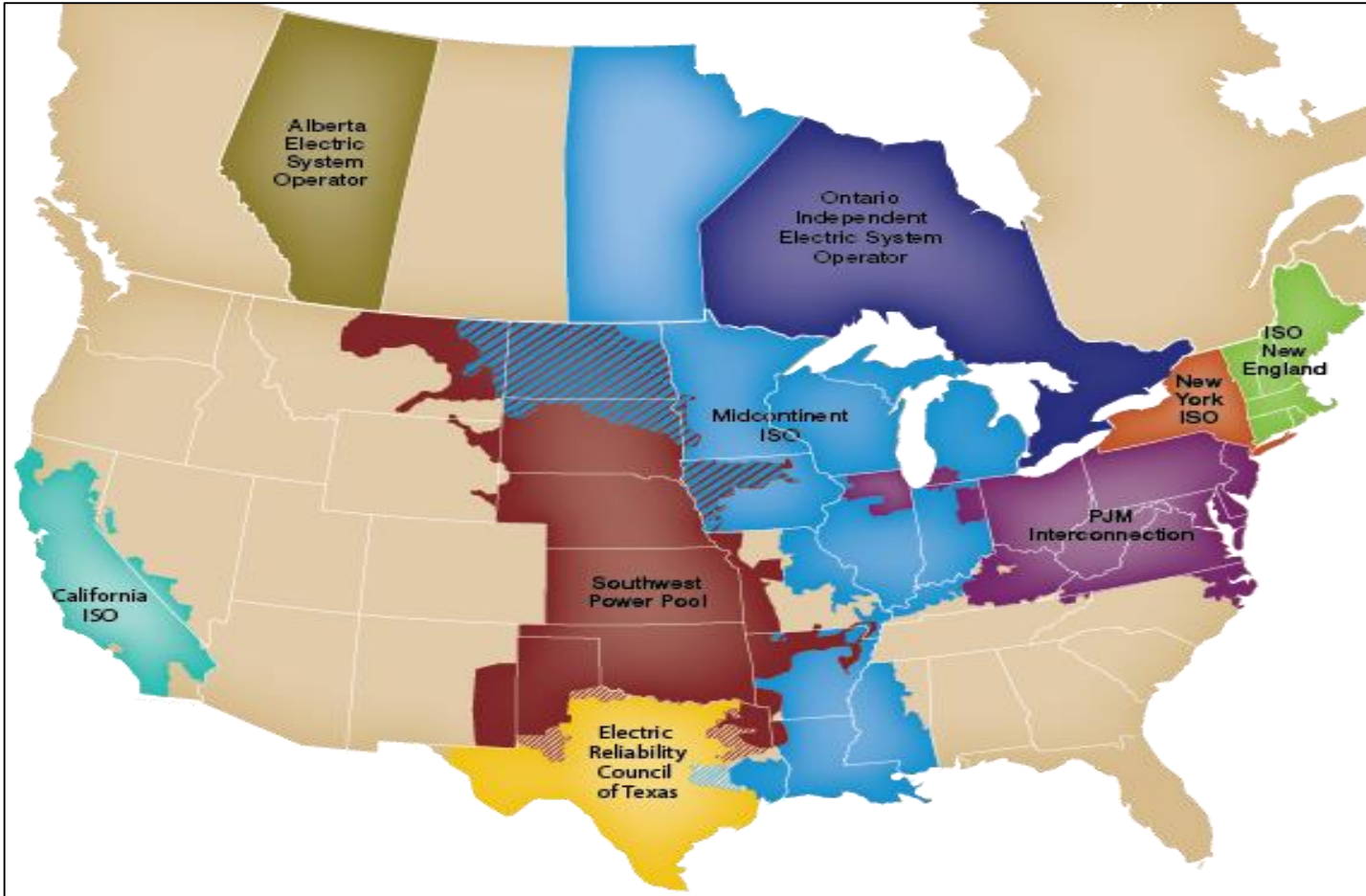


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# **Battery Energy Storage in MISO**

Rao Konidena, Principal Advisor  
Midcontinent ISO (MISO)  
November 14, 2016

# Geographically, MISO is the largest regional transmission organization and independent system operator in North America



Midcontinent ISO	
High Voltage Transmission	66,000 Miles
Installed Generation	180,000 MW
Installed Generation	1,600 Units
Peak System Demand	127,000 MW

## MISO Vision

The most reliable, value-creating RTO

## Mission

Work collaboratively and transparently with our stakeholders to enable reliable delivery of low-cost energy through efficient, innovative operations and planning.

