

Resource Adequacy Initiative

Key Outcomes and Next Steps



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ESIG Fall Workshop

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The Resource Adequacy Challenge

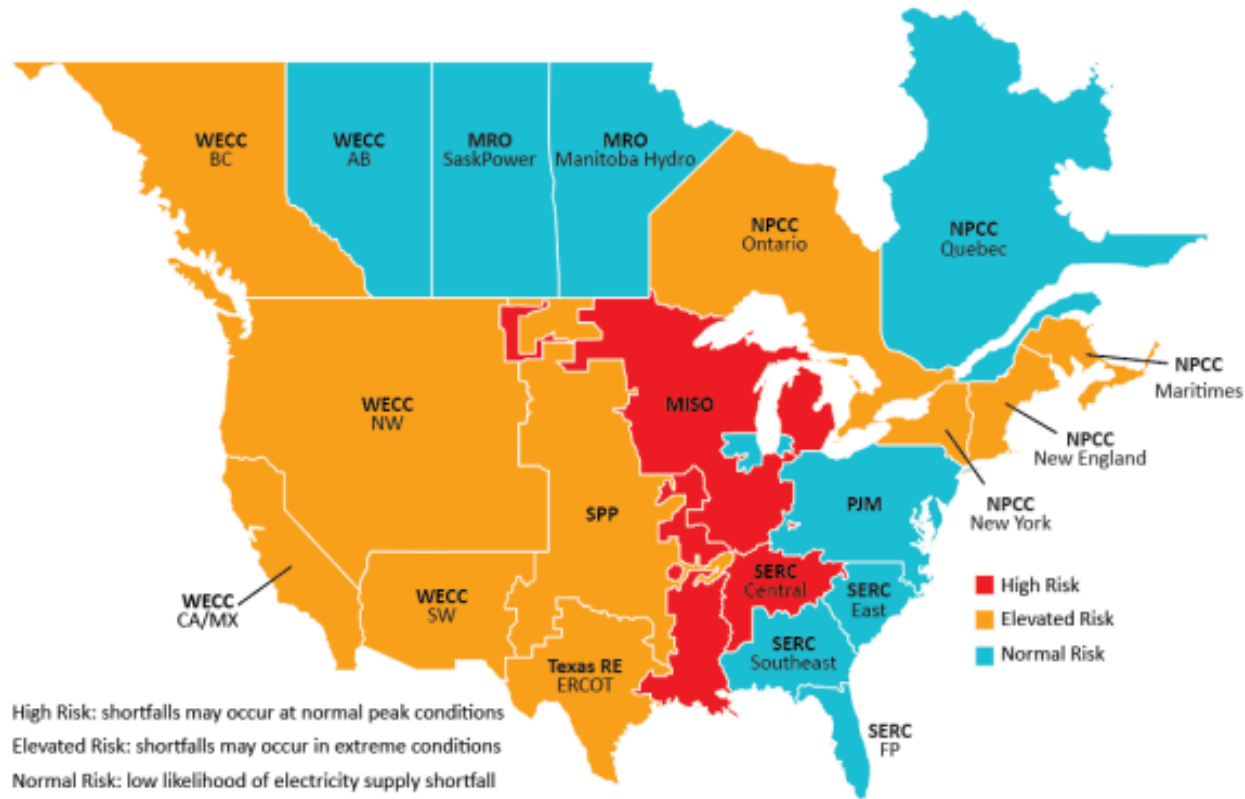


Figure 1: Risk Area Summary 2024–2028⁸

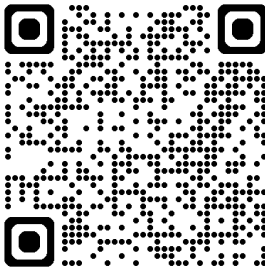
Recent events challenging adequacy:

- [Winter Storm Uri \(2021\)](#)
- [Winter Storm Elliott \(2022\)](#)
- [Winter Storms Gerri/Heather \(2024\)](#)

2023 NERC Long Term Reliability Assessment identified:

- Increasing (elevated/high) risk in many North American regions
- Winter fuel supply challenges
- Capacity reserve challenges

EPRI Resource Adequacy Initiative



Scope and Deliverables

25+ Participants

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.



