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Confidential

MREC: Wind and MISO

3/3/2011

Agenda

- Introduction/Fundamentals
- MISO Pricing With & Without Wind
- MISO Operations With & Without Wind
- Transmission Cost Allocation
- Transmission Projects
- Long-Term Outlook

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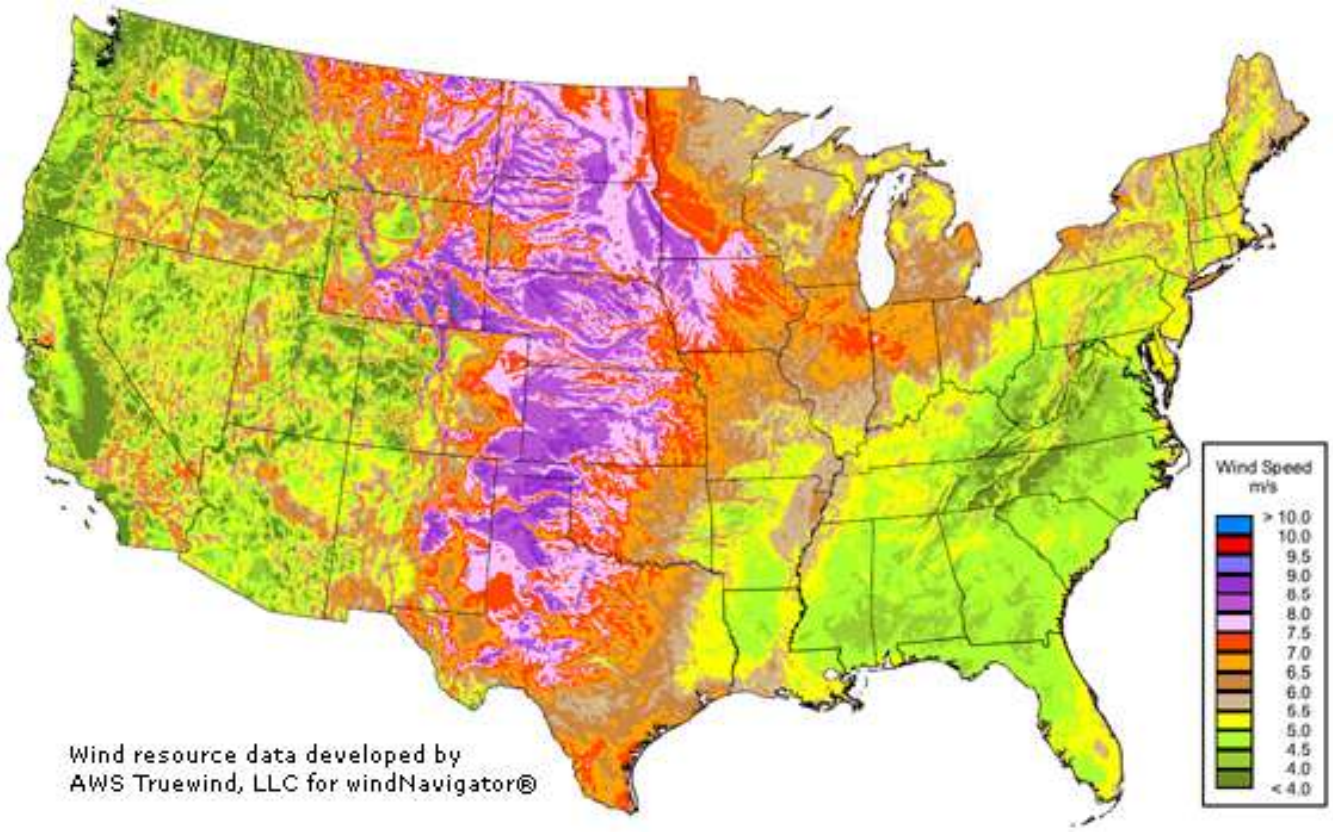
Introduction



http://www.windpoweringamerica.gov/wind_maps.asp

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Introduction

ISO Wind Overview (MWs)

ISO	Installed Wind	Queued Wind	Peak Load
ERCOT	9500	44900	64805
SPP	3800	26000	53012
MISO	8600	68000	116030
PJM	4200	42000	144644

