Uncertainty Management in MISO Real-Time Systems: Needs, Opportunities and Challenges

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Study Scope & Presentation Objective

- MISO is initiating exploratory R&D to evaluate and study stochastic uses in real-time applications and processes.
- The scale and complexity of uncertainty are increasing and opportunities exist to explore practical approaches for stochastic techniques.
- This work will span multiple years.
  - Near-term focus: out-of-market solutions
  - Starting July 2017 through 2018 and Beyond
- Objective today: Seek comments and suggestions on research focus

[Disclaimer] The views and opinions expressed in this presentation are those of the authors and do not necessarily reflect those of MISO.

Uncertainty in Advisory Real-Time Systems, Operations and Processes

Many types of uncertainties exist in our systems today. The types of and complexity of uncertainty will likely grow.

Generation and Load:

- Medium- and short-term load forecast
- (MISO) Renewable generation forecast
- Energy storage, distributed energy resources (DER), and demand response (DR) statuses forecast

Interchange:

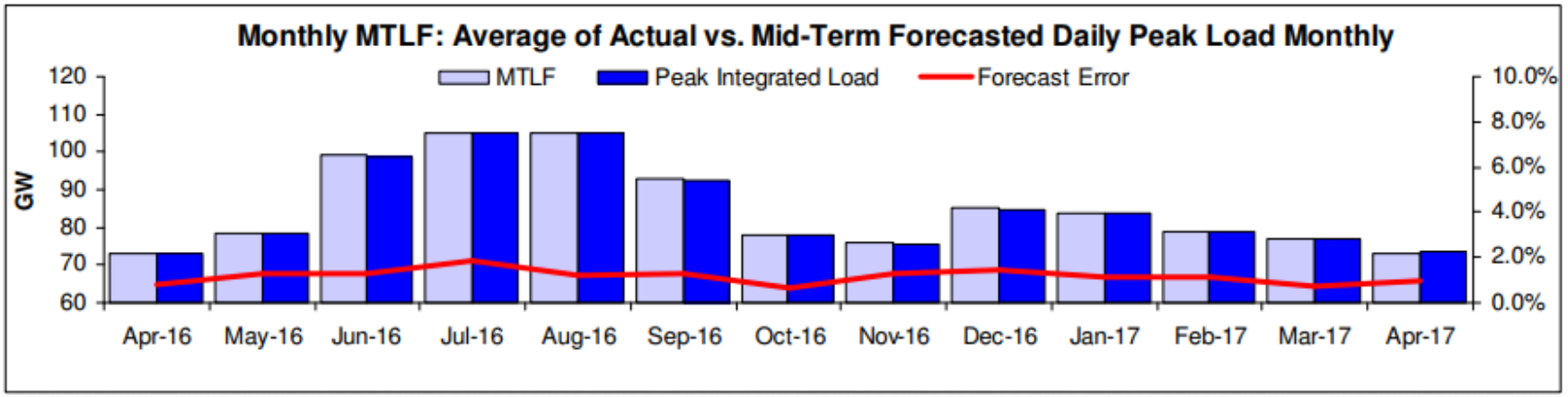
- Net Scheduled Interchange (NSI) forecast

Network:

