Optimization of Flow-Control Resource (FCR) Dispatch

FERC Technical Conference on Increasing Real-Time and Day-Ahead Market Efficiency through Improved Software

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Overview

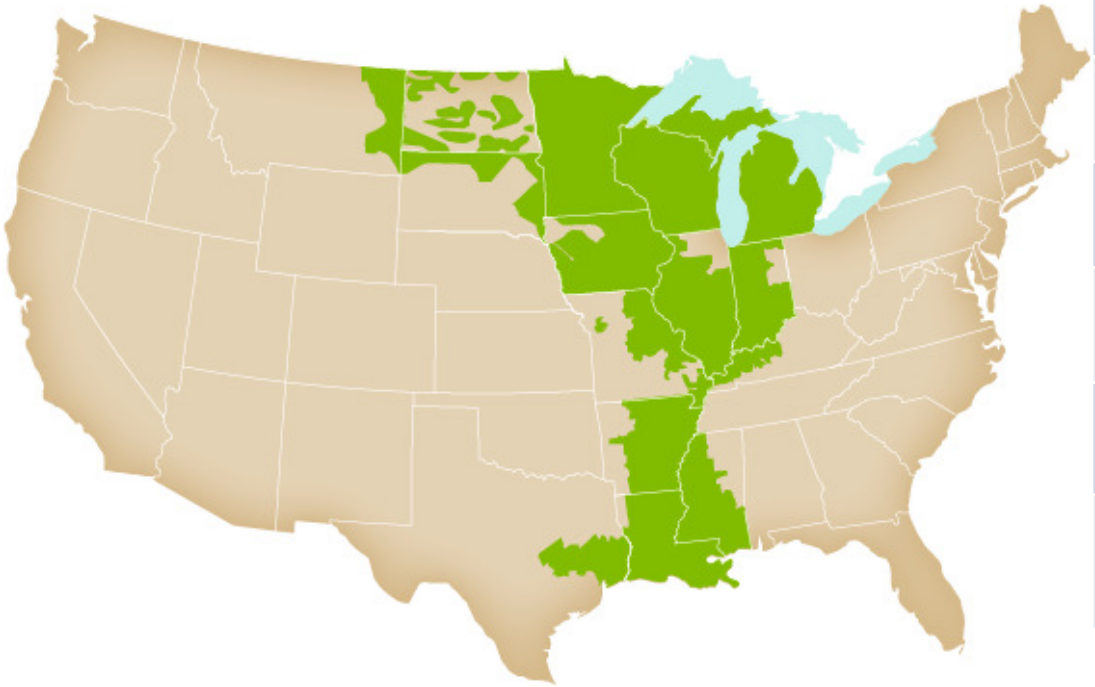
- **Purpose**
  - Consider Optimization of flow-control resource (FCR) to enhance wholesale market efficiency
  - Solicit diverse experts advice on design challenges
- **Key Takeaways**
  - System condition transformation and inability to control the flow-control resources (FCRs) lead to reliability concerns as well as market inefficiency
  - Direct control and optimization of flow-control resources in Day Ahead and Real-time will enhance resource and transmission utilization to achieve overall market efficiency
  - Currently, this project is in evaluation phase in the MISO Roadmap process

Definition of Flow-Control Resource

- **Candidate Criteria**
  - **Device that support control of flow to a scheduled volume**
  - **Device that can follow Real-time dispatch target**
- **Device Examples**
  - **Classic HVDC**
  - **Back to Back HVDC**
  - **Phase shifter**
  - **Variable frequency transformer**
  - **Series compensation FACTS devices**

HVDC: High Voltage Direct Current
FACTS: Flexible Alternating Current Transmission System

