Considerations for Meeting Sub-Annual Needs, and Resource Accreditation across RTOs

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PREPARED FOR

MISO RASC

PREPARED BY

Sam Newell
Michael Hagerty
Hannes Pfeifenberger
Walter Graf

Brattle

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- Background and Motivation
- Considerations for Meeting Sub-Annual Needs
- Experience with Resource Accreditation in Other Markets

Resource Adequacy (RA) Design Flow Chart

Motivation for Reviewing RA Design

- MISO completed a screening analysis of the nature of recent and future reliability risks…
- …and demonstrated that risks are shifting away from just summer peaks
- Neighboring systems, such as PJM, Southern, and TVA, are experiencing similar shifts

Exploratory RA Design

- Review how other markets address similar RA issues
- Identify options for modified RA framework based on nature of reliability risks
- Rule out undesirable options

High-Level RA Design

- Complete detailed RA modeling
- Fully evaluate options and identify best approach for MISO
- Develop high-level rules for modified RA framework

Detailed RA Design

- Develop detailed rules for modified RA design
- Calculate parameters for RA requirements and resource accreditations

Resource Adequacy Construct Elements

To meet RA objectives, RA Requirements and Resource Accreditation must be consistent with each other and with assessed Future Reliability Risks

Future Reliability Risks

Quantify future reliability risks
- Assess annual and sub-annual risks
- Identify patterns of reliability risks
- Select the risk metric(s)

Resource Adequacy Requirements

Determine total resource credits needed to meet objective
- Determine compliance periods
- Set system/zonal requirements
- Translate requirements to LSEs
- Identify new RA products (if any)

Resource Accreditation

Reflect contributions of each resource type to meeting RA requirement
- Set resource capacity credits
- Establish participation requirements
- Develop performance incentive

Mechanisms to support meeting Resource Adequacy Requirements, e.g., PRA

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Considerations for Meeting Sub-Annual Needs

	Current MISO Annual Construct	1. Annual Construct reflecting Sub-Annual Needs	2. Sub-Annual Construct reflecting Sub-Annual Needs
RA Need Determined based on:	Annual summer peak hours	**"RA hours"** with (sub-annual) shortage risks throughout the year	**"RA hours"** with (sub-annual) shortage risks throughout the year
RA Requirement	Annual Planning Reserve Margin (PRM) added to summer peak hours	Annual PRM added to **forecasted loads in RA hours**	Sub-annual PRMs added to **forecasted loads in each period's RA hours**
Resource Accreditation	Mostly based on availability during summer peak	Based on availability **in RA hours** (consistent with RA requirement)	Based on availability **in each period's RA hours** (consistent with RA requirement)
Planning Reserve Auction (PRA)	Annual	**Annual**	**Sub-Annual**

Alternative 1: Annual Construct based on Sub-Annual Needs

Primary Change: Continue to set an annual RA requirement, but the requirement is based on sub-annual RA needs throughout the year identified in the reliability analysis, not just summer peak

System & Zonal PRMs

PRM = Capacity / Load, where

- Capacity = ELCCs of all resources, in total sufficient to meet probabilistic RA requirement
- Load = MISO/zonal (LOLP-weighted) average load during RA hours

LSE Requirements

Each LSEs' annual RA Requirement =

- LSEs' (LOLP-weighted) average load in RA hours
- *plus* System-Wide PRM

Resource Accreditation

- Set credits based on resources' contributions to reducing shortage risks
- Key metric is Effective Load-Carrying Capability (ELCC) or availability during "RA hours"
- Details on following slides

Alternative 2: Sub-Annual Construct based on Sub-Annual Needs

Primary Change: Split the annual RA requirement into two or more separate sub-annual RA requirements based on clusters of RA hours identified in the reliability analysis

System & Zonal PRMs

- Allocate annual RA requirement to each period (e.g., based on % of annual LOLE in each period)
- Calculate PRM needed to meet target in each period, as in annual approach

