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U. S. SPOT MARKET REGULATION

NARUC ENERGY REGULATORY PARTNERSHIP WITH
GEORGIAN NATIONAL ENERGY AND WATER SUPPLY
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Kevin Vannoy, Director Forward Operations Planning,
Midcontinent Independent System Operator (MISO)

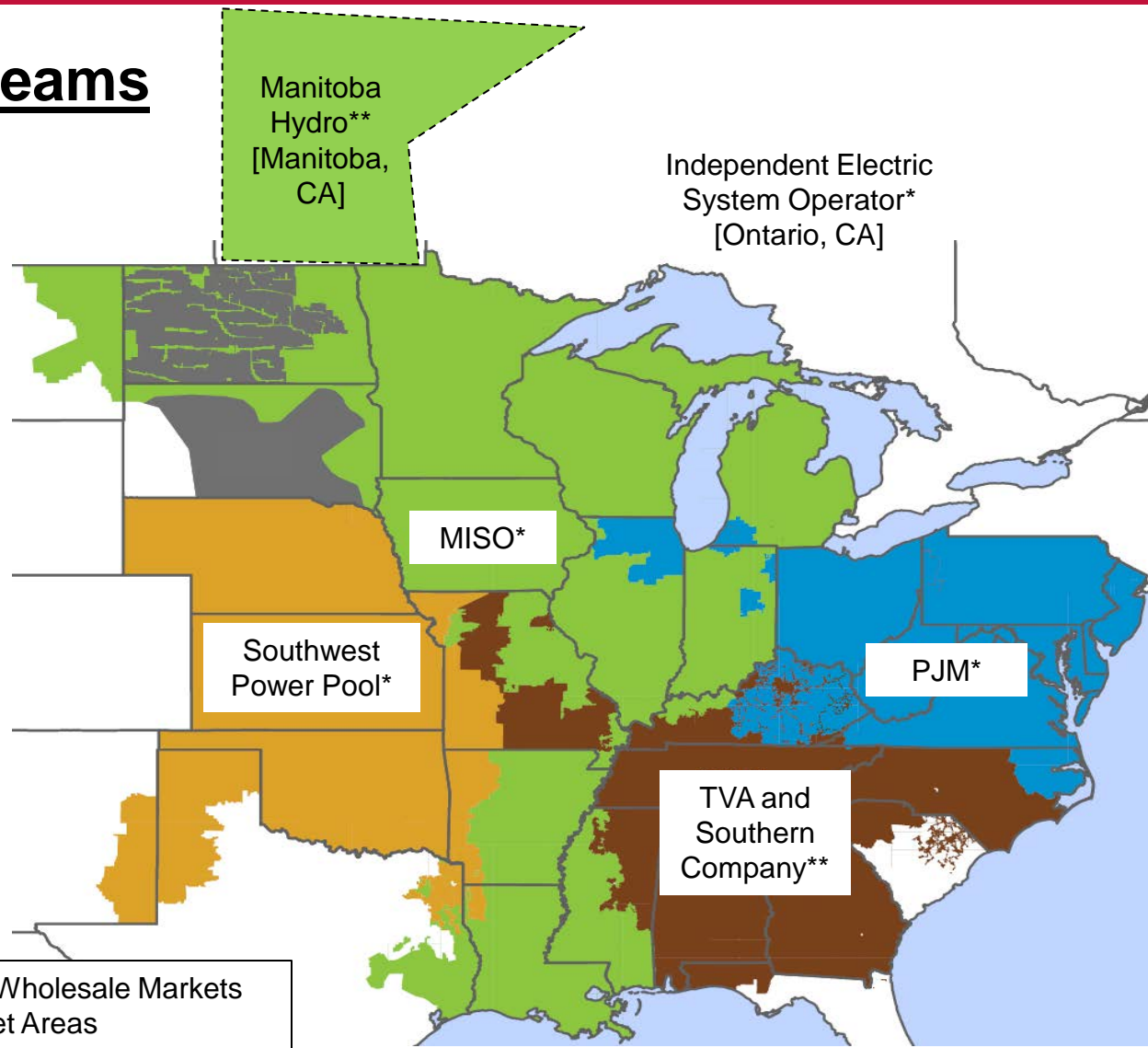
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- The opinions expressed herein are those of the author and do not necessarily reflect the views of the US Agency for International Development, the US Government, The National Association of Regulatory Utility Commissioners, the Michigan Public Service Commission or the Midcontinent Independent System Operator (MISO).*

Congestion Management Tools in MISO's Energy Markets

- Congestion Management Overview
- Interchange Scheduling
- Transmission Rights Overview
- Coordination and Congestion Management with External Systems