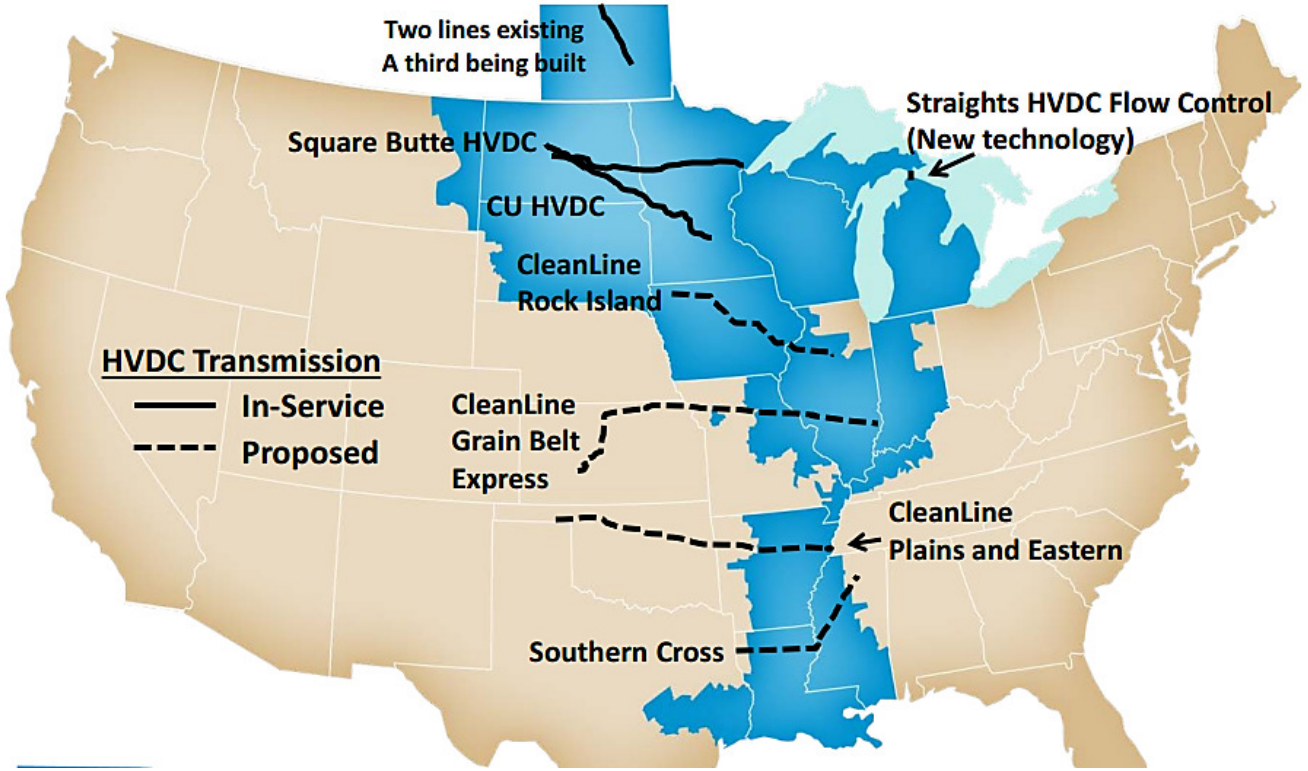
FCR Capacity in MISO



MISO At a Glance	
Market Generation	180 GW
Peak Load	133 GW
Total FCR Capability	**2 GW** **Expected to grow**
States Served	15 Plus Manitoba, Canada
Millions of People Served	42