* Installed Wind and Queued Wind are Approximates

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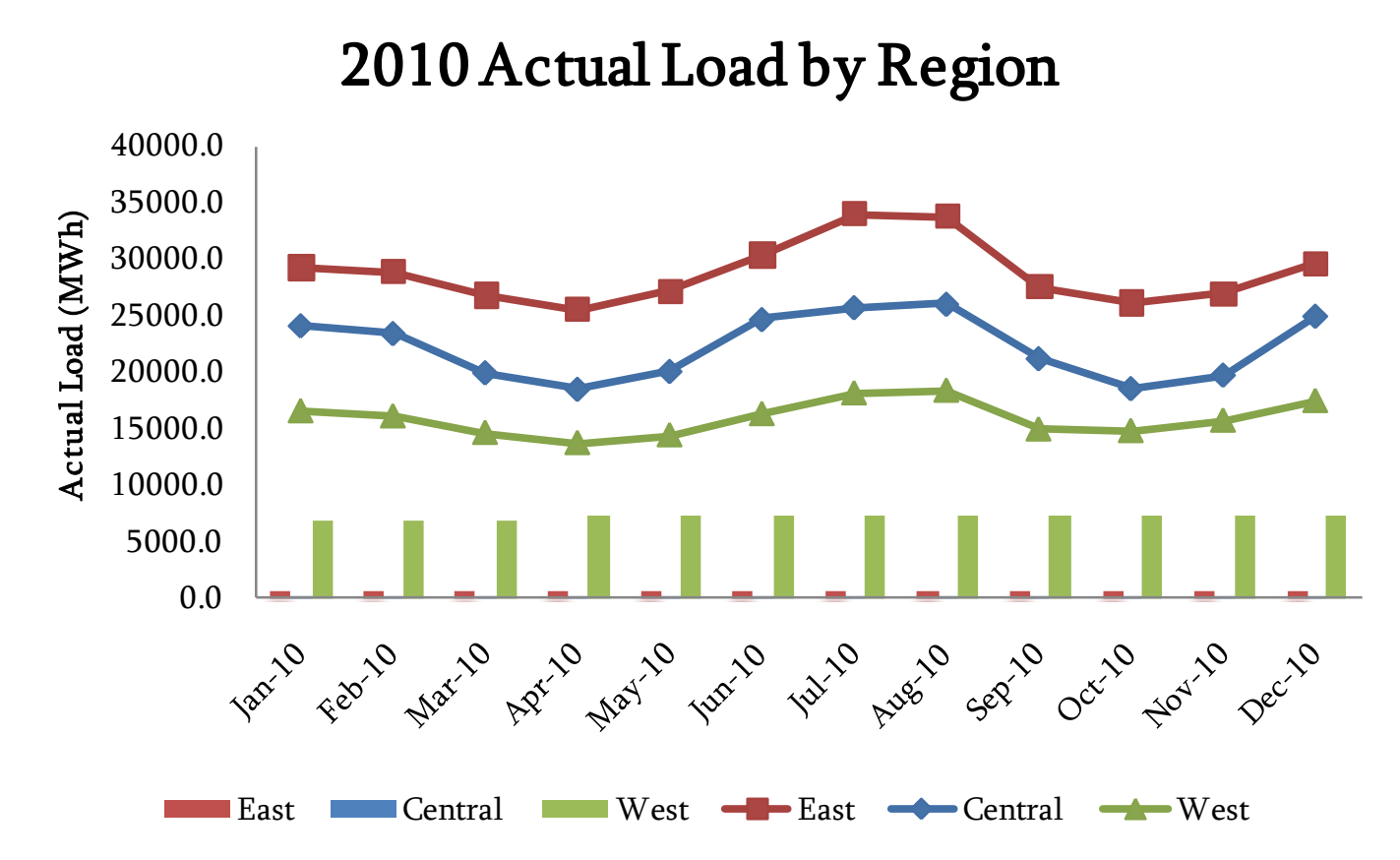
Load vs. Wind by Location