MISO Seams



Congestion Management Overview

- MISO primarily utilizes market-based mechanisms to manage transmission congestion
- MISO also uses non-market Transmission Loading Relief to manage transmission congestion associated with interchange schedules or third party flows on its system
- MISO manages a special category of transmission constraints known as Reciprocal Coordinated Flowgates via market-redispach under special agreements with neighboring markets

Interchange and Transmission Service

- Interchange to or from external systems in the form of Imports or Exports require Transmission Service
- Customers may utilize existing long-term service or procure short-term, as available service including:
 - Network Integrated Transmission Service,
 - Firm Point-to-Point Service and,
 - Non-Firm Point-to-Point Service
- These are cost of service rates for recovery of the transmission facility investments
- MISO coordinates the sale of Transmission Service with adjacent system to determine transfer capability

Measuring Transfer Capability: Net Transfer Capability

- Transmission system operators calculate and announce the transmission capability at each border:
 - Total Transfer Capability (TTC) is the maximum power flow between two interconnected systems.
 - Transmission Reliability Margin (TRM) is a part of TTC that is reserved to cover forecast uncertainties.
 - Transmission system operators uses historical cross border physical and commercial flow data and load-flow models to calculate the TRM.

Determining Available Transfer Capacity

MISO determines the amount of Transmission Service available for sale using the following Available Flowgate Capability (AFC) calculations

- Firm AFC Algorithm
AFC_F = TFC - ETC_Fi - TRM - CBM
- Non-Firm AFC Algorithm
AFC_NF = TFC - ETC_Fi - ETC_NFi - TRM

Table with 2 columns: Symbol and Definition. Rows include AFC_F / AFC_NF, TFC, ETC_Fi / ETC_NFi, TRM, and CBM.

Congestion Charges and Ancillary Charges

- Transmission Service allows Market Participants to schedule interchange transactions, subject to physical curtailment under TLR or Emergency procedures
- As transmission congestion occurs and is managed through generation redispatch, Locational Marginal Prices (LMPs) vary and provide price signals for efficient market operations,
- This may create uncertainty for Market Participants, who are exposed to congestion costs on energy transactions
- These congestion costs, or Financial Transmission Usage Charges are based on Locational Marginal Price differences
- Additionally, Customers pay:
 - Energy imbalance charges,
 - Ancillary Services charges,
 - Administrative charges, and
 - Other market related uplift charges

Interchange Scheduling – Transmission Service

- Load needs Transmission Service
- A Generator offering into MISO energy market doesn't need transmission service
- Generators exporting outside of MISO need transmission service
- Generators need Network Resource Interconnection Service or transmission service to be considered as capacity resources
- Internal transactions don't need to be "physical scheduled"
- Transactions going across the MISO border need to submit physical schedules (e-tag)

Physical Scheduling Overview

- Physical Bilateral Transaction Schedules allow for the transfer, or interchange, of physical energy In, Out, and Through the MISO Market Footprint in the MISO Day-Ahead and Real-Time markets
- Day-Ahead Physical Schedules are either Fixed volume, Dispatchable volume based on price sensitive offers, or Up-To-Congestion based on LMP price differences at scheduling points of delivery and receipt
- The Day-Ahead Ahead Scheduling deadline is 11:00
- Day-Ahead Market awards for Dispatchable and Up-To-Congestion schedules are published at 15:00
- Real-Time Physical Schedules are only Fixed Volume and can be adjusted for every 15 minute interval beginning at 00:00
- The Real-Time Physical Schedule adjustment deadline is 20 minutes prior to the 15 minute interval