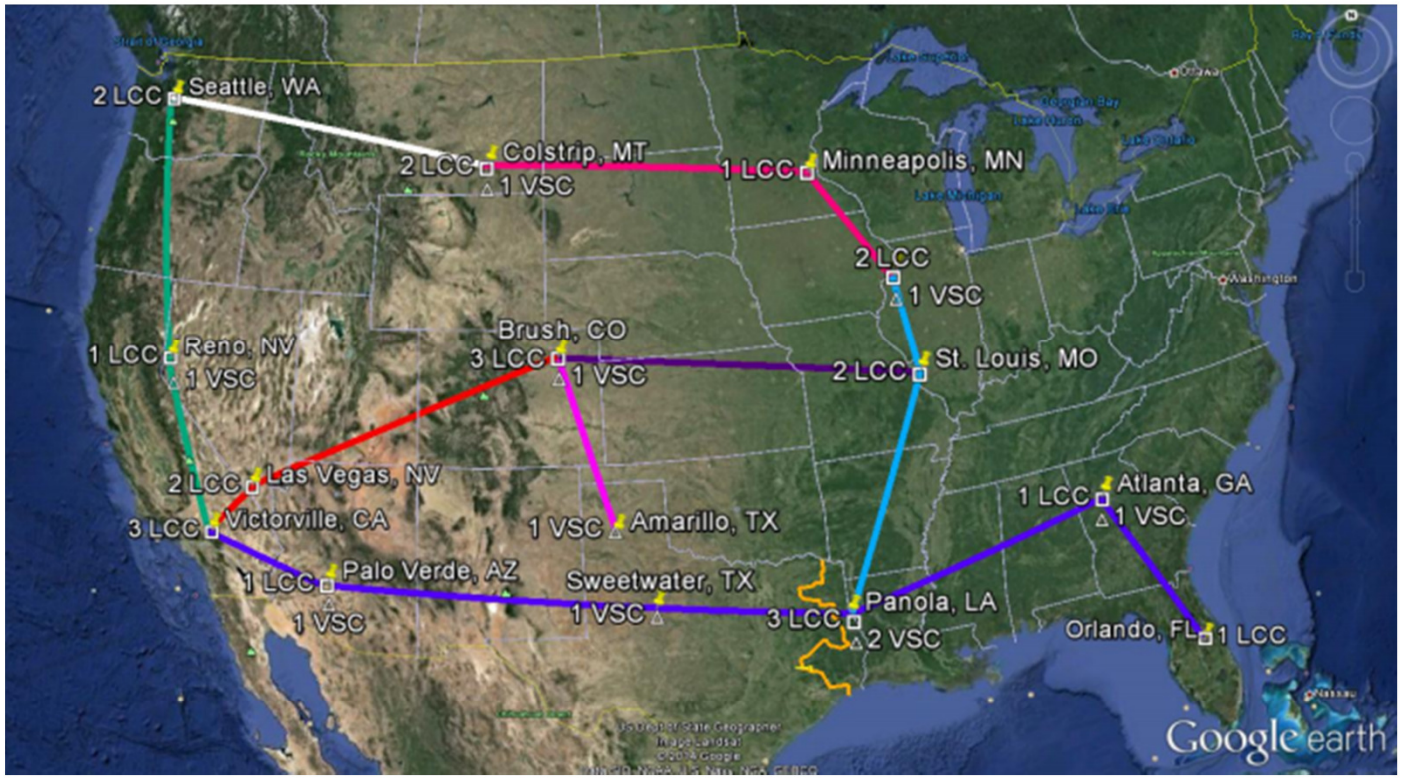
Forecasted Flow-Control Resource Growth

HVDC technology is both in-use and being evaluated for expanded use in the MISO footprint



Source: Emerging Technologies, 6/21/2016 System Planning Committee of the Board of Directors (https://www.misoenergy.org/Events/Pages/SPCBOD20160621.aspx)