LSE Requirements

- Similar to the annual approach, but separate RA requirement for each period

Resource Accreditation

- Similar to the annual approach, but separate capacity value for each RA period

Alternative 2: Allocation of Requirement to Sub-Annual Periods

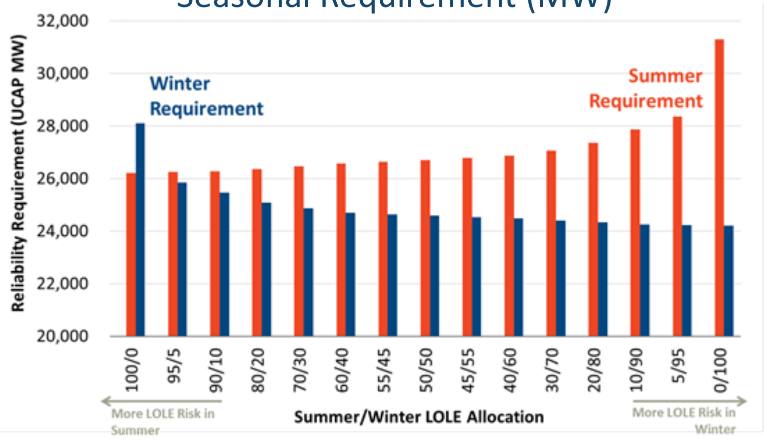
Each period must be reliable enough to achieve the annual target. Example: 2-season model with 0.1 LOLE across the year

Summer LOLE + Winter LOLE ≤ 0.1 Annual LOLE

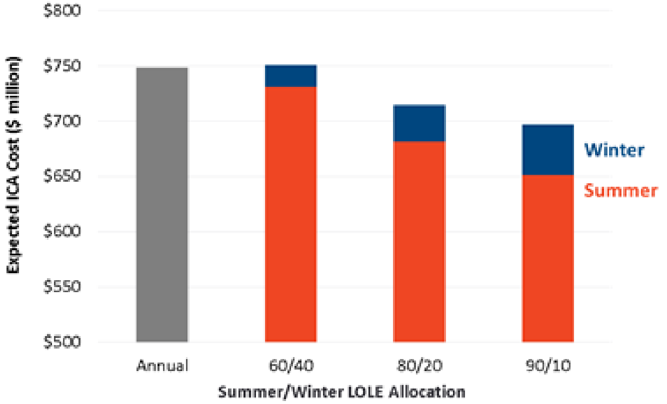
- Allocating risks equally across seasons may result in high summer reserve margins (a few %age points higher), which could be costly in a net-summer-peaking system met mostly by annual resources
- Determining the least-cost allocation would require balancing marginal costs and marginal benefits of capacity in different seasons (in an annual construct, market participants can make these tradeoffs themselves)
- A general rule-of-thumb: concentrating allowable risk in the more challenging periods is lower cost than allocating risk evenly or allocating all risk to summer
- Such allocation is also cheaper than allocating all risk to summer then requiring year-long availability of resources, as in PJM and ISO-NE and as shown as "Annual" in the bottom chart; note this "Annual" differs from the "annual construct" we describe on slide 7, which *does* admit seasonal resources without year-long obligations, albeit with appropriately derated accreditation

Effects of Varying Requirement Allocations

Seasonal Requirement (MW)



Total Costs ($ million)



Source: Brattle analysis for IESO.