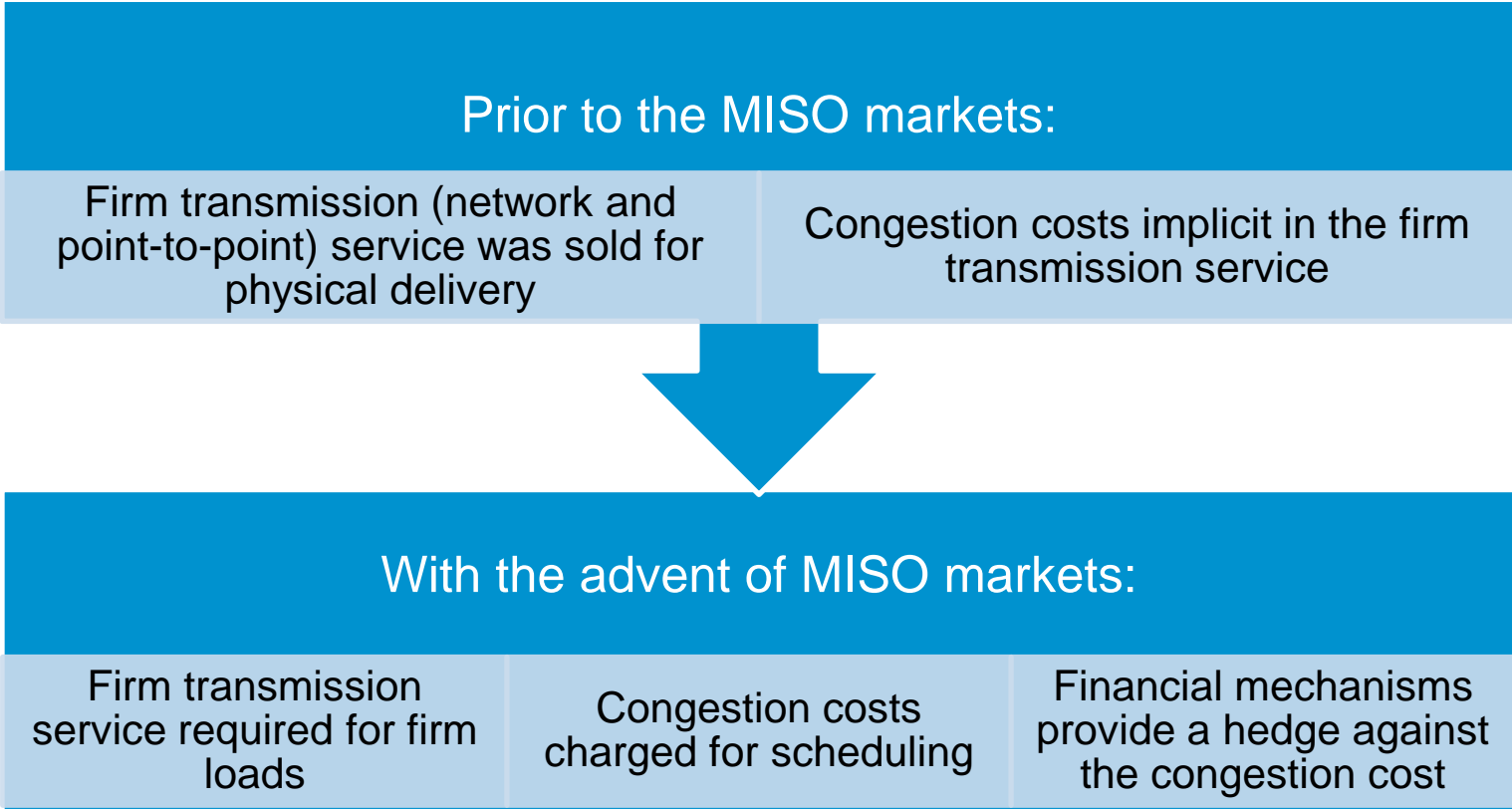
Physical Scheduling Settlements

- Physical Bilateral Transactions receive the Interface Locational Marginal Price for external system where the Transmission Service Reservations Source or Sink for the appropriate market and interval
- Schedule Imbalance volumes between Real-Time and Day-Ahead are settled at the Real-Time LMP
- Export Transactions are charged for Ancillary Services for Contingency Reserves, Market Administration fees, and certain Make-Whole uplift charges
- Fixed Schedules in Day-Ahead and Real-Time are “price takers”, where as, Day-Ahead Dispatchable and Up-To-Congestion schedules are economically cleared and can set the Locational Marginal Price

Transmission Rights Entitlements

- Customers taking Transmission Service on MISO's system may qualify for an allocation of Auction Revenue Rights
- Auction Revenue Rights (ARRs) as well as Financial Transmission Rights (FTRs) provide hedges against market based congestion charges Customers may face when scheduling in MISO's Energy Markets
- In principle, Customers paying for the transmission system on a long-term basis should be allocated congestion rights associated with their historical usage

Transmission Rights Overview



Auction Revenue Rights (ARRs)

Why

- ARRs are financial instruments that entitle their holders to a share of the Auction revenue, which may then be used to offset cost of transmission congestion

What

- ARRs entitle their holder to a share of the auction revenue (credit or charge) generated in the annual FTR Auction

