MISO Quarterly Update: Resource Adequacy Topics

North Dakota Public Service Commission
August 23, 2022
Resource Adequacy Topics

- Planning Resource Auction (PRA)
- Operations overview
  - Summer performance
  - Winter preparation
- Seasonal resource adequacy construct and accreditation reforms
- Managing reliability risk during the resource transition (“Mind the gap”)
2022/2023 Planning Resource Auction (PRA)
The PRA has three participation models where Load-Serving Entities designate how they meet requirements, with a majority having no (or very little) price exposure.

- **Owns or Contracts the Capacity Prior to the Auction**
  - 95% of Load Has No (or very little) Price Exposure
  - Capacity Sufficient for Total Load
  - Elects Option Having No Price Exposure
  - 27% of total load

- **Capacity Purchased in the Auction**
  - 5% Has Significant Price Exposure
  - All or Significant Portion of Load is Covered
  - Only Limited “Net” Price Exposure*
  - 68% of total load

- **Relies on Auction to Purchase Significant Capacity**
  - 5% of total load

Because most participants have little to no price exposure, the PRA is referred to as a “residual auction.”

*Utilities bring load and affiliated capacity into the PRA where both have price exposure, but the positions largely net with one another, resulting in only limited “net” price exposure.*
The PRA uses MISO and participant inputs to verify resource adequacy and produce Auction Clearing Prices at the zonal level.

**INPUTS**

**MISO**
- MISO-wide reserve margin requirement
- Zonal requirements
- Transmission limitations

**Participants**
- Load forecast from Load-Serving Entities
- Resources and offers ($) from suppliers

**OUTPUTS**

- “Cleared” commitment of capacity to the MISO region to meet load and reserve margin requirements
- An Auction Clearing Price (ACP) for each zone

The Independent Market Monitor (IMM) reviews the auction results for physical and economic withholding.
2022-23 PRA demonstrated capacity shortfalls in MISO North/Central resulting in capacity prices equal to CONE

**MISO’s North/Central sub-region**
- Capacity shortage: ~ 1,200 MW
- Auction clearing price: ~ $237/MW-day (CONE)
- Load exposed to CONE: 8,000 MW

**MISO’s South sub-region**
- Capacity surplus: ~2,800 MW
- Auction clearing price: ~ $3/MW-day

PRA: Planning Resource Auction
CONE: Cost of new entry
While total installed capacity has steadily trended up, accredited capacity is moving in the opposite direction due to the capabilities of the resource types selected.
Last year’s OMS-MISO survey projected tight conditions in Zones 4-7 for 2022, and post-COVID load increases drove even higher requirements for this year’s auction.

- The 2021 OMS-MISO survey projected surplus capacity overall for 2022 with Zones 4-7 experiencing tight conditions. However, The OMS-MISO Survey is a “snapshot in time,”

- Increased load forecasts led to a 1.4 GW increase in PRMR for 2022.

- Combined with reduced generation capacity, the auction resulted in a 1.3 GW shortfall, as opposed to the projected minimum survey surplus.
Operations Overview: Summer Performance, Winter Preparation
# MISO’s Market Capacity Emergency Procedures

<table>
<thead>
<tr>
<th>Capacity Advisory</th>
<th>Advance notice of forecasted capacity shortage, requests stakeholders update offer data</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Maximum Generation...</strong></td>
<td></td>
</tr>
<tr>
<td>Alert</td>
<td>Define boundaries, suspend maintenance, set emergency pricing tier 0 offer floor</td>
</tr>
<tr>
<td>Warning</td>
<td>Schedule external resources, curtail export transactions, reconfigure and set emergency pricing tier 1 offer floor</td>
</tr>
<tr>
<td>Event Step 1</td>
<td>Commit emergency resources, declare NERC Energy Emergency Alert (EEA) 1, activate emergency limits</td>
</tr>
<tr>
<td>Event Step 2</td>
<td>Declare NERC EEA 2, implement Load Modifying Resources (LMR), Load Modifying Measures (LMM) Stage 1, commit Emergency Demand Response (EDR) resources, emergency energy purchases, public appeals, and set emergency pricing tier 2 offer floor</td>
</tr>
<tr>
<td>Event Step 3</td>
<td>Utilize operating reserves and LMMs Stage 2</td>
</tr>
<tr>
<td>Event Step 4</td>
<td>Reserve call and emergency reserve purchases</td>
</tr>
<tr>
<td>Event Step 5</td>
<td>Declare NERC EEA 3 (firm load shed), set locational marginal prices (LMP), and market clearing prices to the value of lost load (VOLL)</td>
</tr>
<tr>
<td>...Termination</td>
<td>Maximum Generation and, possibly, Capacity Advisory termination</td>
</tr>
</tbody>
</table>
Summer 2022 is tracking better than past summers in terms of emergency declarations...