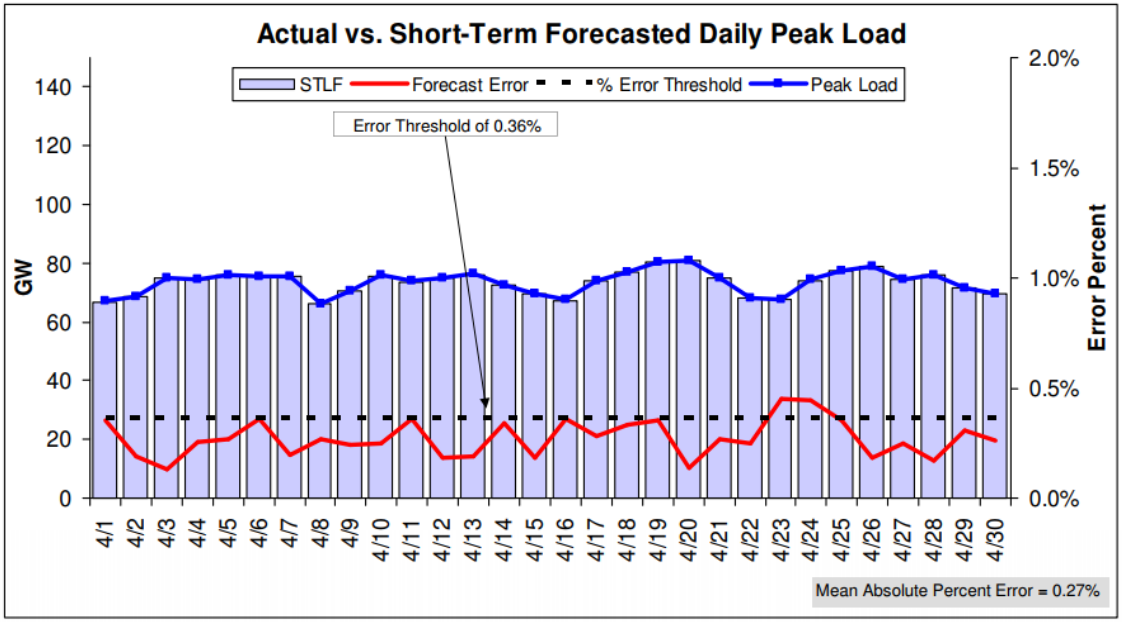
- Forced outages (not in scope): Included in outage coordination study
- Grid topology, e.g., Transmission line switching or flow control devices

