MISO Update

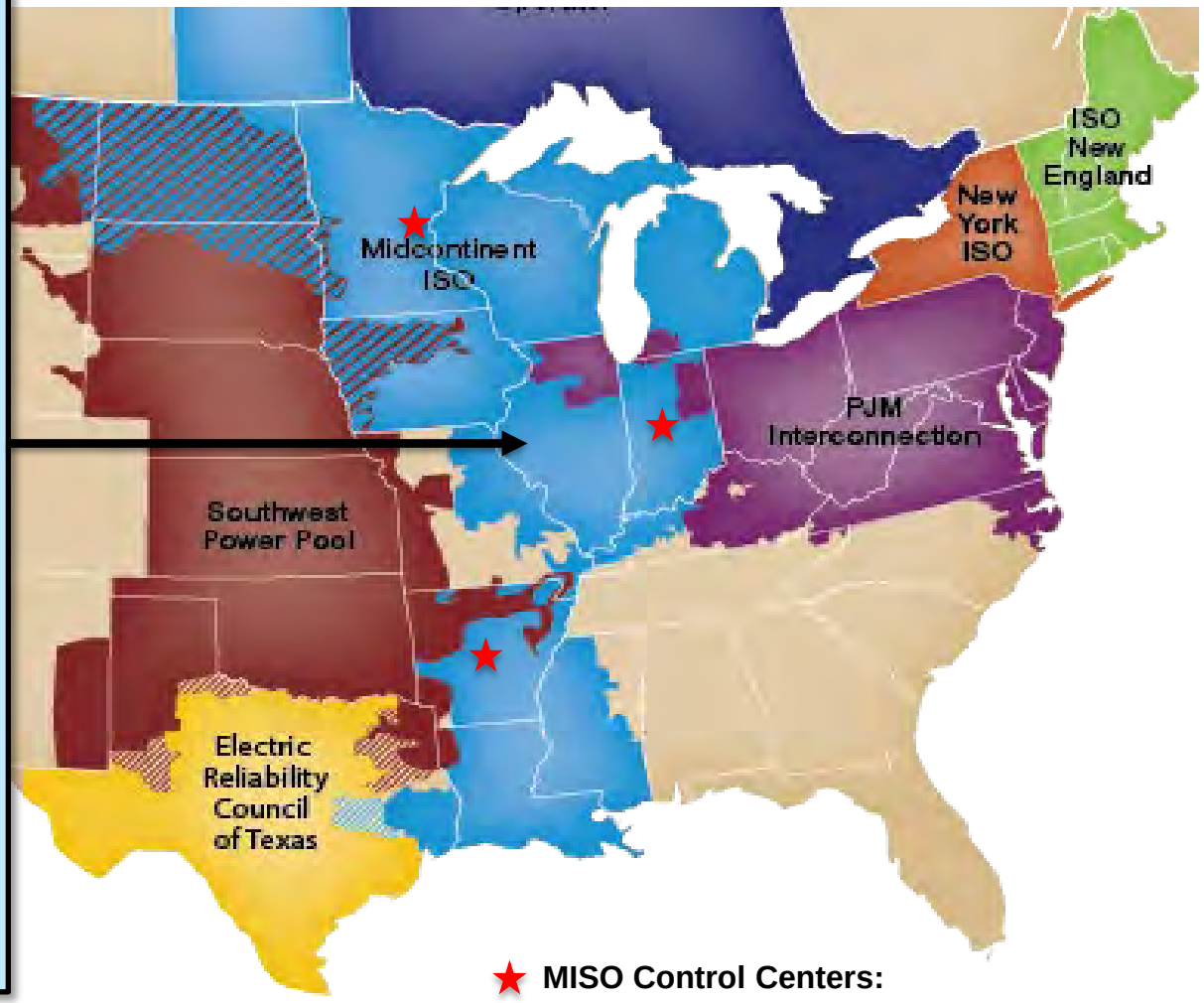
Rural Minnesota Energy Board

April 29, 2022

MISO & neighboring U.S. electric grid operators

MISO
(Midcontinent Independent System Operator)

- 15 states + Manitoba
- 42 million customers
- $25 - 30 billion annual market
- > 6,600 generation units with 175,000 MW of capacity
- 68,500 miles of high voltage transmission lines
- > 190 member utilities
- > 460 market participants



★ **MISO Control Centers: Eagan, Indianapolis (HQ), Little Rock**

What does MISO do?

1. Efficient Wholesale Market Management & Operations to Ensure Reliability

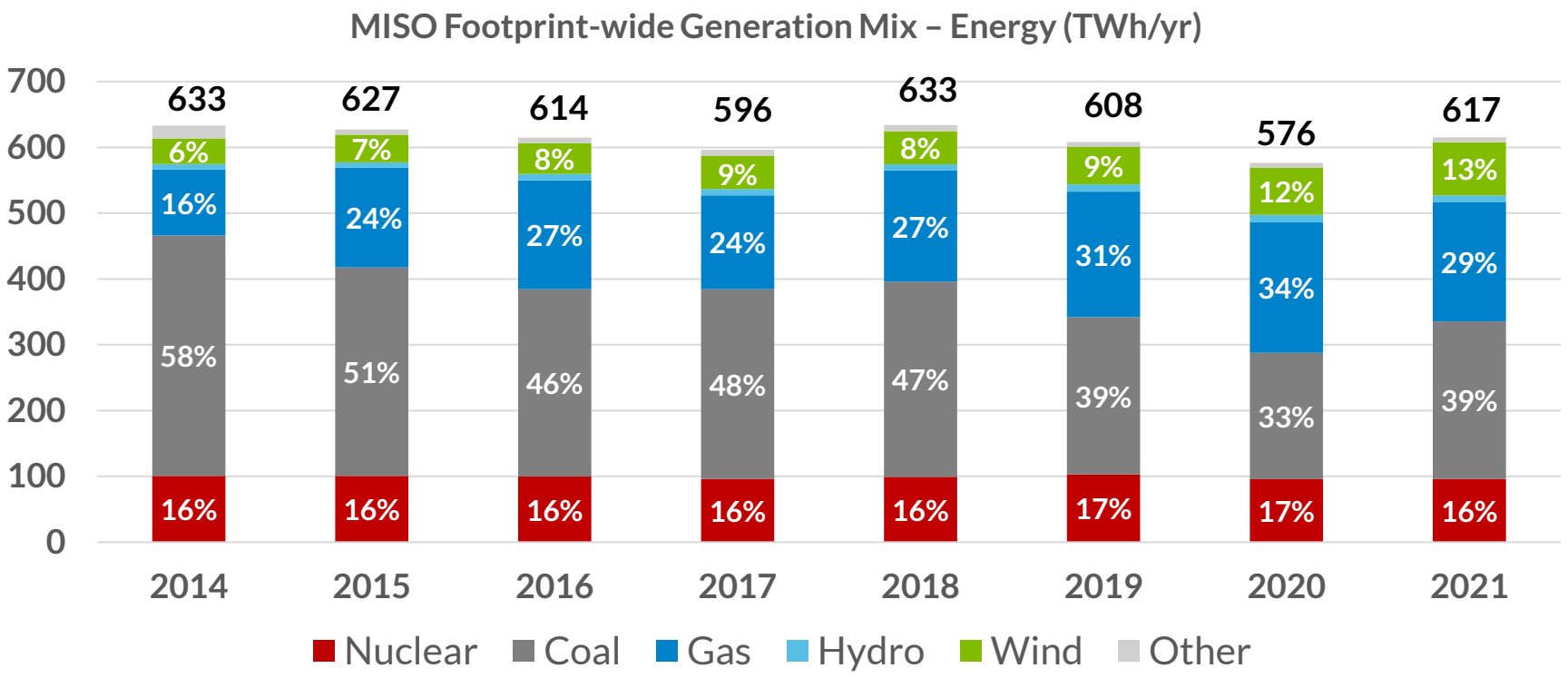
- Conduct day-ahead and real-time energy and operating reserves markets
- Manage least-cost, economic dispatch of generation units
- Monitor and schedule energy transfers on the high voltage transmission system

2. Comprehensive Regional Transmission Planning

- Long-range transmission planning
- New generator interconnection and retirement
- Long-range studies, such as Renewable Integration Impact Assessment (RIIA)

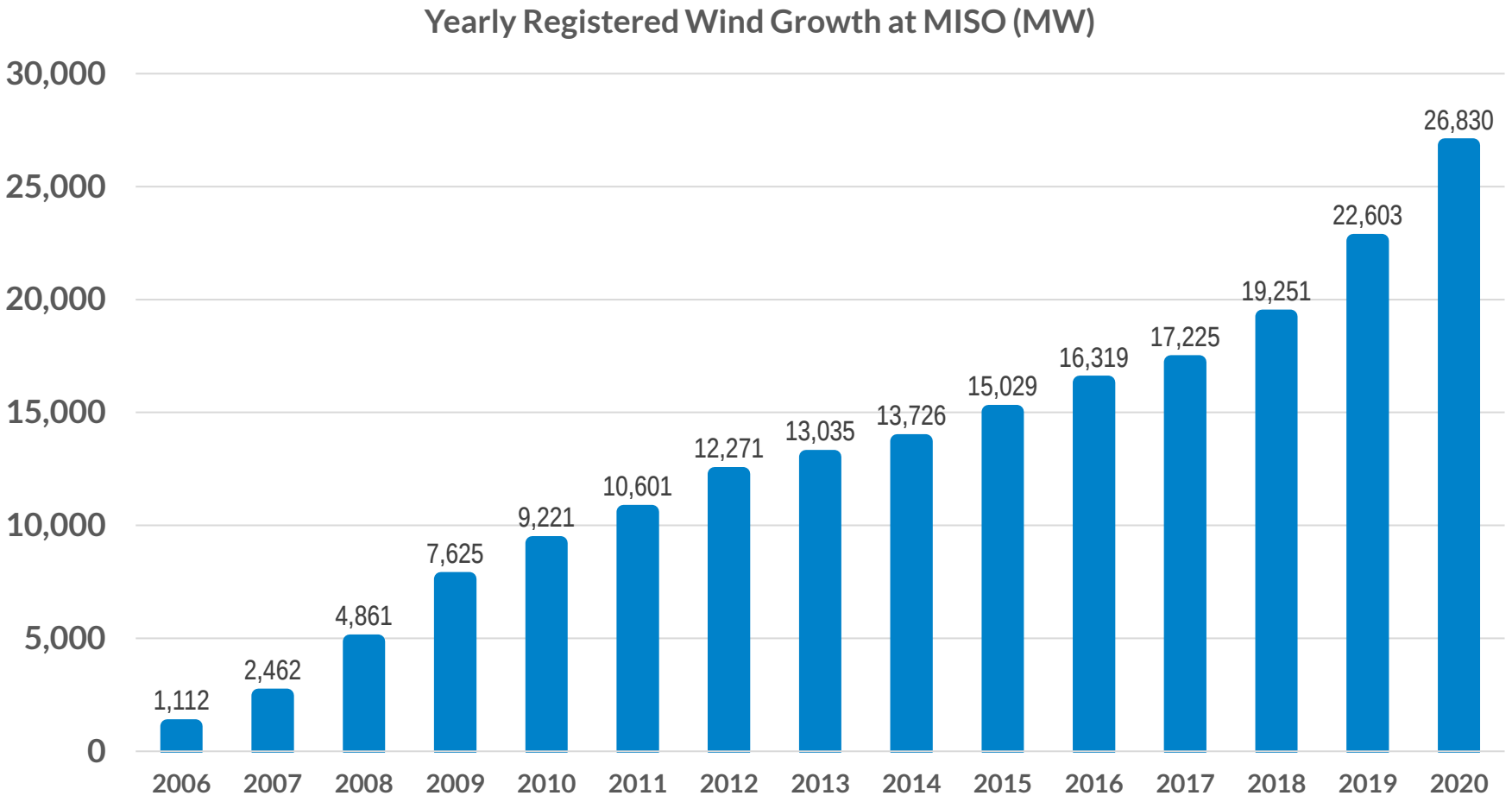
MISO's Vision: Be the most reliable, value-creating RTO