DOE Grid Modernization Study



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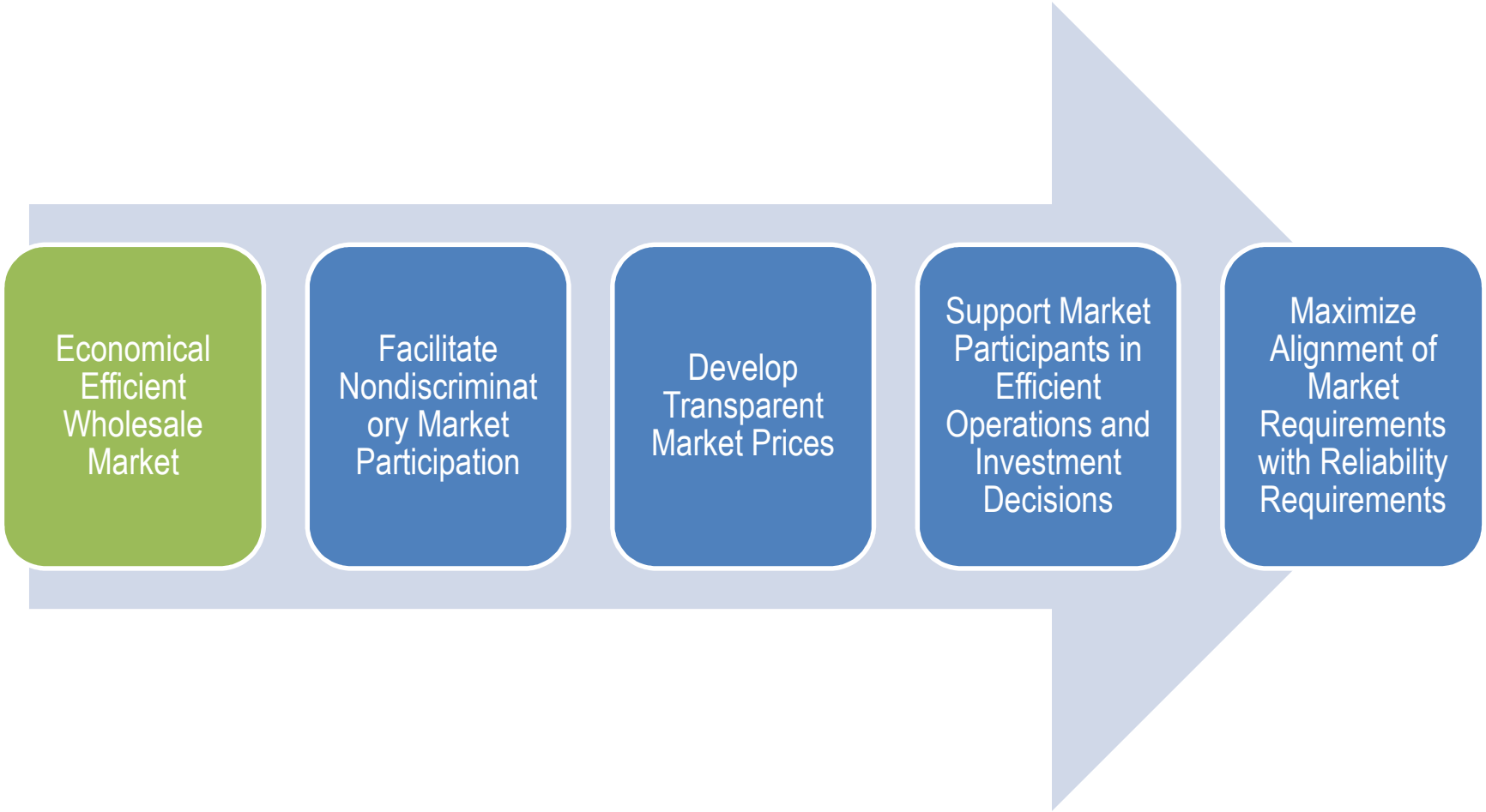
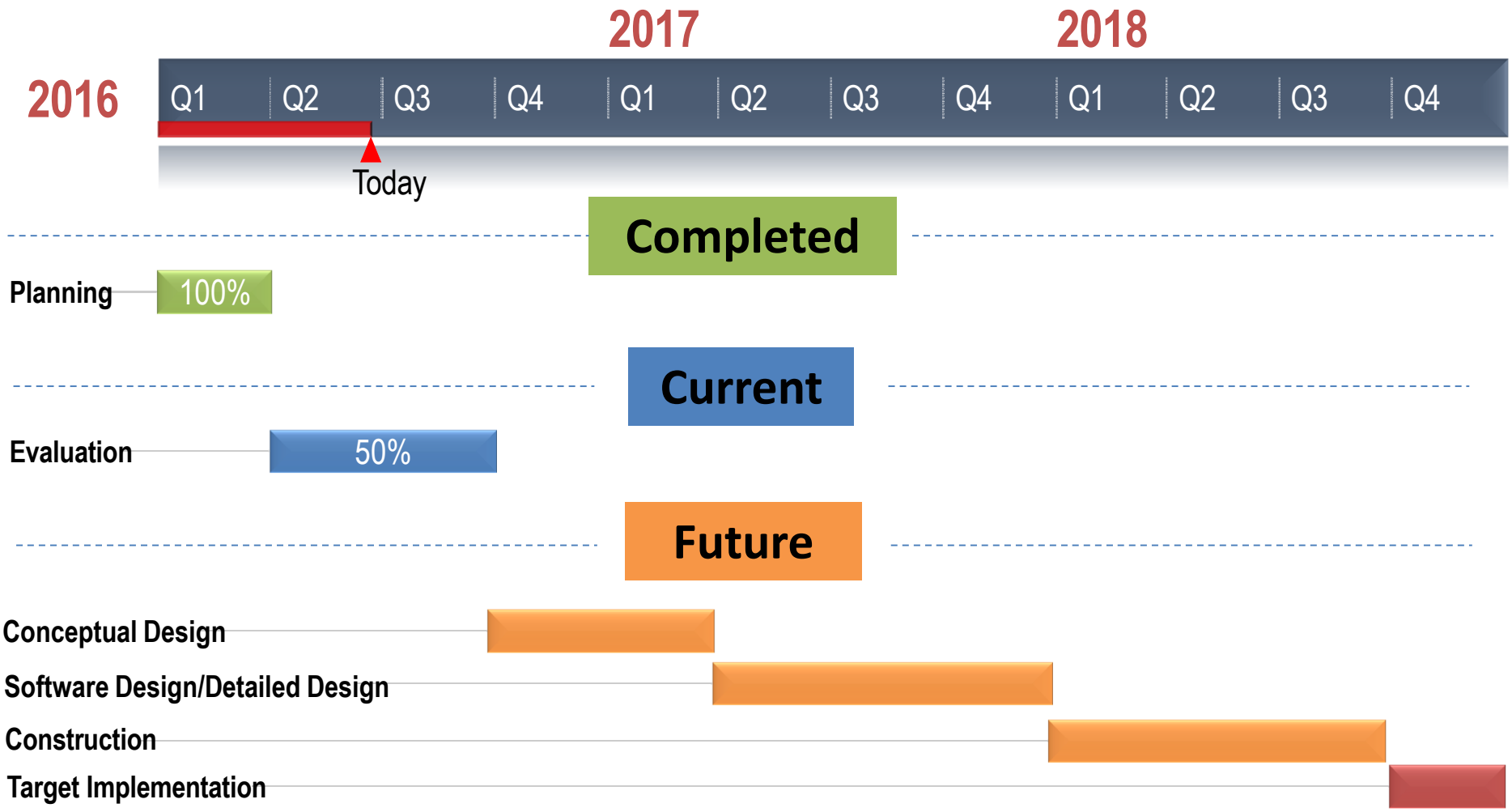
MISO Market Design Guiding Principles



