Northern Area Study

Technical Review Group (TRG)
4th Meeting

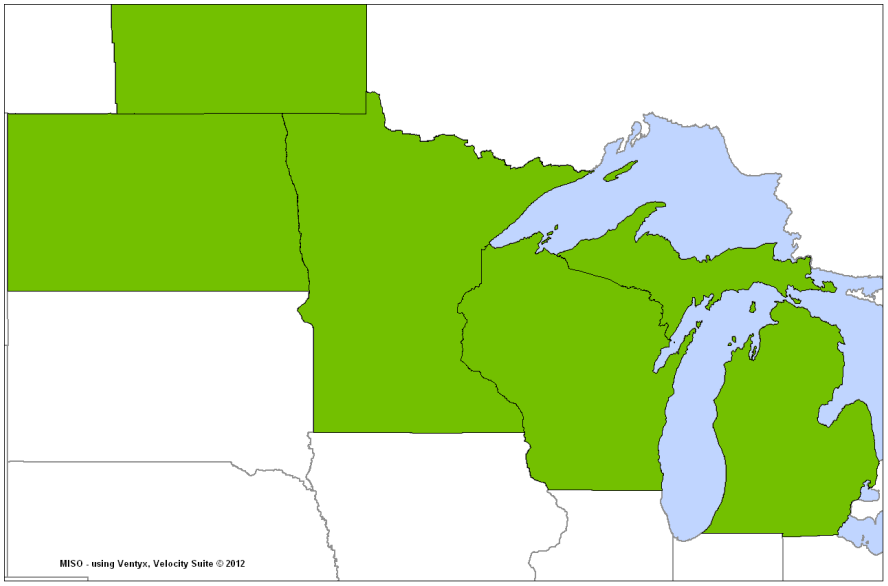
Presentation: November 2, 2012
Slides Updated: November 13, 2012

Agenda

• Welcome, Roll Call, and Review Agenda	9:00 AM
• Recap September 21st Meeting	9:05 AM
• Related Study Status Report	9:30 AM
– Manitoba Hydro Wind Synergy Study	
– TSR Update	
• Presque Isle Retirement Sensitivity Analysis	9:45 AM
• NAS Transmission Solutions and Work Plan	10:15 AM
• Scenario Selection	11:15 AM
• Transmission Line Costs	11:30 AM
• Schedule Update	11:40 AM
• Open Discussion and Next Steps	11:50 AM
• Adjourn and Lunch	12:00 PM

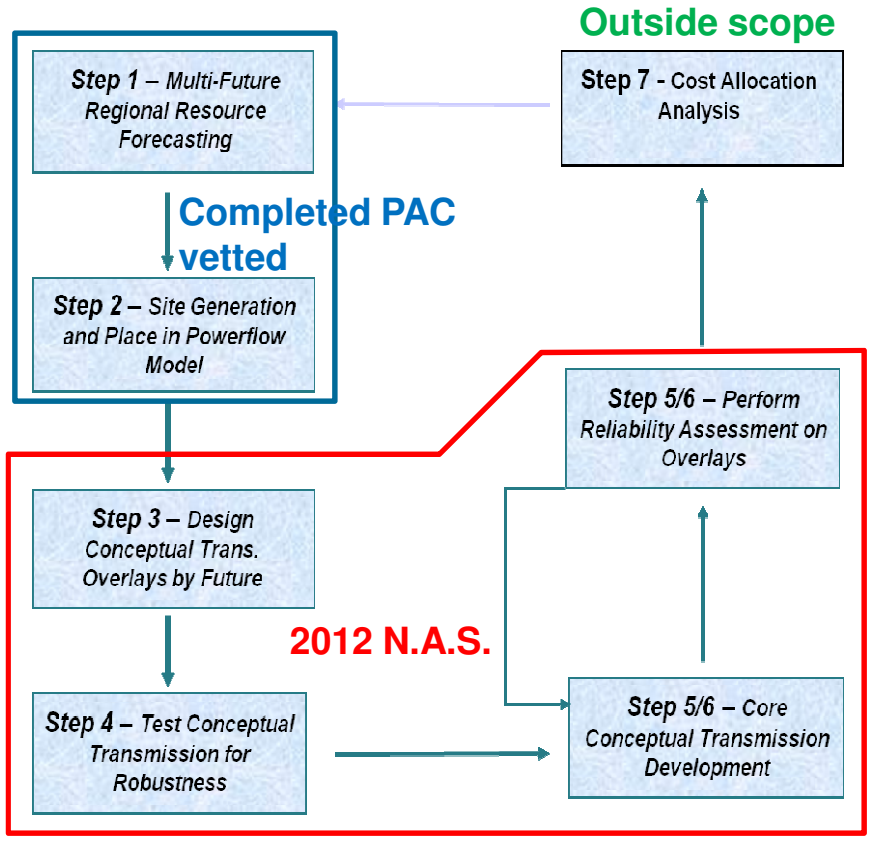
Study Recap

- **Driver: Multiple proposals by stakeholders & reliability issues located in MISO's northern footprint**
- **Objective is to conduct a comprehensive study to:**
  - Identify the economic opportunity for transmission development in the area
  - Evaluate the reliability & economic effects of drivers on a regional, rather than local, perspective
  - Develop indicative transmission proposals to address study results with a regional perspective
  - Identify the most valuable proposal(s) & screen for robustness
- **2012 analysis will provide guidance for next steps**



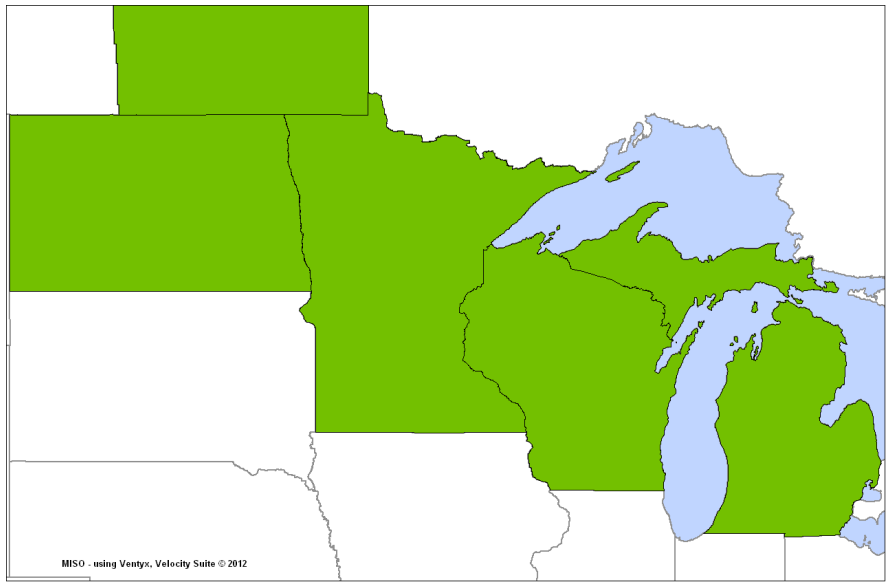
Study Progress

- **Northern Area Study is following the MISO 7 Step Planning Process that has been used for many of MISO's studies, including MTEP**
  - Currently, in Step 3 conceptual transmission overlay design and beginning Step 4 test conceptual transmission
  - Northern Area Study is using MTEP12 models as the base with specific updates to:
    - Load Levels
    - Imports from Manitoba Hydro
    - Presque Isle Unit Retirement
  - Assumptions finalized at July 11th TRG meeting