MISO, like the industry, is facing a massive shift in its resource fleet



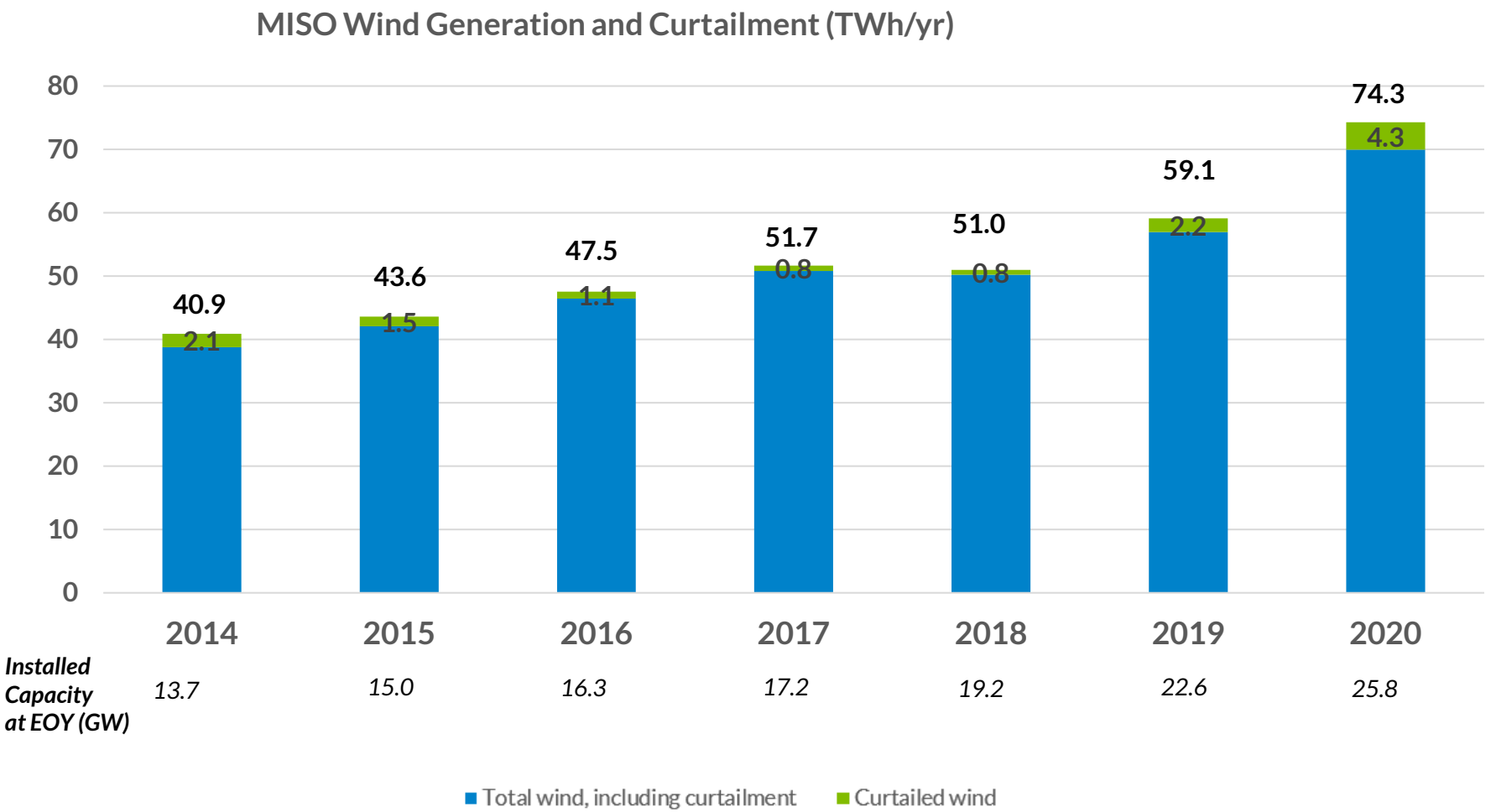
Sources: Historical Generation Fuel Mix (xls); Historical Generation Fuel Mix (xlsx)

MISO-wide wind capacity growth



Source: Resource Integration group, MISO

MISO-wide wind energy generation and curtailment



MISO transmission planning is comprehensive and aligns with the guiding principles of the MISO Board of Directors which incorporate similar principles as those of the OMS

Market access

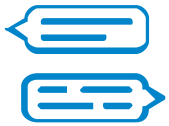
Provide access to electricity at the lowest total electric system cost

Cost allocation

Ensure project costs are commensurate with planned benefits

Planning criteria

Meet policy and transmission owner planning criteria while safeguarding local and regional reliability



Information exchange

Analyze system scenarios and share with policy makers and stakeholders

Policy alignment

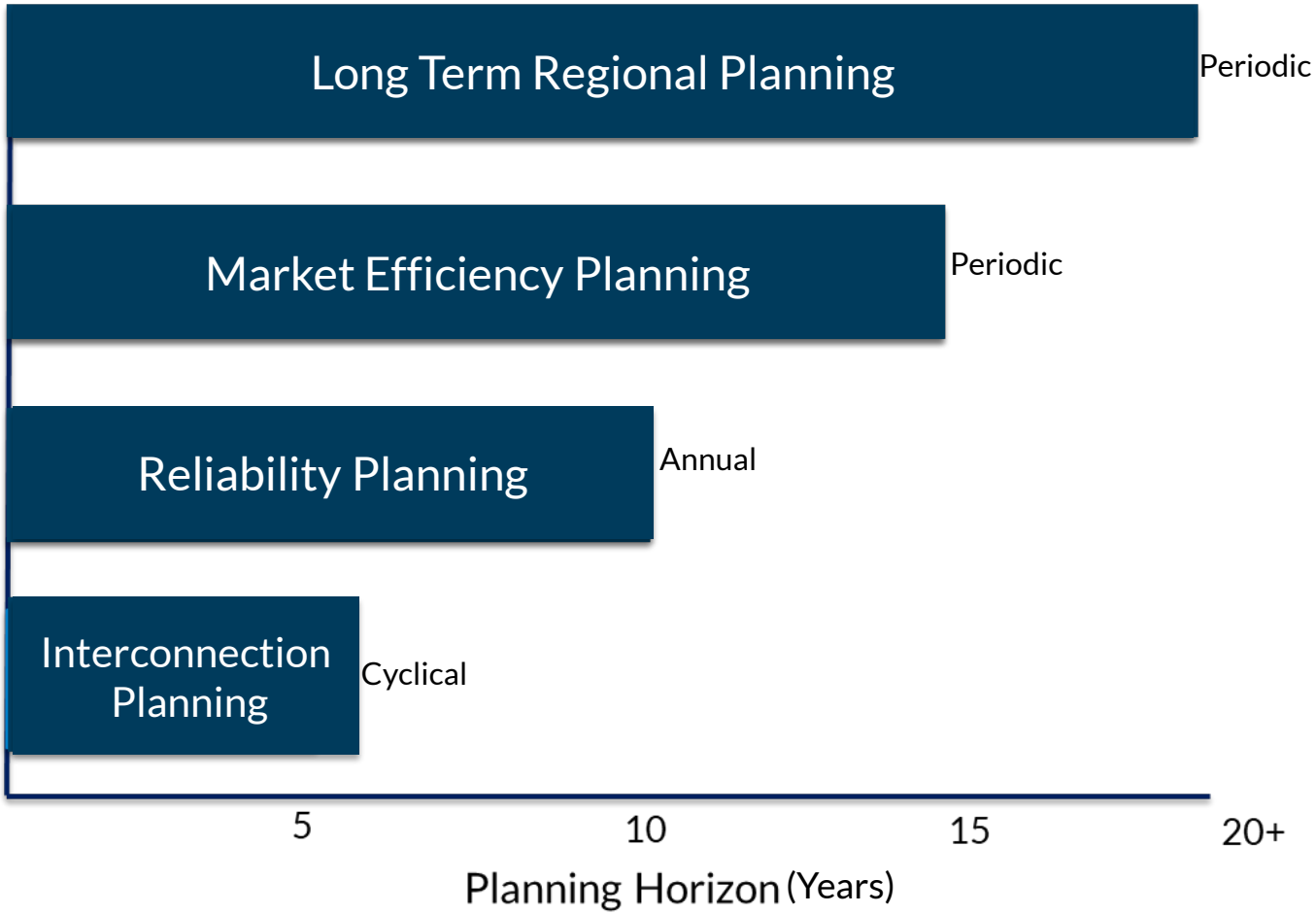
Align planning for changing resources with state and federal policy

Regional coordination

Plan with neighbors to eliminate barriers

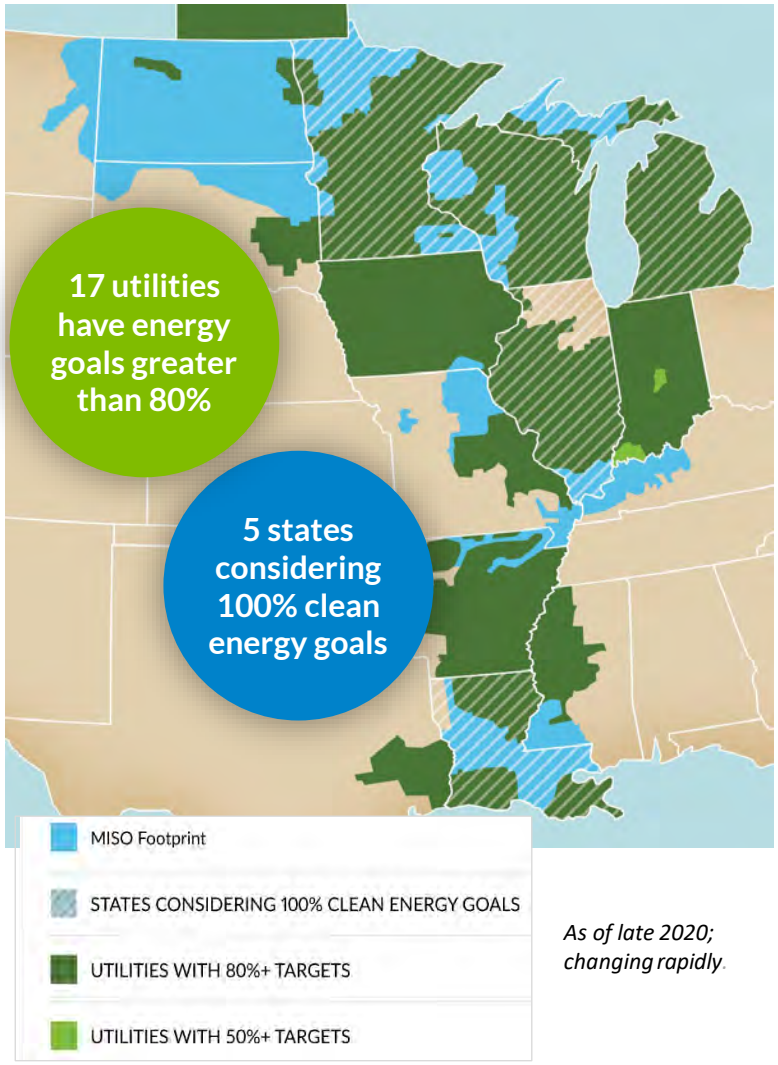
Transmission planning provides a comprehensive approach that covers short and long term needs to address generation additions, ongoing reliability, market efficiency and policy trends

Upgrade needs have different drivers and different planning horizons



MISO's Long Range Transmission Planning (LRTP) uses three "Futures" to incorporate & bookend uncertainty

Future 1	Future 2	Future 3
• The footprint develops in line with 100% of utility IRPs and 85% of utility announcements, state mandates, goals, or preferences. • Emissions decline as an outcome of utility plans. • Load growth consistent with current trends.	• Companies/states meet their goals, mandates and announcements. • Changing federal and state policies support footprint-wide carbon emissions reduction of 60% by 2040. • Energy increases 30% footprint-wide by 2040 driven by electrification	• Changing federal and state policies support footprint-wide carbon emissions reduction of 80% by 2040. • Increased electrification drives a footprint-wide 50% increase in energy by 2040.