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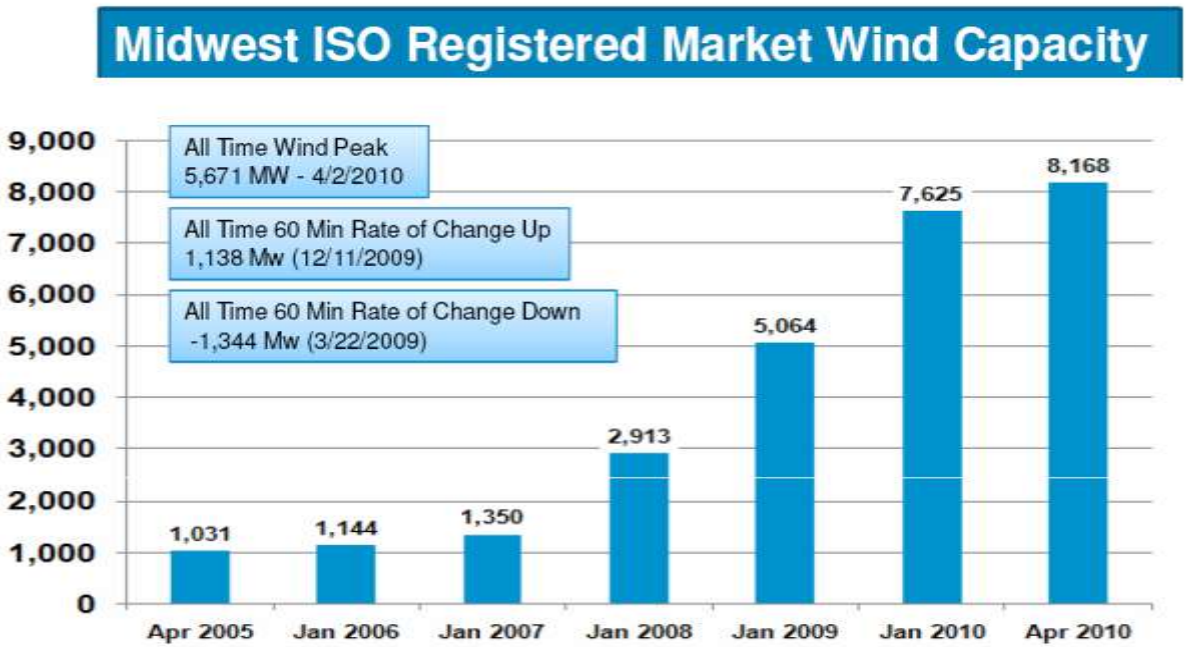
Why Wind Integration?



Source: MISO Wind Integration Workshop

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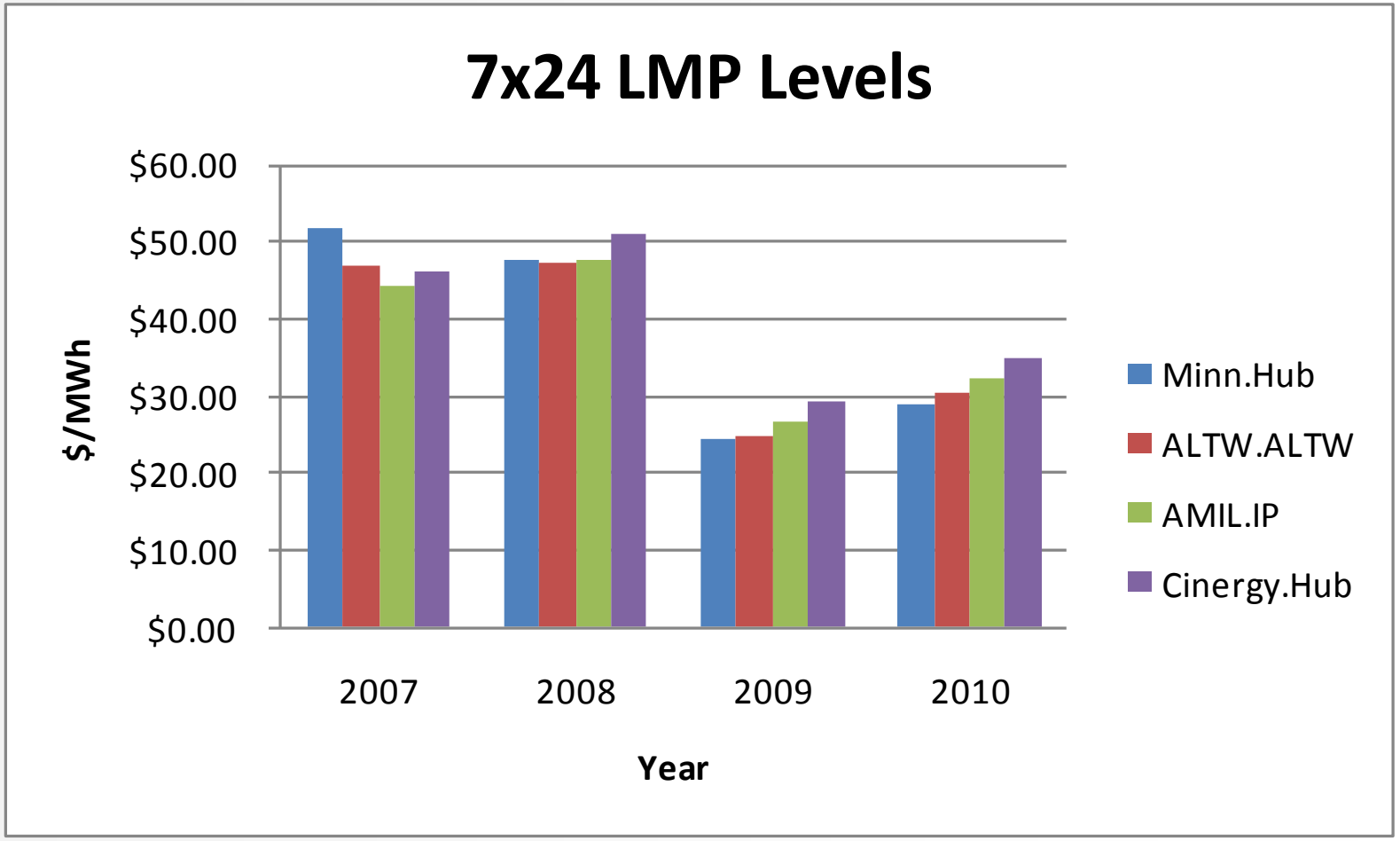
7x 24 MISO LMPs