MISO Market Roadmap: Workplan



MISO's Current Process for Flow Control

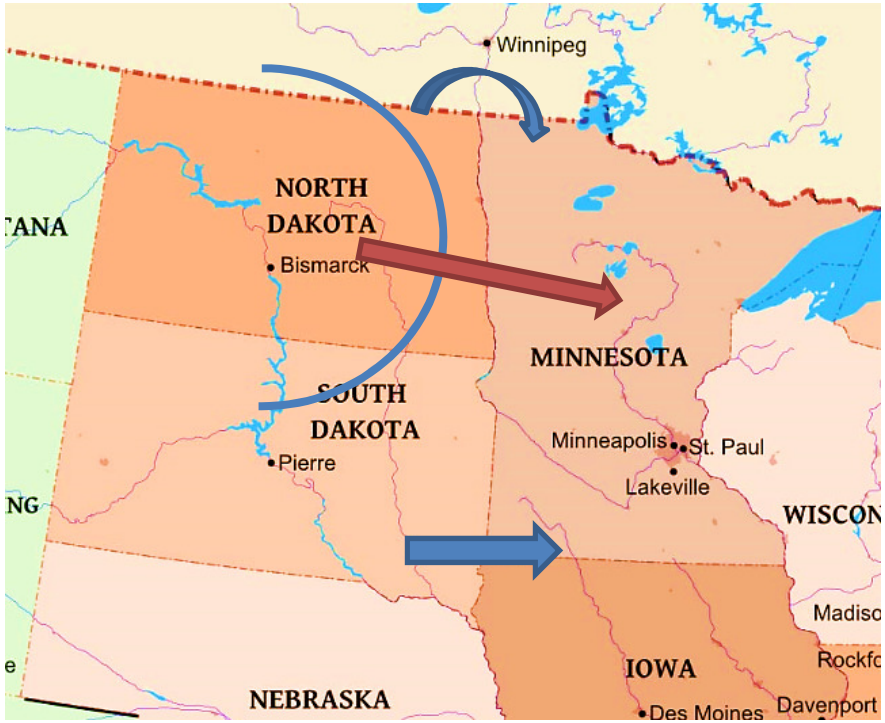
	MISO DART Process
Direct Impact through Optimization	• Generation Commitment / Dispatch • DRR Commitment/Dispatch • EAR Dispatch • PAR Control (reactive power control for MI-ONT interface) • Price Sensitive Demand Bids • Virtual transactions
Indirect Impact	Granting/ denying transmission service based on ATC and interface ramp limits

FCRs are treated as fixed schedules

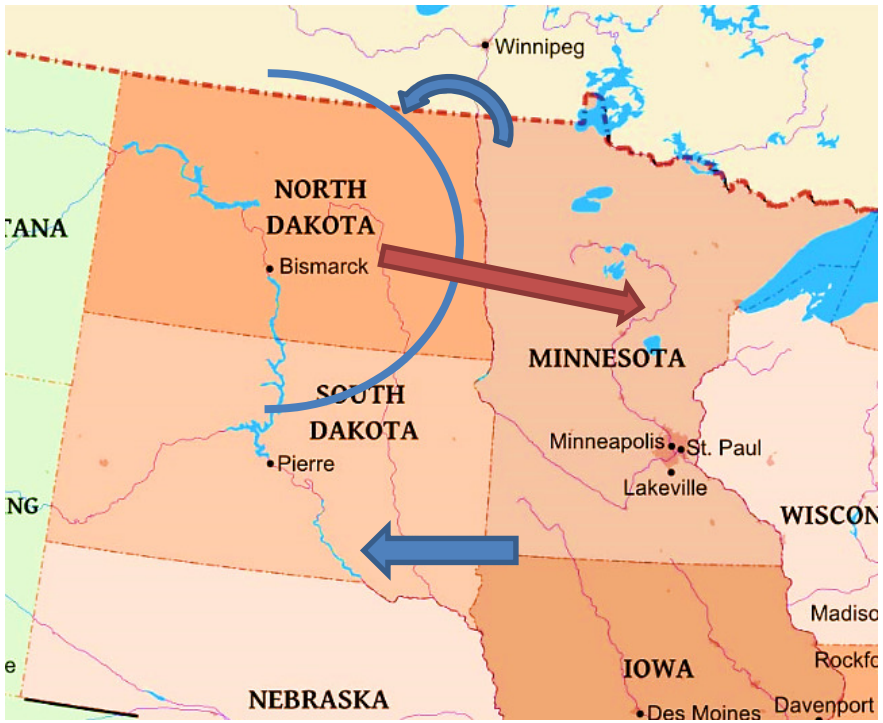
DRR: Demand Response Resource; EAR: External Asynchronous Resource
PAR: Phase Angle Regulator; ATC: Available Transfer Capability; FCR: Flow-Control Resource