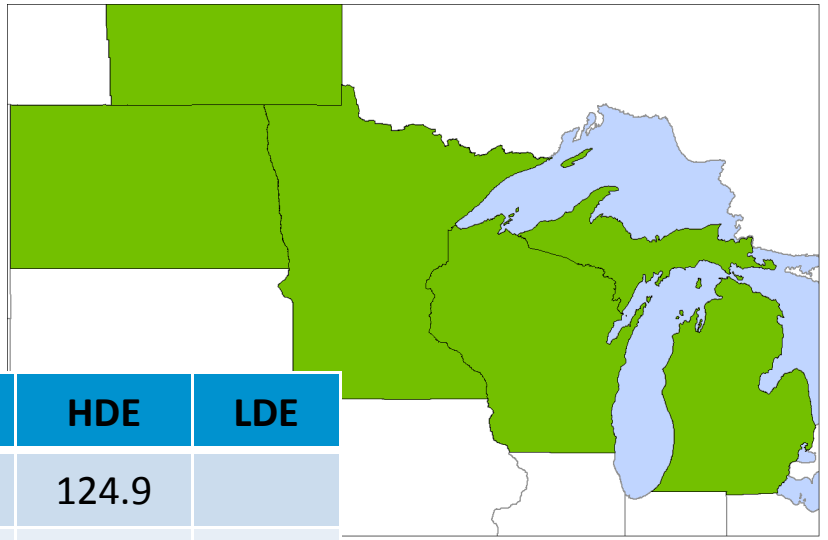
Sept 21st TRG Recap
Economic Potential

- **Provides the magnitude of economic benefits that are available and how best to capture them**
- **Potential calculated by comparing constrained and unconstrained cases – what we have vs. what we want**
- **Unconstrained case relaxes all transmission constraints in the green area (infinite ratings)**
- **Optimal generation dispatch – doesn't care how it gets there**



Sept 21st TRG Recap
Maximum Economic Potential
2027 MISO APC Savings ($M-2027)

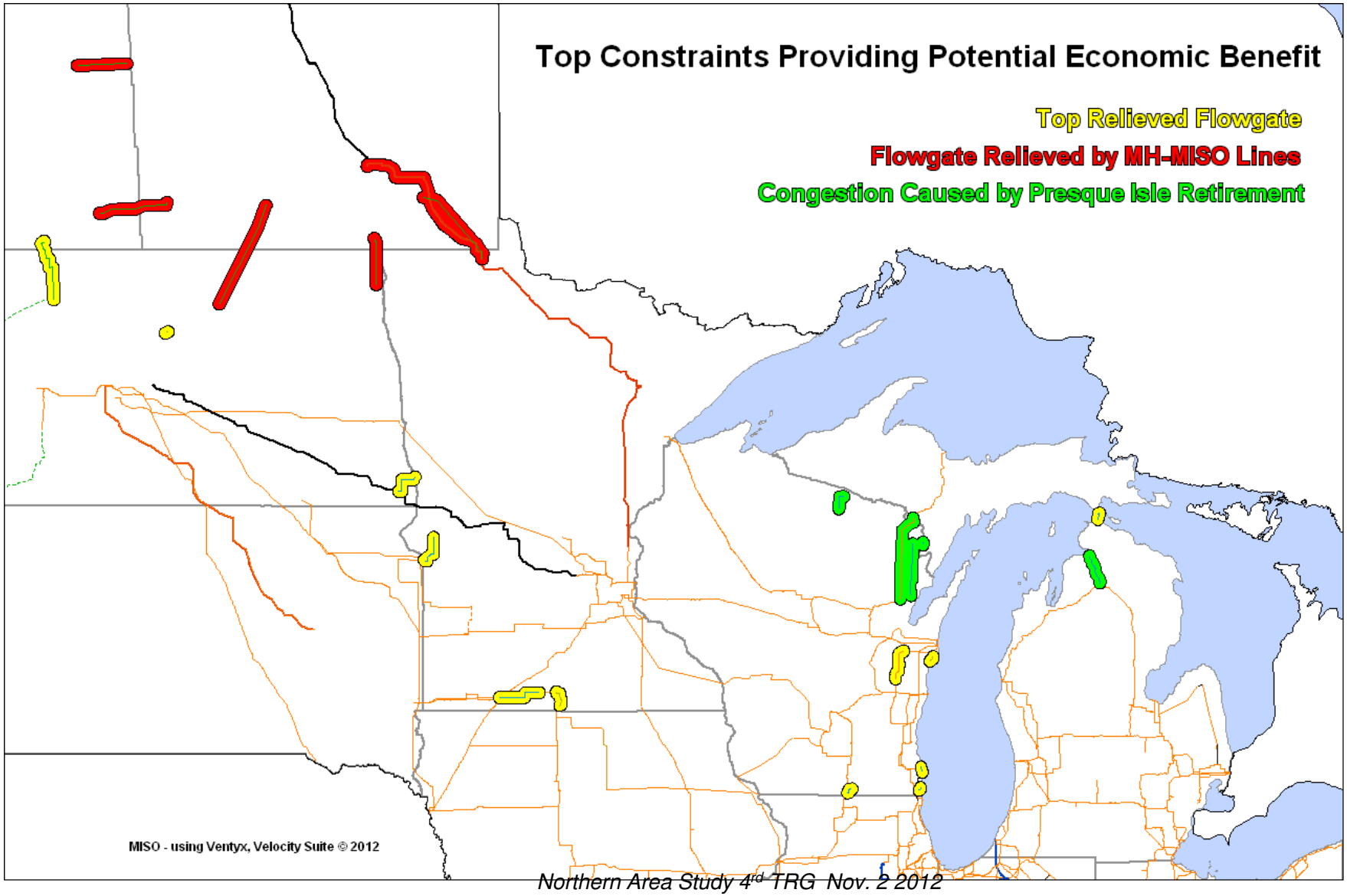
Total MISO benefit from relaxing all constraints in NAS footprint