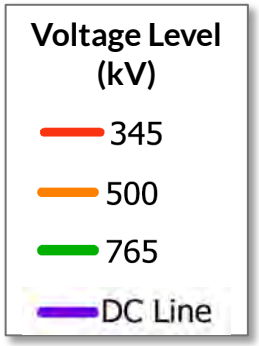
As of late 2020; changing rapidly.

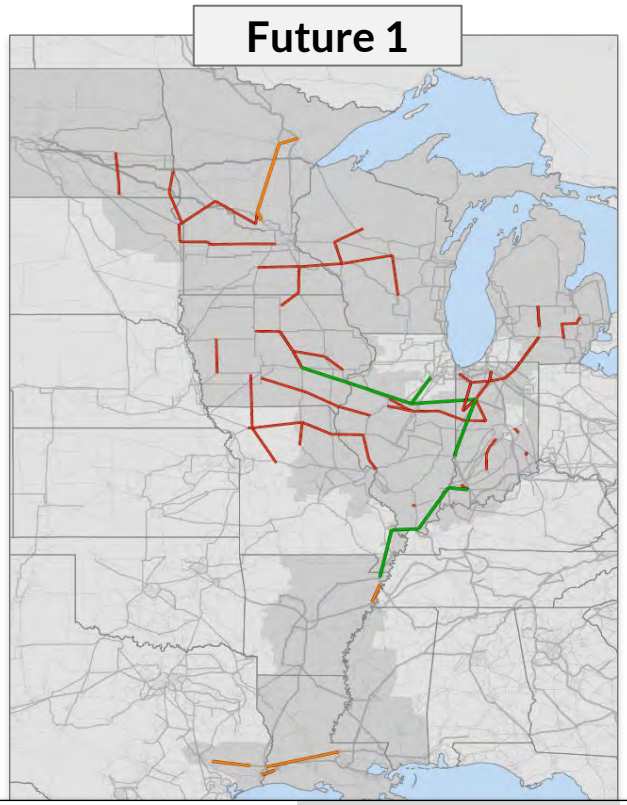
IRP = Integrated Resource Plan

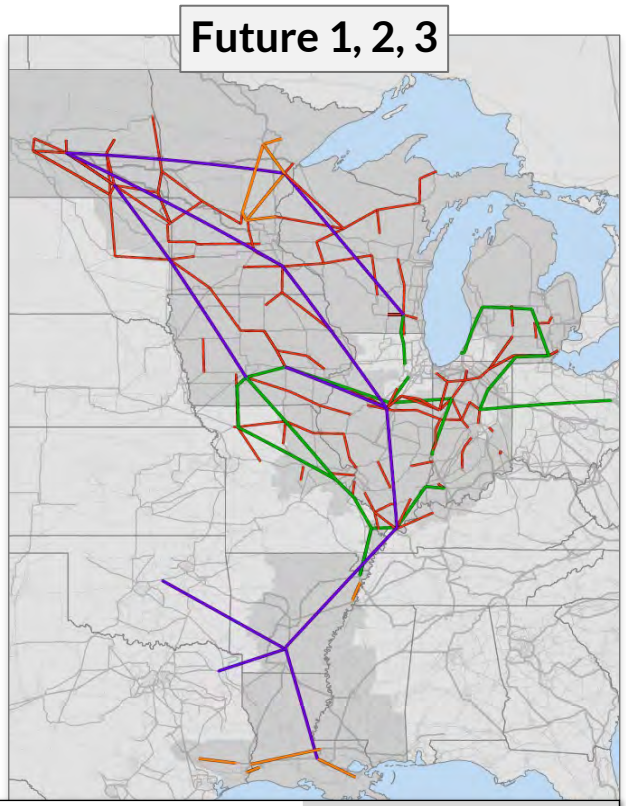
See: MISO Futures Report for details.

LRTP projects will promote regional bulk energy transfer, interzonal support, resource integration and retirements

Indicative 'Roadmaps'



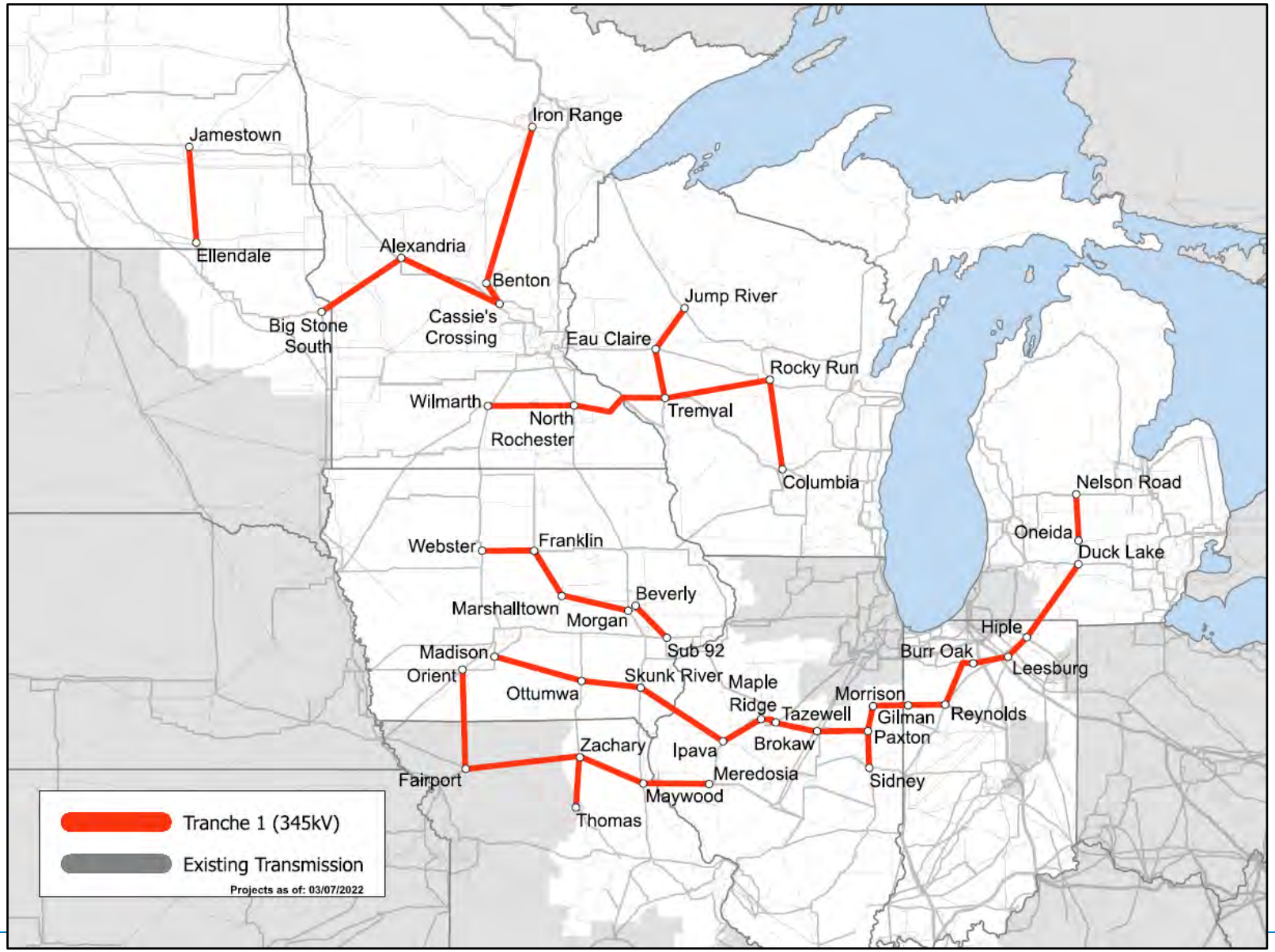




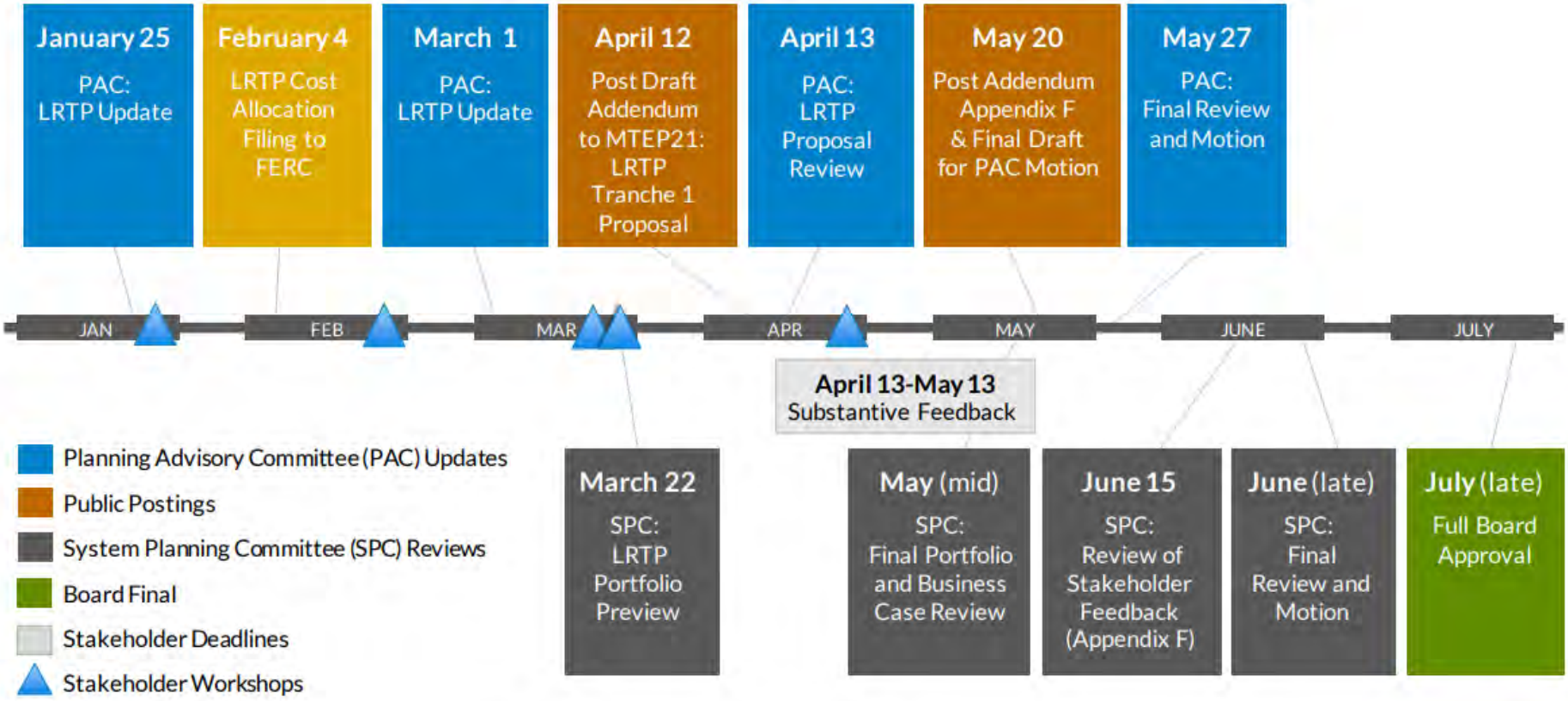
Indicative 'Cost to Achieve'* ($ Billion)	Future 1	Future 1, 2, 3
New Generation/Resources	+/- $ 135 B	+/- $ 430 B
New Transmission Solutions	+/- $ 30 B	+/- $ 100 B
Total New Investment	+/- $ 165 B	+/- $ 530 B

* *Initial 'indicative' investment cost estimates expressed in 2020$s; generation additions thru 2039 are 121 GW in Future 1, 330 GW in Future 3; generation costs from EGEAS modeling; transmission solutions cost from MISO transmission cost estimating tools.*

“Tranche 1” projects are focused in MISO’s Midwest region



MTEP21 LRTP Stakeholder Review Timeline



Reconfiguration for Congestion Cost Task Team Update

Reliability Subcommittee

April 28, 2022

Reconfiguration for Congestion Cost Task Team - Topic History

- Increasing interest among Market Participants (MPs) and the Independent Market Monitor (IMM) to optimize transmission to address congestion
- MISO MPs have contracted a 3rd party vendor to run studies to identify reconfiguration options; submitted requests to MISO and Transmission Owners (TOs)
- MISO performed studies and sent results to the appropriate TOs for evaluation; largely rejected by TOs
  - Reliability/other concerns cited
  - Lacking a process for how to handle these requests

Proposed Process Schematic

STEP 1: A Market Participant identifies a congestion pattern of interest

STEP 2: The Market Participant identifies reconfiguration solutions, analyzes them and submits requests to MISO and the Transmission Operators

Step 3: MISO and the Transmission Operators assess reliability and economic impacts; Generation Operators that are directly affected evaluate their risk exposure

Step 4: MISO and TOP approves or denies the solution

Step 5: MISO and the Transmission Operators implement the solution if real-time conditions allow

Exit

If an economic reconfigure is no longer effective or reliable due to changes in system conditions, or fails one of the initial screening criteria, MISO and the TOP will exit the congestion cost reconfiguration.

