



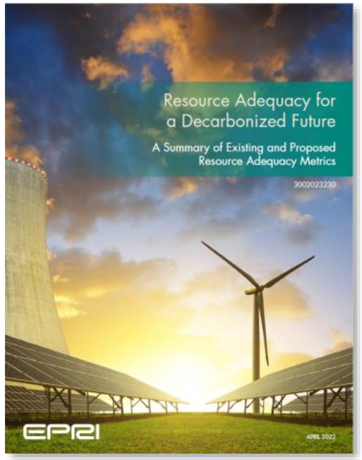
Including WDO in RA risk assessment exposes additional risk

EPRI RAI provides methodology for creating generation WDO curves, modeling guidance (renewables, storage, and, transmission, et. al.), and guidance on data and application in tools

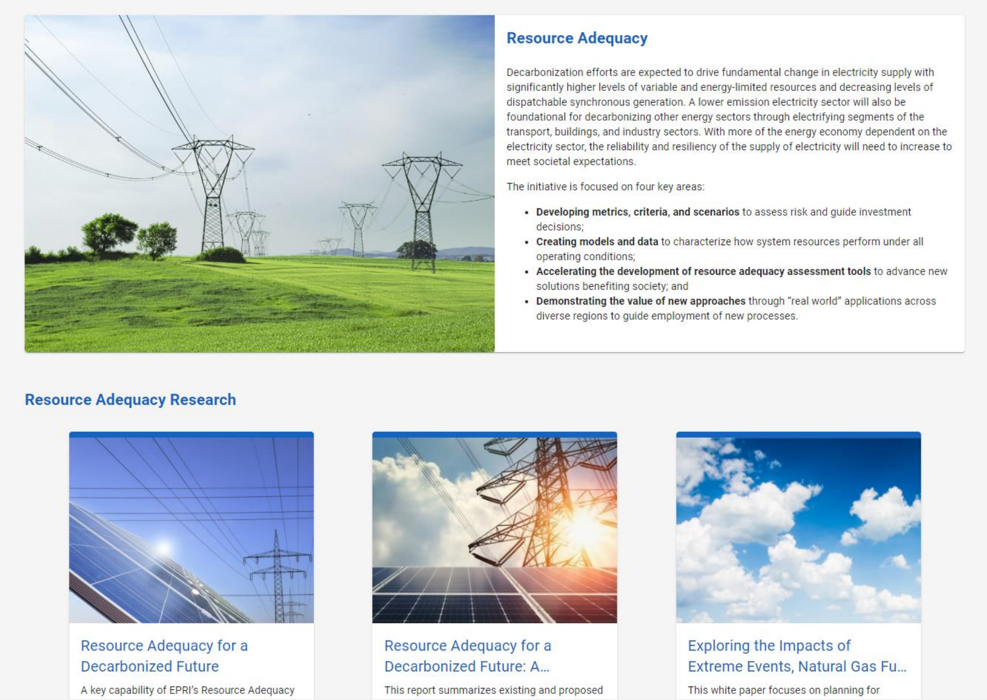
EPRI initiative – Where can I find additional information?

Available today:

- Website is already live, with initial set of reports
- Will be adding material to this as it gets published
- Tools and potentially data also housed here



www.epri.com/resource-adequacy



Available soon:

- In-depth technical reports:
  - Data guidelines
  - Metrics and criteria recommendations
  - Survey of tool capabilities,
  - Scenario generation guidelines
  - Reference of model options by technology type
- Summary papers and videos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