Number of Days Under a Max Gen “Alert, Warning, or Event”

Summer 2022 (thru 8/19)
- Some Capacity Advisories and Conservative Operations
- 2 Max Gen “Alerts”
- No Max Gen “Warnings” or “Events”
Lessons learned from the 2021 cold weather event continue to inform MISO’s evolution of operations practices
MISO is planning to continue fuel assurance surveys started in 2021 to better inform winter operations.

2021 Gas Fuel Survey Results

Variations on gas resource availability

- Total MISO Gas Generation: 80,845 MW
- No Response: 7,405 MW
- Total Responsive: 73,440 MW
- Firm Transport (FT): 17,685 MW
- FT and Dual-Fuel: 579 MW
- Shared FT and Interruptible Transport (IT): 27,686 MW
- Dual-Fuel, Shared FT and IT: 5,434 MW
- IT: 8,912 MW
- Dual-Fuel, IT: 2,021 MW
- Unknown Transportation Type: 11,121 MW

FT is Firm Transportation, IT is Interruptible Transportation.
Seasonal Resource Adequacy Construct and Accreditation Reforms
The MISO resource adequacy construct establishes planning requirements, assesses accredited resource value, and helps provide visibility into local and regional capacity sufficiency.

**Requirements**
- What is needed for reliability

**Accreditation**
- How resources are counted, including thermal and non-thermal resources

**Visibility**
- Portfolio trends in short-term and long-term, including resource retirements and investments
  - Planning Resource Auction
  - OMS-MISO Survey
  - Seasonal Assessments
  - Regional Resource Assessment
Recently filed reforms to the Resource Adequacy construct will help address today’s reliability challenges and prepare for the future.

<table>
<thead>
<tr>
<th>RA Requirements</th>
<th>Current Annual Construct</th>
<th>Filed Sub-annual Construct Proposal</th>
</tr>
</thead>
<tbody>
<tr>
<td>MISO performs annual LOLE analysis to determine <strong>annual resource adequacy requirements</strong>.</td>
<td>MISO will calculate <strong>4 distinct sub-annual resource adequacy requirements on a seasonal basis</strong>.</td>
<td></td>
</tr>
<tr>
<td>MISO <strong>accredits conventional resources annually based on a 3-year forced outage rate</strong>, excluding planned outages and other exceptions.</td>
<td>MISO will <strong>accredit by season based on resource’s availability (SAC)</strong> to align resource accreditation with availability in the highest risk periods.</td>
<td></td>
</tr>
<tr>
<td>MISO <strong>conducts annual Planning Resource Auction</strong> to meet annual resource adequacy requirements.</td>
<td>MISO will <strong>conduct independent auctions for all seasons at one time to meet seasonal resource adequacy requirements</strong> and will require <strong>a Minimum Capacity Obligation (MCO) prior to the auction</strong>.</td>
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</tbody>
</table>

LOLE = Loss of Load Expectation | UCAP = Unforced Capacity | SAC = Seasonal Accredited Capacity

“Outages” includes forced and planned outages, or de-rates reported in the MISO Outage Scheduler.
A number of key changes have been proposed, or are in the Market Redefinition workplan

<table>
<thead>
<tr>
<th>Filed at FERC</th>
<th>Current Activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Improved Resource Accreditation</td>
<td>Improved Resource Accreditation</td>
</tr>
<tr>
<td>➢ Thermal changes filed in 2021</td>
<td>➢ Renewable and Load Modify Resources the focus in 2022</td>
</tr>
<tr>
<td>Resource Adequacy Construct</td>
<td>Resource Adequacy Construct</td>
</tr>
<tr>
<td>➢ Proposed move from annual to seasonal filed in 2021</td>
<td>➢ Potential improvements to the Planning Resource Auction</td>
</tr>
<tr>
<td>Pricing</td>
<td>Pricing</td>
</tr>
<tr>
<td>➢ Initial scarcity price reforms were filed in 2021</td>
<td>➢ Continued refinement of scarcity price reforms</td>
</tr>
<tr>
<td>Resource Attributes</td>
<td>Resource Attributes</td>
</tr>
<tr>
<td>➢ Considering approaches to valuing resource attributes</td>
<td>➢ Improved modeling, such as a sloped demand curve, to achieve more efficient</td>
</tr>
<tr>
<td></td>
<td>attributes critical to reliably operating the evolving portfolio</td>
</tr>
<tr>
<td></td>
<td>Future Activities</td>
</tr>
<tr>
<td>Pricing</td>
<td>Pricing</td>
</tr>
<tr>
<td></td>
<td>➢ Improved modeling, such as a sloped demand curve, to achieve more efficient</td>
</tr>
<tr>
<td></td>
<td>market outcomes and price signals</td>
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</table>
Managing Reliability Risk during the Resource Transition ("Mind the gap")
There are different definitions of reliability and different customer reactions to outage depending on causes.