Some Pros and Cons of Alternative Approaches
as the Fleet Transforms

	Current MISO Annual Construct	1. Annual Construct reflecting Sub-Annual Needs	2. Sub-Annual Construct reflecting Sub-Annual Needs
Resource Adequacy	**Declining**. Shortages may occur in periods other than peak load	**Adequate**. Requirements and accreditation reflect LOLP throughout the year	**Adequate**. Requirements and accreditation in each period (season or more granular) reflect LOLP throughout the period
Economic Efficiency	**Declining**. Does not reflect reliability value or tradeoffs among resources	**High**. Valuing resources at marginal value/cost can support optimal decisions	**Medium-High**. Same as Alternative 1 within a period, but pre-specifies risk allocation across periods, not necessarily optimally; exploiting diversity across periods requires bilaterals
Predictability to Inform Resource Planning	**Declining**. Not a sustainable construct as fleet transforms	**Medium**. Potential for more surprises since focus will primarily remain on summer peak; e.g., in a summer-peaking system, LSEs could comply with summer-only resources; if the system shifts to winter-peaking, some resources' capacity value may fall to zero	**Medium-High**. Fewer surprises since LSEs must plan for multiple periods; e.g., LSEs would plan for winter and won't be far off if system peak shifts to winter; there may still be surprises within a season, such as PV ELCC decreasing as penetration increases more than expected and peak shifts into evening hours

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Resource Accreditation

Concept: accurately rate the contribution of each resource to meeting MISO's probabilistic RA objective (e.g., 0.1 LOLE), such that each MW provides an equivalent reduction in shortage risk

Diverse resources can contribute to reducing risks in different ways

- Account for availability limitations: forced (and planned?) outages, run-hour limits, intermittency, correlations with reliability events
- Ideally, rate all resources at their ELCCs, which most accurately captures contributions to meeting MISO's RA objective
- Historically, markets developed ELCC proxies for each resource type, focusing on the inherent limitations of each type

Examples of Accreditation Issues by Resource Type

Resource Type	Key Characteristics for Accreditation	Current Accreditation Approaches
Dispatchable Generation	• Dispatchable to Pmax during reliability events, except during forced and maintenance outages/derates • Fuel access can limit availability during reliability events • Rated capacity may vary by season	• Season-specific maximum output derated by EFORd (planned outages not part of derate in most, but not all, RTOs)
Intermittent Renewable Generation	• Availability dependent on wind and solar irradiation • Increasing penetration tends to shift RA risk into net peak load periods when output is lower	• Historical generation during peak (or net-peak) periods • ELCC
Energy Storage	• Availability limited during longer shortage events • Value dependent on storage duration & resource mix	• Output over required duration (2 – 10 hours) • ELCC
Interruptible Load	• Availability specific to certain periods depending on load type (e.g., AC load in the summer, commercial loads only available during business hours) • May be limited by frequency and length of interruptions	• Planned capacity that can meet RTO-specific requirements, including interruption frequency and length, notification time, reliability periods (e.g., summer/winter), and M&V requirements

Dispatchable Generation

Credited at Pmax with Outage Adjustments

Forced Outages

- Most RTOs derate credit by EFORd

Fuel Availability

- Fuel access can be challenging during sustained cold snaps, e.g., 2014 Polar Vortex
- PJM and ISO-NE have acknowledged these challenges; but instead of accounting for fuel availability in accreditation, they implemented performance incentives

Maintenance Outages

- Most RTOs do not include planned outages in the derate of the max capacity
- AESO proposed accreditation based on availability during key hours, irrespective of planned or unplanned outages

Ambient Conditions

- Pmax of thermal generation higher in the winter than the summer by about 5-10%

Intermittent Renewable Generation

Most markets use **deterministic approaches** to estimate the capacity value of renewables…

RTO	Methodology	Wind	Solar
ERCOT	Average output of 10 years for wind and 3 years for solar over 20 peak load hours by season	Non-Coastal: 15% (Summer) to 20% (Winter); Coastal: 43% (Winter) to 58% (Summer)	12% (Winter) to 74% (Summer)
PJM	Average output of prior 3 years during peak summer hours	14.7% (Mountainous) to 17.6% (Flat)	38% to 60% based on configuration
NYISO	Average output of prior year during peak summer and winter hours	11% (Onshore) to 38% (Off-shore) for new resources	26% to 43% for new resources based on configuration
Ontario IESO	Median output of prior 10 years during top 5 contiguous demand hours	13.6% (Summer) to 37.8% (Winter)	0.0% (Winter) to 10.1% (Summer)
WECC	Rule of thumb	5% to 16% by pool	60%
SPP	2014-2016 average output during top 3% of load hours by balancing area and season	27.5% (Summer) to 38.8% (Winter)	N/A (very low penetration)

But systems with growing renewables are moving toward **ELCC** to account for intermittency and correlations

- MISO uses ELCC for wind
- CPUC uses ELCC for wind & solar
- PJM is discussing ELCCs

Use of ELCC requires choices between average and marginal (see next slide)

What is the difference between Average and Marginal ELCC?