Example: Load Forecast

Day-Ahead Mid-term Load Forecast

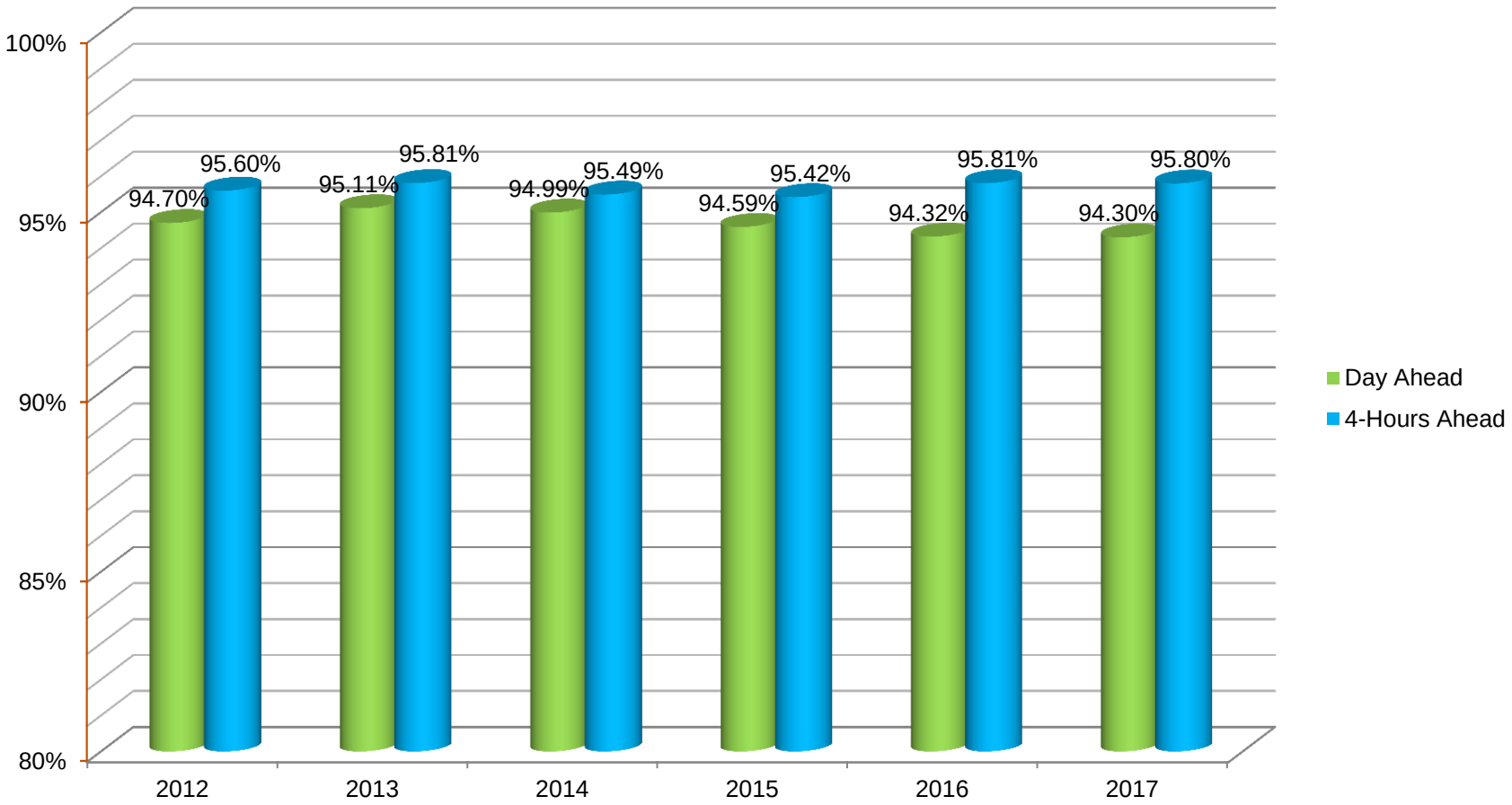


Shor-term Load Forecast



Source: MISO Forecast Engineering Department, Market Evaluation and Design Department