Partners



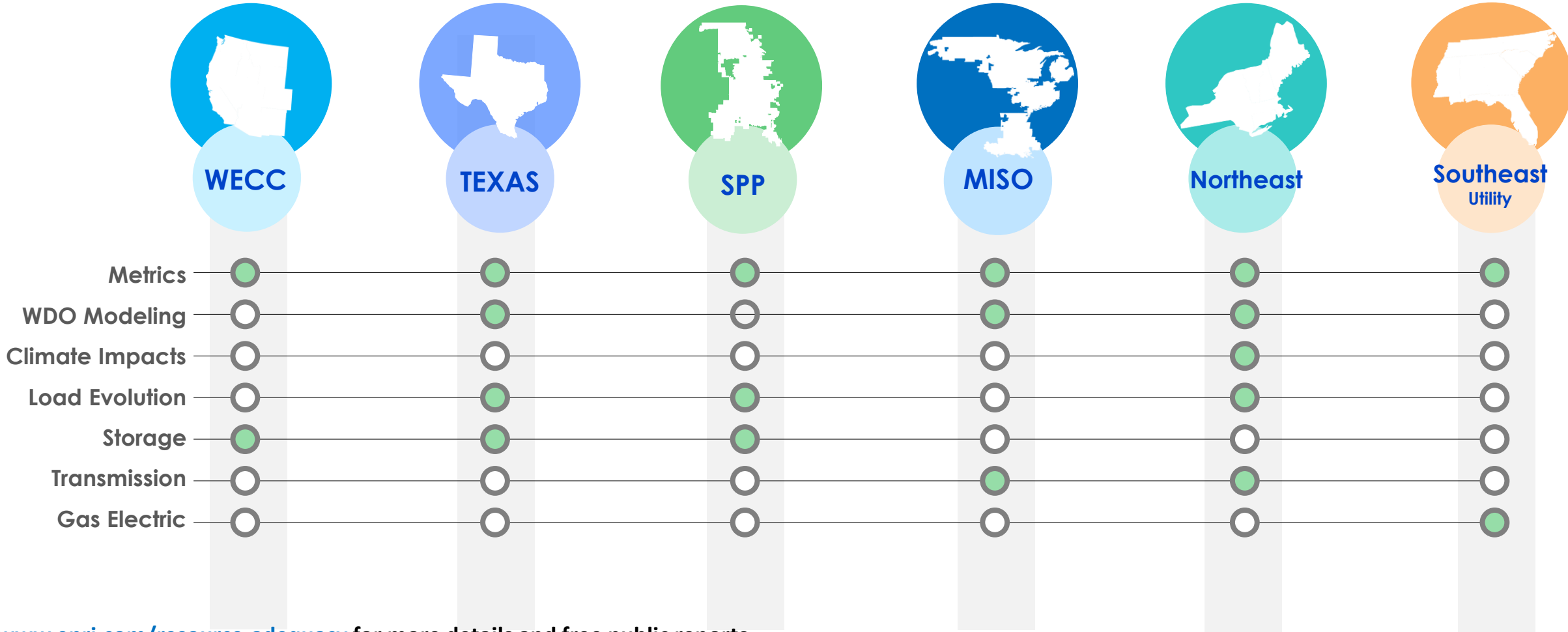
External Advisory

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



Foundational Case Studies

Six case studies of future systems were carried out for different climate and electrification contexts to assess a range of key questions and study tool capabilities that are relevant for each region. All are intended to be future looks at how systems may evolve, and do not replace standard planning studies in the region



www.epri.com/resource-adequacy for more details and free public reports

EPRI Resource Adequacy Decision Support Framework

The case studies, together with extensive review of other studies and consultation with industry stakeholders, provided the evidence base upon which a guideline and decision support framework was developed.

Strategic Guidance: Assessment Design Principles

Resource Adequacy Philosophy

- Use this to:**
- Review the purpose and scope of resource adequacy assessments
 - Leverage foundational principles in process design
 - Compare existing assessment processes to verify completeness

Scenario Selection Guidance

- Use this to:**
- Identify the range of variables and factors that may influence the outcome of adequacy assessments
 - Prioritize approach to considering each of the variables within assessment processes

Metrics & Criteria Guidance

- Use this to:**
- Review the metrics and criteria used to measure adequacy around the world
 - Understand how metrics are calculated and the differences in the risk conveyed by the metrics

Tactical Decision Support: Study Execution Decision Support

Technology & System Models

- Use this to:**
- Review methods by which supply and demand technologies are represented in adequacy models
 - Determine appropriate level of detail that is recommended for each asset type

Data Requirements

- Use this to:**
- Review recommended data sources, variables, extent and quality required to parameterize models
 - Determine appropriate level of detail that is recommended for each variable

Assessment Tool Capabilities

- Use this to:**
- Review the analysis capabilities of commonly applied resource adequacy assessment tools
 - Compare the approaches applied within each, in the context of the recommended model and data guidance

Research Gaps

Resource Adequacy Gap Assessment

- Use this to:**
- Understand the unmet challenges faced by resource adequacy stakeholders, with prioritization of next tasks.

Metrics Recommendations

- 1 Reduce reliance on a single metric
- 2 Consider top percentiles and outlier events
- 3 Better leverage existing metrics
- 4 Describe characteristics of involuntary load shedding events

These recommendations shouldn't be particularly new to those who have been following!

The EPRI Resource Adequacy Initiative Case Studies demonstrate these recommendations in regions across North America.