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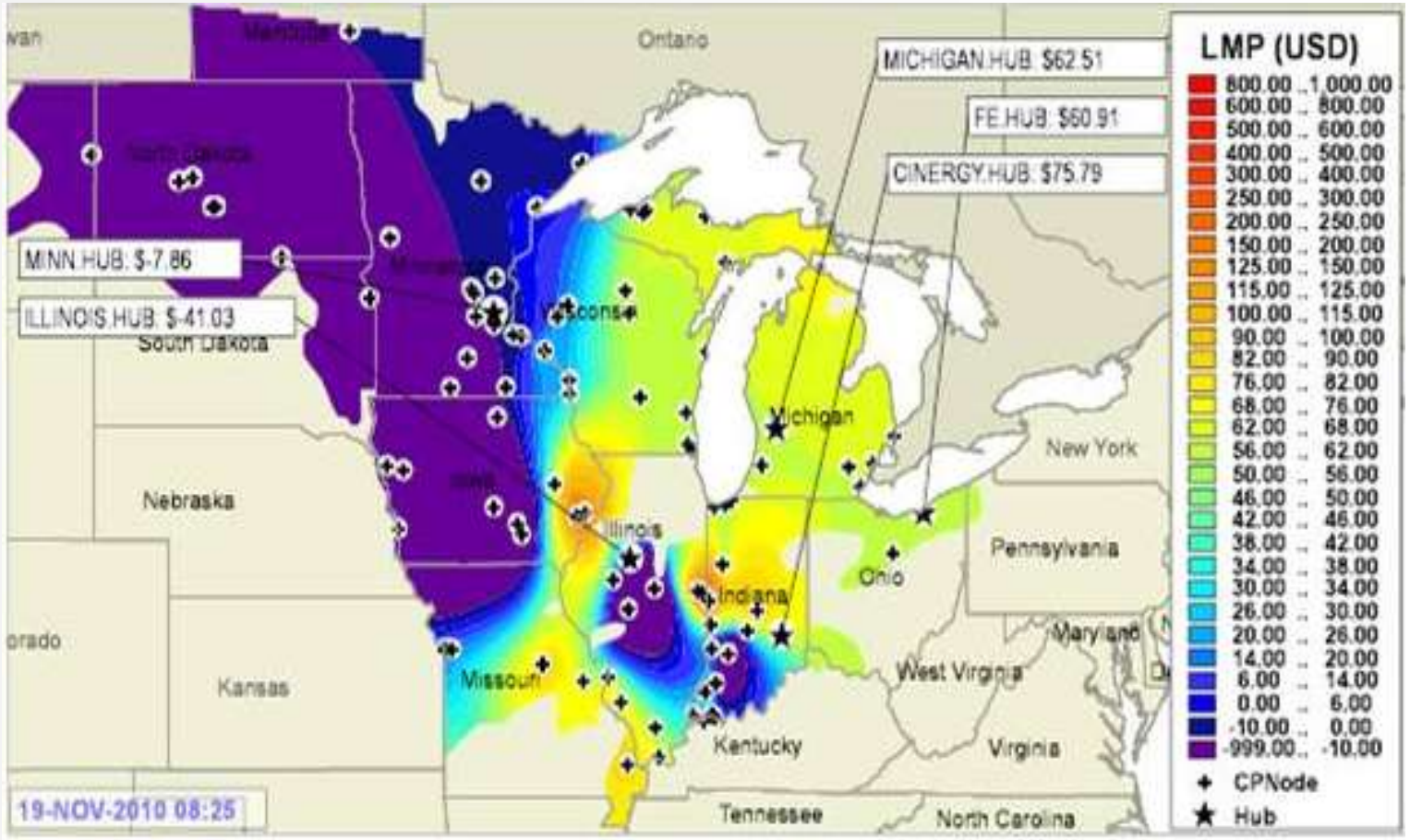
Price Example