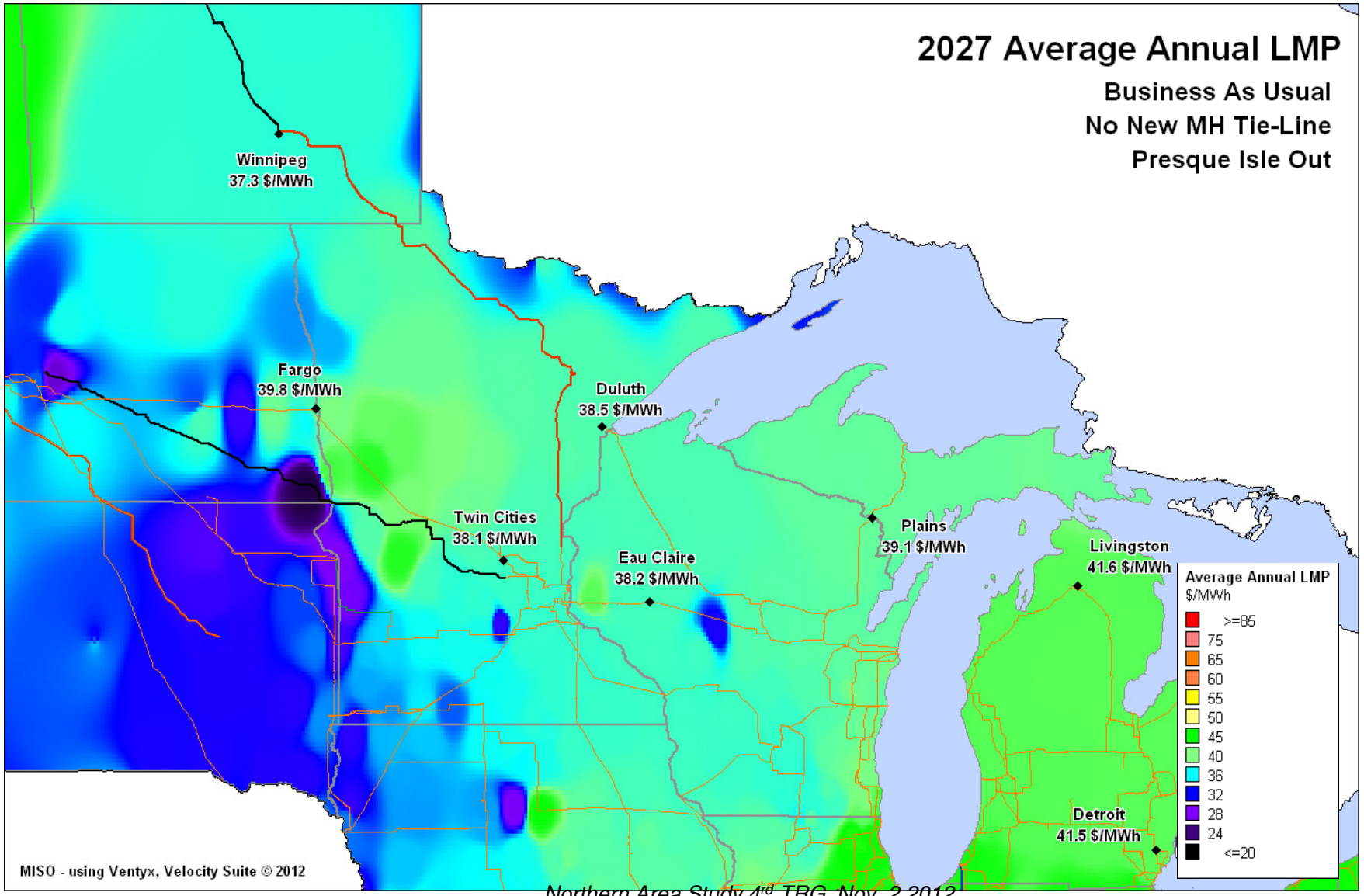
Scenario	BAU	HDE	LDE
No new MH tie-line, Presque Isle In	31.5	124.9	
No new MH tie-line, Presque Isle Out	30.1	126.8	5.5
MH - Duluth 500kV tie-line, Presque Isle In	20.9	113.0	4.7
MH - Duluth 500kV tie-line, Presque Isle Out	22.6	113.7	5.0
MH - Fargo 500kV tie-line, Presque Isle In	30.8	107.1	13.2
MH - Fargo 500kV tie-line, Presque Isle Out	29.9	110.7	12.8
MH - "T" 500kV tie-line, Presque Isle In	24.4	111.8	4.6
MH - "T" 500kV tie-line, Presque Isle Out	24.1	117.3	4.1

$100M in maximum economic potential could justify a $300M project with a 1.25 B/C ratio