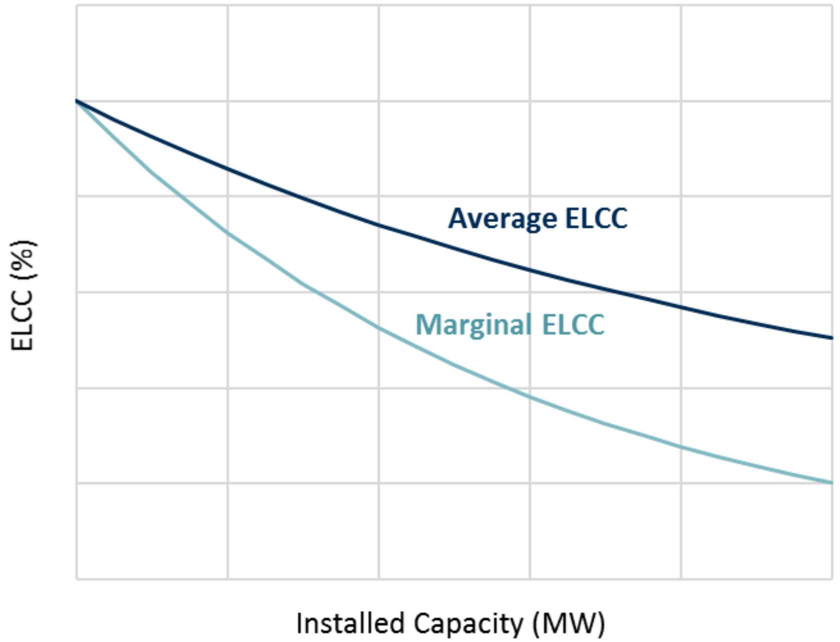
Average ELCC expresses value of the entire resource fleet

Marginal ELCC expresses incremental value of the next MW

There is not an industry consensus on average versus marginal

- MISO uses average ELCC for wind; CA uses average ELCC for solar and wind accreditation, but marginal ELCC for planning/ contracting new investment
- Marginal ELCC would provide the right investment signal, but the inframarginal value must be recognized somewhere
- If average ELCC is used for accreditation, marginal ELCC should still be reported to inform LSEs that:
  - Incremental value will be lower than the average
  - Average ELCC will decrease as more like resources are added

Illustrative Relationship between Average and Marginal ELCC



Energy Storage

Most U.S. RTOs have been setting a duration over which energy storage must be able to provide continuous output

- 2 hours: ISO-NE
- 4 hours: MISO, CAISO, NYISO, SPP, AESO (proposed)
- 10 hours: PJM

But some of these are moving toward ELCC:

- NYISO will apply ELCC based on duration and penetration starting summer 2021
- PJM is revisiting its 10-hour rule based on ELCC (ongoing)
- For IRP purposes, CPUC estimates the average ELCC of energy storage