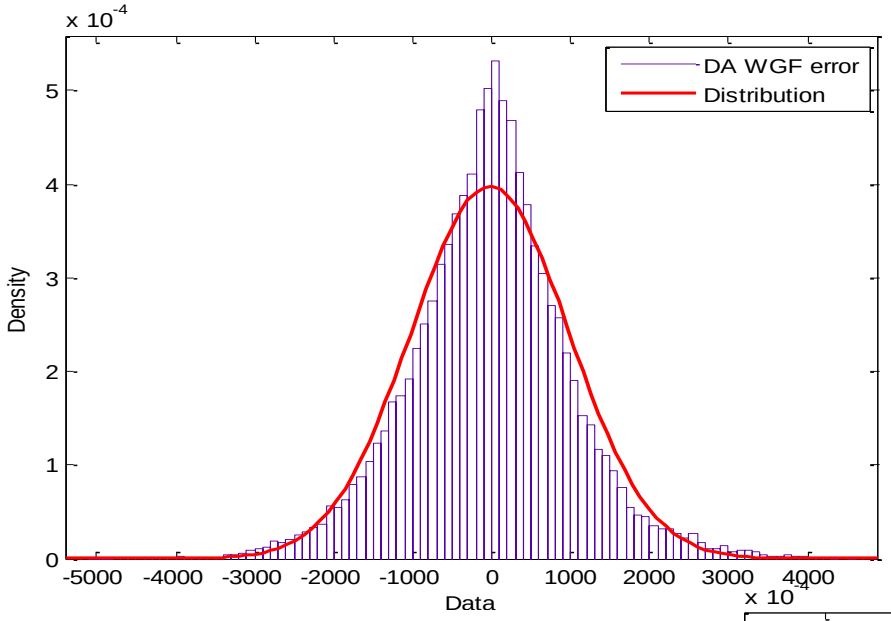
Example: Hourly Wind Forecast Accuracy



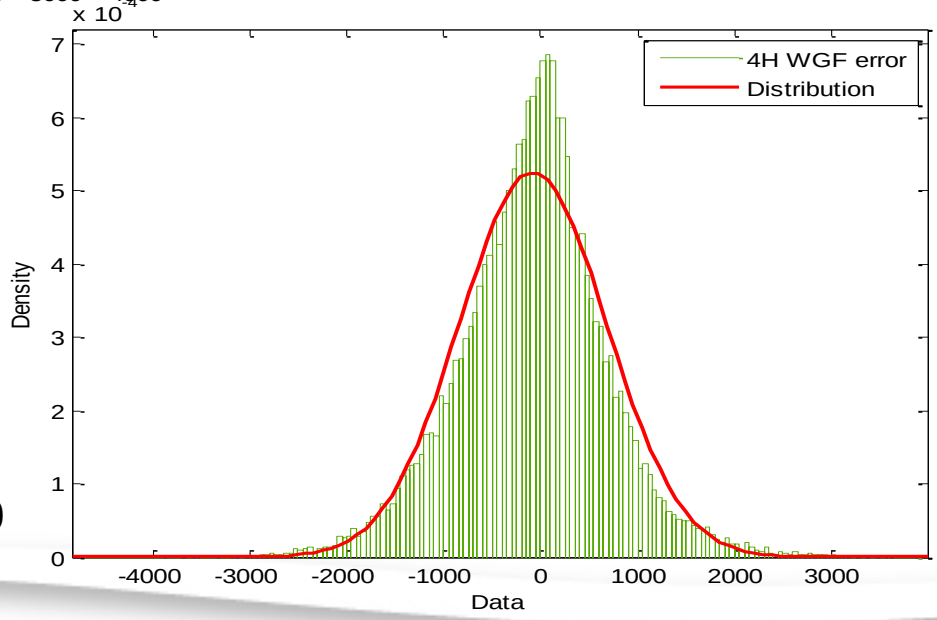
The 2017 accuracy data is as of June 15th.

Source: MISO Forecast Engineering Department

Example: Wind Forecast Error Distributions



Mean: -20
Standard deviation: 1000



Mean: -80
Standard deviation: 760

Source: MISO Forecast Engineering Department. Normal distributions are assumed.

Current Practice: Deterministic-like Engines and Tools combined with Operators' Experience

Current practices work to address uncertainties but could benefit from more transparency into these uncertainties.

- **Engines** – e.g., FRAC/IRAC, LAC
- **Tools – deterministic analog of stochastics**
  - "Most-likely" scenario
  - Reserve requirement
  - DA commercial flow limit
  - RT peak-hour summary
- **Operators' Experiences**
  - Override on forecasts
  - Judgements in decision-making

Ramp Capability: A Recent Market Product to Hedge against Uncertainty

MISO's Ramp Capability went live on 05/01/2016 and was designed to help uncertainty management.

Simulation-based analysis indicates that Ramp Capability Product leads to *:

- Reduction in RT prices
- Reduction in RT price volatility
- Improvement in DA-RT price convergence
- Total cost savings

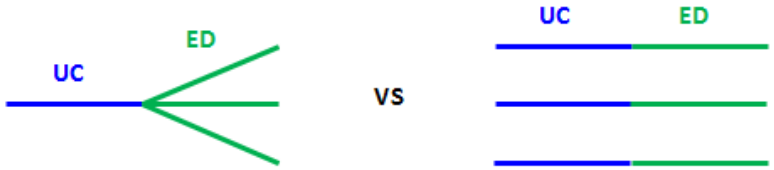
*Source: https://www.misoenergy.org/Library/Repository/Meeting%20Material/Stakeholder/MSC/2016/20161129/20161129%20MSC%20Item%2005f%20Ramp%20Capability%20Post%20Implementation%20Analysis.pdf

Example: LAC

- Key deterministic inputs that are uncertain:
  - MISO 5-min STLF
  - NSI forecast
  - Renewable generation forecast (5-min forecasts from Participants or MISO, and SE values)
  - Topology: at “the best knowledge”

- Three load forecasts scenarios are generated based on STLF input.

- LAC engine is a rough “stochastic” optimization as it is a combination of three independent deterministic approaches.



- Three sets of commitment suggestions are provided to operators.