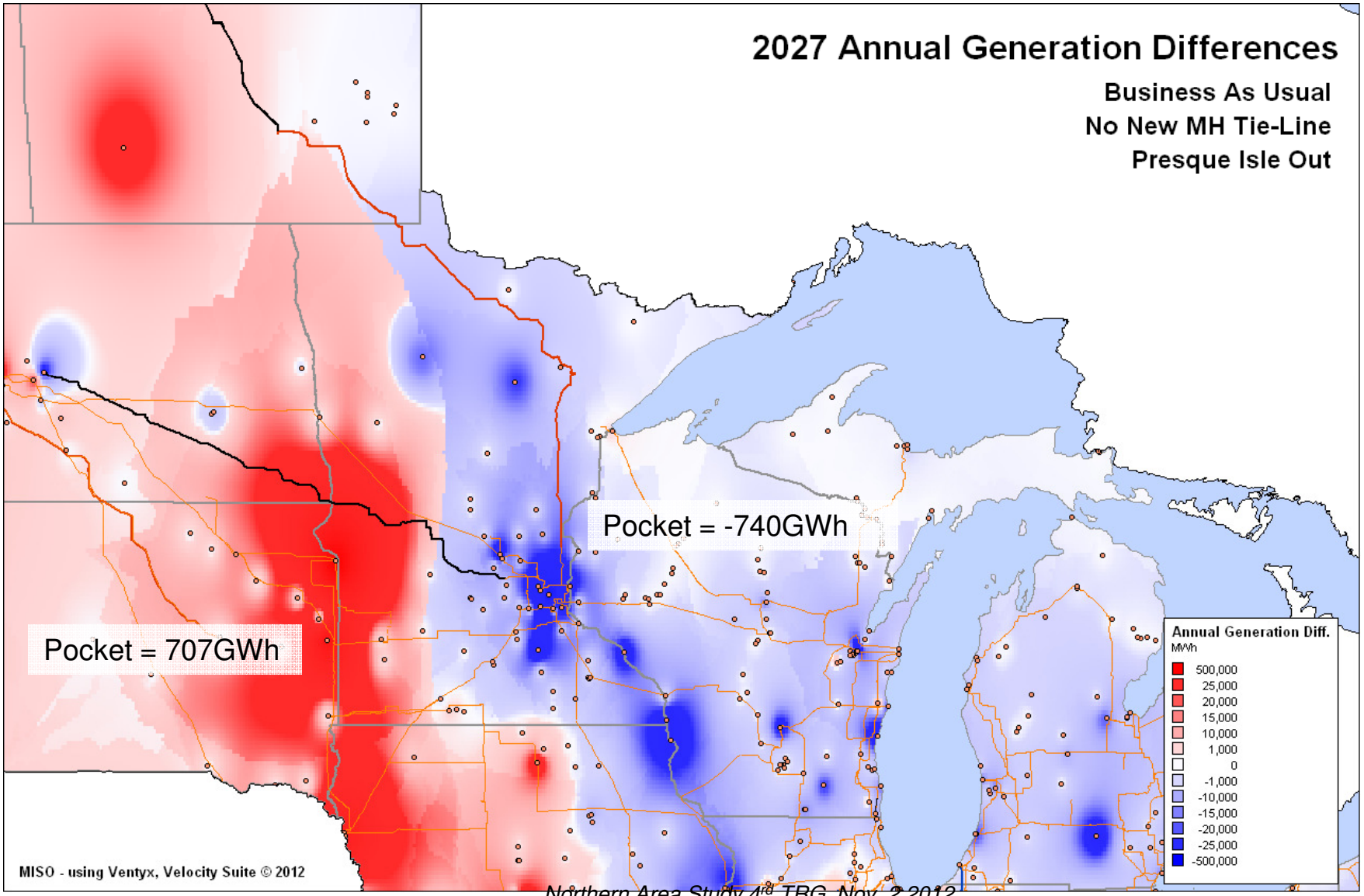
Sept 21st TRG Recap
Congestion Report



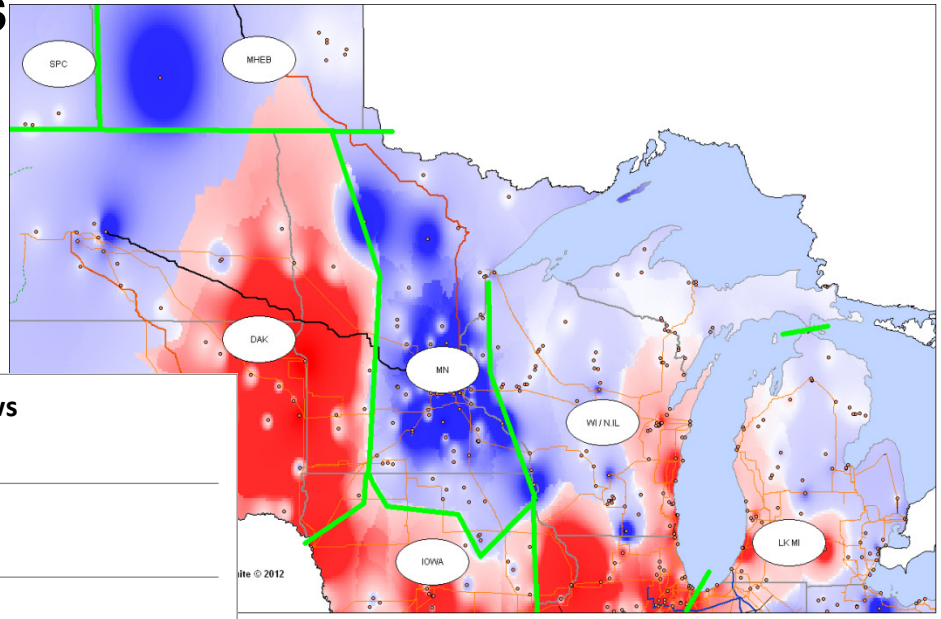
Sept 21st TRG Recap
Average Annual LMP

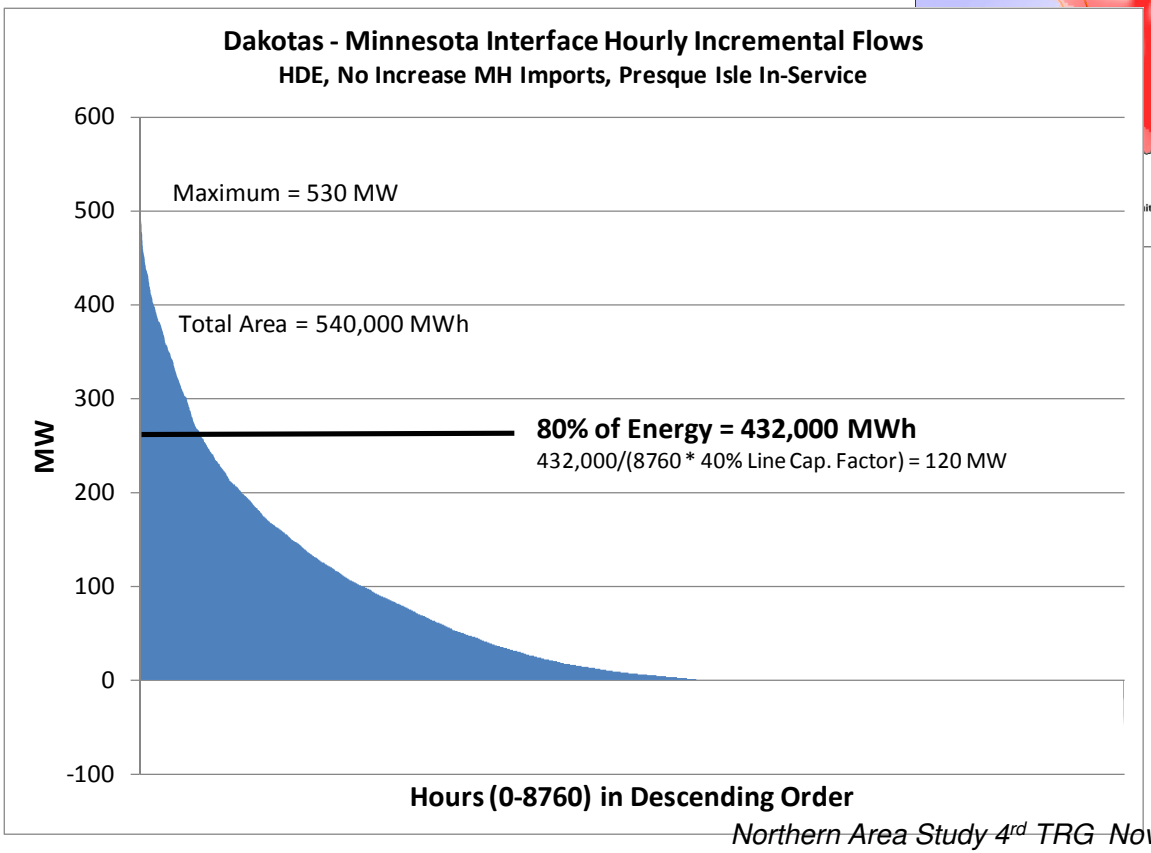


Sept 21st TRG Recap
Sources and Sinks



Sept 21st TRG Recap
Incremental Interface Flows





Sept 21st TRG Meeting Follow-Ups

- **Posted full economic potential results package**
- **PROMOD models posted to the FTP site**
- **Asked TRG to review economic potential results and send in transmission plans**

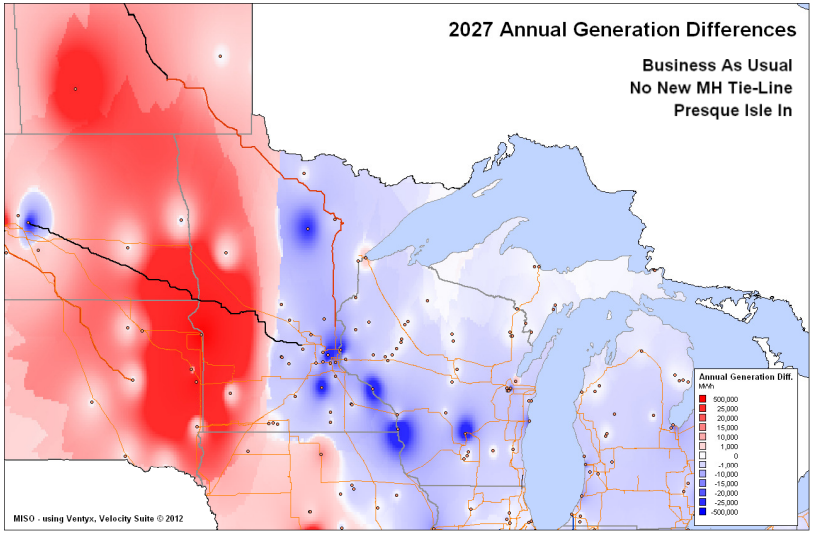
Models Updated With TRG Feedback

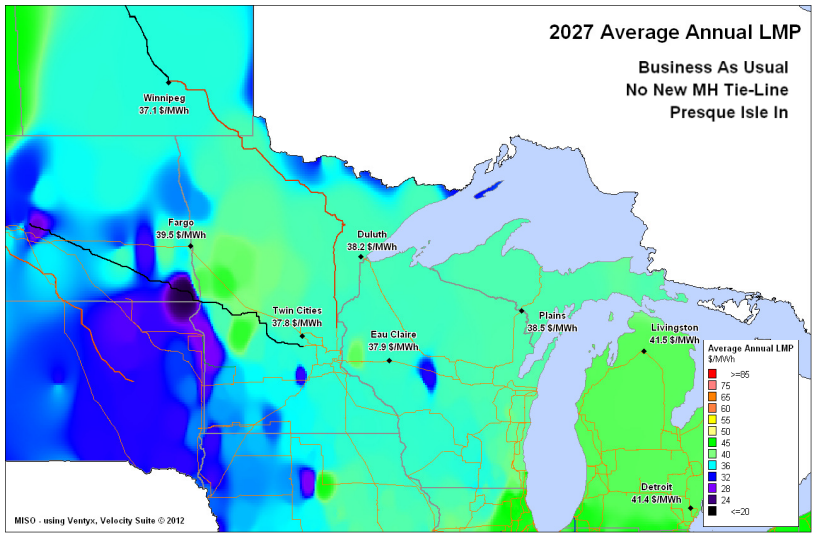
- **Noteworthy Updates:**
  - Manitoba Hydro units updated
    - Run-of-river hydro units modeled as hourly schedules to be consistent with Manitoba Hydro Wind Synergy Study
    - MH generation changed from Keeyask to Conawapa in the *No New Tie-line to MH* scenario. The *With New Tie-line* scenarios includes both Keeyask and Conawapa, which is unchanged and consistent with MH's power resource plan
  - Ontario and SaskPower generating units updated
  - Transmission projects in Wisconsin corrected
  - New Manitoba – Fargo option modeled
- **Updated PROMOD models posted to the MISO FTP site (NDA and PROMOD license required)**