MISO's Experience Evolution

Efficient Flow Example



Inefficient Flow Example



Blue: AC system

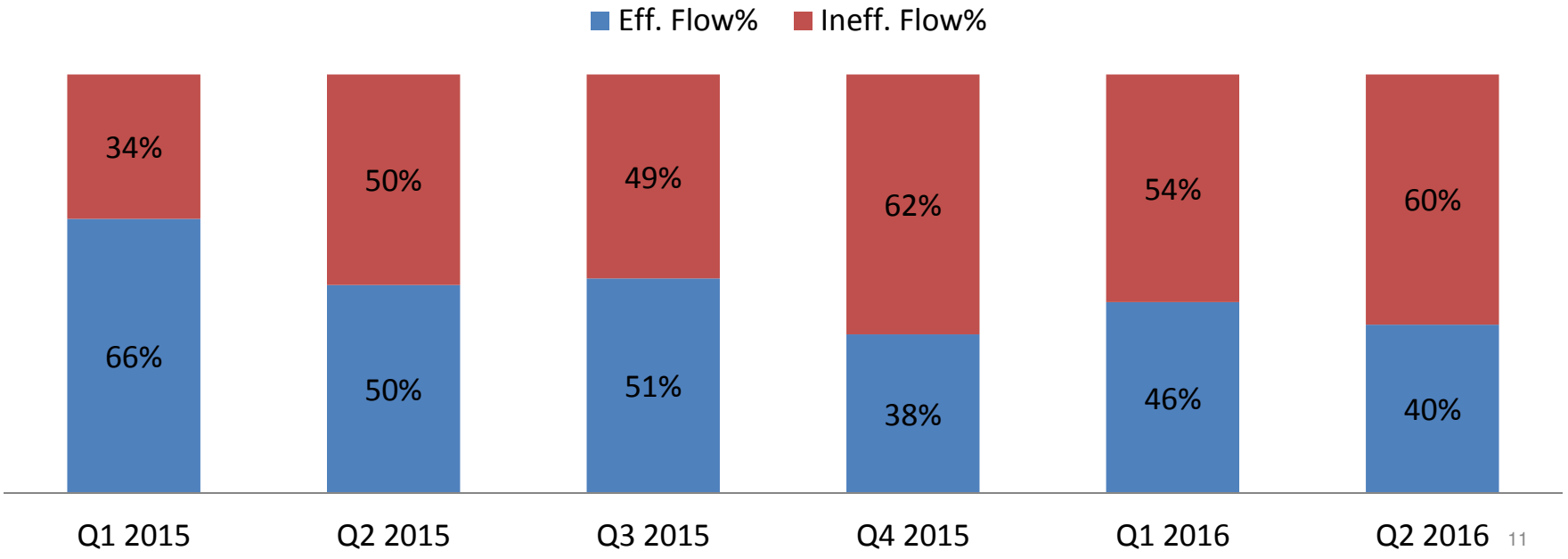
Red: DC system

FCRs Flow Efficiency

- Definition
  - Efficiency: Sign(DC flow) = Sign (Price Spread)
  - Inefficiency: Sign(DC flow) ≠ Sign (Price Spread)

- Observation
  - Percentage of inefficiency has been steadily increasing over the past 18 months

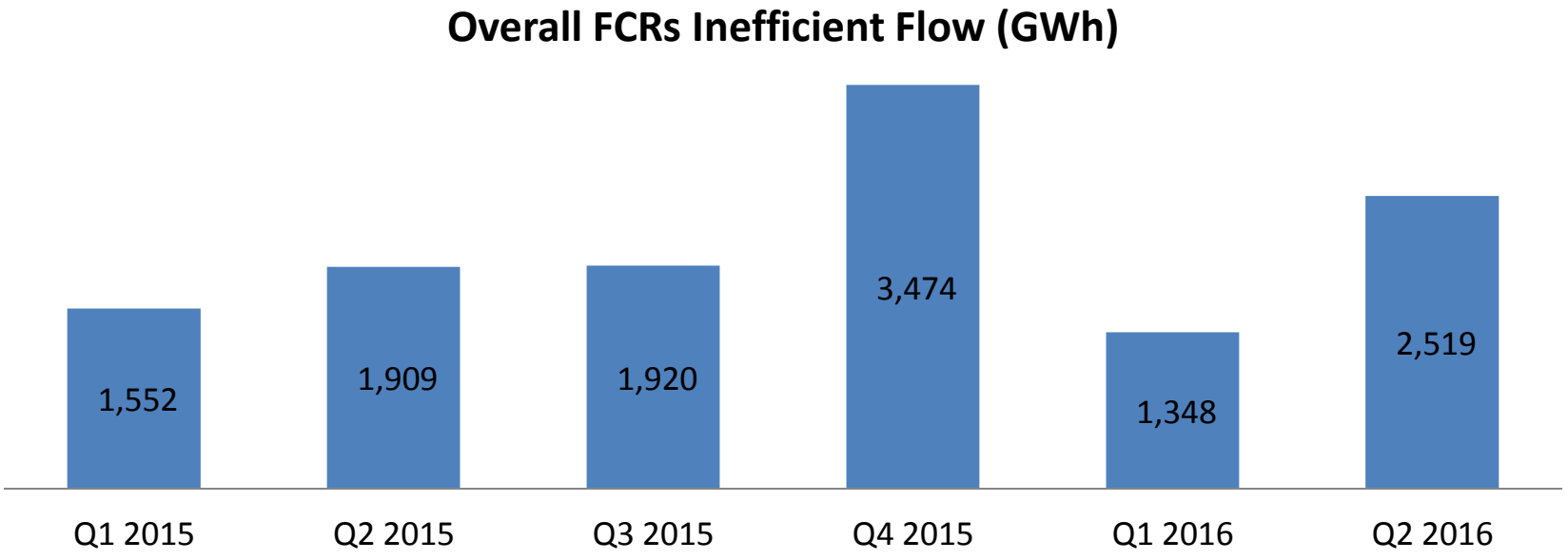
Overall FCRs Operational Efficiency (%)