TOP = Transmission Operator

Questions?

Extra slides

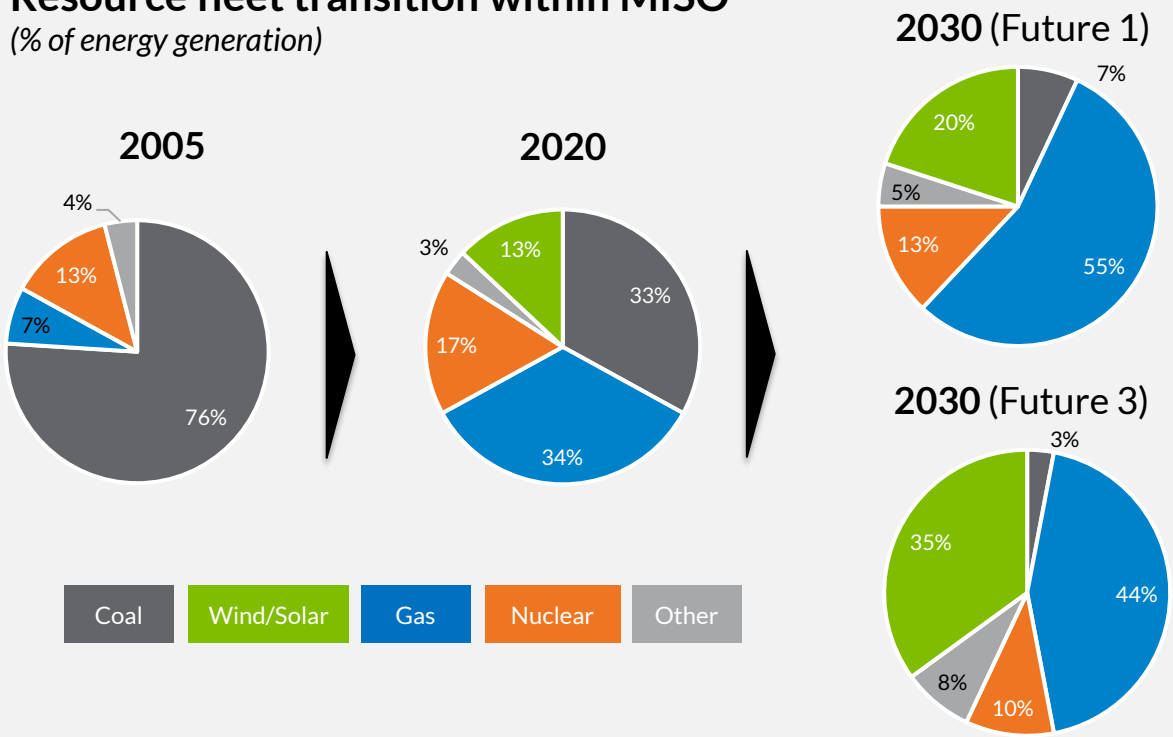
MISO's role is concentrated in a few key areas

What We Do	Implications
Provide independent transmission system access	• Equal and non-discriminatory access • Compliance with FERC requirements • Eliminate transmission rate pancaking
Deliver improved reliability coordination through efficient market operations	• Improved regional coordination • Enhanced system reliability • Independent lowest cost unit commitment, dispatch, and congestion management
Coordinate regional planning	• Integrated system planning • Broader incorporation of renewables • Balance transmission and generation tradeoffs
Provide platform for wholesale energy markets	• Encourage prudent infrastructure investments • Facilitation of regulatory initiatives • Market price/value discovery

MISO's actions as part of the Reliability Imperative address emerging needs on the system as member resource fleets evolve

Resource fleet transition within MISO

(% of energy generation)



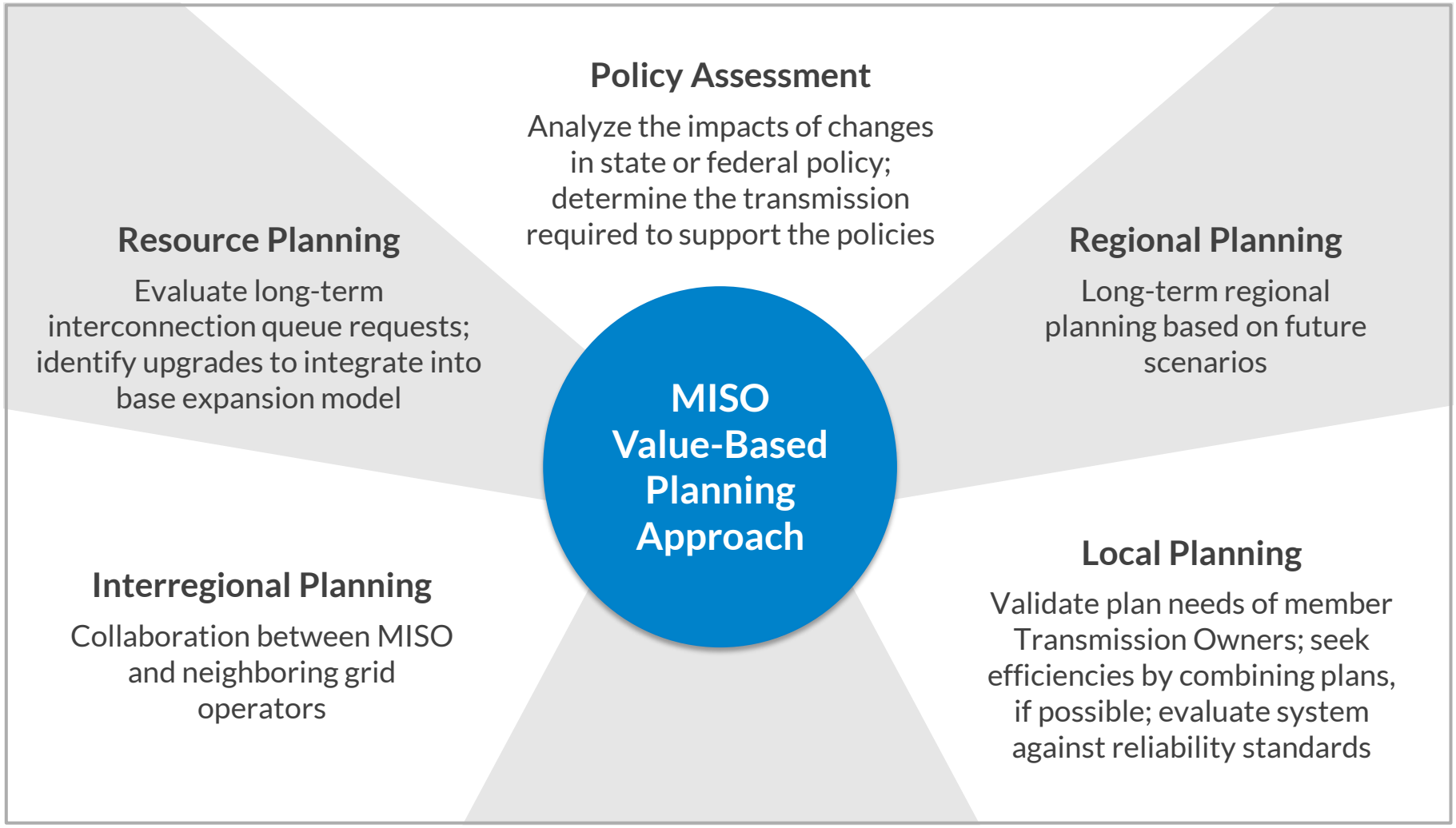
Trends:

- Accelerating retirement of traditional resources
- Increasing customer demand for renewables (~140 GW in interconnection queue, predominately solar)
- More decentralization (distributed resources) and electrification
- Increasing extreme events …

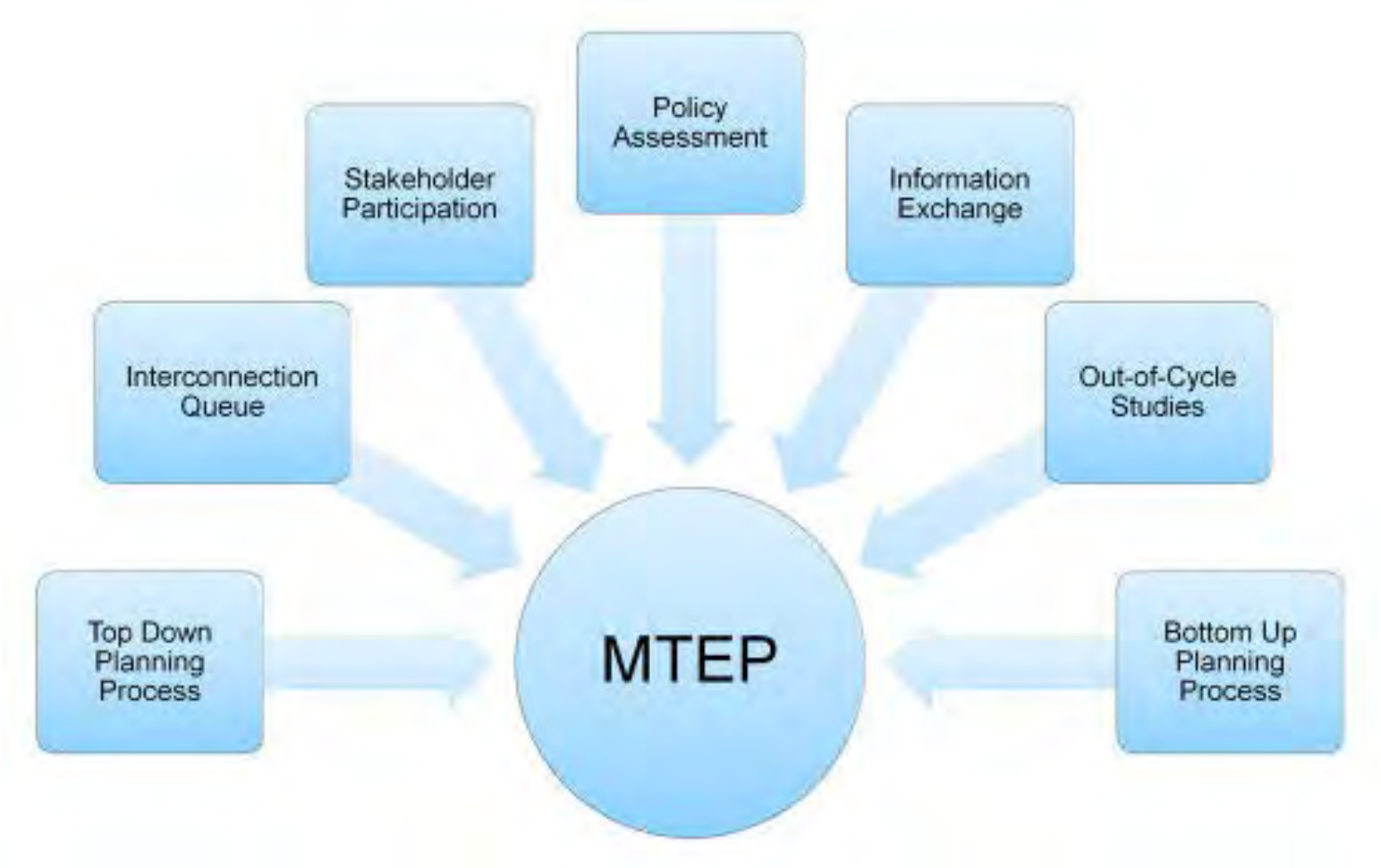
Long Range Transmission Planning (LRTP) is a key pillar of MISO's response to the region's Reliability Imperative