  ftp://ftpstp.midwestiso.org/pub/promodug/Northern_Area_Study_11022012/

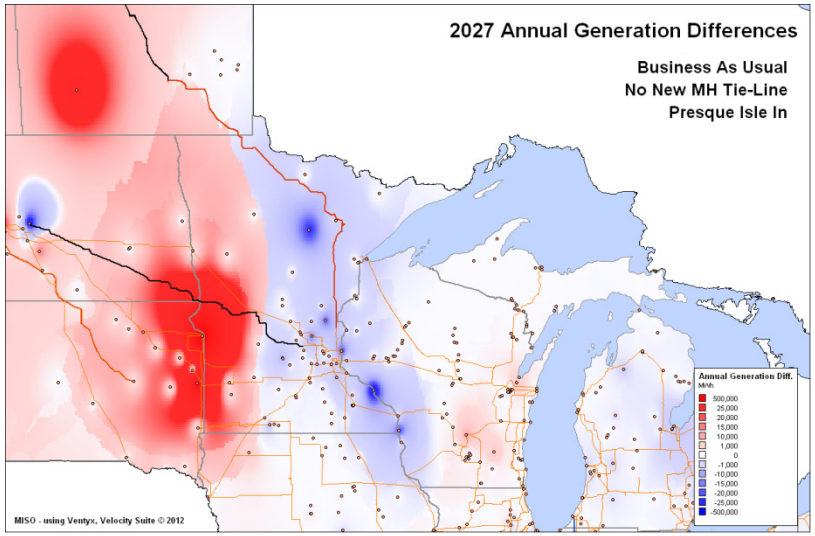
Model Updates Don't Significantly Affect Trends

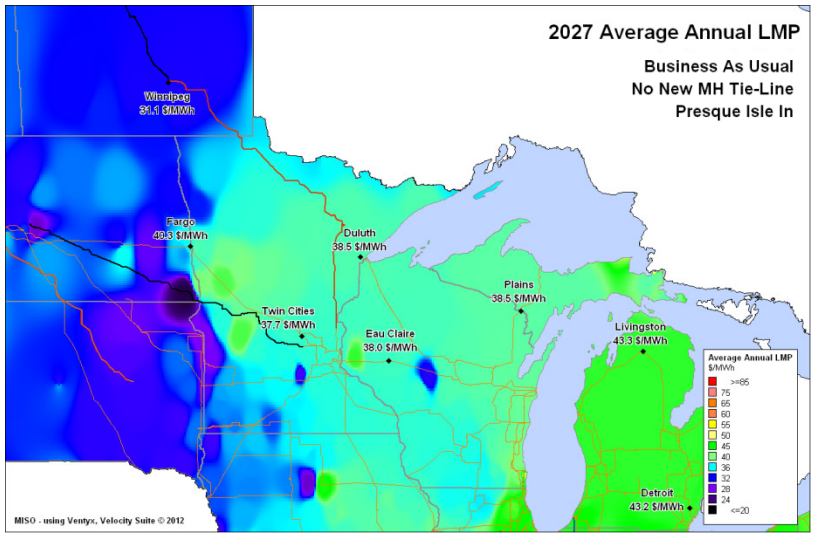
9/21





Updated



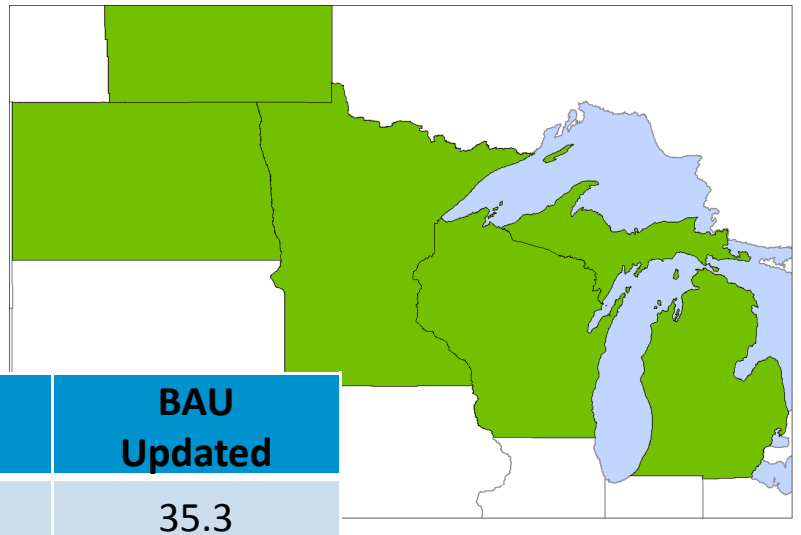


Northern Area Study 4rd TRG Nov. 2 2012
Slides Updated Nov. 13 2012

Model Updates Provide Similar Potential Benefits

2027 MISO APC Savings ($M-2027)

Total MISO benefit from relaxing all constraints in NAS footprint



Scenario	BAU 9/21	BAU Updated
No new MH tie-line, Presque Isle In	31.5	35.3
No new MH tie-line, Presque Isle Out	30.1	36.5
MH - Duluth 500kV tie-line, Presque Isle In	20.9	34.0
MH - Duluth 500kV tie-line, Presque Isle Out	22.6	34.2
MH - Fargo 500kV tie-line, Presque Isle In	30.8	28.9
MH - Fargo 500kV tie-line, Presque Isle Out	29.9	29.0
MH - "T" 500kV tie-line, Presque Isle In	24.4	33.6
MH - "T" 500kV tie-line, Presque Isle Out	24.1	33.4

HDE and LDE have similar trends

Kewaunee Nuclear Plant Retirement

- **On October 22, Dominion Resources announced they would retire the Kewaunee Nuclear Plant by mid-2013**
- **Maximum capacity of 556 MW**
- **Located in Carlton, Wisconsin (southeast of Green Bay)**
- **How to account in NAS?**
- **Attachment Y upgrades are not known**
- **Planning reserve margins must be maintained**
- **Proposal 1: Retire Kewanee in all cases all scenarios**
  - Updated EGEAS expansion shows no change to 2027, in-service date moves up for select RRF units (will change earlier year cases)
  - Attachment Y upgrades not included
- **Proposal 2: Leave unit as is and wait for more clarity**
- **Once line testing begins we can't change model assumptions**
- **TRG thoughts?**

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Manitoba Hydro Wind Synergy Study Update

- **Phase 1 and 2 are finished**
  - Established PLEXOS model with both electric system and hydraulic system included
  - Evaluated the potential benefit of bi-directional RT participation of MHEB hydro resources through external asynchronous resource (EAR)
- **Phase 3 study work is under way**
  - 3 transmission options received
  - First iteration of simulation is done
  - Preliminary results to be presented in Nov. 5th TRG meeting

Manitoba Hydro Long-Term TSRs

TSRs currently queued

- **Group study 4 TSRs totaling 1,100 MW**
- **Facility study completed $1.5 Billion in upgrades required.**
- **Customers have not indicated a willingness to commit to upgrades to date.**

Minnesota Power has requested that MISO perform a sensitivity study for their portion of the group study plus two additional options.