http://www.midwestmarket.org/page/LMP+Contour+Map+(EOR)

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Other Pricing Impacts

MISO

- Tax Credits Lead to Negative Hourly Pricing
  - Production Tax Credit
  - Similar Impacts in ERCOT
  - Starting to See Negative Pricing in SPP
- Increased Congestion

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MISO Before Wind

Operations

- Sufficient Transmission Build In Most Areas
- Limited Cycling of Baseload Generation
- Limited Congestion in Western MISO

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Impacts on Thermal Generation

MISO

- Wind is at the Bottom of the Generation Stack
- Due to High Off-Peak Wind, Cycling of Gas and Coal has Become More Common
  - Leads to an Increase in Required Maintenance for Coal
- Nuclear Facilities in High Wind Areas Receive Lower Pricing Because of Inflexible Dispatch (eg. Duane Arnold)

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Market Impacts

Minimum Generation

- Low Load and High Wind
- MISO Must Dispatch Thermal Generation at Minimums
- Too Much Supply

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Curtailment

MISO

- ISOs Can Curtail Wind Based on Reliability and Transmission Congestion
- All ISOs Have or Will Have a Penalty for Not Reacting to a Curtailment Request
- Wind generation is price sensitive, but will not voluntarily curtail until much lower than normal

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Exports

Southeast

- TVA Purchased 1625MW From MISO and SPP Interconnections
- Entergy Indicated Interest
- SOCO Will Have Pressure to Follow

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Transmission Cost Allocation

MISO

- Limited Transmission Capability Near Existing Wind
- Wind Is Not Near Load Centers
- Increase In Congestion/Constraints Due to Installed Wind
- Transmission Needed to Meet State RPS Standards

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Transmission Cost Allocation

Regional Generation Outlet Study

- MISO Studied Needs for Transmission Portfolios to Meet State RPS Standards
- Cost of New Transmission Ranged from $16B-$22B
- Led to Candidate MVP Projects

Source: Midwest ISO Regional Generation Outlet Study 11/19/10

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Transmission Cost Allocation

MISO

- The Midwest ISO Filed Their New Cost Allocation Methodology on July 15, 2010
- FERC Approved Methodology in in December 2010
- Summary:
  - 100% Postage Stamp of Revenue to Load and Exports for MVPs
  - Unclear What Criteria Qualifies as MVP
  - Generation Interconnection is Unchanged
  - An Export Rate Will Be Developed to Eliminate Free Riders Outside of MISO
- Generation Interconnection Costs Mostly Paid by the Interconnection Customer

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Transmission Cost Allocation

Comparison to Other RTOs

- MISO: Initial MVP Projects Coming Soon
- ERCOT: Stable Method, Construction of CREZ Projects Underway
- SPP: FERC Approved Highway Byway, Construction of New Lines Underway
- PJM: Method in Place, Construction of New Lines Underway