Long Range Transmission Planning

MISO's planning process ensures local needs are integrated with regional requirements

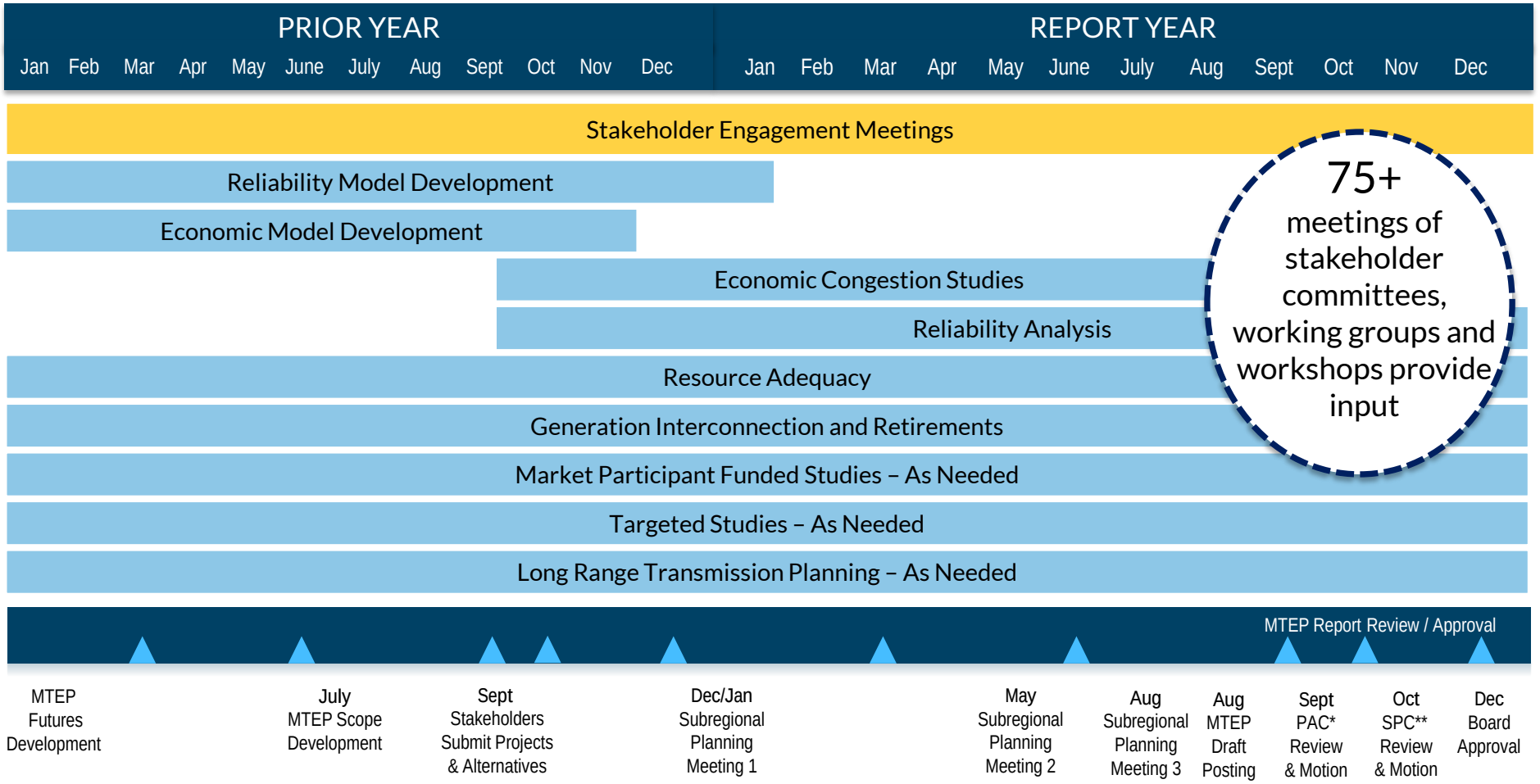


MISO Transmission Expansion Plan



MTEP is developed in overlapping cycles and delivered annually

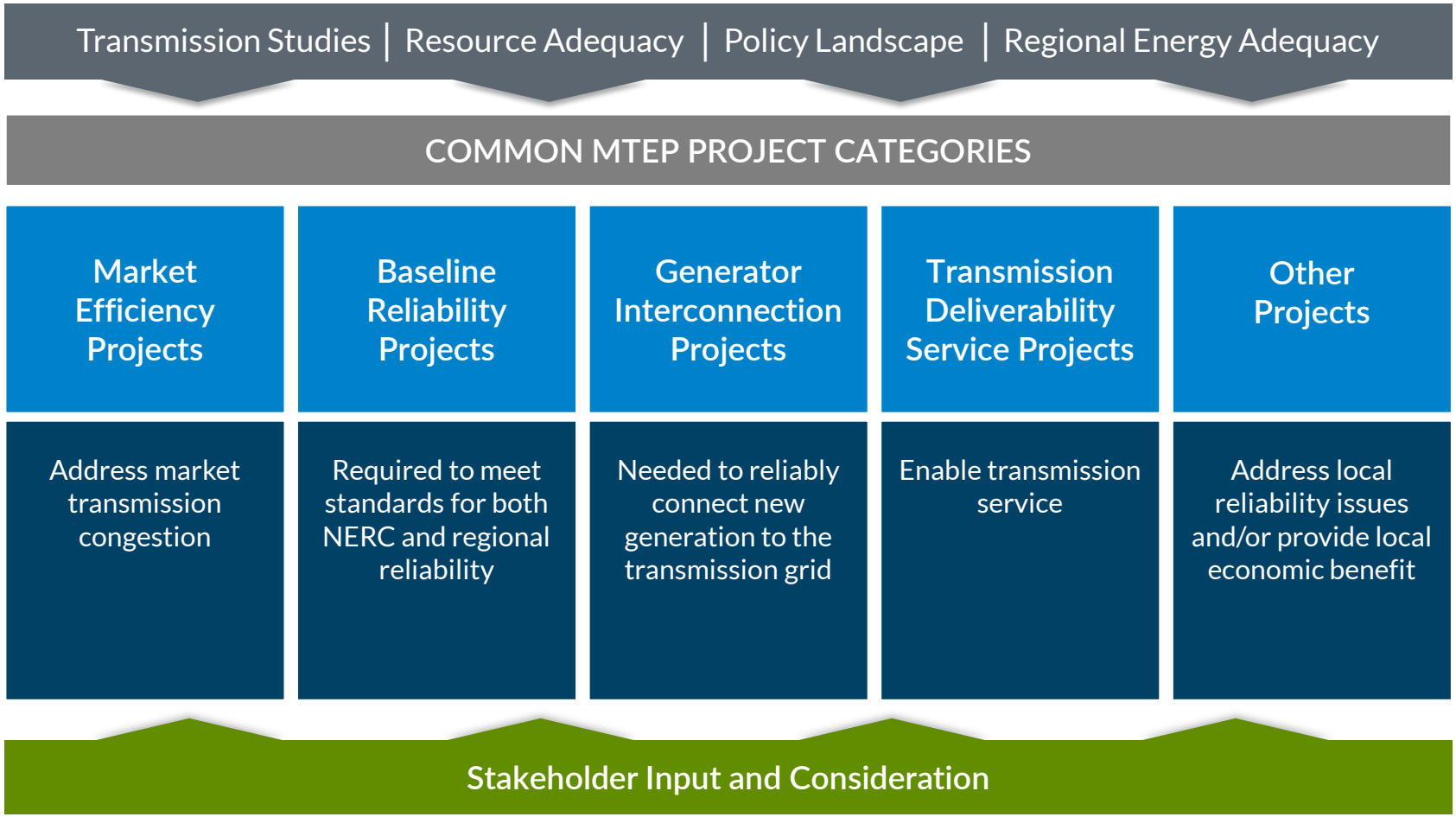
Typical MTEP Cycle



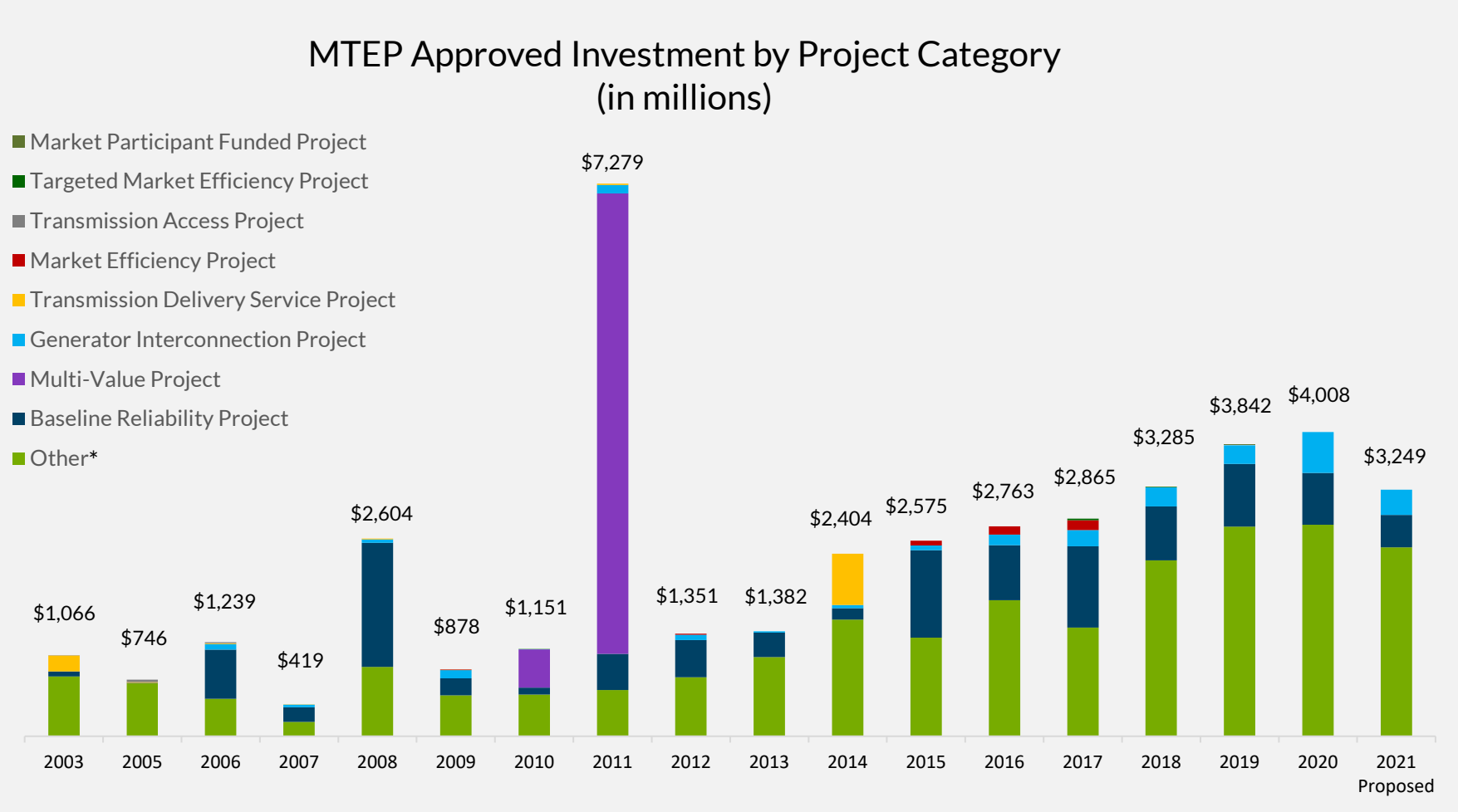
Board Meetings

*Planning Advisory Committee; **System Planning Committee

Projects approved for MTEP are listed in Appendix A of the report and most typically consist of these project types



In December, the MISO Board approved 367 new projects totaling over $3 billion in MTEP21



*Other = Projects based on local needs including reliability, economics, equipment age and condition, environmental, etc. Numbers provided are as approved by the Board of Directors (2021 pending approval).