- **Three transfer options currently under study.**
  - 250 MW, 750 MW and 1,100 MW

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Presque Isle Retirement Sensitivity Analysis

- **It is public knowledge that retirement is being *considered* for the Presque Isle plant**
- **A MTEP sensitivity analysis is recommended because of potentially significant upgrades may be required to be planned and constructed in constrained time period**
- **Therefore, developing a potential mitigation plan in open stakeholder process is reasonable and prudent MTEP sensitivity analysis**
  - We need to determine what is necessary to allow Presque Isle to retire
  - We should also consider alternatives that may enable a long-term economic solution which are under study in NAS

Presque Isle Retirement Sensitivity Analysis

- **Presque Isle plant in Marquette, MI is the only base load plant in the Upper Peninsula**
  - 5 units: 2x55 + 3x78 MW = 344 MW total
  - Except for when on peak, at least one unit is always on maintenance outage
- **Base models: MTEP12 2017 Phase 2 series**
  - Peak
  - Off-peak with UPMI scalable loads to 80%
- **Generation dispatch**
  - Apply any topology adjustments
  - Outage plant and SCED for the “off” cases
  - Return plant to service and scale down ATC thermal fleet for the “on” cases

Presque Isle Retirement Sensitivity Analysis

- **Assumptions**
  - Straits VSC
    - Peak: 0 MW
    - Off-peak: 40 MW North-South
  - Load growth in the study area can be neglected. 2016 ≈ 2017
- **Topologies**
  - 2016
    - Escanaba Steam repowered as biomass
  - 2017
    - Green Bay-Morgan 345 kV line in service
    - Chalk Hills-18th Road 138 kV line in service

Presque Isle Retirement Sensitivity Analysis

- **Options to mitigate retirement-driven constraints**
  - Morgan-Plains-National 345 kV
  - Gardner Park-Venus-National 345 kV
  - Arrowhead-National 345 kV line
  - National-Livingston 345 kV line
  - Eau Claire-Park Falls-Cranberry-Plains 345 kV line
  - A generic “3rd 138 kV line” to the load pocket
  - Any new ideas?

Presque Isle Retirement Sensitivity Analysis

- **Steady State AC contingency screening**
  - Peak: Category A, B, C
  - Off-peak: Category A, B, C

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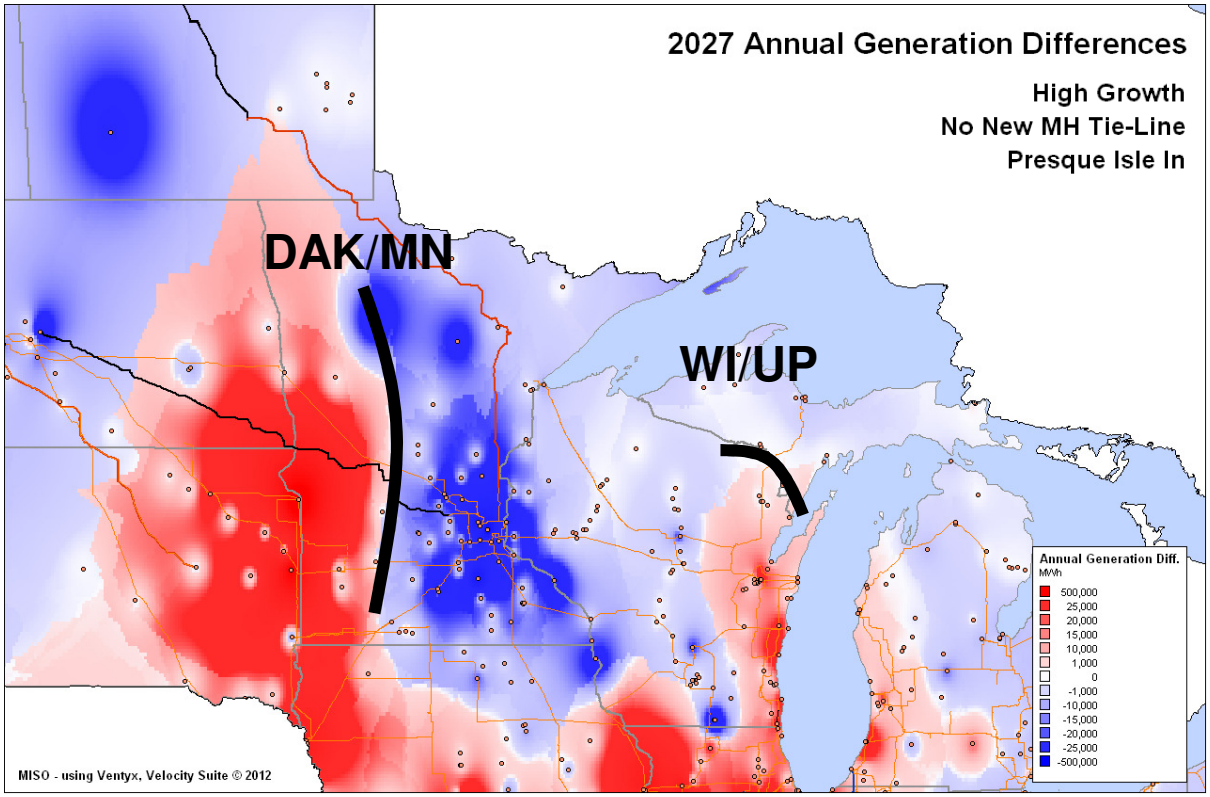
Northern Area Study Transmission Solutions

- **Goal: Present transmission solutions in an open and transparent setting**
- **Discuss proposed transmission solutions and how they exploit economic potential – are there other plans that may work better or aren't included?**
- **Additional transmission plans will be accepted through Friday November 9 – complete list of plans will be emailed to TRG**
- **Ultimate goal is to test, refine, and combine plans into optimal "if" solutions**
  - "If" this were to happen then this transmission project may be a good fit
- **Transmission design is an iterative process – "fix" something then see what happens**

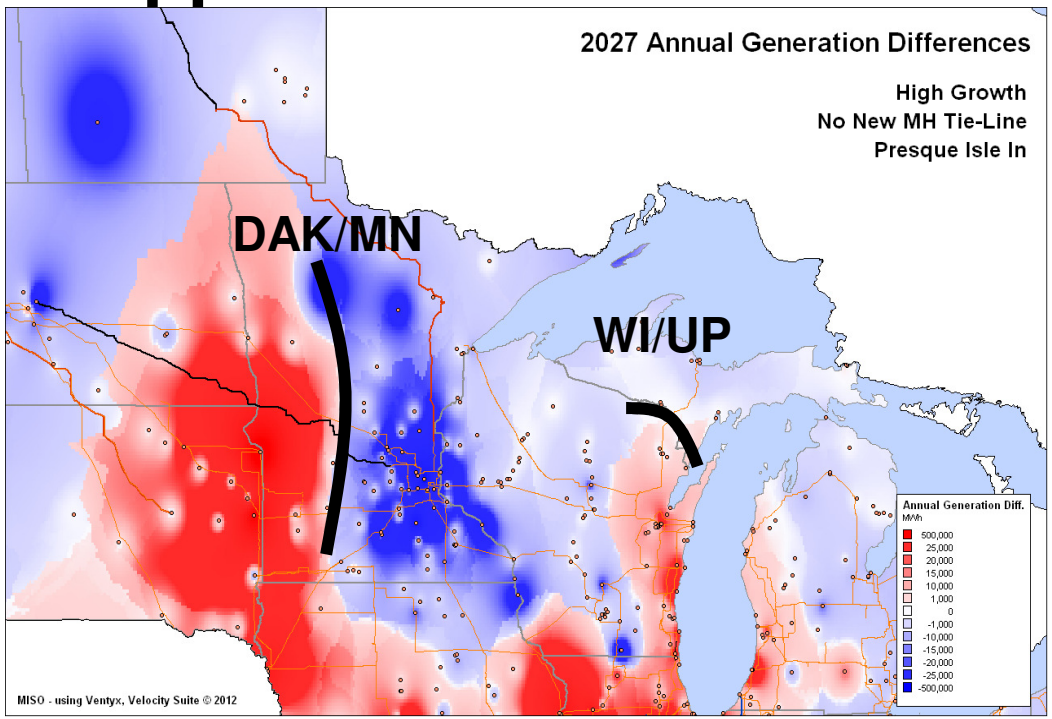
Economic Potential Data Trends



- **Generally, all 24 sensitivities had similar trends**
- **Two primary "pockets" or interfaces for potential benefit**
  - Dakotas – Minnesota border
  - Wisconsin/Upper Michigan