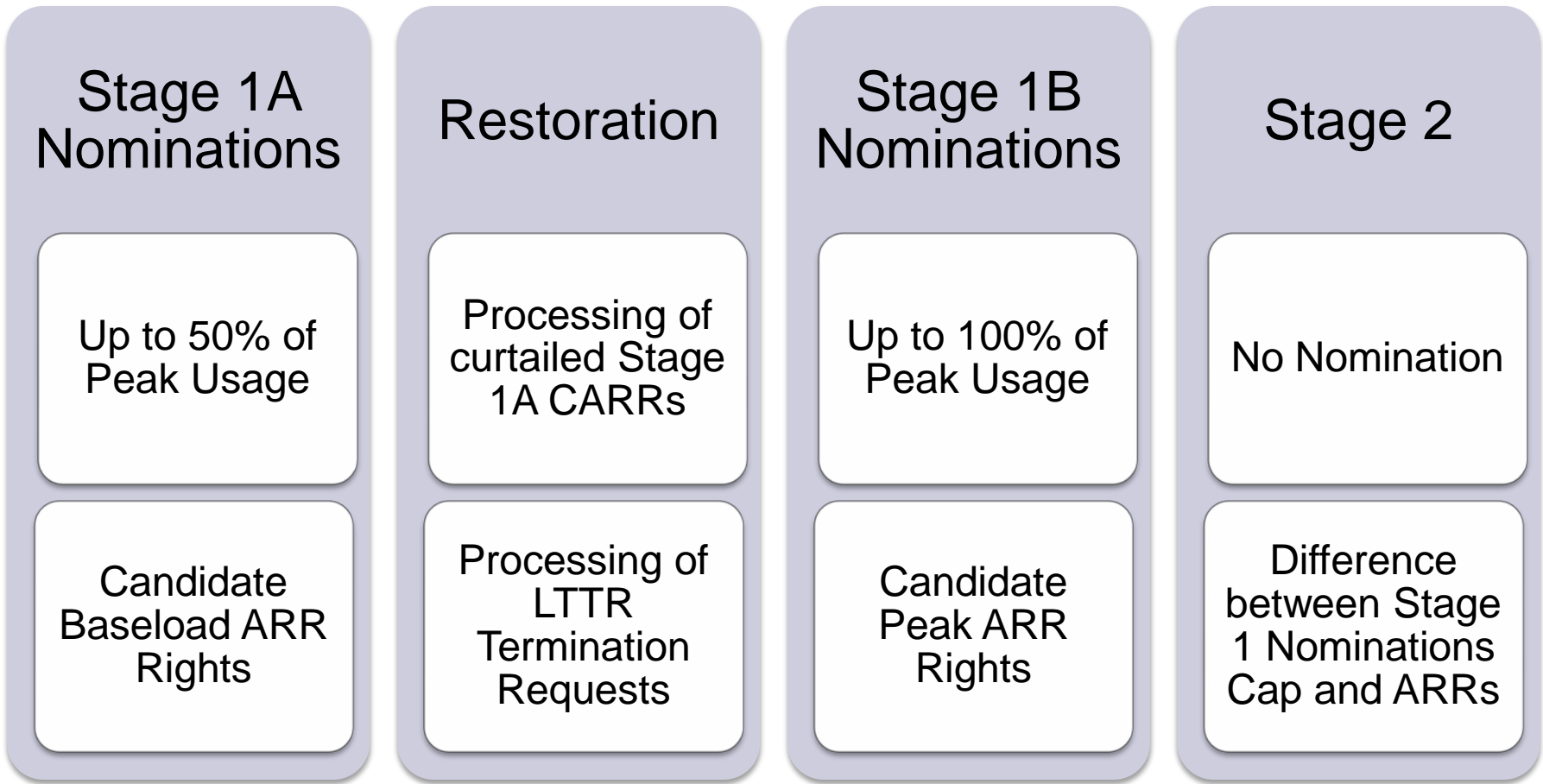
Who

- ARRs are allocated to Market Participants based on firm historical usage of the transmission network and Market Participants that have funded network upgrades