<table>
<thead>
<tr>
<th>INDUSTRY GROUP/ENTITY</th>
<th>HOW THEY DEFINE “RELIABILITY”</th>
</tr>
</thead>
<tbody>
<tr>
<td>RTO</td>
<td>No cascading outages</td>
</tr>
<tr>
<td>Distribution Company</td>
<td>Minimize frequency and duration of distribution outages</td>
</tr>
<tr>
<td>End Use Customer</td>
<td>Lights/outlets work EVERY TIME</td>
</tr>
</tbody>
</table>

### Outage Cause

- **Lines down**
  - Customer Reaction: Don’t like it, but understand because cause is visible

- **Inadequate generation**
  - Customer Reaction: Unacceptable, cause and responsible party feel “unexplainable”
MISO’s resource portfolio is on track for continued decarbonization in the future, necessitating controllable resources to balance weather-dependent resources.
And we will continue experience a growing and widening gap between resources and availability if the transition continues outpacing our ability to adapt.

Decline in dispatchable generation
(from 84% in 2020 to as little as 57% in 2030, Future 3)

Growing fuel uncertainty for coal and gas
(25% of coal units had concerns about winter fuel supply in 2021)

Less certainty around imports from neighbors
(as their regions experience the same challenges as MISO)

Increased forced outage rates
(driven by aging thermal units and increased weather-dependent units)

Public policy driving the pace of change
(e.g., EPA and state commissions driving fleet change and electrification)
The preliminary 2022 Regional Resource Assessment shows addition of largely renewable resources, coupled with retirement of controllable resources...

The assessment includes information provided by members representing 75% of MISO’s load.
Looking at accredited capacity, planned additions are not on pace to make up for planned retirements

**Estimated Accredited Capacity**
RRA 2022 Survey Results

*Preliminary*

Estimated accredited capacity: 16.6% for wind; 35% for solar, 87.5% for battery, 90% for coal, 90% for gas, and 95% for nuclear
Despite capacity additions, accredited capacity is projected to decline due to the rapid pace of retirements of controllable resources.

*Future projections calculated as change from Future 1 2022 load assumption

Estimated accredited capacity: 16.6% for wind; 35% for solar, 87.5% for battery, 90% for coal, 90% for gas, and 95% for nuclear
While energy and capacity are given significant attention, there are actually many critical attributes that are required to reliably operate the system.

<table>
<thead>
<tr>
<th>Illustrative Attributes</th>
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<tbody>
<tr>
<td><strong>Controllability</strong></td>
</tr>
<tr>
<td>Ramp rate up</td>
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<tr>
<td>Ramp rate down</td>
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<tr>
<td>Rapid start up</td>
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<tr>
<td>Minimum downtime</td>
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<tr>
<td><strong>Certainty</strong></td>
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<tr>
<td>Available in all seasons</td>
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<tr>
<td>Fuel availability</td>
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<tr>
<td>Energy adequacy / Output sustainability</td>
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<tr>
<td>Run time limitations</td>
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<tr>
<td>Inertia</td>
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<tr>
<td>Carbon reducing</td>
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</tbody>
</table>

Note: MISO and the industry as a whole are still defining attributes. This list is illustrative and not exhaustive.
Different resource types each bring a unique mix of those attributes – while every resource does not need to bring all attributes, the system will need an “adequate” supply of each

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Battery</th>
<th>Coal</th>
<th>Gas</th>
<th>LMR</th>
<th>Nuclear</th>
<th>Solar</th>
<th>Wind</th>
</tr>
</thead>
<tbody>
<tr>
<td>Controllability</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ramp rate up</td>
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<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
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<tr>
<td>Ramp rate down</td>
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<td>●</td>
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<td>Minimum downtime</td>
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<td>●</td>
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<tr>
<td>Run time limitations</td>
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<tr>
<td>Inertia</td>
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<td>●</td>
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<tr>
<td>Carbon reducing</td>
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<td>●</td>
<td>●</td>
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<td>●</td>
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<td>●</td>
</tr>
</tbody>
</table>

Key: Weak Provider of Attribute - ◐
     Strong Provider of Attribute - ●

Note: MISO, and the industry as a whole, are still defining Attributes. This list is illustrative and not exhaustive.
We collectively need to be prudent in our actions to ensure sufficient resources and flexibility during the fleet transition.

