Purpose Statement

Review the participation and historic performance of Load Modifying Resources (LMRs) in MISO’s Capacity and Energy Markets, including:

- Use by Load Serving Entities (LSEs) to meet Resource Adequacy Requirements.
- Availability reporting during peak season obligations and throughout the Planning Year.
- Deployment performance during emergency declarations.
- Impact throughout the Planning Year (June 1st to May 31st of the following year) to support reliable and efficient operations to meet operational needs.
- Impact of greater reliance by LSEs on LMRs in proportion to all Planning Resources.
- Addressing concerns by LMR market participants and Regulatory Authorities who rely on such resources.

Executive Summary

Load Modifying Resources, or LMRs, are Demand Resources and Behind the Meter Generation not typically modeled or measured as part of MISO’s operations, but used during capacity shortages to help meet the energy balance. Well before and since the energy markets launched in 2005, Load Serving Entities (LSEs) have relied on LMRs in part to meet their Resource Adequacy Requirements. In recent years, LSEs are relying on LMRs to a greater extent to meet these requirements. Due to market and portfolio evolution, however, the uncertainty about the effectiveness of such resources in the future has become an issue. Originally registered as resources only available to MISO under declared Emergencies, LMRs have been called by MISO only 8 times since market start, and only once have all available LMRs been called. One reason for such limited use has been an ample surplus of other Capacity Resources.

MISO originated from 26 separate balancing authorities, each with its own resource adequacy requirements; now MISO coordinates a least-cost dispatch pool with shared requirements. In the past MISO had surpluses higher than 40% of coincident peak, and consequently MISO’s rules governing LMR capacity participation focused on accommodating existing utility programs and capabilities as long as the minimal resource adequacy reliability requirements were met. Current Resource Adequacy LMR participation and qualification rules require availability and performance only in summer months to meet the traditional summer peak. This differs from other Capacity Resources which have year round availability obligations.

Over the last several years, MISO has implemented enhanced LMR operational capabilities, including taking over deployment responsibility of LMRs from the local balancing authorities. MISO maintains situational awareness of available LMR capacity through control room tools and performs frequent drills with participants to verify communication capabilities throughout all seasons. But more work can be done.
Load Modifying Resources

Conditions have changed. Today, tightening surplus reserve margins and rapid change in the resource mix with greater reliance on LMRs to meet capacity requirements (table below) have increased the occurrence of Emergency declarations and the likelihood of depending on using LMRs for resource adequacy. MISO has initiated the Resource Availability and Need (RAN) initiative to analyze and define issues impacting the conversion of committed capacity in the annual Planning Resource Auction (PRA) to energy to meet operational needs in all time frames. Assessing LMR qualification, capabilities and performance is one of five key trends identified in the initial evaluation of RAN due to their Emergency Only availability.

<table>
<thead>
<tr>
<th>Planning Year</th>
<th>LMRs (percent of Cleared PRA MWs)</th>
<th>LMRs (MWs)</th>
<th>Surplus(^1) (MWs)</th>
<th>Planning Surplus (%)</th>
<th>Operating Reserves (MWs)</th>
<th>Emergency Only: Non-LMRs (approx. MWs)</th>
<th>LMRs + Emergency Only: (% of Cleared PRA)</th>
</tr>
</thead>
<tbody>
<tr>
<td>15-16</td>
<td>7.3%</td>
<td>9,924.2</td>
<td>9,501.3</td>
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<td>4.5%</td>
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<td>7,393.2</td>
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<td>8.2%</td>
<td>11,062.1</td>
<td>6,602.2</td>
<td>4.9%</td>
<td>2,400</td>
<td>4,573(^2)</td>
<td>11.6%</td>
</tr>
</tbody>
</table>

Given the uncertainty around LMR performance and greater expectation of reliance on LMRs for resource adequacy, MISO is assessing risks and opportunities associated with LMRs in conjunction with the RAN initiative, including: (1) Assess availability, communication and performance impacts on operations and reliability with emphasis on improved accreditation and measurement and verification (M&V) protocols; (2) Evaluate process and tariff changes to enhance situational awareness, availability, and self-scheduling related to LMRs; (3) Engage stakeholders providing education, training and market notices around LMR deployment; and, (4) Collaborate with stakeholders to develop needed tariff changes to assure efficient and reliable procurement and use of LMR capacity.