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Transmission Projects

MISO

- MISO Uses MTEP as the Primary Expansion Plan but Regional Generation Outlet Study (RGOS) is Looking at Wind Penetration through Regional Expansion Criteria and Benefits Task Force (RECBTF)
- CapX2020 – 11 utilities in Minnesota to expand aging infrastructure connecting ND, SD and WI to transmission around Twin Cities
- SMARTransmission – Upper Midwest utilities, EHV overlay for wind integration
- MEGA GONZO – Excel Engineering plan for 45GW wind integration to Upper Midwest

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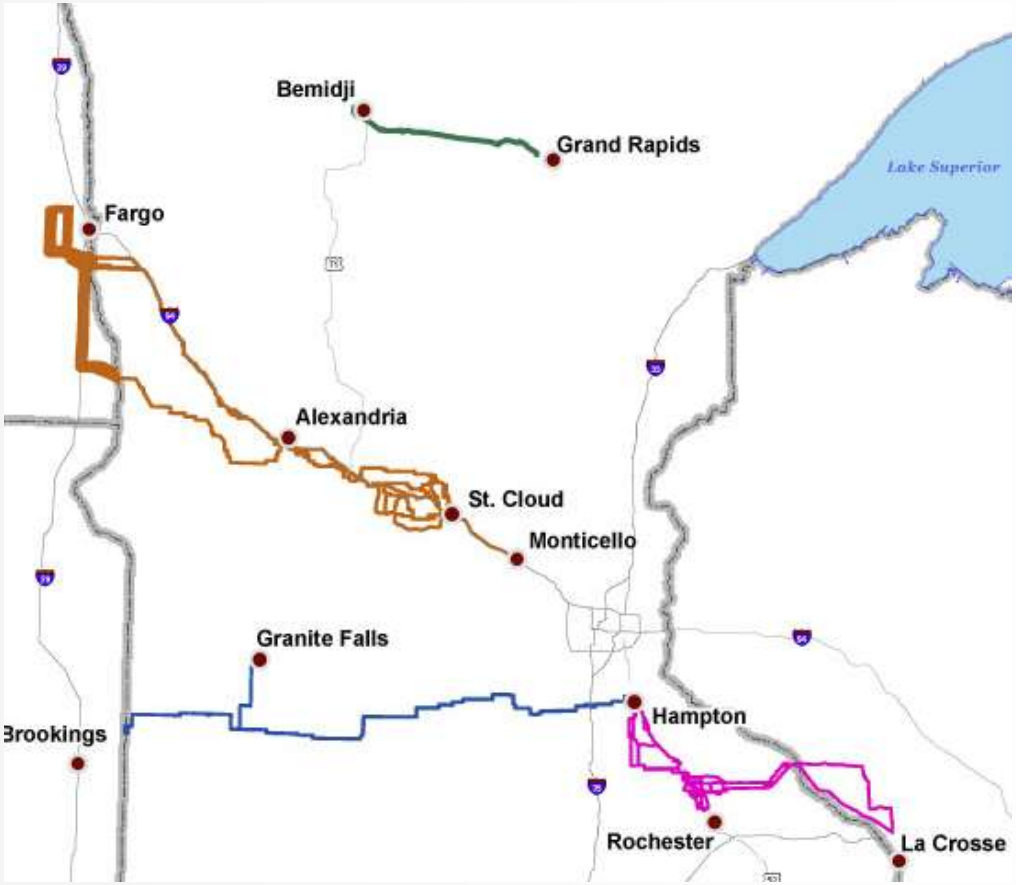
Transmission Projects

MISO



http://www.capx2020.com/Projects/

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Transmission Projects

MISO MVP

- A result of the RGOS process
- Predominantly 345 kV
- Intended to interconnect RGOS zones to existing infrastructure
- Designed to be compatible with multiple future transmission solutions
- Included in MTEP 10 as possible suggestions for addition and will be further analyzed in MTEP 11