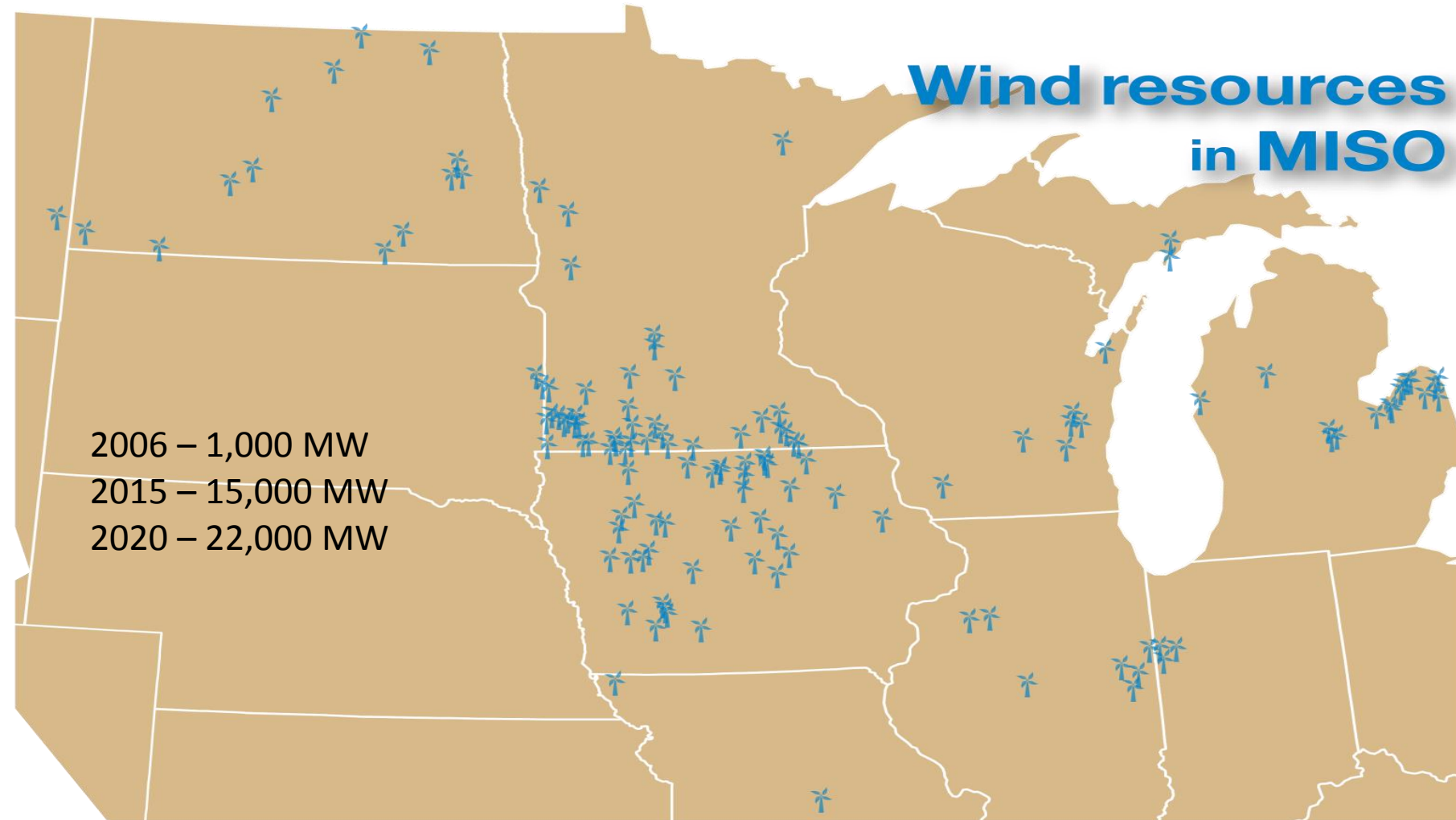
# What We Do

**MISO provides reliable system operations through:**

- ***Real-time Operations (Keeping the Lights On)***  
Safe & reliable operation of the electric grid
- ***Wholesale Market Administration***  
Open energy markets, including centralized scheduling and economic dispatch of generation to support reliability and efficiencies across the system