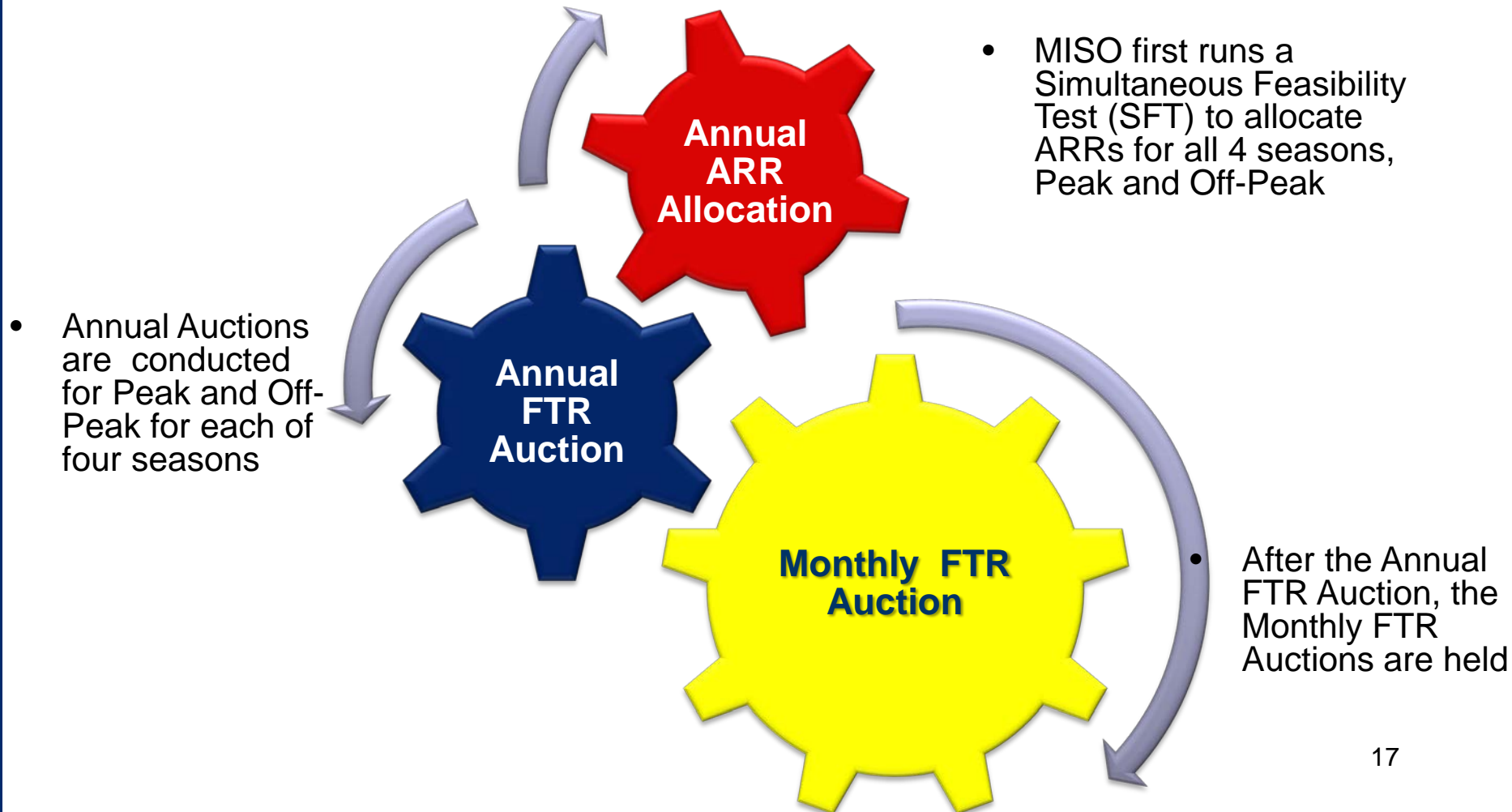
How

- ARRs are acquired in the annual ARR allocation

ARR Allocation – Conducted in Stages



FTRs / ARR are Awarded Through a Series of Processes



Financial Transmission Rights (FTRs)

Why

- As transmission congestion occurs, LMPs vary and provide price signals for efficient market operations, creating uncertainty for MPs, especially in congested areas

What

- FTRs enable their holder to hedge against the cost of congestion in the Day-ahead market