**States**
- Factor regional considerations into state resource adequacy, resource attribute, and market construct requirements
- Inform the broader policy and statutory discussion at the state level
- Consider NERC recommendations for resiliency and reliability

**Members**
- Collaborate with MISO and States on timely resource adequacy, market enhancements and regional transmission
- Share resource plans with MISO to enable accurate regional view

**MISO**
- Enhance transparency of resource evolution and regional outlook
- Improve Resource Adequacy construct
- Visibility into and reviewing impacts of resource retirements
- Inform the broader policy discussion with federal policymakers and agencies
Most members continue to meet resource adequacy requirements through fixed plans and self-scheduling, despite fixed plans decreasing by over 10,000 MW this year.

<table>
<thead>
<tr>
<th>PRMR (MW)</th>
<th>20-21</th>
<th>21-22</th>
<th>22-23</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cleared Non-Self Scheduled</td>
<td>7,419.1</td>
<td>4,858.42</td>
<td>10,920.1</td>
</tr>
<tr>
<td>Self Scheduled</td>
<td>82,240.0</td>
<td>82,286.90</td>
<td>86,784.1</td>
</tr>
<tr>
<td>FRAP</td>
<td>46,320.2</td>
<td>46,757.40</td>
<td>36,390.5</td>
</tr>
</tbody>
</table>

% of PRMR:
- 20-21: 60.5%
- 21-22: 61.5%
- 22-23: 64.7%

FRAP: 5.5% 3.6% 8.1%
The planning resource mix shows the continuation of a multi-year trend toward less solid fuel and increased gas and non-conventional resources.
Committed accredited capacity projections show deficits starting in 2023, with increasing shortage over survey period.

- **Legend**
  - Committed Capacity
  - Potentially Unavailable Resources
  - Potential New Capacity
  - PRM

- **Notes:**
  - RDT limit of 1900 MW is reflected in this chart
  - Bracketed values indicate difference between Committed Capacity and projected PRMR
  - Potential New Capacity projected per methodology consistent with past years. Actual accredited New Capacity is expected to be 2 GW to 3 GW annually.
MISO conducts annual Effective Load Carrying Capability analysis to determine capacity values for wind resources

**Effective load carrying capability (ELCC):** The amount of incremental load a resource can dependably and reliably serve, while considering the probabilistic nature of generation shortfalls and random forced outages as driving factors to load not being served*

- Leverages probabilistic methods
- Accounts for uncertainties that affect resource's availability
- Requires numerous years of historical weather data
- Renewable hourly profiles

* MISO's Planning Year 2021-2022, Wind & Solar Capacity Credit, December 2020
MISO is pursuing further renewable accreditation enhancements post Seasonal alignment for non-thermal resources proposed in 2021 RAN filing

<table>
<thead>
<tr>
<th>Resource Category</th>
<th>Current Annual Accreditation</th>
<th>Seasonal Accreditation proposed in 2021 RAN filing</th>
<th>Further Enhancements currently underway Post-Filing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wind</td>
<td>Annual ELCC and then allocate to individual wind resources based on performance over 8 peak summer days per year</td>
<td>Seasonal ELCC and then allocate to individual wind resources based on performance over 8 peak days per season</td>
<td>Evaluate ELCC methodology along with other availability-based accreditation approaches</td>
</tr>
<tr>
<td>Non-wind intermittent resources, including solar</td>
<td>Three-year, historical availability-based hours 15,16,17 EST from June to August</td>
<td>Three-year, historical availability-based hours 15,16,17 EST for spring, summer and fall. Hours 8, 9, 19, 20 EST for winter</td>
<td></td>
</tr>
</tbody>
</table>

ELCC = Effective Load Carrying Capability
The electric industry is experiencing a rapid transition; new resources have different characteristics than retiring resources, putting reliability at risk if the transition is not managed.

**Wind**
- Growing wind portfolio increases the volatility and variability of its output.
- Wind utilization maximized when complimented by flexible and dispatchable resources.

**Solar**
- Solar outputs steep daily ramps.
- The impact will grow as MISO’s solar capacity grows from 2.4 GW to as high as 30 GW in 2039.

**Thermal Resources**
- Thermal resources have predictable output and flexibility characteristics.
- However, thermal resources are declining rapidly, from over 70% today to around 36% in 2040.