- ***Planning***  
For safe, reliable and economically efficient transmission expansion

# Key Takeaways of Today's Discussion

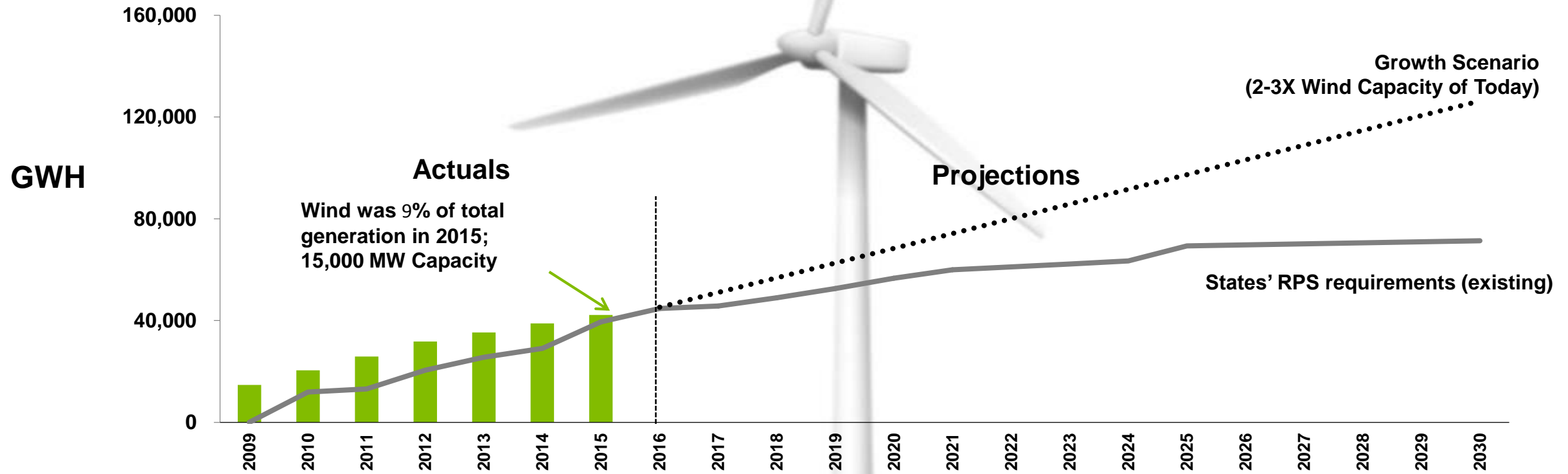
- MISO endeavors to create markets based on services to support the grid --not specific assets
- Storage must compete with conventional assets to provide these services
- MISO is going through a process to better integrate energy storage