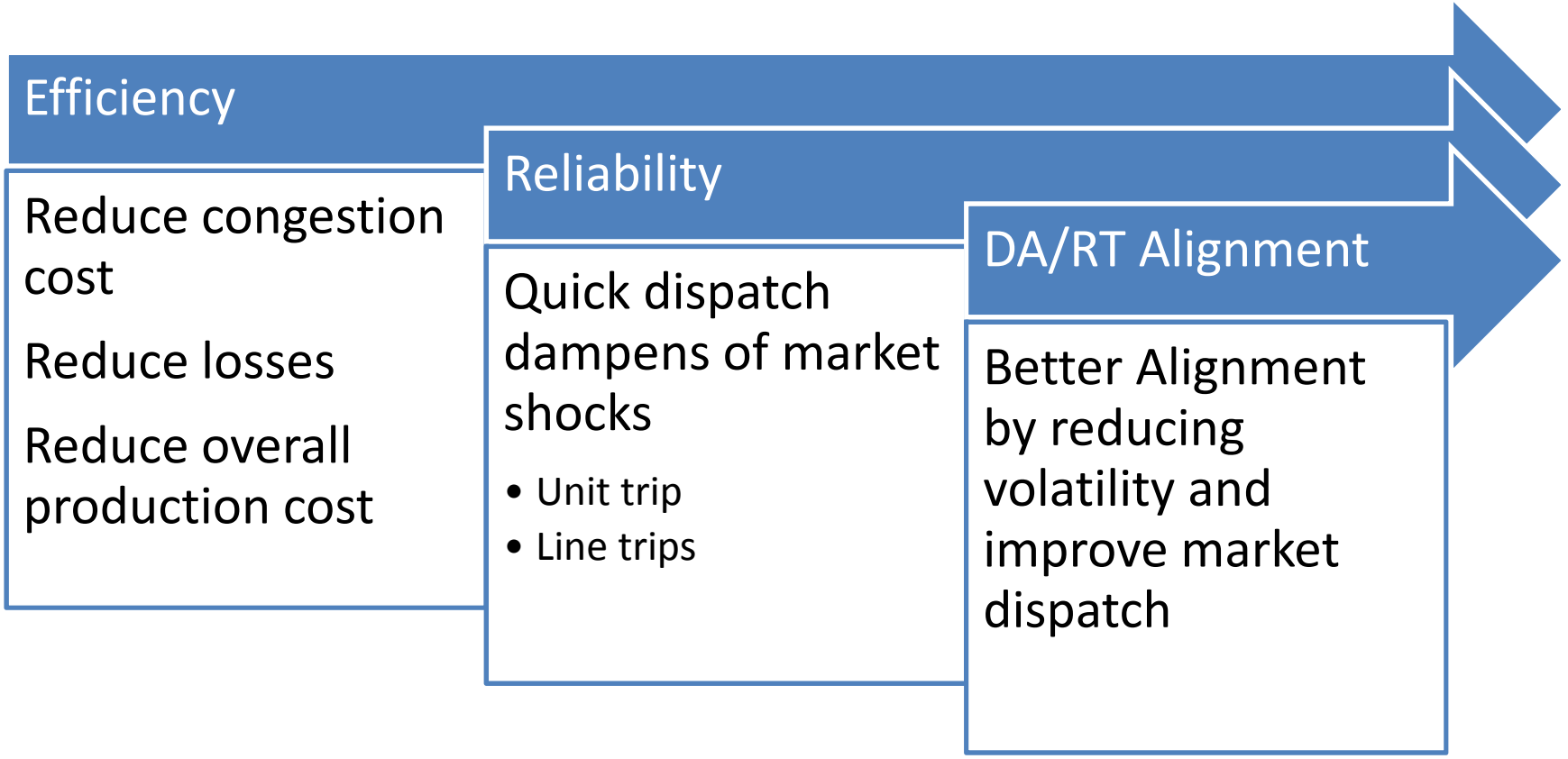
FCRs Flow Efficiency

- Definition
  - Overall FCRs Inefficient Flow is the sum of all inefficient flows

- Observation
  - The MWh volume of inefficiency has been increasing over the past 18 months