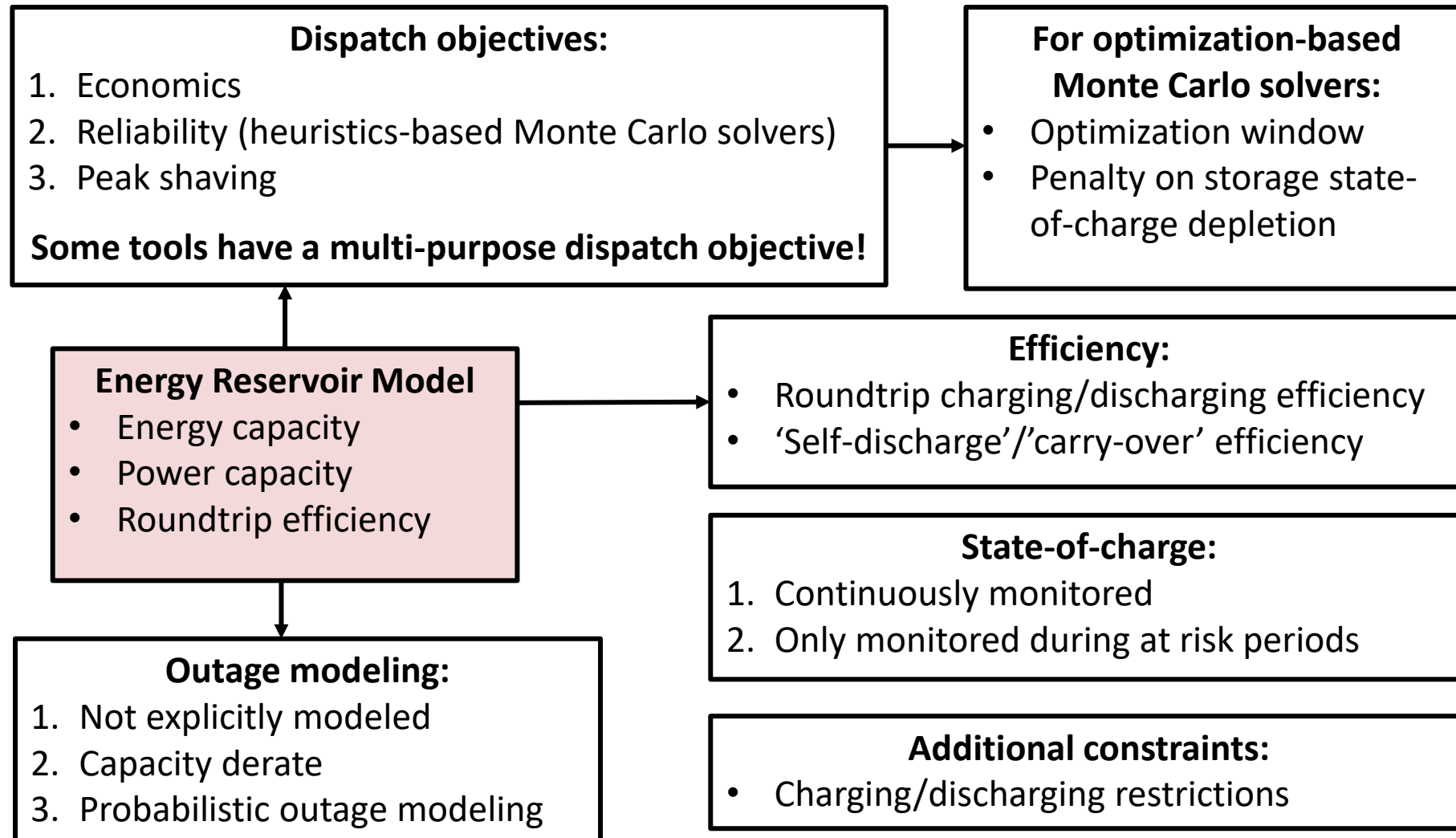
Criteria Setting Considerations

- 1 Adequacy exists on a spectrum and should not be a binary choice
- 2 Criteria setting should not be conducted independent of economic assessment
- 3 Reliability criteria may need to be updated to meet customer expectations as the nature of risk changes
- 4 There is no universal criterion for an adequate system

In a lot of ways, this is the more challenging part!