Source – MISO Communications Department

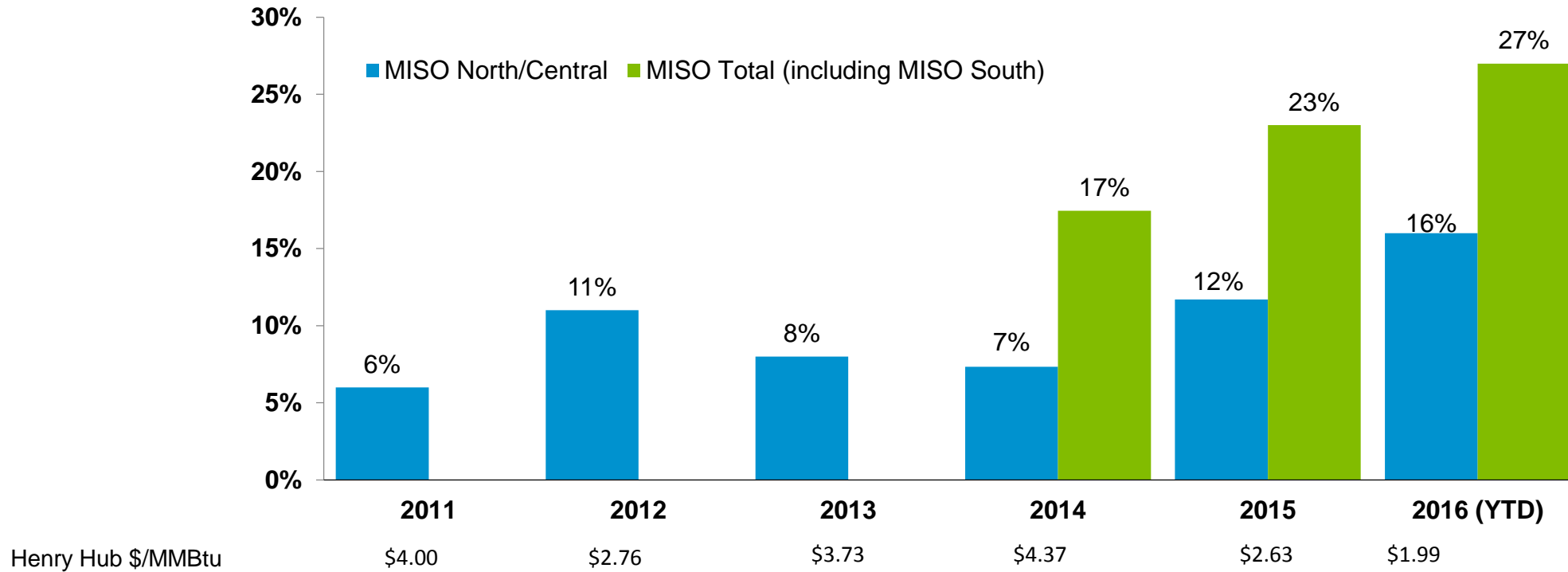
# MISO expects significant growth in wind generation