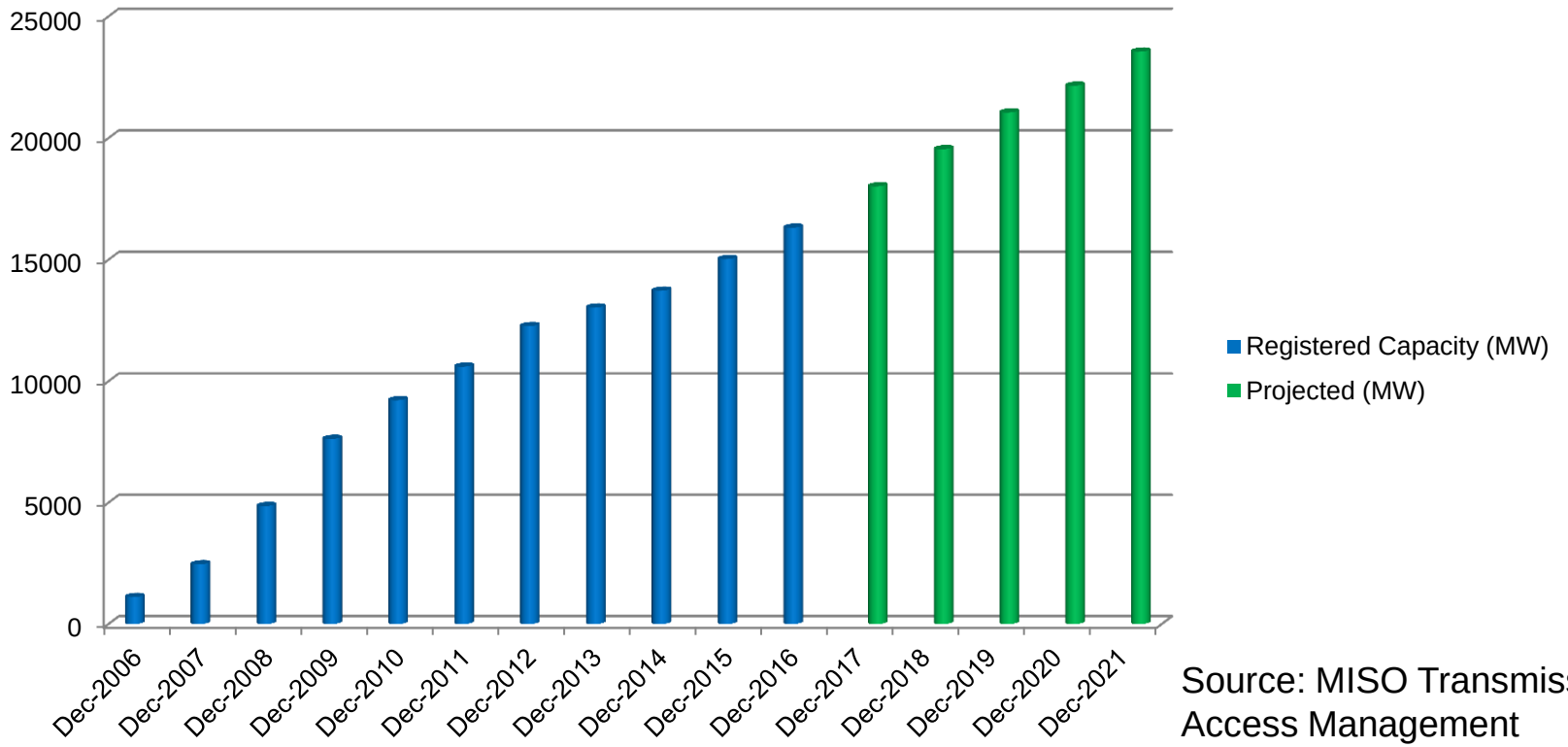
Needs for More Research Questions & Efforts

Industry trends point to a growth in the scale and complexity of uncertainty.

MISO expects to see an increase in the factors that generate uncertainty in our system today. MISO also expects that multiple factors will contribute to certain types of uncertainty, increasing its overall complexity.

- Renewable Generation Penetration => Increased Supply Uncertainty
- Energy Storage, DER, and DR => Another Dimension of Complexity
- Emerging Transmission Technologies => Grid Topology Uncertainty
- New Market Products => Price/Behavior Uncertainty