\(^1\) In excess of planning reserve margin requirements
\(^2\) Simple average of previous years
1. Problem Statement

Load Modifying Resources (LMRs) are in the last set of Planning Resources deployed to meet the energy balance during declared Emergencies prior to using operating reserves and subsequently interrupting firm load. As reliance on these resources becomes more frequent, confidence in their capability and performance is vital. MISO and our stakeholders require better understanding of these assets, including quantification of risk associated with these resources. This effort is one part of the RAN initiative. Areas for additional analysis and enhancements include:

- Review of historic performance of how LMRs have met MISO’s Resource Adequacy Requirements.
  - Availability reporting during peak season obligations and throughout the Planning Year.
  - Deployment performance during all emergency declarations.
- The impact throughout the Planning Year (June 1st to May 31st of the following year) of LMR reliance as capacity as currently defined to support reliable and efficient operations to meet operational needs.
- As LSEs rely more on LMRs in greater proportion to all Planning Resources, the ability of the overall impacts on reliable and efficient operations under future scenarios like, for example, use of 15,000 MWs of LMR backed capacity.
- Addressing concerns by LMR market participants and Regulatory Authorities who rely on such resources.

2. Overview of LMRs

To address the problem, LMRs are properly defined by considering the following: how these assets were used prior to MISO existence, MISO’s existing tariff requirements for LMRs, historic use at MISO, and frequency statistics for the current planning year.

Definition: LMRs are Demand Resources (DR) or Behind the Meter Generation (BTMG) used to meet an LSE’s Planning Reserve Margin Requirements, callable during MISO-declared Emergencies. Demand Resources are Interruptible Load or Direct Control Load Management, commonly referred to as Demand Side Management (DSM) Programs at the retail level.

Historic practice before MISO. Most MISO LSEs are vertically integrated utilities under retail rate regulation faced with developing periodic integrated resource plans (IRPs). To meet least cost objectives established by the Relevant Electric Retail Regulatory Authority (RERRA), LSEs matched the expected load duration curve with a commensurate resource mix. LMR-type assets were used to meet super-peaking needs, those few hours (< 50 hours per year) when demand was much higher than the expected
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forecast, usually because of extreme weather conditions. These conditions typically occurred in the summer season for most LSEs. At MISO start, LSEs and RERRAs requested the continued use of LMRs to meet their resource adequacy obligations, callable under MISO Emergencies. MISO LOLE studies (loss of load expectation) at market start in 2005 indicated non-zero LOLP (loss of load probabilities) occurring only in the summer season, with at most 5 occurrences.

Tariff requirements. A Market Participant (MP) must possess ownership or equivalent contractual rights for the LMR asset. The asset must be equal to or greater than 100 kW (smaller resources can be aggregated), with a maximum 12 hours advance notice. The LMR asset must be capable of ramping load down to meet the targeted demand reduction amount or to achieve the firm service level by the hour designated by MISO. The asset must maintain the targeted amount of demand reduction or firm service level for at least four (4) continuous hours. It must be capable of being interrupted for at least the first five (5) times requested during the Summer season (when called upon by MISO). Unless unavailable as a result of maintenance requirements or for reasons of Force Majeure, when a demand reduction is requested by MISO, the resultant reduction must be a reduction that would not have otherwise occurred within the next twenty four (24) hour period. Last, the MP must demonstrate demand reduction capability for each Planning Year on an annual basis as established in the Business Practices Manual for Resource Adequacy.