## MISO Wind Generation: Past and Future



# MISO has experienced significant growth in gas

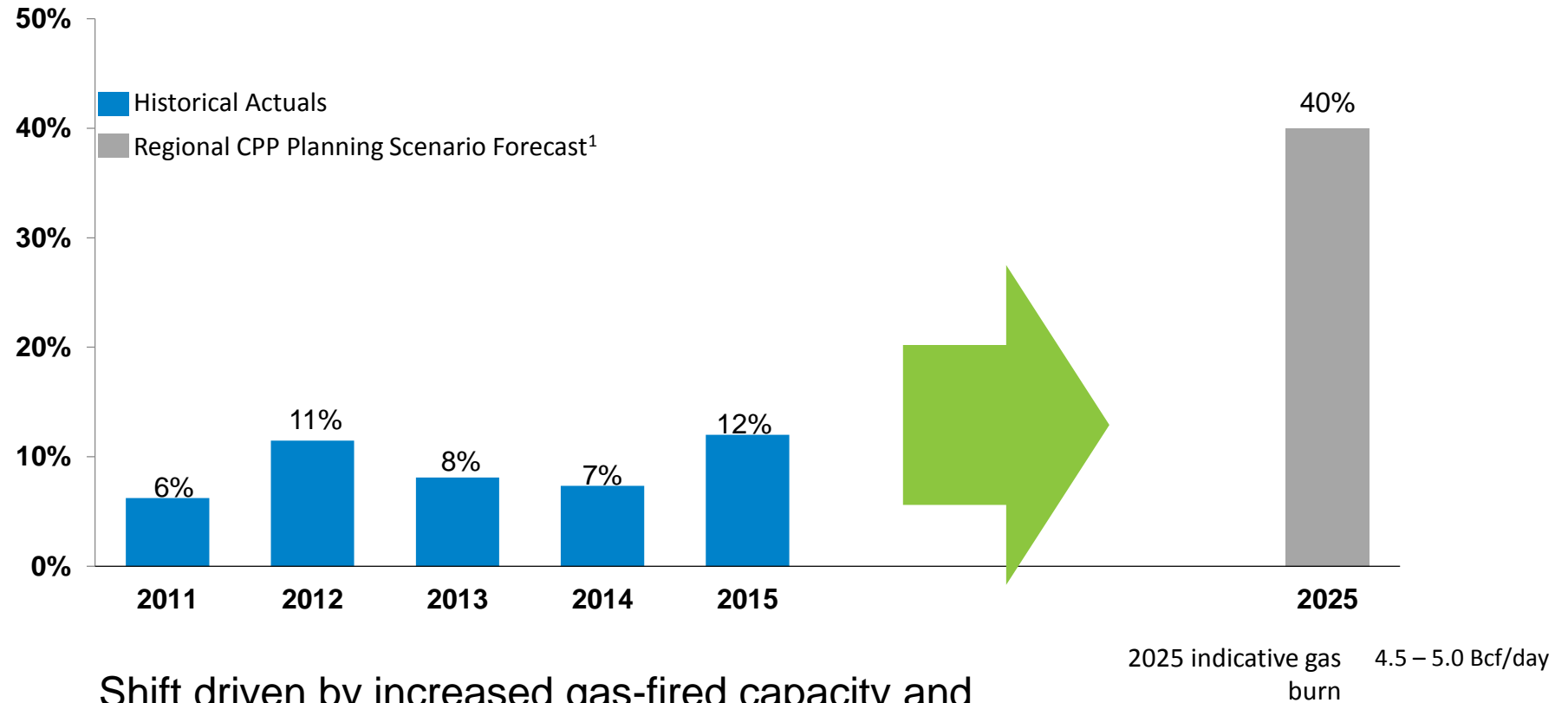
Gas Share (%) of MISO Electric Generation (MWH)



- 2015 significantly eclipsed prior gas utilization...and the trend continues in 2016 (YTD)
  - Though MISO South historically has high gas reliance, gas increased appreciably from 46% in 2014 to 55% in 2015 and 58% in 2016 (YTD)

# With more natural gas growth is expected

## Gas Share (%) of Electric Generation (MISO North/Central)



Shift driven by increased gas-fired capacity and increased capacity factors

1 - Forecast figure based on MISO MTEP16 assumptions and models for "Regional Clean Power Plan" scenario (assumes 26 GW coal retirement, 14 GW new gas-fired combined cycle, carbon cost \$32/ton in 2025, solar and wind include an economic maturity curve to reflect declining costs over time). The gas price forecast applicable to year 2025 has been updated to reflect recent outlooks with Henry Hub gas prices assumed at ~\$4.45/MMBtu.