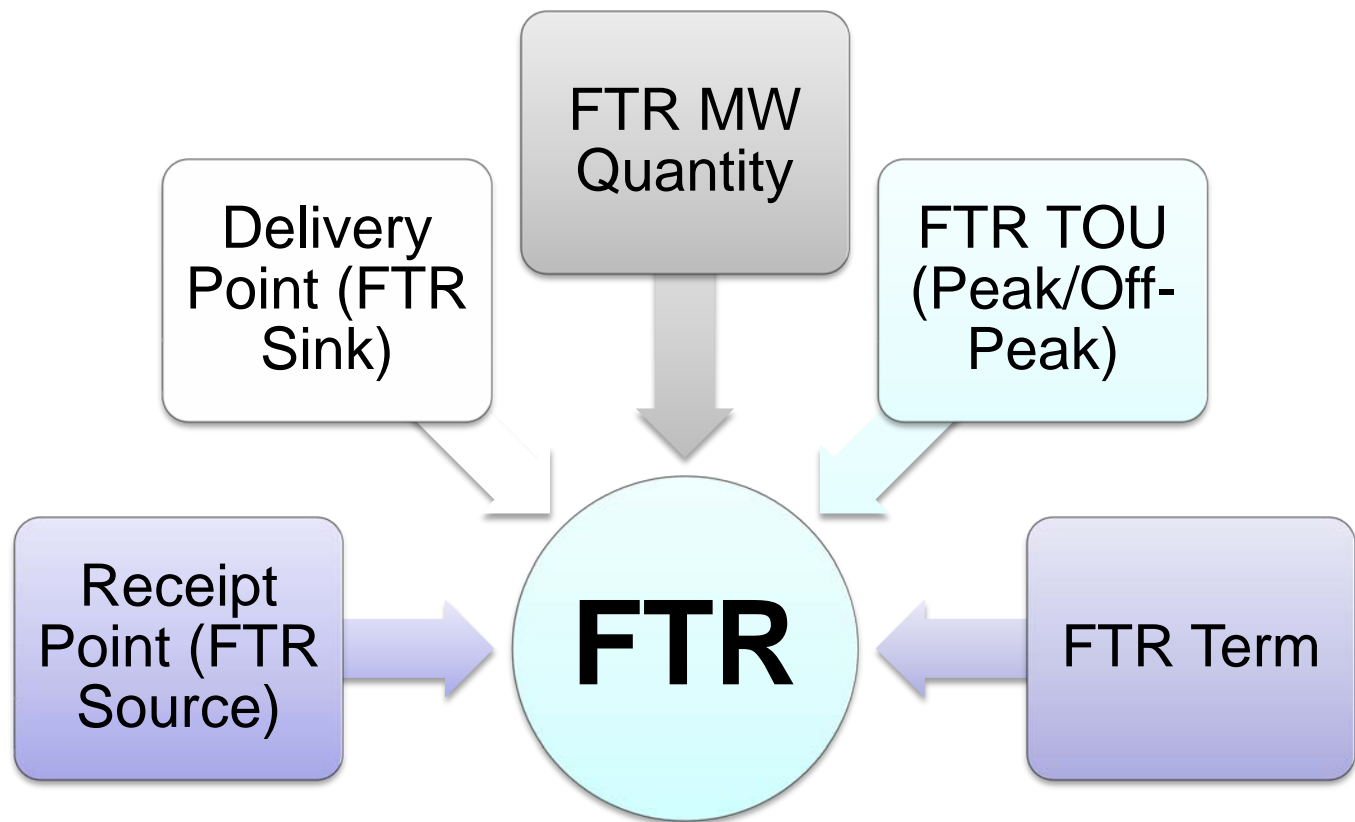
Who

- ARR holders converting ARRs into FTRs
- Any Market Participant with creditworthiness can purchase FTRs

How

- FTRs can be acquired in the Annual or Monthly Auctions
- Can be acquired bilaterally on the Secondary market