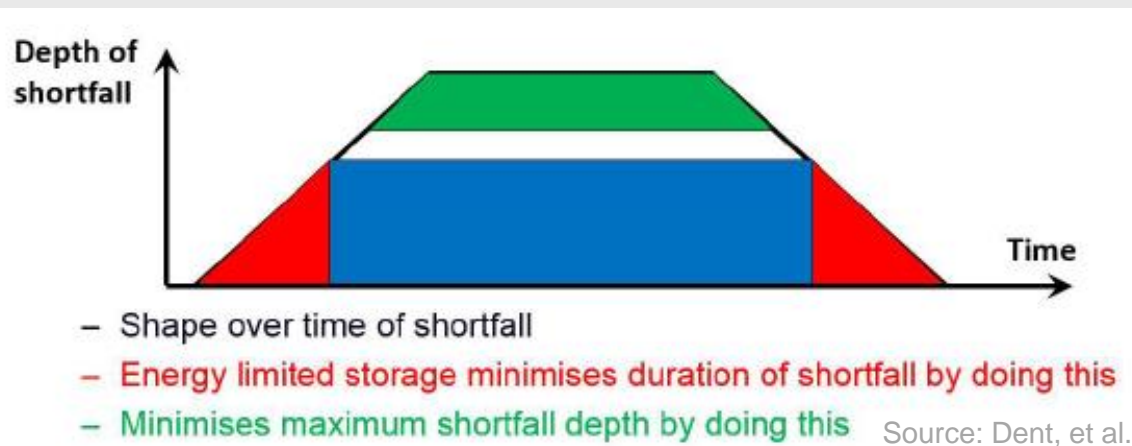
These criteria setting considerations are further detailed in the publicly-available EPRI report: [*Metrics and Criteria: Insights from Case Studies and Recommendations and Considerations for Future Practice \(3002030638\)*](#)

Modeling Energy Storage – Capabilities Needed



Model/Data/Tools focused-papers provide key insights for assessing storage

Texas case study – Impact of storage scheduling options



Multiple objective functions considered in PLEXOS:

- **Economic:** minimize system cost (number of hours)
- **Min LOLEv:** minimize the number of events
- **First Come First Serve:** immediately discharge at max output as soon as unserved energy starts and do not hold energy for later periods (likely reflects actual operations, absent market intervention)
- **Min Shortfall:** minimize the depth of the shortfalls (max load unserved for any given hour, potential market operator intervention)

	Econ	Min LOLEv	First Serve	Min Shortfall
LOLE (days/yr)	0.103	0.103	0.082	0.105
LOLH (hours/yr)	0.387	0.438	0.230	0.557
EUE (MWh/yr)	724.52	724.52	724.52	724.52
Avg Depth (GW)	2.2	2.0	3.9	1.4
Max Depth (GW)	6.3	6.3	9.0	4.3
Avg Duration (hrs)	2.8	3.3	2.8	5.8

Note: Min LOLEv optimization did not result in lower LOLE than alternative methods due to step size and optimization horizon, and different definitions of event classification (i.e. consecutive hours vs. days, etc.)

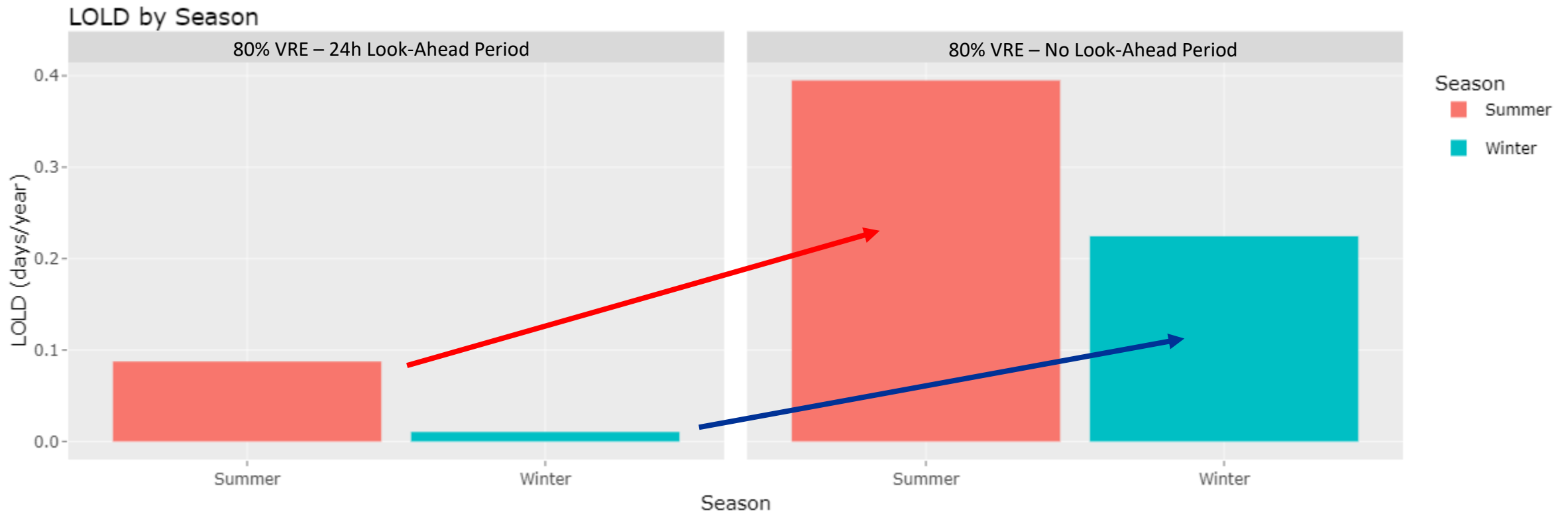
Different methods of dispatching batteries under scarcity conditions yield different results for LOLE but identical results for EUE