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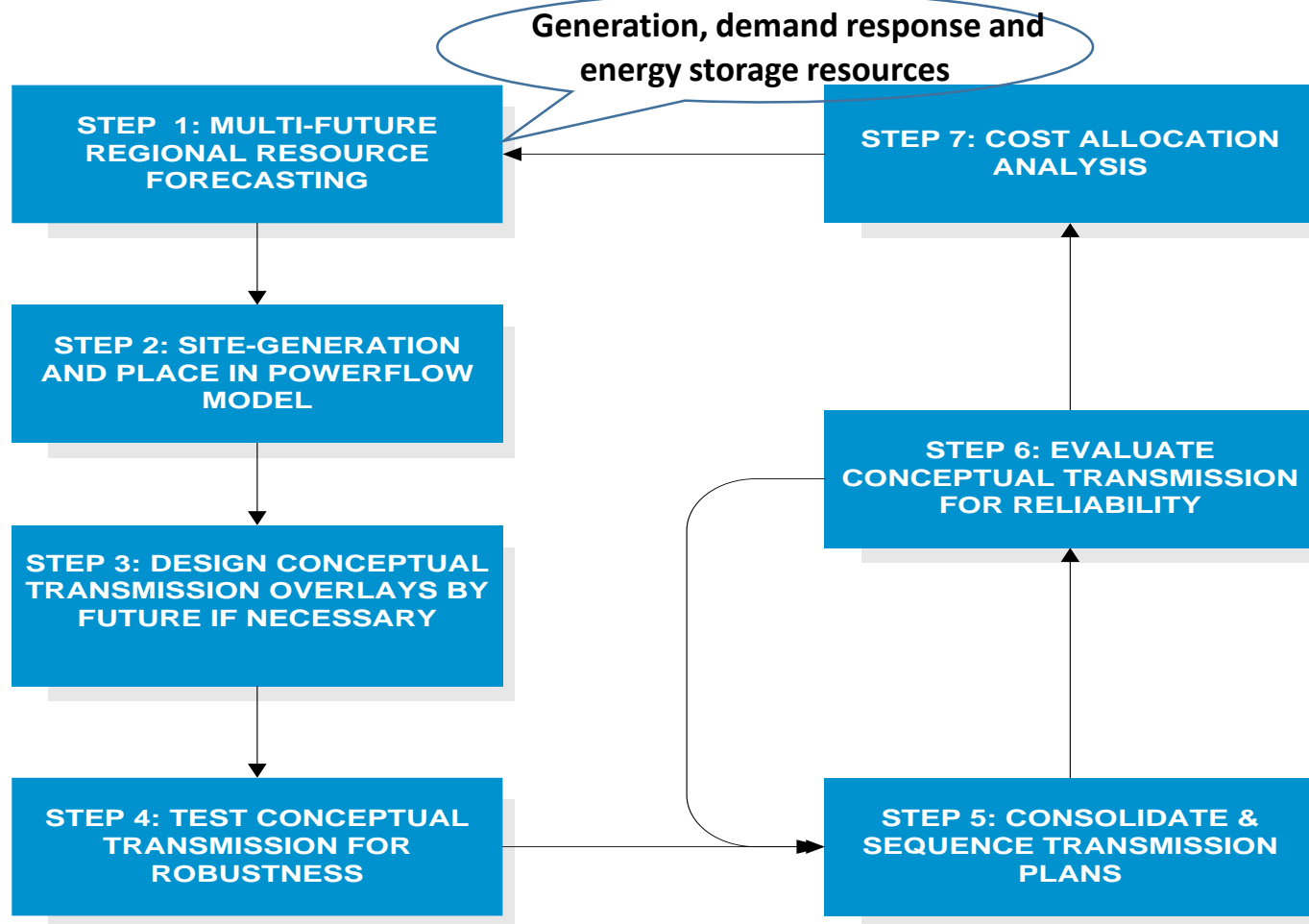
# **Energy Storage Efforts at MISO – Planning Perspective**



# Value-Based Planning Implementation



# MISO Value Based Planning Process



- Objective of value based planning is to develop the most robust plan under a variety of scenarios – not the least-cost plan under a single scenario
  - The “best” transmission plan may be different in each policy-based future scenario
  - The transmission plan that is the best-fit (most robust) against all these scenarios should offer the most future value in supporting the future resource mix

## Non-Transmission Alternatives or Non-Traditional Transmission Alternatives?

- Discussion and comments from MISO planning stakeholders have targeted several aspects of incorporating alternatives into the planning process
  1. Ensuring that generation and demand-side (as load-reducing) solutions are considered in addition to transmission solutions to transmission system issues (**Non-transmission Alternatives**)
  2. Ensuring that adequate advance indication of where and how much of these solutions would be needed, to facilitate their development
  3. Enabling the use of energy storage (ES) devices as transmission solutions with these devices categorized as transmission assets for rate recovery (**Non-traditional Transmission Alternatives**)
  4. The development of appropriate market rules for incorporating ES devices that provide market services (e.g. regulating service or capacity)
  5. The ability of ES devices that may be interconnected to the grid primarily for market purposes (regulation services or capacity resources) to also impact the need for transmission solutions. (**? Impact of a Non-transmission device**)
  6. The best approach to evaluating the reliable interconnection of ES devices