Historic use at MISO: Since MISO Market start, roughly 8,000 – 9,500 MWs of LMRs have been cleared annually to meet resource adequacy needs, with an additional 1,500 to 2,000 MWs clearing in the last year. Since MISO Market start, there have been only 8 events where LMRs have been called to address capacity shortages:

- 1 August 2006: system-wide capacity emergency. Despite claims that only one half of the cleared LMRs provided relief or demand reduction during this event, actual performance cannot be quantified due to a lack of automatic reporting systems.

- 3,4,5 February 2007: localized capacity emergency, in SE Wisconsin. Roughly 300 – 500 MWs were called on each day. No analysis can be found for this event but no additional steps in the emergency protocols were taken.

- 4 April 2017: MISO South local event, roughly 700 MWs called. Analysis suggested some underperformance by a few assets, but the event occurred outside the summer season. See https://cdn.misoenergy.org/20170713%20MSC%20Item%2020%20LMR%20Deployment%20Clarification75024.pdf.

- 17-18 January 2018 (17 January HE 8-11, 17 January HE 20-21, 18 January HE 7-10): MISO South local event, roughly 700-900 MWs called. Analysis suggested some underperformance by a few assets for a few hours, and over-performance in other hours, but the event occurred outside the summer season. See https://cdn.misoenergy.org/20180503%20RSC%20Item%2020%20Liaison%20Report188318.pdf.
MISO compiled data and analyzed LMR attributes for LMRs that have cleared this and the previous planning year’s PRA, for June 2018 – May 2019 and June 2017 – May 2018 and note the following:

- Evidence suggests that additional retail DSM programs across states in the MISO footprint are not currently being used to meet resource adequacy needs in MISO but may be available for future use.
- Some MISO local resource zones (LRZs) make little use of LMRs, while five of the LRZs (1/2) have over 80% of LMR capacity.
- Participation of Aggregators of Retail Customers (ARCs) is scant but growing within MISO.
- Over 3,000 MWs of LMR capacity require a 12 hour notification, while almost 60% of LMR capacity is available within a 4 hour window.
- Almost 2/3 of LMRs are Demand Resources, which makes accreditation problematic without actual testing requirements, and requires M&V (measurement and verification) protocols to infer delivery of demand reduction.

LMR characteristics at MISO
3. Emerging issues

MISO performed a comprehensive ‘bid to bill’ assessment of issues with the use of LMRs to meet resource adequacy requirements and an assessment of other issues with the use of LMRs related to performance reliability. Highlights include:

- **Physical Attributes:** the usefulness of LMRs that require 12-hour notification during MISO-declared Emergencies to meet the energy balance is an issue. At best, a 12-hour notification requirement is simply not consistent with emergency operating procedures, it being difficult to imagine conditions such that EEA level 2b emergency events would be called twelve hours in advance. At a minimum, notification times should be based on physical operating characteristics codified in the tariff and should be justified during registration. Other physical attributes of LMRs should be assessed to see if information on them could help support reliable grid operations and codified in the tariff if deemed supportive (e.g., ramp rates).

- **Summer only resources:** LMRs must be available to MISO during declared Emergencies at least the first 5 times during the summer season. With Emergency events now occurring outside the summer months, MISO should assess LMR requirements and evaluate modifications. If so, we should recognize that if additional non-summer performance requirements are added, some LMRs may not be available (e.g., air conditioning programs).

- **Demand Resources** can be weather sensitive assets and/or firm service level assets.
  - Some LMRs have varying abilities to reduce demand dependent on weather conditions (e.g., air conditioning cycling programs).
  - Some MPs with LMRs have varying abilities to reduce demand dependent on where the end-use customer is in its production process. Further, the end-use customer needs a certain amount of base energy to support critical processes that it cannot go below. Base level is called firm service level.

  A better assessment of the range or distribution of potential load reduction from these types of assets (weather-sensitive or firm service level) should be made.

- **Price takers:** Market Participants with LMRs that do not dual register as Emergency Demand Response Resources (EDRs) are price takers when called to provide energy during MISO Emergencies. They cannot submit monetary offers to indicate their costs to reduce demand. EDRs can submit monetary offers for the specified demand reduction. MISO should investigate why the majority of MPs with LMRs are price takers.