Certain conditions must be satisfied to implement a transmission plan

Aligned Interests

Consensus on transmission required to address the footprint's collective needs

Robust Business Case

Include an analysis of benefits and costs for each project

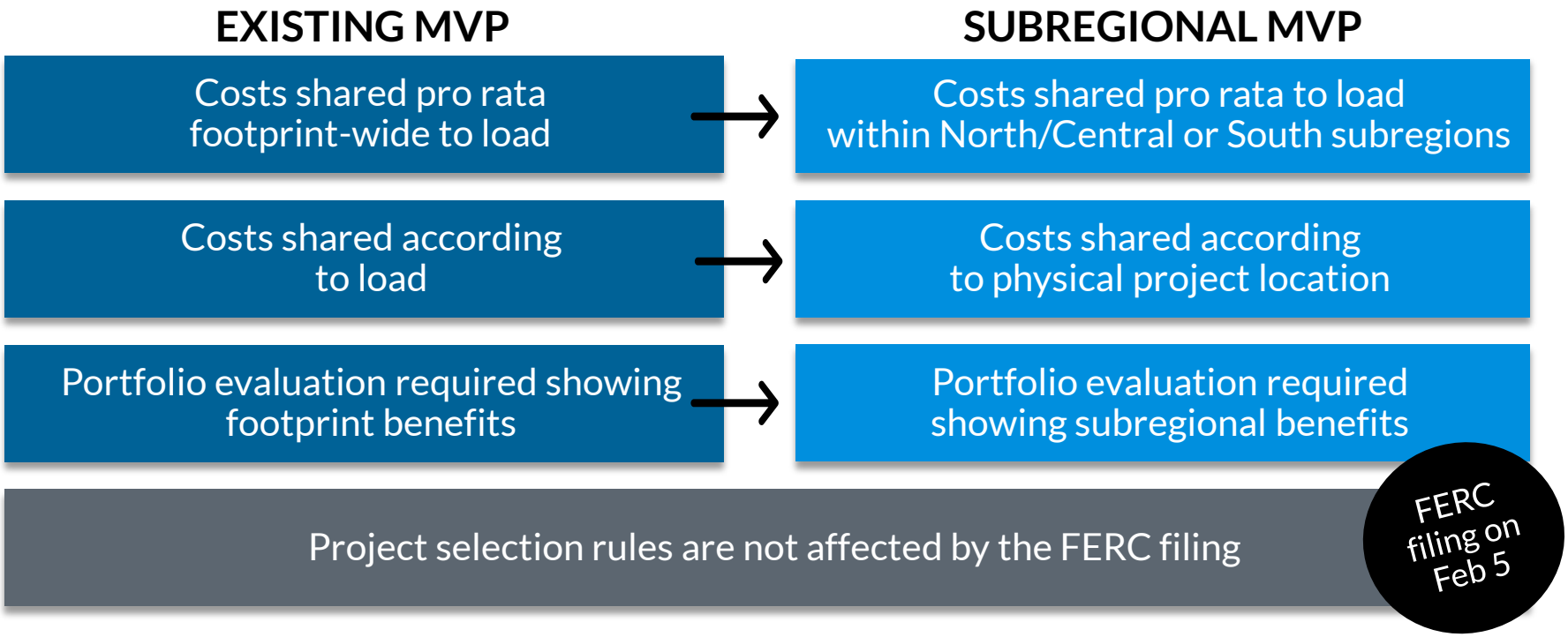
Cost Allocation

Assign cost roughly commensurate with benefits

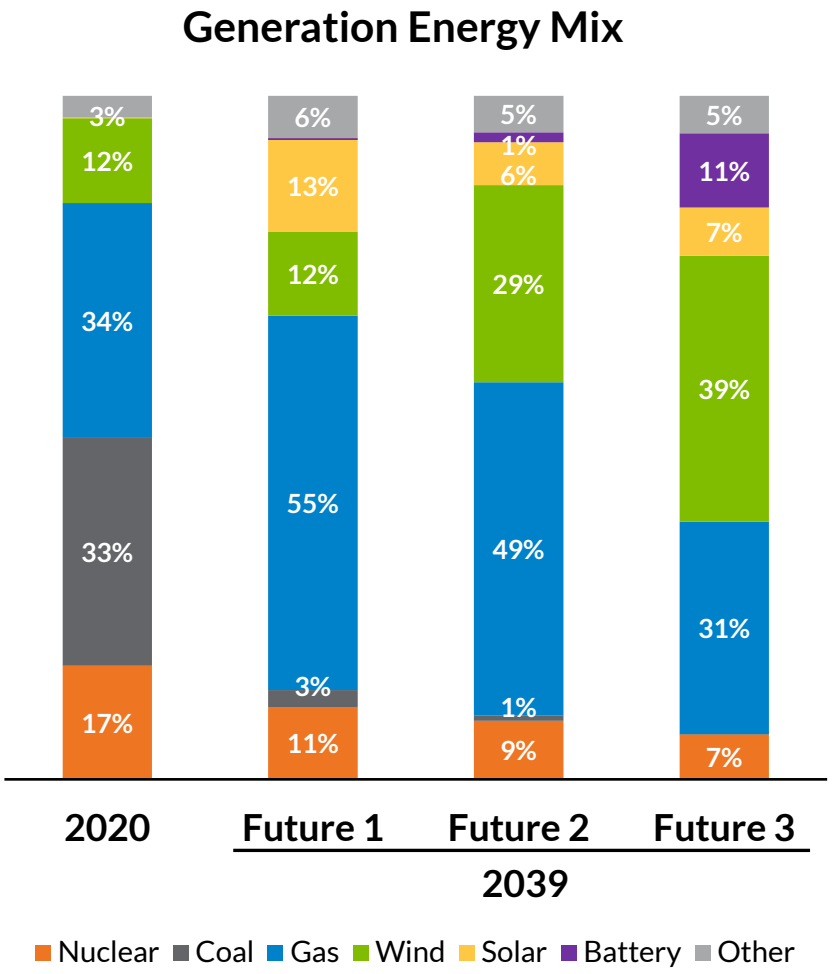
Cost Recovery

Reduce financial risk with recovery mechanisms

Cost Allocation uses the Multi-Value Project (MVP) approach based on subregional differences to ensure a roughly commensurate 'beneficiaries pay' cost allocation



Future scenarios incorporate and build upon member plans to inform the resource transition and changing demand patterns

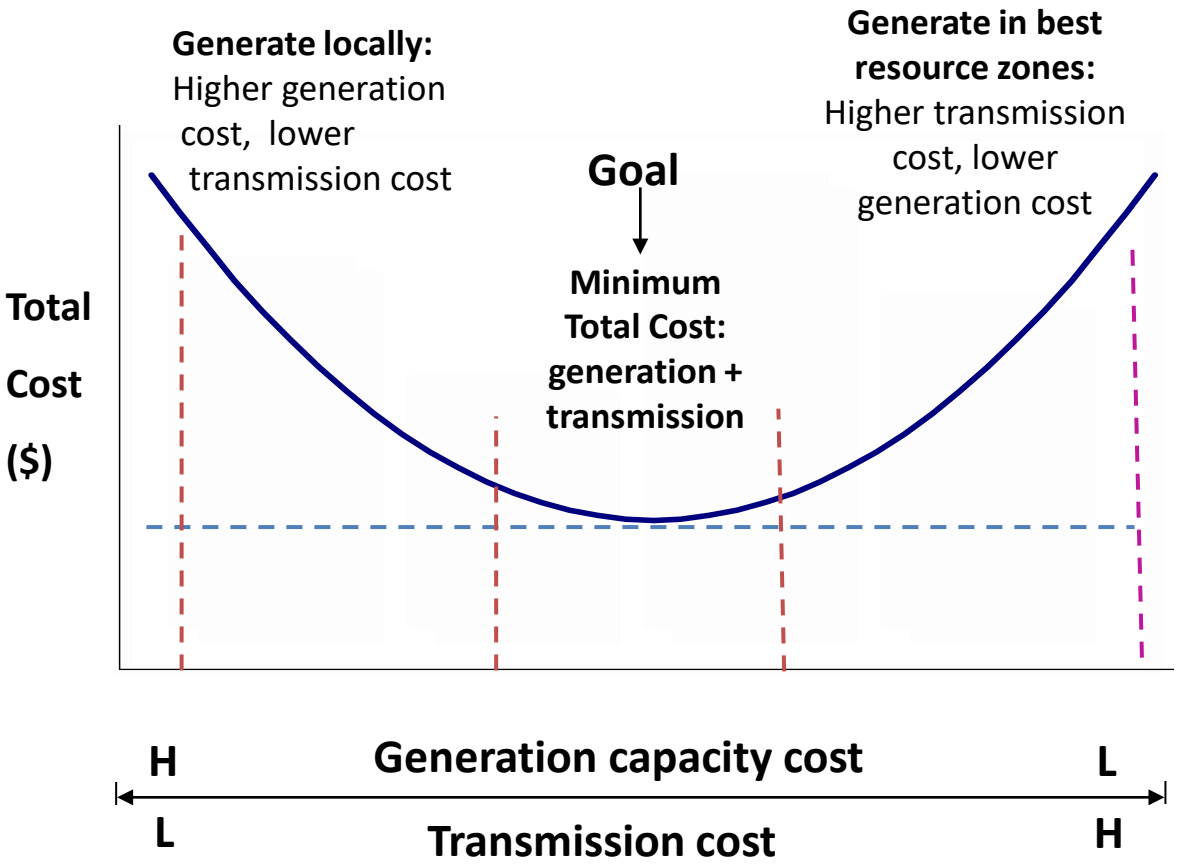


By 2039…	Future 1	Future 2	Future 3
Additions	121 GW	170 GW	306 GW
Retirements	77 GW	80 GW	112 GW
Peak Load	136 GW	148 GW	164 GW
Emissions*	↓ 63%	↓ 65%	↓ 81%

* Resulting emission reductions based upon 2005 levels

See: MISO Futures Report for details.