# **Current Market Rules for Energy Storage**

# Philosophy on development of market resources

## Market products: technology neutral

- Capacity
- Energy
- Regulating reserve
- Spinning reserve
- Supplemental reserve
- Ramp products: Up ramp capability / Down ramp capability

## Market resources are defined based on characteristics

- Generator
- Demand Response Resource (DRR)-Type I and DRR Type-II
- Stored Energy Resource (SER)
- External Asynchronous Resource (EAR)
- Dispatchable Intermittent resource (DIR)

# Market resources and current eligibility for market products

	Energy	Regulating Reserve	Spinning Reserve	Supplemental Reserve	Ramp Product	Capacity
<b>Generator</b>	Y*	Y*	Y*	Y*	Y*	Y*
DRR-I	Y*	N	Y*	Y*	N	Y*
<b>DRR-II</b>	Y*	Y*	Y*	Y*	Y*	Y*
<b>SER</b>	N	Y*	N	N	N	N
EAR	Y*	Y*	Y*	Y*	Y*	Y*
DIR	Y*	N	N	N	Y*	Y*

\* Subject to qualification, offer status and commitment

## Examples of other services not settled through market

- Reactive power supply and voltage control (transmission settlement)
- Blackstart service (transmission settlement)
- Primary frequency response (no compensation)

# Phase-In Approach for Energy Storage

## Goal- Prioritize initiatives while balancing costs and benefits

### • **Near-term (2016-early 2017)**

- Relatively straight forward and low cost items
  - Require minor tariff and Business Process Manual (BPM) clarification, and minimum system changes
  - Provide clear picture of how storage can participate in the near term

### • **Medium-term (mid 2017-forward)**

- Items that have been prioritized through market roadmap
- Tie to other on-going initiatives and stakeholder discussions

### • **Long-term (2017-2019)**

- Items involving complexity
  - Requiring broader regulatory or stakeholder discussion, or greater investment

# MISO Market Roadmap: Energy Storage relevant items

- New Storage Resource
- Behind Meter Storage Aggregation Under DRR Type II
- AGC Enhancement for Fast-Ramping Resources
- Aggregate Load to Meet Minimum Participation Limits
- Demand Response/Behind The meter Generation (BTG)/Emergency Demand Response (EDR) deployment during Capacity Emergency



# To continue the dialogue – MISO Stakeholder Committee discussions for Energy Storage

Forum	Topic	Dates
MISO Market Sub-Committee	Energy Storage Workshop	Jan, Mar, Apr 2016
MISO Planning Sub-Committee	Non Traditional Transmission Alternatives	Aug, Oct, Dec'15, April June 14, Aug 16, 2016
MISO Reliability Sub-Committee	Frequency Response	June 8, 2016, Aug 10, 2016
MISO System Planning Committee of the Board	Transmission Planning	June 21, 2016
Market Roadmap New Candidates Workshop	Market Roadmap	June 28, 2016
MISO Market Symposium	Energy markets inside out	Aug 18-19, 2016
MISO Advisory Committee	Hot Topics discussion - Resource Adequacy	Sep 14, 2016
MISO Interconnection Process Task Force	Storage Interconnection	Aug 11, 2016
MISO Resource Adequacy SubCommittee	Capacity Credit for Storage	Aug 31, 2016

# FERC Storage related activities

- Notice of Information (NOI) - Primary Frequency Response (RM16-6)
  - Essential Reliability Services and Evolving Bulk-Power System
- Review of Generator Interconnection Agreements (RM16-12)
  - See ER16-1211
- Electric Storage Participation in Region (AD16-20)
- Utilization In the Organized Markets of Electric Storage Resources as Transmission Assets Compensated Through Transmission Rates, for Grid Support Services Compensated in Other Ways, and for Multiple Services (AD16-25)

# Contact Information

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  - Minnesota Energy Storage Alliance Steering Committee Member