Financial Transmission Right Description

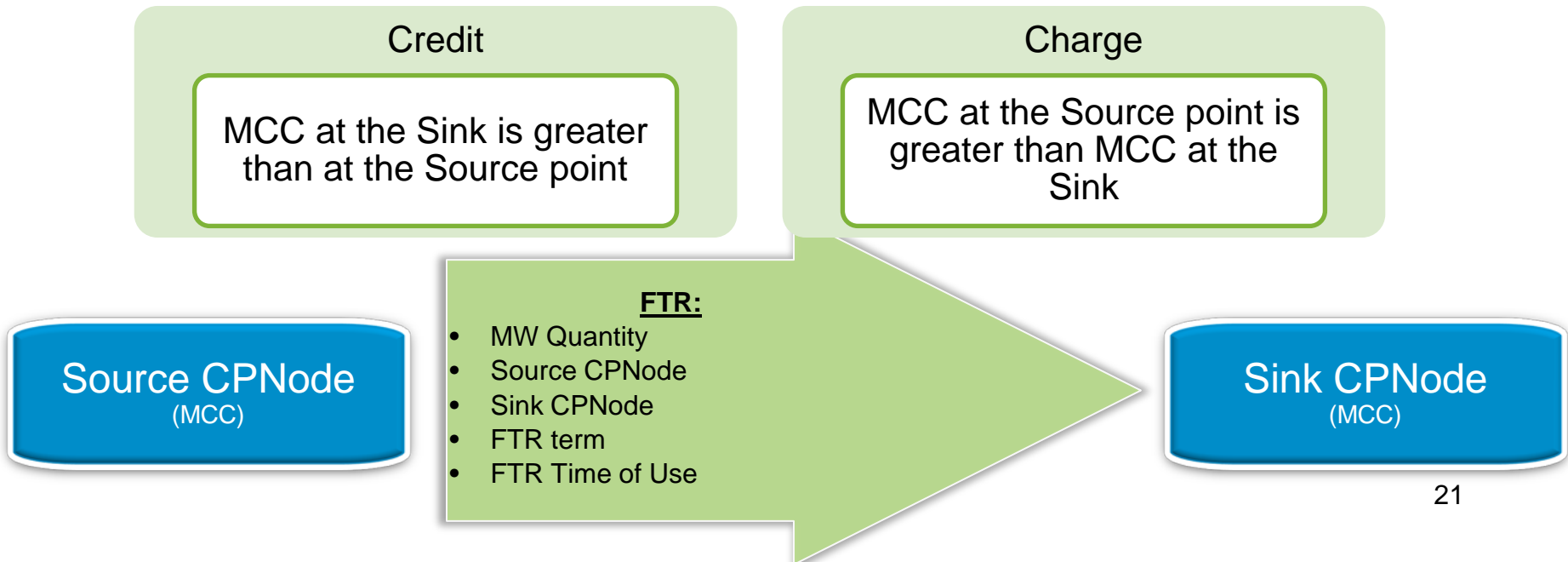


FTR Auction Objectives

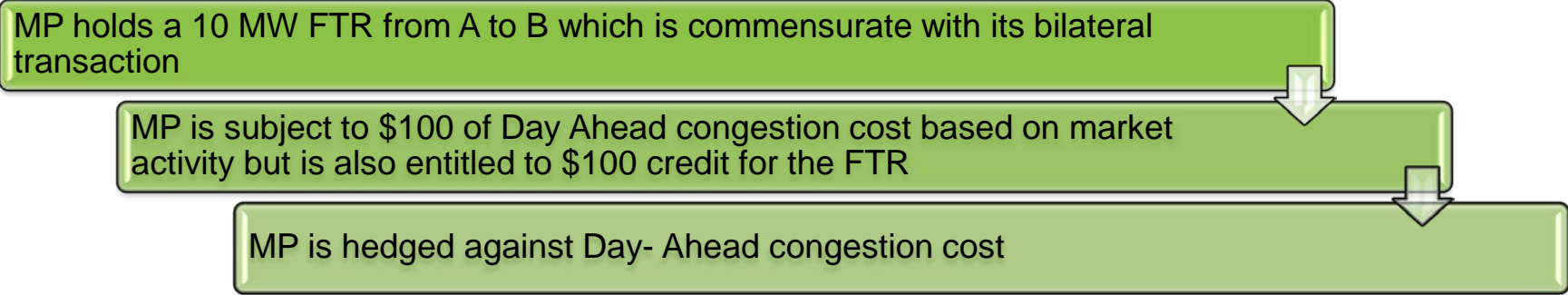
- Maximize “value” of transmission system in the Auction
- Maintain Simultaneous Feasibility
 - Enforce appropriate transmission element limits
 - Respect previously awarded transmission rights capacity
 - Ensures Revenue Adequacy
- Determines Prices through available capacity, awarded rights, and supply and demand curves developed by auction offers and bids

FTR Settlement Values

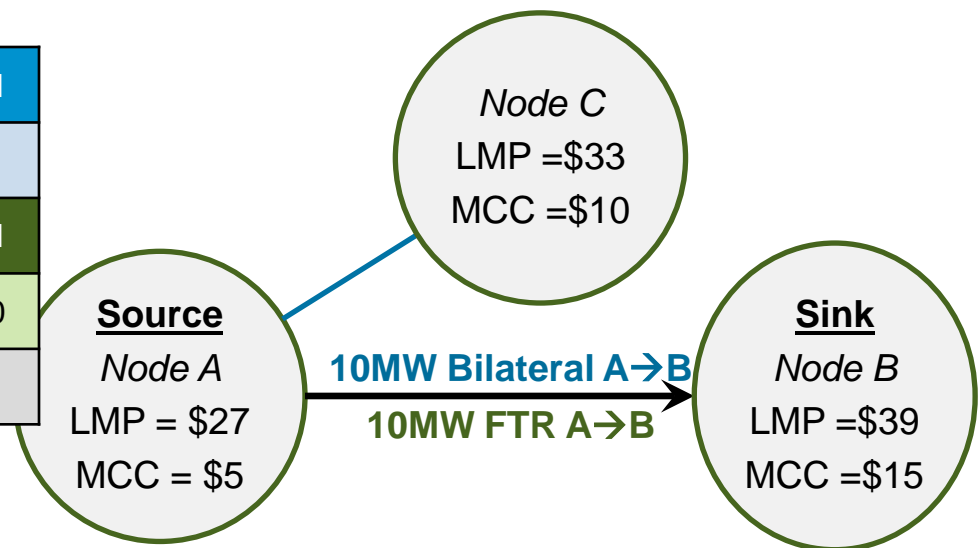
- FTRs have a monetary value which will be paid to (or owed by) the holder
- FTR values are based on the difference between the Marginal Congestion Component (MCC) of the Day-Ahead LMP at the source and sink



FTR Hedging Example



Description	Sink	Source	MW	Total
DA Congestion Cost	(\$15	- \$5) *	10	= 100
Description	Source	Sink	MW	Total
FTR Target Credit	(\$5	- \$15) *	10	= -100
Net:				\$0



Note: FTR Target Credit calculation is reversed to indicate cash flows with respect to MISO
 (-) MISO pays, (+) MISO collects

Coordination and Congestion Management with External Systems

- MISO seams operating agreements
 - PJM Joint Operating Agreement
 - Southwest Power Pool (SPP) Joint Operating Agreement
 - **Manitoba Hydro (MHEB) Seams Operating Agreement**
 - **[Manitoba, Canada]***
- MISO reliability coordination agreements
 - Tennessee Valley Authority (TVA)
 - **Independent Electricity System Operator (IESO)**
[Ontario, Canada]*
 - Southern Company (SOCO)

*** International Agreements**

What are Seams?