In an energy-constrained system, an energy metric (EUE) may be best suited for a new reliability criterion

[Link to Study](#)

SPP case study – modeling of look-ahead

Scenario	LOLH (hours/year)	LOLD or LOLE (days/year)	LOLP (%/year)	LOLEv (events/year)	EUE (MWh/year)	NEUE (ppm/year)
80%_VRE (24h look-ahead)	0.15	0.098	0.03	0.11	98	0.33
80%_VRE (no look-ahead)	2.05	0.619	0.17	0.74	1010	3.40



With less foresight, heightened risks are expected both in summer and in winter

[Link to Study](#)

Western US case study – Long-duration storage modeling

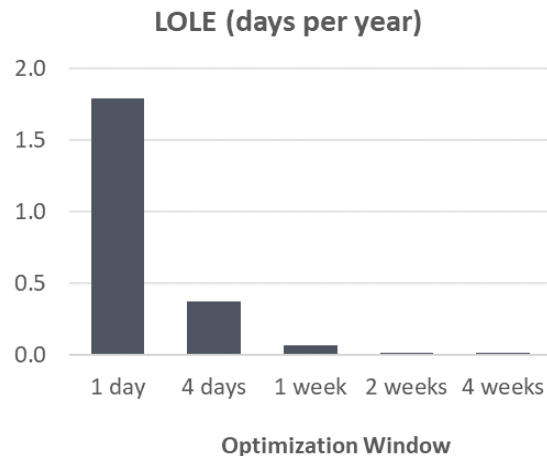
	Wind + Solar	Battery Storage	Generic Thermal	Multiday Storage
Portfolio 6	240 GW	60 GW (8 hrs)	0 GW	43.2 GW (569 hrs)

Default settings:

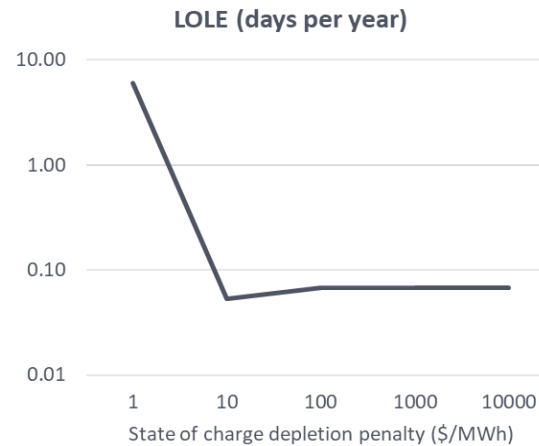
- Optimization window: 1 week
- State of charge depletion penalty: \$100/MWh
- Simulation start date: Week 23 (June 4th)

- Longer optimization windows (i.e., more foresight) reduces RA risk across all metrics.
- For 1-week optimization window, state of charge depletion penalty in the last time step had to be at least \$10/MWh to encourage the storage to adequately charge for future weeks.
- Beginning the simulation in June yields lower RA risk, aligns with more realistic operating practices, and reduced runtimes.