Project Benefits



Product Design Objectives

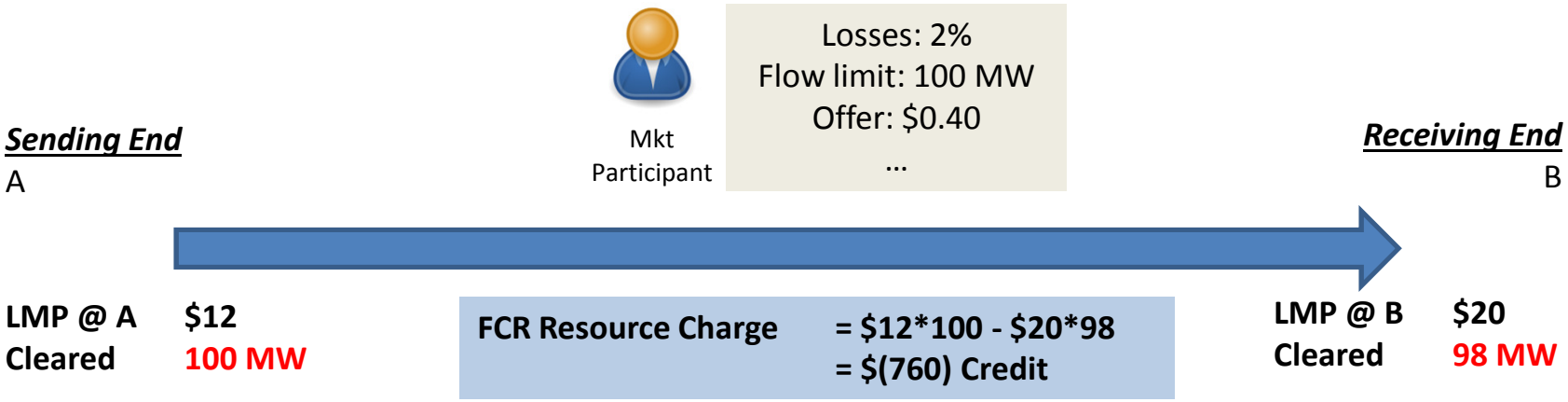
Purpose
- Improve congestion management
- Model physical characteristics and limitations of FCRs

Guiding Principle
- Support an economically efficient wholesale market system that minimizes cost to serve load

Focus Area
- Maximize economic utilization of existing and planned transmission infrastructure

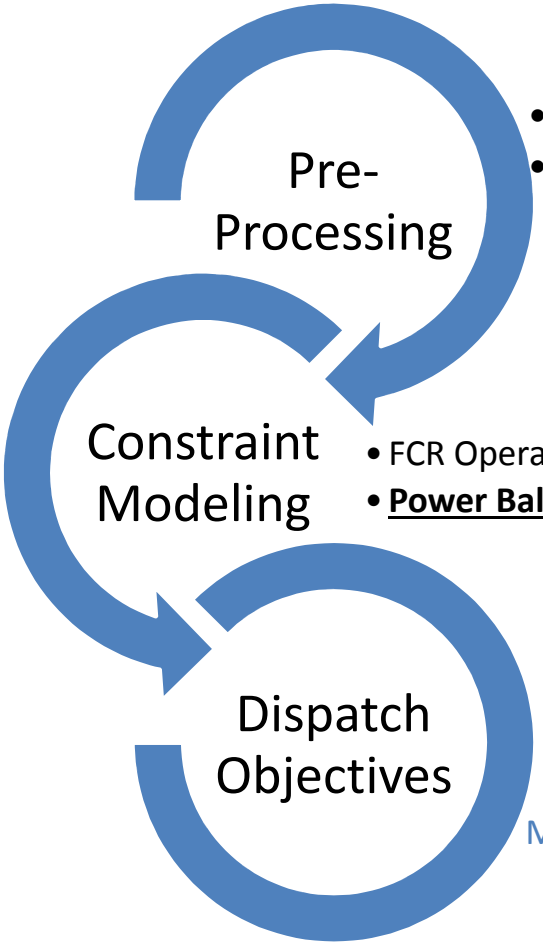
Reliability
- Improve reliability, utilization and efficiency of transmission system

Solution Proposal



- Use the physical locations for DA and RT offers and bids
  - Define terminal points
  - Define facility specification (directionally specific)
    - Min/Max inputs
    - Eco/Emergency Min/Max
    - Actual marginal loss curve
    - Maximum ramp rate curve
    - Offer curve
- MISO AGC will calculate and send the base points for the receiving end based on the Real-time UDS results

Market Clearing Modification Framework



- Parameter pre-processing
- FCR Availability Initialization

- FCR Operational Constraints
- **Power Balance Constraint**

Global Power Balance

$$\sum_{fcr} ReceivingMW(fcr,h) - SendingMW(fcr,h)$$

FCR Power Balance

$$ReceivingMW(fcr,h) = SendingMW(fcr,h) * [1 - LossRate(fcr,h)]$$

- **FCR Energy Dispatch Cost**

Model offer cost for FCR dispatch

$$\sum_{fcr,h} ReceivingMW(fcr,h) * FCRCost(fcr,h) * PeriodLength(h)$$

Future Efforts

- Treatment of FCR in market construct
- Incorporation of transient and voltage stability limits in constraint modeling
- Modeling impacts to forward and planning process
- Identify unintended consequences from settlement perspective

Summary

- Recent changes in load pattern, fuel prices, resource mix lead to increase of market inefficiency and reliability concerns
- Inability to control these FCRs leads to market inefficiency and system reliability concerns
- Project to optimize FCR dispatch will improve system reliability as well as market efficiency
- MISO is committed to this project as indicated in the MISO Roadmap Process

  https://www.misoenergy.org/WhatWeDo/MarketEnhancements/Pages/MarketEnhancements.aspx