- **LMR availability:** No penalties occur if the LMR is unavailable due to planned maintenance or force majeure. LMRs receive capacity payments ($/MW-day) every day during the entire planning year, with a requirement to only be available 5 times in the summer. MISO should evaluate the
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value LMRs provide and if they should be available when called with no forgiveness if not available (i.e., penalties will occur).

- Operational impacts with self-scheduled use: As MISO calls for conservative operations and moves through the stages of its Emergency Operating Procedures, LSEs can and do respond by calling on their LMRs voluntarily. Over-commitment issues and other reliability impacts can arise. Also, MPs can, at any time, voluntarily use their LMRs, either during MISO calls for conservative operations, for local reliability issues, or to mitigate exposure to high LMPs. MISO has little situational awareness of these actions. MISO should have better situational awareness of MPs’ use of LMRs at all time periods, codifying a requirement to do so in the tariff.

- MISO lacks knowledge and use of the detailed location of LMRs which could support more efficient and reliable operations, and should be pursued for better congestion management at a minimum. Further investigation of appropriate level of communications protocols for LMRs should also be pursued.

- Capacity credit: LMRs that are DRs are credited at 100% of their registered capacity. No other resources receive 100% capacity credit, but are decremented to reflect their unforced capacity. Some evidence exists that LSEs have conservatively estimated their demand reduction capability during the registration process. But some evidence during MISO-declared Emergencies shows some LMRs underperforming when called outside the summer season. As a result, there is currently no substantive analysis to support the notion that MPs with LMRs will not perform as expected during MISO-declared Emergency events, though there is a significant amount of uncertainty around that expectation.

- A disparate set of tools at MISO are used to manage the LMR asset base. The Module E Capacity Tracking system is used to register, accredit, document M&V protocols, facilitate auction participation and trade zonal resource credits with counterparties, including those with LMRs. The MISO Communication System is used to update availability status for LMRs for MISO staff use and for MISO communications with asset owners. The Demand Response Resource Tool is used for collecting appropriate meter data for settlement of LMRs when called during emergencies. LMRs are not included or administered in MISO’s unit commitment tools or UDS (unit dispatch system). As more frequent use of LMRs occur, consideration for a more formal market systems spanning all aspects of LMR interaction should be considered.

4. Summary

The problem statement identified a number of areas for further analysis and enhancement:

**How have LMRs performed to date in meeting our LSEs’ resource adequacy needs?** MISO has called on LMRs so infrequently since market start that this question cannot be answered with any certainty. More recent activations, on 4 April 2017 and on 17-18 January 2018, occurred outside the summer season where LMRs are not required to perform. While performance was slightly lower than the
scheduling instruction for some hours, with over performance occurring in other hours, we should not
draw any conclusion from a sample of a few observations. The Emergency Events occurred outside the
summer season. As a result, there is no substantive analysis to support the notion that MPs with LMRs
will not perform as expected during MISO-declared Emergency events, though there is a significant
amount of uncertainty around that expectation.

**MISO rarely sees the amount of LMRs that cleared in the PRA made available in real-time through the MCS.** This issue requires further investigation, however, three reasons are possible. First, some Demand Response is weather sensitive load; at times coincident with MISO peak, we expect a greater amount of MWs from these DRs, yet during other times less capacity is available. Without further investigation across all weather-sensitive DRs, a quantity associated with this variation cannot be made. Second, almost 4,000 MWs of DR is the firm service level reduction type. If the end use customer behind this firm service level DR is at a lower production level than is expected coincident at MISO’s system peak, the amount of demand reduction will be commensurately less. And third, and most importantly, reporting availability of LMRs in the MCS tool is voluntary and not codified as a requirement in the tariff.