Optimization Window Tests

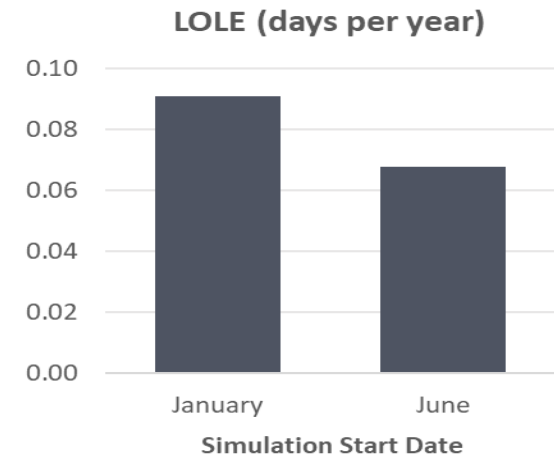


State of Charge Depletion Penalty Tests

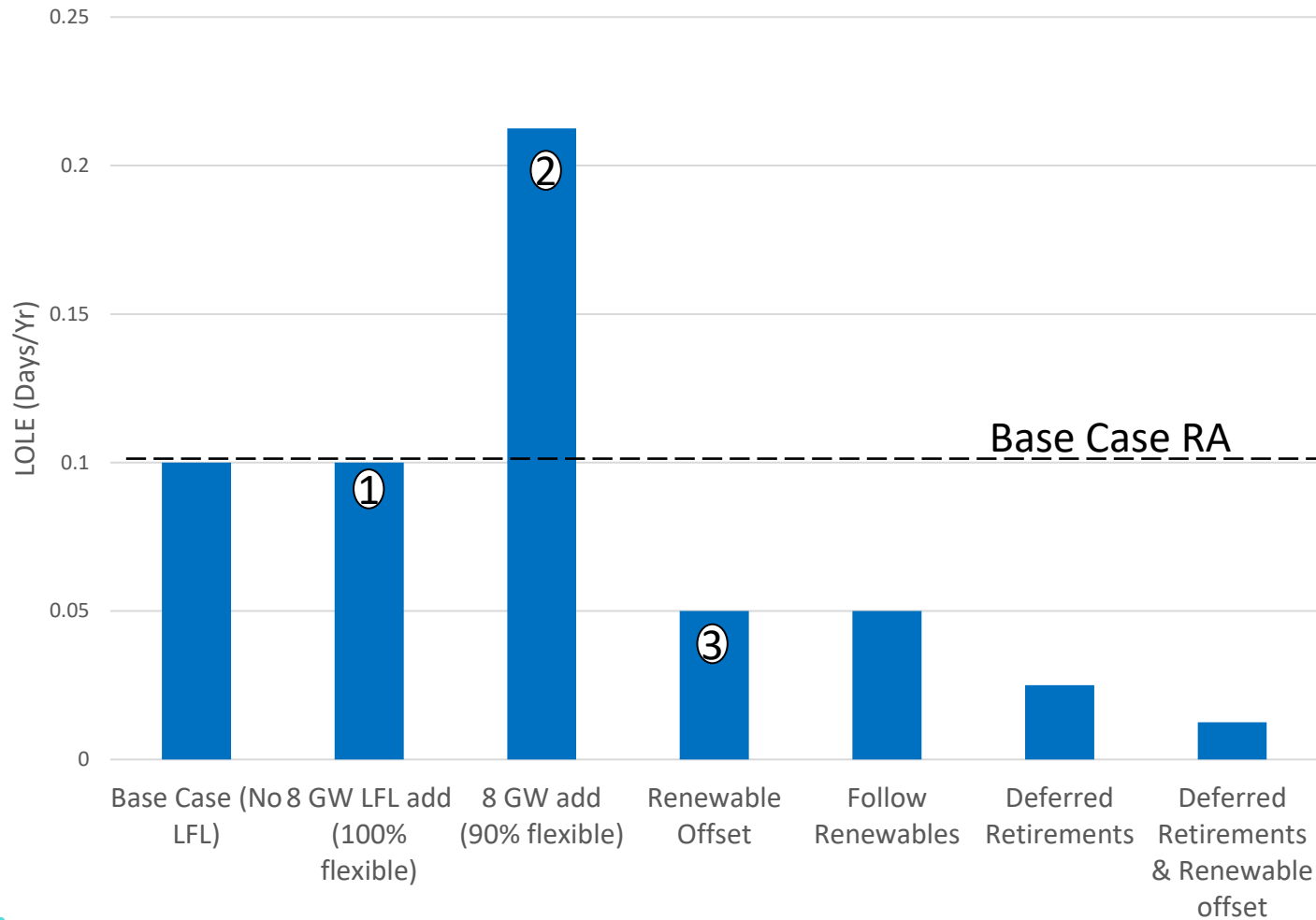


[Link to Study](#)

Simulation Start Date Tests



RA impacts from adding 8 GW of large load to ERCOT system



1. Adding fully flexible load has neutral impact (used infrequently in most cases)
2. Observe significant impact on resource adequacy even if only 10% of new load is inflexible (require additional new resources)
3. If large flexible loads (LFL) incentivize a decrease in thermal generation retirements and/or renewable generation additions, loss of load risk is significantly reduced, with compounding benefits.



TELOS ENERGY

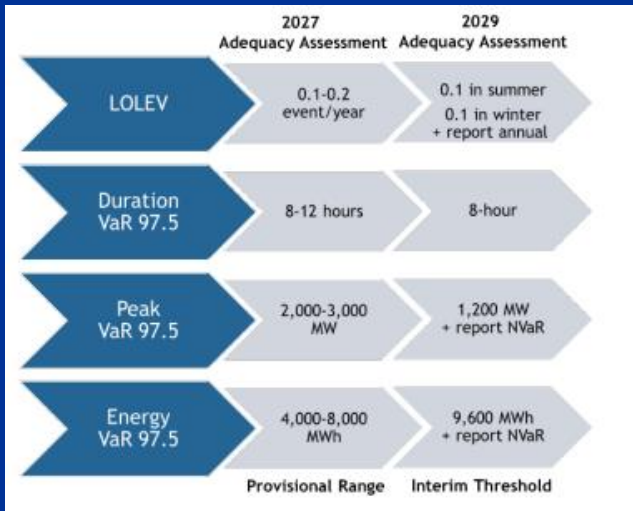
Reliability impacts vary with tariff/data center, operating profile and interactions with system