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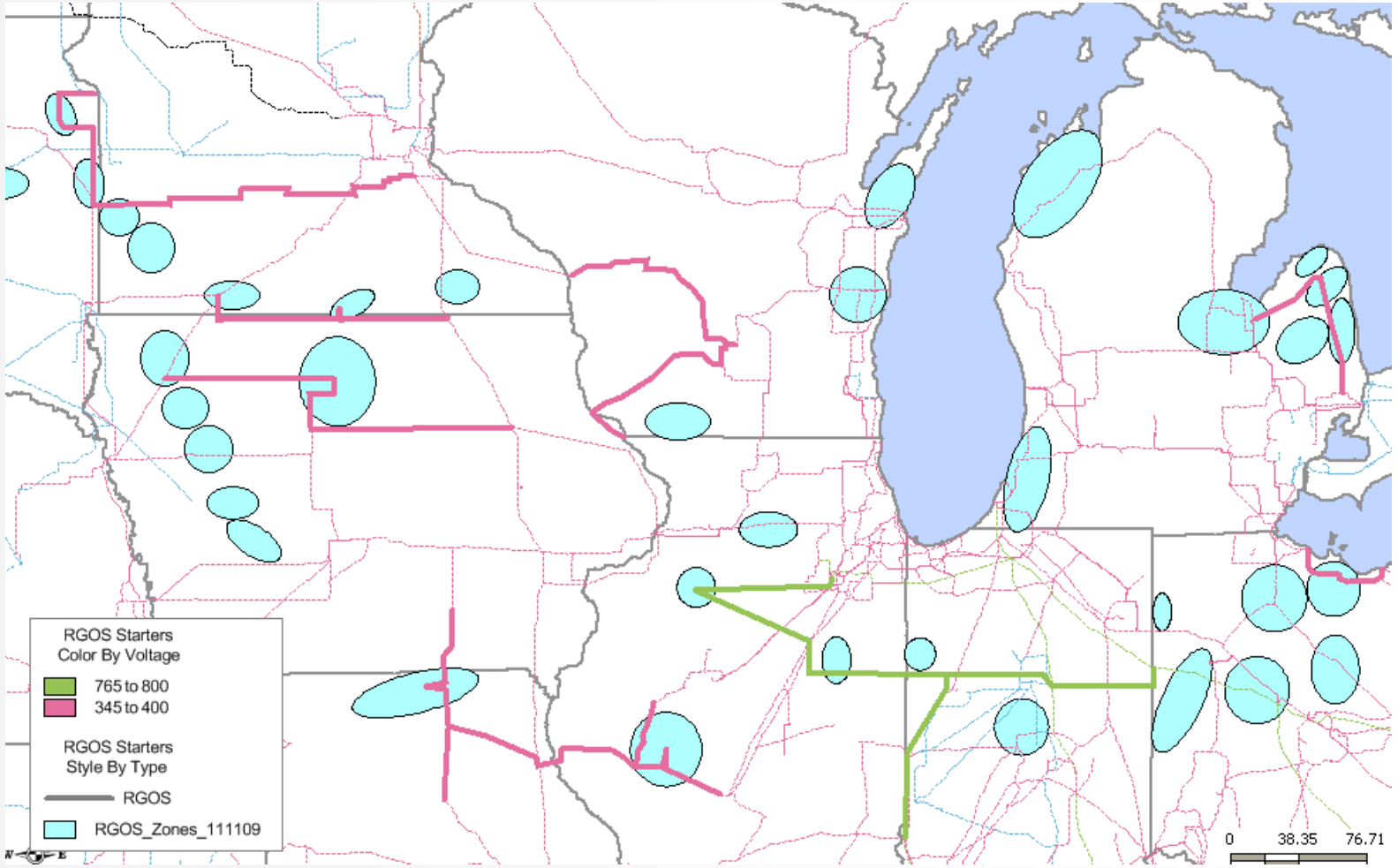
Transmission Projects



https://www.midwestiso.org/Library/Repository/Study/MTEP/MTEP10/MTEP%2010%20Final%20Report.pdf

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Long Term Outlook

- Dispatchable Intermittent Resources (DIRs)
  - Ability to Dispatch Wind Down
  - MISO Filed with FERC
- Continued Growth In Wind
  - Tax Credits Last Until At Least 2012
  - MISO Needs ~22,000 MW of Renewable Resources to Meet State RPS Needs (Does Not Include Exports)
- MISO Needs to Get Transmission Built
  - CapX2020 Is First Step
  - Much More is Needed

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Long Term Outlook

- Continued Low Prices in Western MISO
  - Particularly with Low Natural Gas Prices
- Limited Baseload Build in Western MISO
  - Due to Economics
  - Lmiited Transmission
- MISO Member Movement
  - Do Not Want to Pay for Transmission

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Questions

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