**As reserve margins tighten, LMRs will be called upon more frequently to support reliable and efficient operations posing new operational challenges.** Tightening reserve margins in and of themselves do not raise concerns over LMRs meeting operational needs, however, MISO’s reliance on LMR capacity will require enhanced operating guides and tools for managing and measuring the deployment of LMRs. The RAN initiative may identify additional operational needs in order to effectively administer Emergency Events. LMR refinements, for example, may be required to address not only non-zero LOLPs in the summer, but capacity shortages during outages and peak winter months. LMRs have performed in non-summer months without a defined obligation. As resource adequacy and resource availability issues become a concern in the non-summer months, LMR requirements and processes may need refinement.

**Current rules and market conditions can accommodate 11,000 MWs of LMRs, however, future growth to as much as 15,000 MWs may present challenges and consequences.** The current rules are sufficient for an increased amount of LMRs meeting LSEs’ resource adequacy requirements. We should note, however, that with an increased amount of LMRs comes increased likelihood of using them, which will require more frequent Emergency declarations and the resulting impacts to MISO operations, market participants, and regulatory authorities. Continued growth of LMRs with reduced surpluses, will move MISO closer to the one day in ten reliability standard, increasing likelihood of involuntary firm load curtailment.

**Future questions might be raised by LMR market participants and regulatory authorities when they are deployed more frequently.** As the likelihood of calling demand reduction from LMRs increases, MISO must provide enhanced information, education and market notices around LMR deployment. MISO should provide workshops for RERRAs and the Organization of MISO States on the entire LMR process from registration and accreditation to settlement, or ‘bid-to-bill’. Similarly, MISO should provide workshops for stakeholders with LMRs. These should provide detailed information about
5. **Next steps**

Next steps are divided into near-term and intermediate-term. Near-term includes issues that might be addressed without much controversy among stakeholders, and, if a tariff filing is required, should move through FERC relatively smoothly. Intermediate-term includes issues that may have difficulties moving through the FERC and/or the stakeholder process or requires a significant capital budget.

### 5.1 Near-term Actions:

- **MISO Communications System**: Enhance this tool and make MPs with LMRs report their availability as a tariff requirement for improved situational awareness and operational decision making.
- **Registration and accreditation**: Review tariff rules and develop templates and guidelines appropriate to LMR asset types for use during the registration process.
- **Weather-sensitive demand resources**: Develop templates and guidelines for reporting and providing justification of weather elasticities.
- **Firm service level assets**: Make reporting availability a tariff requirement for improved situational awareness.
- **Emergency Demand Response registration versus Price takers**: Conduct analysis on Market Participant’s decision to dual register LMRs as Emergency Demand Response.
- **Measurement & Verification protocols**: Analyze state-of-the-art M&V and develop templates and guidelines based on M&V type.
- **Self-scheduled LMRs**: Make reporting availability a tariff requirement for improved situational awareness.
- **Locational requirements**: Make location identity a tariff requirement for improved situational awareness.
- **Performance reliability**: Conduct analysis in-house to develop a distribution of possible outcomes.
- **Emergency operations**: Provide additional training for MISO stakeholders.
- **Education/training/situational awareness**: Enhance information, education and market notices around LMR deployment.
5.2 Intermediate-term:

LMR notification times: Revisit maximum notification time for accrediting LMRs where MISO can operate the grid reliably.

Must offer requirements: Consider additional obligations outside MISO-declared Emergencies.

Summer only resources: Consider additional obligations outside the summer season.

LMR availability: Consider the quid pro quo for LMRs only available during Emergencies being the expectation to be available when called with no forgiveness if not available (i.e., penalties will occur).

Emergency procedures: Consider revising the Emergency Operating Procedures to take advantage of lower cost LMRs.

Penalty structures: Revisit penalties given the increased reliance on and design of LMRs and their intended use.

Changing RAN: (diagram below) Fit the LMR capacity instruments into the holistic RAN efforts to ensure the successful conversion of committed capacity into sufficient energy.

Capacity credit: Assess whether to apply forced outage rates to Demand Resources along the same lines as those applied to generation assets.

MECT/MCS/DRR Tool/UDS: Develop a formal market system encompassing all LMR interactions, tied to market commitment and dispatch in the market system.