Resource Adequacy – Current Key Issues We Have a Good Handle On



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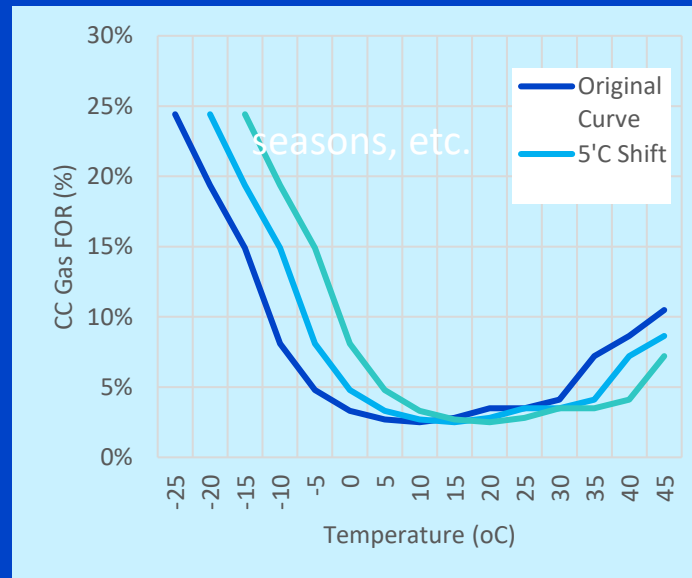
- Additional metrics/criteria needed to assess adequacy risk



From [NWPPC Power Supply Adequacy Assessment](#)

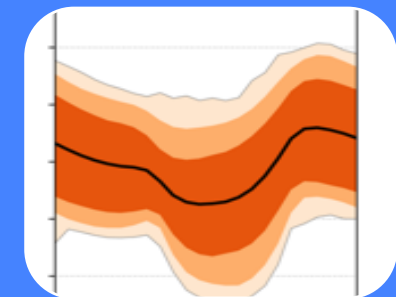
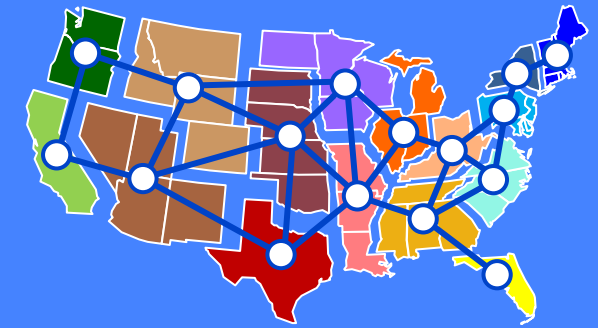
ERCOT multiple metrics
 MISO seasonal RA construct
 NWPPC multiple metrics

- Need to consider range of operational conditions and resource behavior



Weather dependence in PJM
 Flexibility requirements in CA

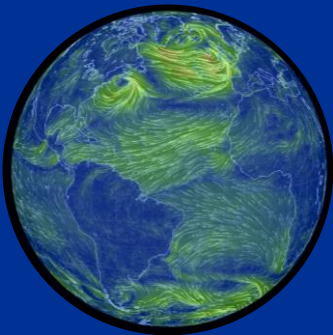
- Need more comprehensive data and models



ESIG dataset report
 ENTSO-E ERAA datasets/scenarios

What are things we know less about?

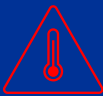
- How do we consider extreme events and climate change?



Cold Snap



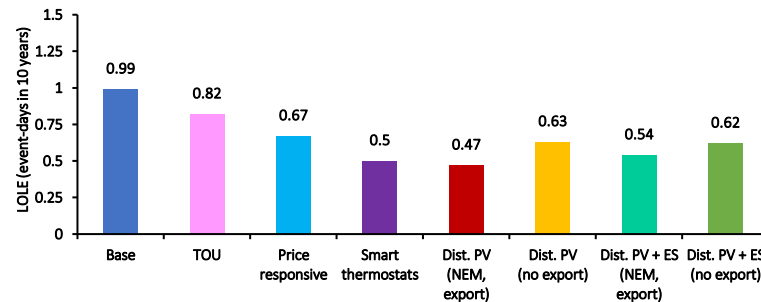
Severe Storm



Heatwave

EPRI/ISO-NE Risk Screening
Extreme events in NWPCC, etc.

- How do we include changes in load – demand flexibility, electrification, etc.?



Data Center Flexibility
VPP flexibility

- How can we better assess resource contribution to system reliability?



Capacity accreditation updates in many ISO/RTOs
Ongoing EPRI/NREL work w/DOE

RA Knowledge Center – Ongoing

Goal

To provide clear, complete and insightful information to support practitioners in their selection of methods to assess resource adequacy.