Dakotas – Minnesota Opportunities

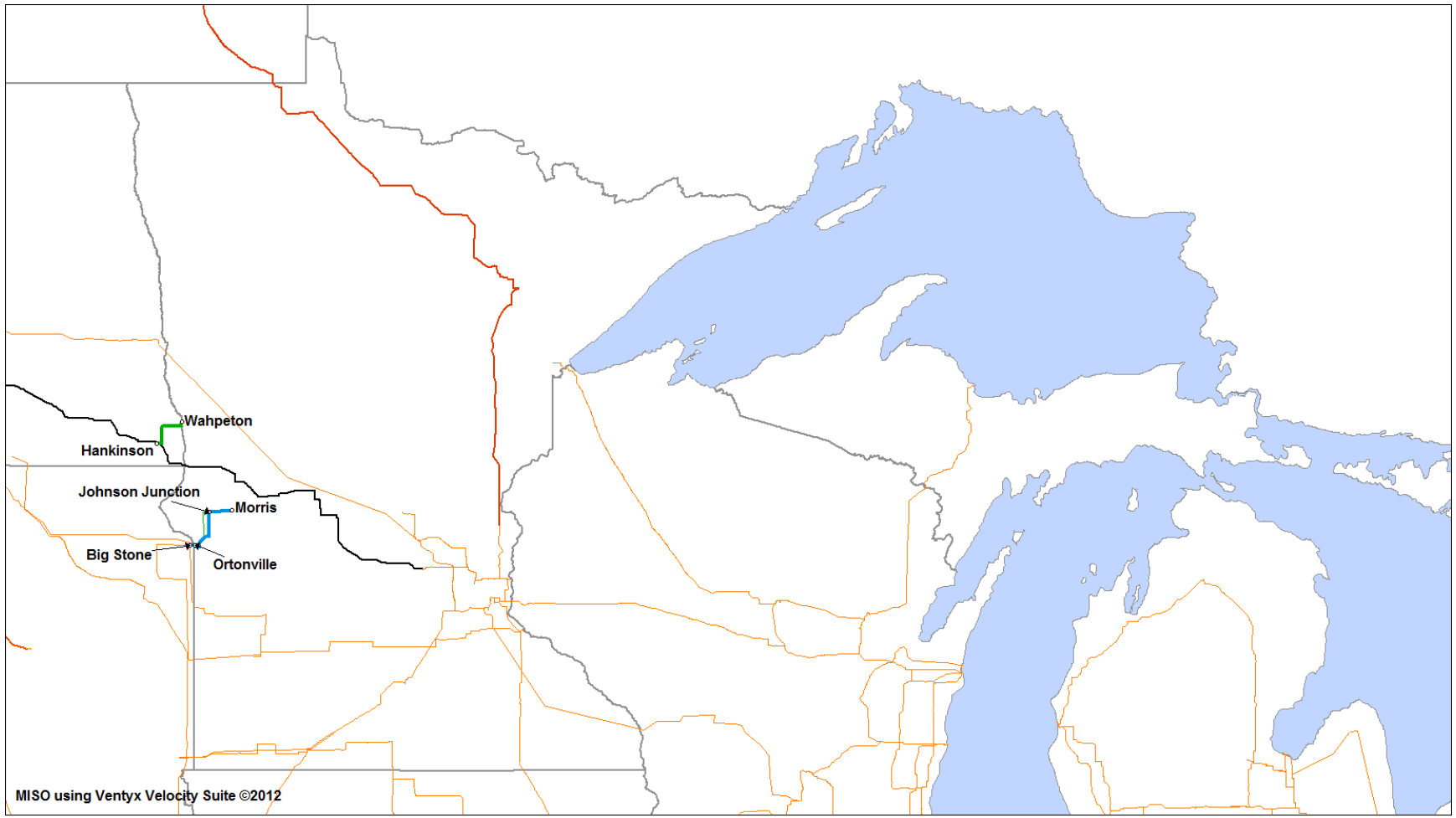
- **Congestion from wind**
- **Seen in all cases; MH-MISO plans all lessen congestion**
- **Presque Isle retirement has little to no effect on this area**



- **Primary Binding Constraints**
  - Hankinson – Wahpeton 230kV
  - Ortonville – Johnson Jct. - Morris 115kV
- **Interface Flow**
  - BAU: 550 GWh (600 MW max,130 MW at 80% duration and 40% CF)
  - HDE: 1,400 GWh (800 MW max, 320 MW at 80% duration and 40% CF)

TRG Supplied Plans (Dakotas – MN)

Upgrade Hankinson – Wahpeton 230kV and Big Stone – Morris 115kV



Lines are for illustrative purposes only, actual line routing may differ

TRG Supplied Plans (Dakotas – MN)
Big Stone – Hazel 345kV

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TRG Supplied Plans (Dakotas – MN)
Brookings – Hampton 345kV

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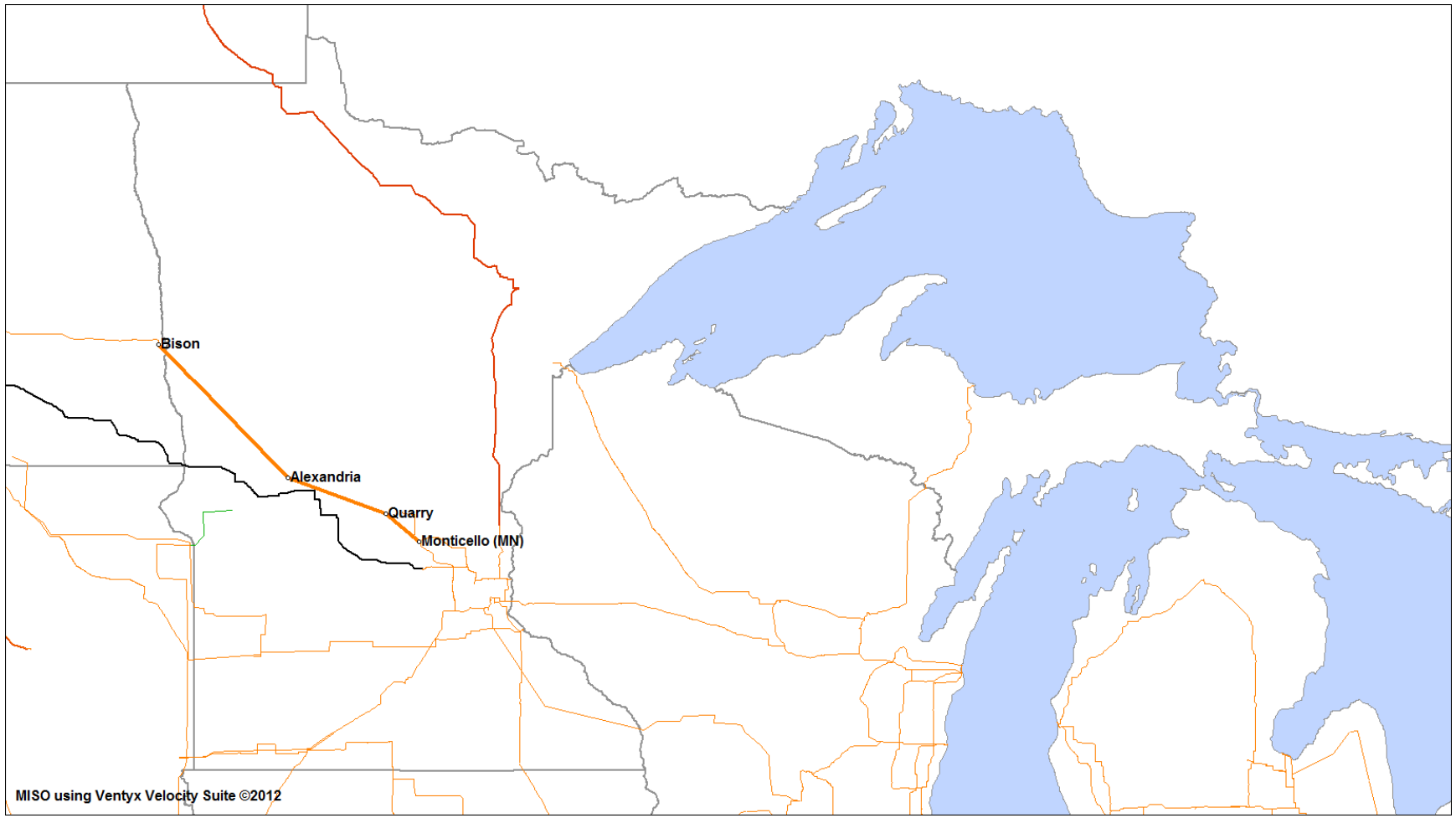
TRG Supplied Plans (Dakotas – MN)
Fargo – Monticello 345kV