MISO plans transmission, not generation, but minimizing total costs requires balancing both generation and transmission investment



MISO's long range transmission planning process is focused on minimizing the total cost of delivered power to consumers – of energy, capacity and transmission – to meet a given objective

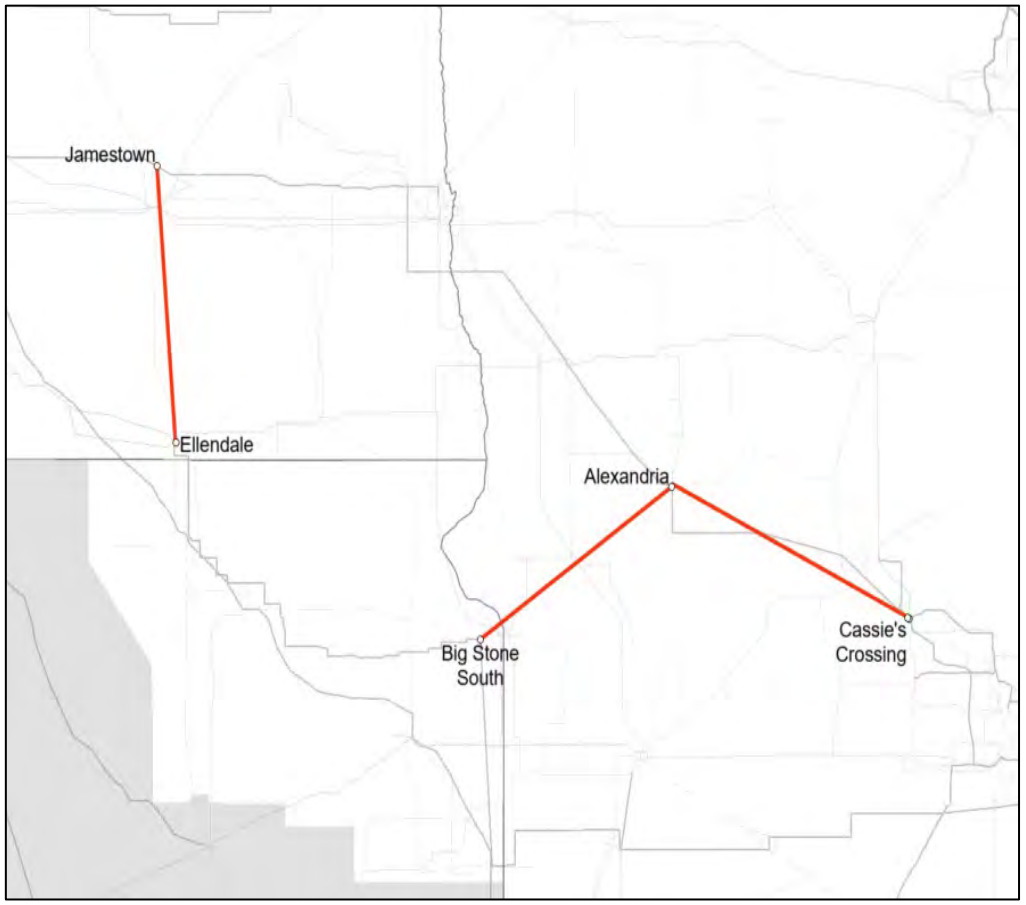
MISO Currently Preferred LRTP Solution

Jamestown – Ellendale & Big Stone South – Alexandria – Cassie's Crossing

- Project reduces thermal overloads on 230kV system around Wahpeton to <100% and relieves congestion
- Ties two otherwise disjoint 345 systems together

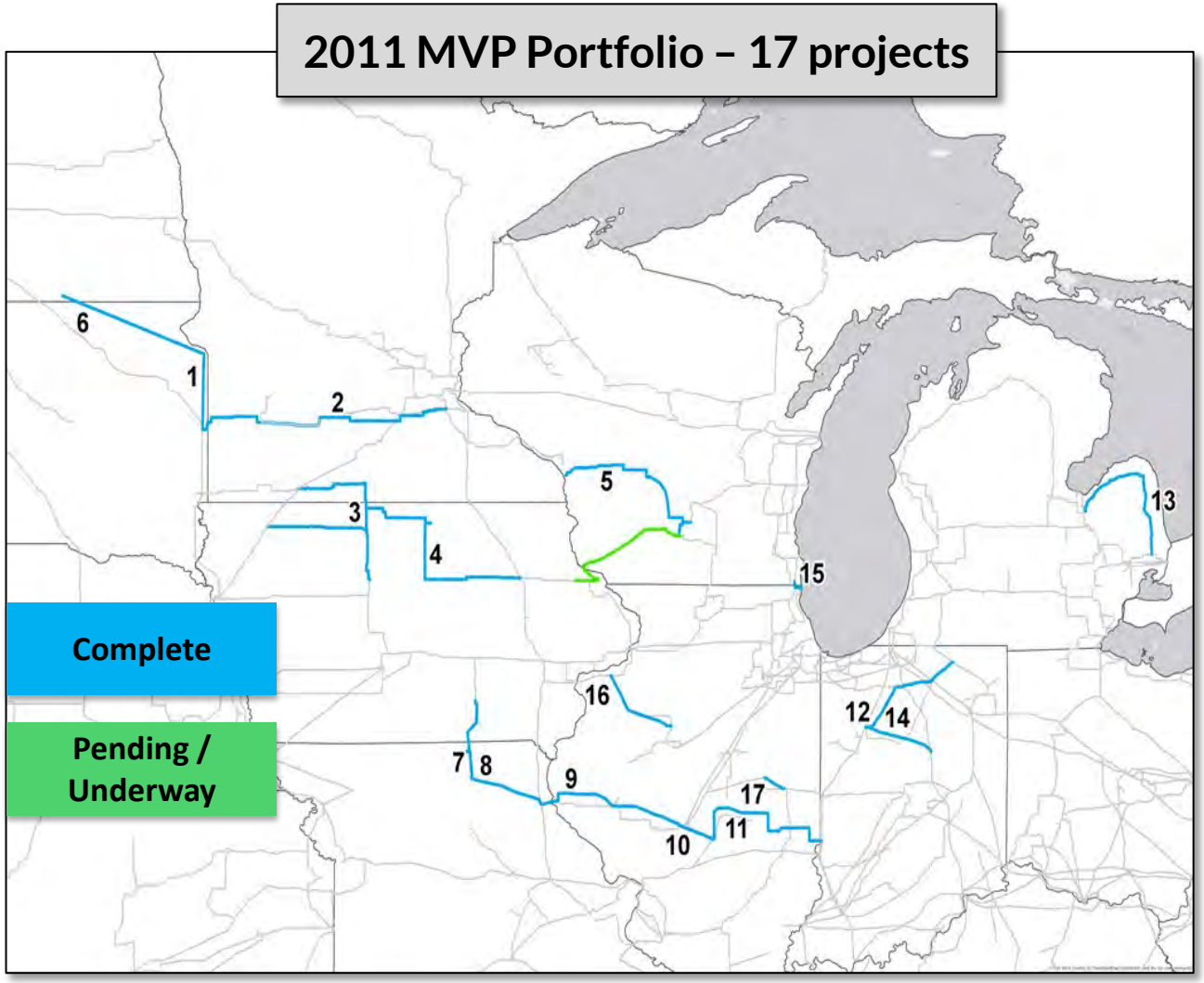
Alexandria has been identified as a preferred tap point for the 345kV section coming from BSS

- Reduces congestion on 230kV system in the BSS area
- Provides a low impedance path north towards Fargo
- Alexandria – Cassie's Crossing reduces thermal loading on 115kV system at Alexandria due to P1 along CapX line
- Tapping at Alexandria provides slight voltage improvements for the area in reliability studies



Work-in-Progress: For discussion Purposes Only

MISO's Multi-Value Project (MVP) portfolio illustrated regional cooperation; today's challenges are even greater…



- Began studies in 2008
- Approved by MISO Board in 2011; current estimated portfolio cost of $6.6 billion
- 16 projects complete; 1 still in process
- Projected to enable:
  - 50 million MWh of renewable energy per year to meet state goals and mandates
  - $7 – $39 billion in net benefits
- New capacity is already fully subscribed

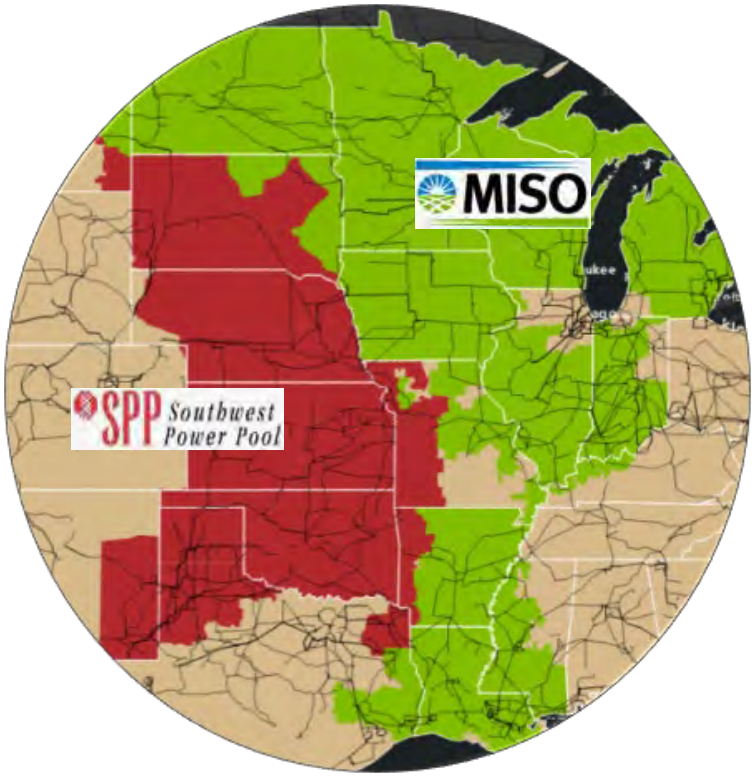
Links: MISO MVP Business Cases; MVP History/Lessons Learned

MISO-SPP Joint Targeted Interconnection Queue Study

JTIQ Executive Summary

- The SPP-MISO Joint Targeted Interconnection Queue (JTIQ) Study aims to identify projects required for the interconnection of low-cost resources that benefit the MISO and SPP regions
- MISO and SPP conducted studies to identify common constraints and potential solutions, with significant stakeholder engagement
- A portfolio of projects to optimize the transmission for interconnection across the seams is being refined and a cost allocation methodology is advancing

The SPP-MISO JTIQ Study focuses on optimizing transmission needed for interconnection across the seams and for the evolving resource mix

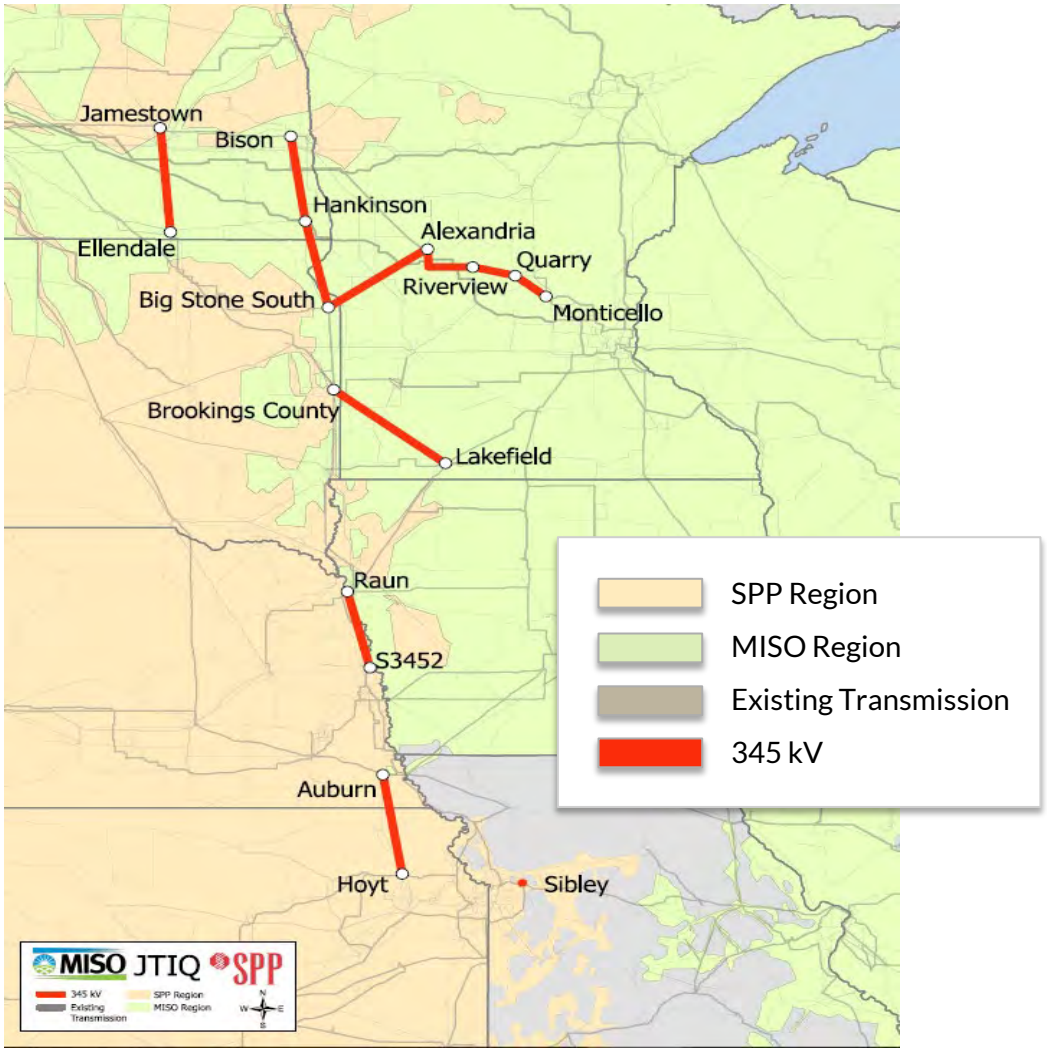


- SPP and MISO are experiencing similar resource mix shifts
- The transmission system is at capacity along the SPP-MISO seam
- Upgrades are too costly for small groups of interconnection customers, contributing to churn in the queue
- The study accomplishes what FERC Affected System Studies were meant to achieve