Mailing List –
Scan Below or
Click Here

<https://gridops.epri.com/Adequacy>



SCAN ME

EPRI Metrics Processes Methodologies & Data Tools Resource Accreditation Innovation Gaps

Resource Adequacy

Resource adequacy (RA) is an assessment of whether the current or proposed resource mix is sufficient to meet capacity and energy needs for a particular grid.

RA assessments are used to identify potential shortfalls in the availability of resources across different time horizons, from long-term planning (5 to 20+ years), to seasonal and day-ahead assessments. As the RA look-ahead time approaches real-time operations, options to address identified shortfalls become fewer and more expensive.

[READ MORE](#)

Resource Adequacy Tools

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- [Resource Adequacy Viewer Tool](#)
- [Materiality Calculator](#)
- [RA Tool Summary](#)

Case Studies

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- [Title Case Study 1 One or Two Lines](#)
- [Title Case Study 2](#)
- [Title Case Study 3](#)

Innovation Gaps

What does EPRI see as the main challenges to ensuring resource adequacy?

EPRI has ongoing research in this area, and recent events reinforced the importance of each development.

What follows is a collection of some of the most relevant areas of research related to resource adequacy.

- Resource Modeling
- Customer Demand
- Developing Planning Scenarios
- Standards, Guidelines, and Criteria
- Simulation Tools

Standards, Guidelines and Criteria

The best line of defense for safe and reliable electric power is agreement on standards and guidelines, spearheaded by technical expertise.

EPRI will continue to address challenges in evaluating existing methods that consider diverse events, new and emerging resources and increased consideration of demand-side resources. These need to be identified and applied in a manner that accurately reflects the mix, and criteria set to ensure that adequacy is maintained at levels that can be justified. The goal is to understand which resources best reflect adequacy and other related risks, and set appropriate levels of resource adequacy event.

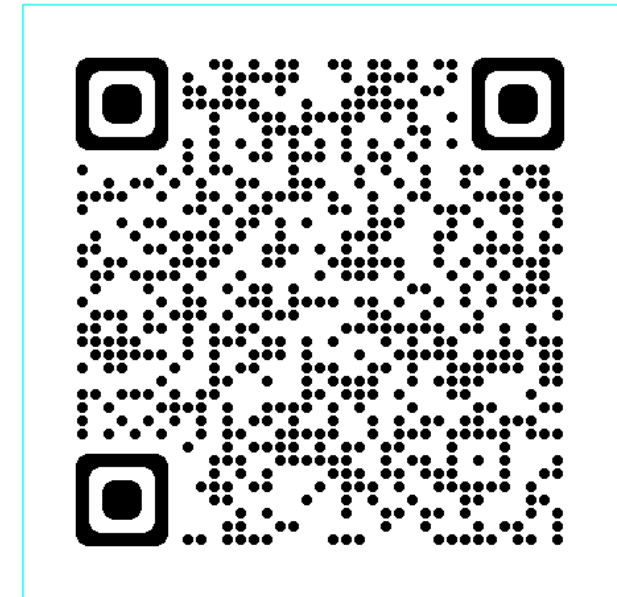
A Simple Roadmap to Address Emerging Resource Adequacy Challenges

EPRI actively researches RA topics and has developed a detailed understanding of the issues. To address these, resource planners, regulators, and power sector stakeholders can follow the following simplified roadmap to unlock capacity from the grid's resources that will be needed now and in the future. The roadmap is divided into three phases of action: Right Now, Next, and Then, each with a suggested action for resource planning groups. The effectiveness of each action depends on the unique current and future situations of each grid.

- Right Now**
 - Tools & Methods: Adjust methods and study tools that capture risk across the full study period, not just at peak (i.e., hourly models).
 - Scenario: Choose demand and weather profiles that cover multiple years and are representative of the best estimate of future expected conditions. They can be different from historically observed conditions.
 - Resources: Gather data and begin to use new methods to assess RA contributions from emerging technologies including renewables, storage and hybrid power plants, leveraging the latest resource models.
- Next**
 - Tools: Include flexibility considerations in planning and expansion models to inform investment.
 - Distributed Resources: Assess for distributed resource RA contributions, considering how limits on their ability to support the system, as well as the unique characteristics of these assets (e.g., volatility, PV, batteries, electric vehicles, etc.).
 - Customer Demand: Develop models of "non-firm" grid interaction options for assets that limit export during pre-defined conditions.
- Then**
 - Standards: Adopt a risk-based probabilistic approach to grid and resource expansion.
 - Validation: Plan for an increased exchange of grid services between distribution and transmission.
 - Energy Systems Integration: Assess the integration of other energy systems, including heat, transportation, etc., in electric system resource adequacy, both in terms of the demand due to increased electrification and the ability of these systems to provide flexibility and capacity.

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