Wind Capacity Growth



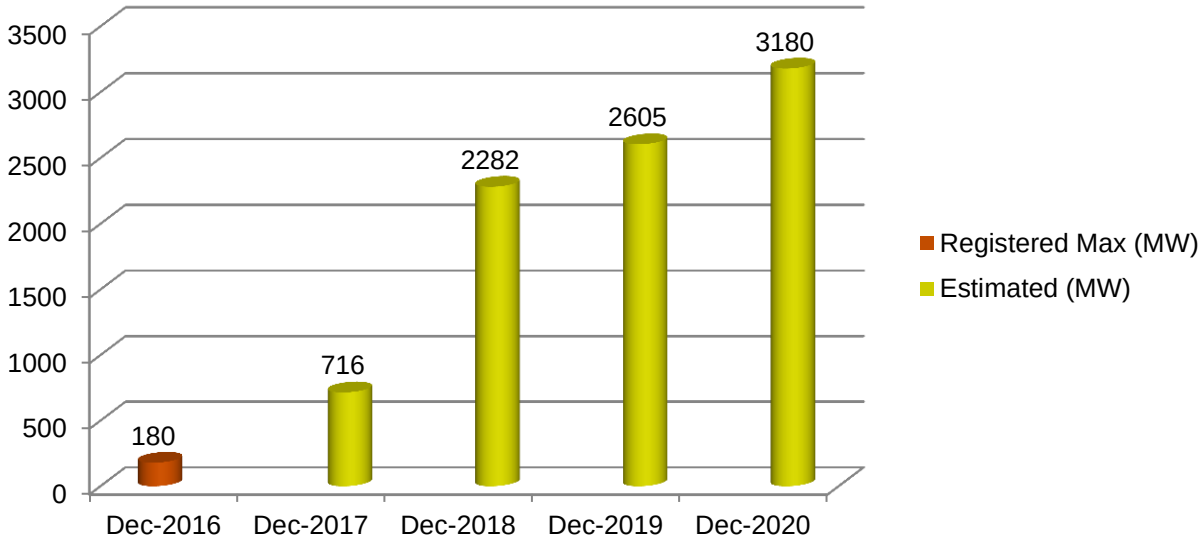
Source: MISO Transmission Access Management

- Around 85% of the wind resources are DIR.
- Projections do not consider potential withdraws due to PTC expiration after 2019.
- Wind production also increases, and will likely benefit from energy storage integration.

Solar Capacity Growth

MISO began the integration of solar in December 2016. Connecting to MISO >=69KV facilities:

- MW Amount of Projects in Service: 180MW
- MW Amount of Projects with a GIA and under Construction: 286 MW
- MW Amount of Projects in the Queue: 8,036MW



Source: MISO GI Queue 06/16/2017; Estimation is based on Active and Done Solar Projects with GIA, GIA in Progress or in DPP studies.

MISO's Continuous Efforts to Deal with Uncertainty

MISO is currently working on enhancements to better address uncertainty.

- Load forecast improvement
- Renewable forecast improvement
- LAC enhancement (e.g., renewable generation forecast utilization, Regional Dispatch Transfer constraints integration, and etc.)
- DA commercial flow limits enhancement
- Constraint manager
- Reserve Procurement (e.g., Ramp Capability deliverability)

Research Questions

In tandem with existing efforts, MISO will review uncertainty in our systems and explore the viability of practical stochastic solutions.

- What techniques can sufficiently validate the outcome of stochastic methodologies (operator decisions; stochastics vs. ODC, existing issues)?
- What approaches can help overcome computational performance limitations (IEEE 118-bus system vs. MISO system)?
- What techniques can help address combined sources of uncertainties (e.g., renewable + energy storage)?
- What are the pricing implications of incorporating stochastic techniques?
  - e.g. CTS, emission constraints, and etc.
- What is the feasibility of applying stochastics in operating procedures?

Proposed Applications & Focus Areas

Near-term: What are the implications of the “fixed variables” in current designs? How might stochastic approaches help?

- Reserve requirements and deliverability (stranded MW & headroom calculations)
- Ramp capability requirement

Long-term: What is the feasibility and value from stochastic or stochastic-like engines?

- FRAC/IRAC: NSI forecast, MTLF, hourly renewable forecast, etc.
- LAC: NSI forecast, STLF, 5-min renewable forecast, topology uncertainty, etc.

Next steps

- MISO is looking for feedback on its research questions, information on relevant research or applications to date and ideas about potential techniques to explore further.
- MISO will begin characterizing target areas of uncertainty and exploring near-term applications.

Thank You!

Comments and suggestions are welcome.

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