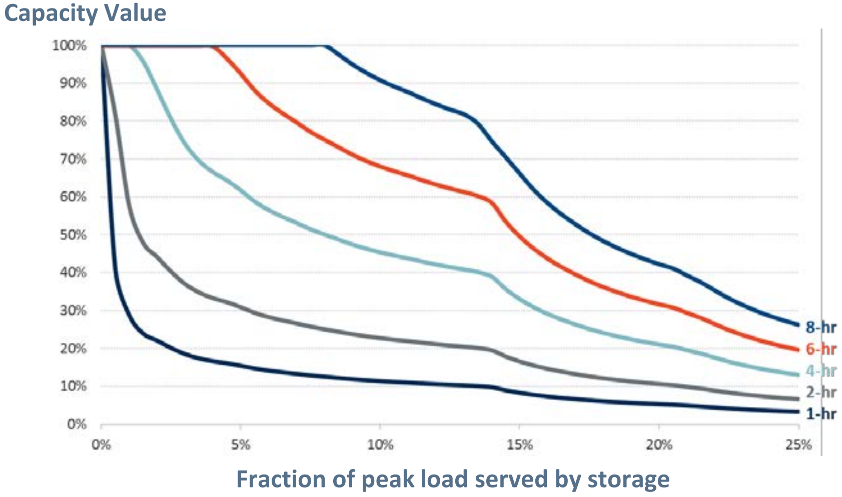
Energy storage capacity value depends on several variables (as shown in the figures to the right), including:

- Total amount of energy storage deployed (x-axis of both figures)
- Type of energy storage (various lines in top figure)
- Solar installed capacity (various lines in bottom figure)

Hybrid solar+storage resources require additional consideration

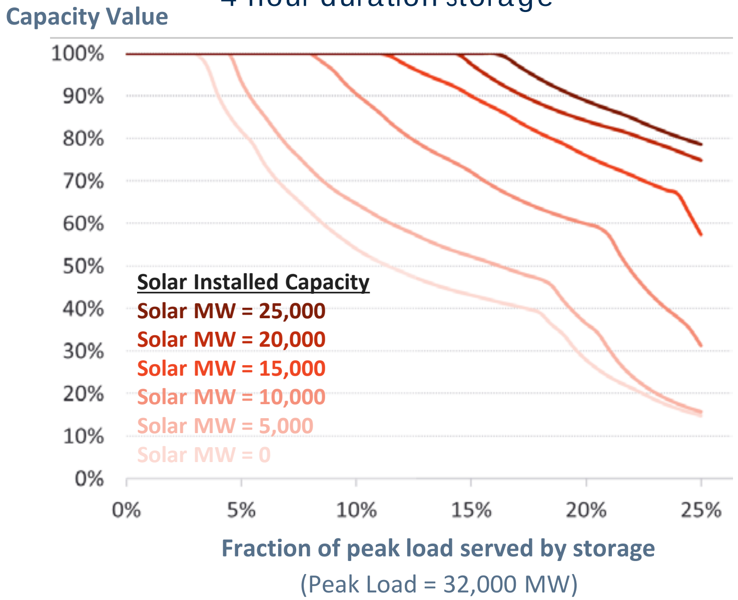
Storage Capacity Value vs. Amount Deployed

Modeled results, Northeast power system



Effect of PV on Storage Capacity Value

4-hour duration storage



Source: Pfeifenberger and Lueken, The Evolving Landscape for Storage: Wholesale Market, T&D, and Customer Benefits, May 13, 2020.

Interruptible Load

Accreditation and participation rules vary by RTO

	PJM	ISO-NE	AESO (proposed)
Qualification Criteria	• Unlimited interruptions • 30-min lead time (can apply for 60- and 120-min) • Qualified based on customer acquisition plan	• Unlimited interruptions • 10- and 30-min lead time • Qualified based on customer acquisition plan	• Based on customer acquisition plan • If DR unable to produce >75% of its UCAP by second rebalancing auction, it must buy out of the difference between tested capacity and UCAP
Measurement Approach	Both firm service level and guaranteed load drop	Only firm service level	Both firm service level and guaranteed load drop
DR Operational Process	Called when all non-emergency resources are exhausted; longer lead-time DR called first. Dispatched according to energy offer or strike price.	Called during shortage conditions. Dispatched according to energy offer.	
Testing Frequency (if not called)	Annual	Seasonal	

Two concepts for establishing load reductions:

- **Guaranteed Load Drop (GLD)** requires a resource to guarantee the amount of load it can shed from a running baseline
- **Firm Service Level (FSL)** requires a resource to reduce its consumption to its FSL regardless of demand just before the event; load "reduction" is the customer's forecast baseline minus FSL

Performance is measured in actual calls or tests