- Seams occur at points of Interface and Interconnection between MISO and neighboring systems
- Operational and Market inefficiencies may result at seams due to:
 - Differences in market rules and designs,
 - Operating and scheduling protocols and service charges,
 - Business practices which inhibit or preclude the ability to transact capacity and energy across the interface,
 - Equipment Limitations,
 - Barriers to participation and economic transactions

Seams Issues Impacts

Managing Seams Issues can have positive benefits to markets, transmission systems, and end-use customers

Efficiency (market liquidity)

- Reduced Production costs
- Transactional costs
- Elimination of barriers to participation

Effectiveness (market optimization)

- Congestion Management
- Managing third party flows (loopflows)
- Economic Commitment and Dispatch
- Emergency and Contingency support

Seams Issues Solutions

MISO has successfully addressed Seams issues with PJM, SPP, and Manitoba through individual agreements through, including:

- **Economic Efficiency**
 - Contingency Reserve Sharing
 - Bilateral and Unilateral Transactions Spot In Transmission Service
 - Market Dispatchable Day Ahead Transactions
 - Locational and Interface Pricing
- **Evolution of Market Products and Services**
 - External Asynchronous Resources (Bidirectional) with MHEB
- **Establishing Market-based Congestion Management through coordination in Real Time with PJM and SPP**
 - Improved operations coordination and visibility
 - Outage planning and coordination
 - Emergency procedures
- **Physical Solutions (Phase Angle Regulators)**

Evolution of Market Products and Services

- In 2009, MISO implemented the External Asynchronous Resource (EAR)
- The EAR represents a portion of the Transmission Capacity and associated interchange schedule between Manitoba and MISO's Energy Markets
- The EAR is controlled and offered by a single Market Participant and is backed by Hydro-powered Generation in Manitoba
- The EAR can be committed and dispatched by MISO in the Day-Ahead and Real-Time Markets

External Asynchronous Resource Characteristics

- Dispatchable Resource in MISO's Economic Dispatch in Day-Ahead and Real-Time Markets
- Provides multi-part offer for Energy Ancillary Services
 - Start-Up
 - No-Load
 - Energy Offer
 - Regulation and Spinning Reserve Availability
- Bidirectional, can be dispatched to withdraw/export during over-supply or to relieve transmission congestion

Joint Operating Agreement: PJM and MISO

- Real-Time and Day-Ahead Market coordination on Reciprocal Coordinated flowgates allows for market-based congestion management resulting in lowest cost redispatch
- Exchange of operating data: real time generator data, planning data, facilities data
- Consistency of modeling for Available Transfer Capability (ATC), congestion management, outage scheduling

Lake Erie Phase Angle Regulators (PARS)



- PARS relieve congestion elsewhere on the grid by curtailing unscheduled loop flow
- Loop flow impacts on multiple entities' systems: MISO, PJM, IESO [Ontario, CA], and New York-ISO
- Benefits Michigan Utilities and MISO through reduced re-dispatch costs to manage congestion
- Requires approval of multiple control areas and countries

THANK YOU!

- Any Questions?
- My contact information:
- Kevin Vannoy
- Midcontinent Independent System Operator (MISO)
- kvannoy@misoenergy.org

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<https://www.misoenergy.org/Library/Tariff/Pages/Tariff.aspx>
- Business Practices, available at,
<https://www.misoenergy.org/Library/BusinessPracticesManuals/Pages/BusinessPracticesManuals.aspx>
- Market Settlements Business Practices Manual – BPM 005 Market Settlement

References – Seams Agreements

Rate Schedule 2 - MISO – Manitoba Hydro Coordination Agreement

- <https://www.misoenergy.org/Library/Repository/Tariff/Rate%20Schedules/Rate%20Schedule%2002%20-%20Midwest%20ISO-MH%20Coordination%20Agreement.pdf>

Rate Schedule 5 - MISO – PJM Joint Operating Agreement and Congestion Management Plan

- <https://www.misoenergy.org/Library/Repository/Tariff/Rate%20Schedules/Rate%20Schedule%2005%20-%20MISO-PJM%20JOA%20and%20CMP.pdf>

Rate Schedule 6 - MISO – Southwest Power Pool Joint Operating Agreement and Congestion Management Plan

- <https://www.misoenergy.org/Library/Repository/Tariff/Rate%20Schedules/Rate%20Schedule%2006%20-%20Midwest%20ISO-SPP%20JOA%20and%20CMP.pdf>

Rate Schedule 8 - MISO – Manitoba Hydro Seams Operating Agreement

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