SPP and MISO are finalizing a portfolio of projects to mitigate most constraints along multiple MISO-SPP state boundaries

This portfolio provides a range of benefits:

- **Improves reliability** and mitigates existing constraints
- **Increase interregional transfer capability,** and
- **Provides economic Adjusted Production Cost benefits**

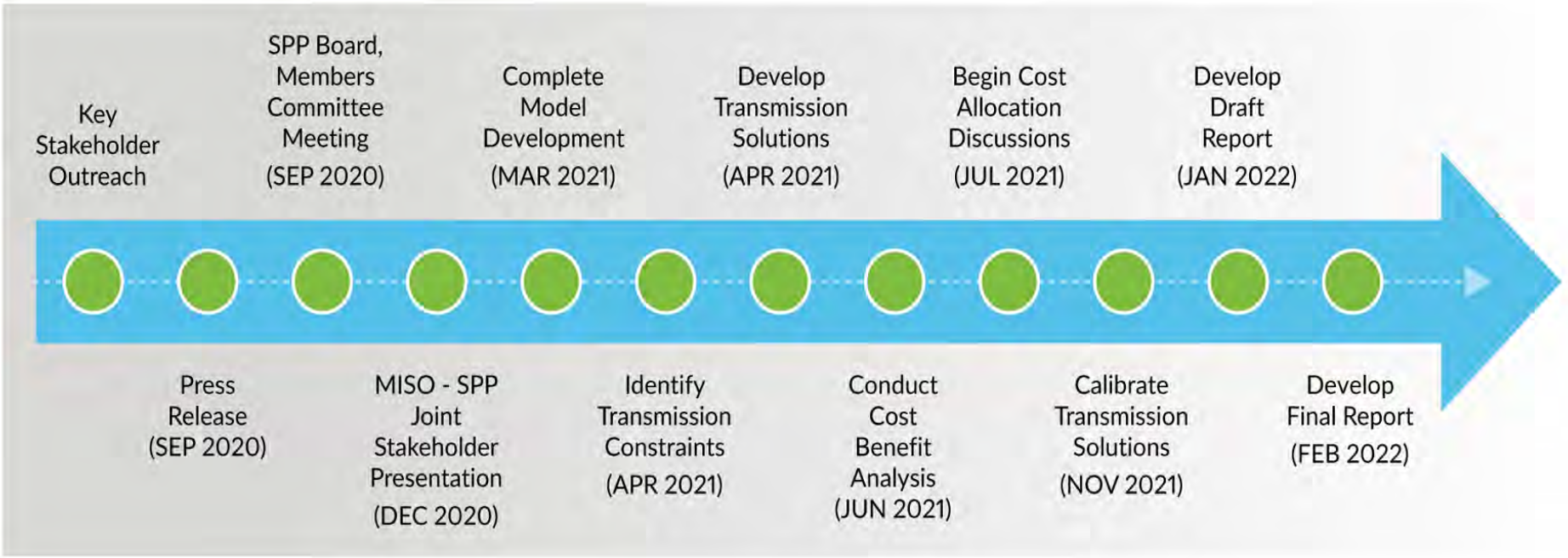


Next steps

- Continue stakeholder engagement through cost allocation workshops
- Refine the cost allocation framework and submit FERC filing
- Seek Board approval after FERC approval

Q1 - 2022	Q2- 2022	Q3 - 2022	Q4 - 2022	Q1 - 2023
Report posted after stakeholder feedback received		MISO stakeholder (RECB) meeting	FERC filing	Board approval
	Cost allocation meetings Apr, May, Jun	Cost allocation meetings July, August		

Study Timeline



The JTIQ Portfolio will enable the ability to interconnect new capacity along the SPP-MISO seam

- JTIQ Portfolio could enable new generation capacity along the combined MISO and SPP seam
  - MISO Power flow models estimated 28 GW of combined new enablement
  - SPP Power flow models estimated 53 GW of combined new enablement
- Capacity Enabled Calculations include
  - Generation enabled by constraints mitigated by JTIQ projects in both RTOs
  - Additional Generation at existing resources by utilizing unused capacity on mitigated constraints and JTIQ portfolio projects
- SPP performed analysis on the impact of including the JTIQ portfolio in a previous SPP Affected System Study for a MISO DPP Cycle and a SPP DISIS Cycle
  - JTIQ Portfolio alleviates 60% of the constraints previously identified in AFS Study
  - JTIQ Portfolio alleviates 44% of the constraints previously identified in DISIS study
  - No adverse impacts observed (no additional constraints) in DISIS or DPP Affected System study in the region of interest

Next steps

- Finalize the report end of February 2022
- Continue stakeholder engagement through future cost allocation workshops beginning Q1 of 2022
- Seek Board approval after FERC approval of cost allocation

Additional Pages from

Reconfiguration for Congestion Cost Task Team Update

Reliability Subcommittee

April 28, 2022

Purpose & Key Takeaways

Purpose: To update the RSC on progress from the RCCTT.

Key Takeaways:

- RCCTT has met monthly since January.
- Draft proposal has been created and is being reviewed by the task team.
- MISO continues to work to identify a process for performing market analysis on the requests.

Topic History

- Increasing interest among MPs and IMM to optimize transmission to address congestion
- MISO MPs have contracted a 3rd party vendor to run studies to identify reconfiguration options; submitted requests to MISO and TOs
- MISO performed studies and sent results to the appropriate TOs for evaluation; largely rejected by TOs
  - Reliability/other concerns cited
  - Lacking a process for how to handle these requests

Review of proposed process

- A coalition of interested stakeholders submitted a proposal outlining a process to manage these requests, the RCCTT is using this as a template for the draft process.
- Two possible paths for reconfiguration solutions
  - Coming into MISO and the TOPs (Ad-Hoc)
  - MISO is also considering a monthly list of top economically impacted constraints
- All requests must be submitted to MISO through Client Relations. Requests may also simultaneously be submitted to the TOPs
- Ad-Hoc Process will have 4 phases; Initial Screening, Evaluation, Implementation and Exit

Initial Screening Phase (1 of 3)

- The process will outline what needs to accompany a request:
  - Company submitting request, including on behalf if applicable
  - Target constraint/s for relief
  - Operational action specification
  - Conditions under which the actions are requested for implementation
  - Requested duration
  - Expected flow relief on target constraint/s
  - Any potential risks identified
  - Load radialized by the requested actions, if any
  - Generation radialized by the requested actions, if any
  - Power flow cases used in the assessment
  - Expected cost savings
  - Notes

Initial Screening Phase (2 of 3)

- The process will outline conditions that requests must pass:
  - It must not result in changing the definition of a M2M FG with SPP into including a generation facility within the contingency.*
  - It must not result in radial load.
  - If it does not resolve the constraint completely, it must at a minimum provide 15% of relief on the congestion it is meant to relieve.
  - Any impacts to stability conditions, including but not limited to those addressed in operating guides, must be resolved prior to evaluation by MISO.
  - It cannot result in delaying or cancelling a planned outage.

* MISO and SPP are discussing options

Initial Screening Phase (3 of 3)

- The process will outline conditions that requests must pass:
  - Units in testing cannot be considered for this process.
  - The reconfiguration must not be in an area where the following conditions/statuses are true:
    - Conservative Operations
    - Extreme weather events
    - LTE/TSE
  - Any switching must be accomplished through remote switching.
  - Any limits within GIAs must be respected.
  - If the request had previously been studied by MISO or the TOP, with no major changes in system configuration, and failed evaluation.

Evaluation Phase (1 of 4)

- The request(s) will be analyzed by each of the relevant TOPs for operational feasibility and any reliability impacts, by GOPs for any specific operational risk imposed on power plants, and by MISO for regional reliability impacts and market impacts.
- The assessment criteria may vary depending on the TOP, to account for TOP practices and local system characteristics.
- In any case, the assessments and criteria will be consistent with, and no less stringent than, the assessments conducted by the same organization when implementing the same actions for reasons other than the request (e.g., reconfiguration for Reliability purposes).

Evaluation Phase (2 of 4)

- The result of each reliability assessment by each TOP shall be either “acceptable” or “unacceptable” reliability risk.
- Upon a reliability assessment of “acceptable” by all TOPs and MISO, the request may proceed to the market assessment.
- Upon an “unacceptable” reliability assessment by any one TOP or MISO, the request is immediately returned to the submitter.
- In such case, the organization deeming the request as posing an unacceptable reliability risk shall provide details about the results of the evaluation to justify the decision.

Evaluation Phase (4 of 4)

- The Market evaluation will consist of studying the system with and without the reconfiguration implemented.
- Reconfiguration may not be approved if significant adverse market impacts are identified.
- The general principle of approving the reconfiguration from a market impact perspective is:
  - Market-based simulation agrees with MISO/TO proposed study on relief of congestion (e.g reduction of shadow price on target constraints and/or reduction of LMP on target nodes), without significantly increasing congestions in neighboring areas.
  - The proposed reconfiguration will not result in system-wide market efficiency deterioration and will not significantly affect financial market efficiency adversely.
  - Participants in the MISO market (FTR, DA or RT) will not be significantly and adversely impacted by the proposed reconfiguration.

Implementation Phase

- Once a request has been deemed “acceptable” through the evaluation phase by all required parties, the reconfiguration must be documented for the real-time Operators (MISO RC and TOPs) for operational awareness.
- MISO Operations will communicate internally to ensure all required teams are aware
- MISO Operations and the TOP will follow normal operating procedures to study and implement reconfigurations.
- The TOP shall enter in a CROW ticket.
- Nothing in this proposed process would limit the ability of MISO and TOPs to take appropriate actions to ensure reliable operations.

Exit Phase

- If an economic reconfigure is no longer effective or reliable due to changes in system conditions, or fails one of the initial screening criteria, MISO and the TOP will exit the congestion cost reconfiguration.
- MISO RC along with the corresponding TOP will study putting the equipment in service to ensure this does not adversely impact the system.
- If all parties agree it is reliable to exit, they will coordinate these actions as they currently do for other similar situations, (e.g. Outage returning from service or a reliability-only based reconfiguration.)

Next Steps

- RCCTT to finish a near-final draft
- MISO will continue work on the market analysis process.
- Report back to RSC for review and comments.

Questions?

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