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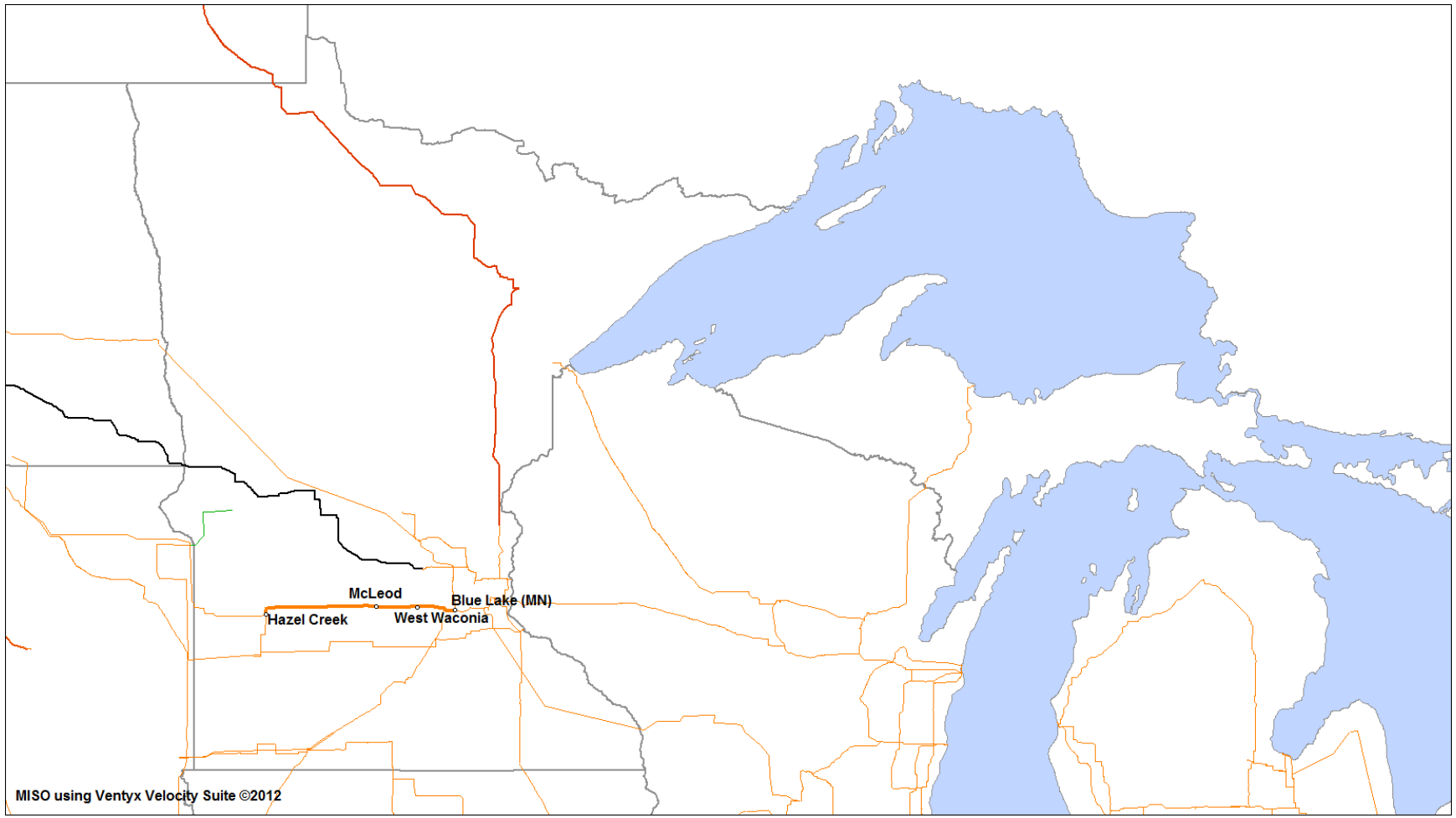
TRG Supplied Plans (Dakotas – MN)

Corridor Project: Convert MN Valley/Hazel – Blue Lk 230kV to 345kVx2



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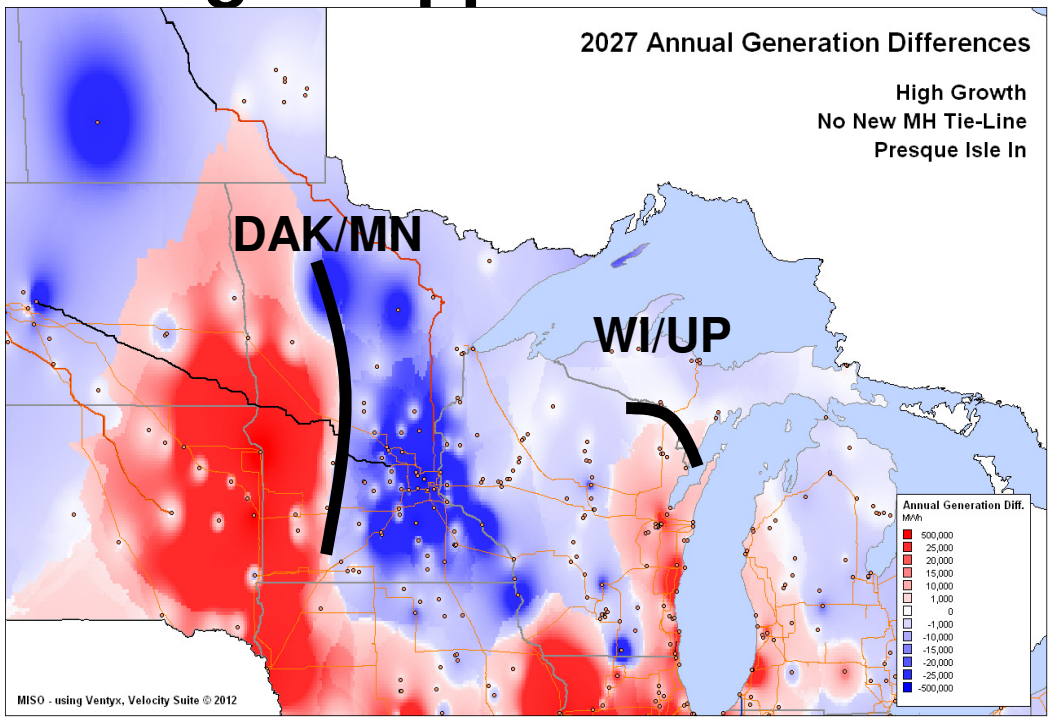
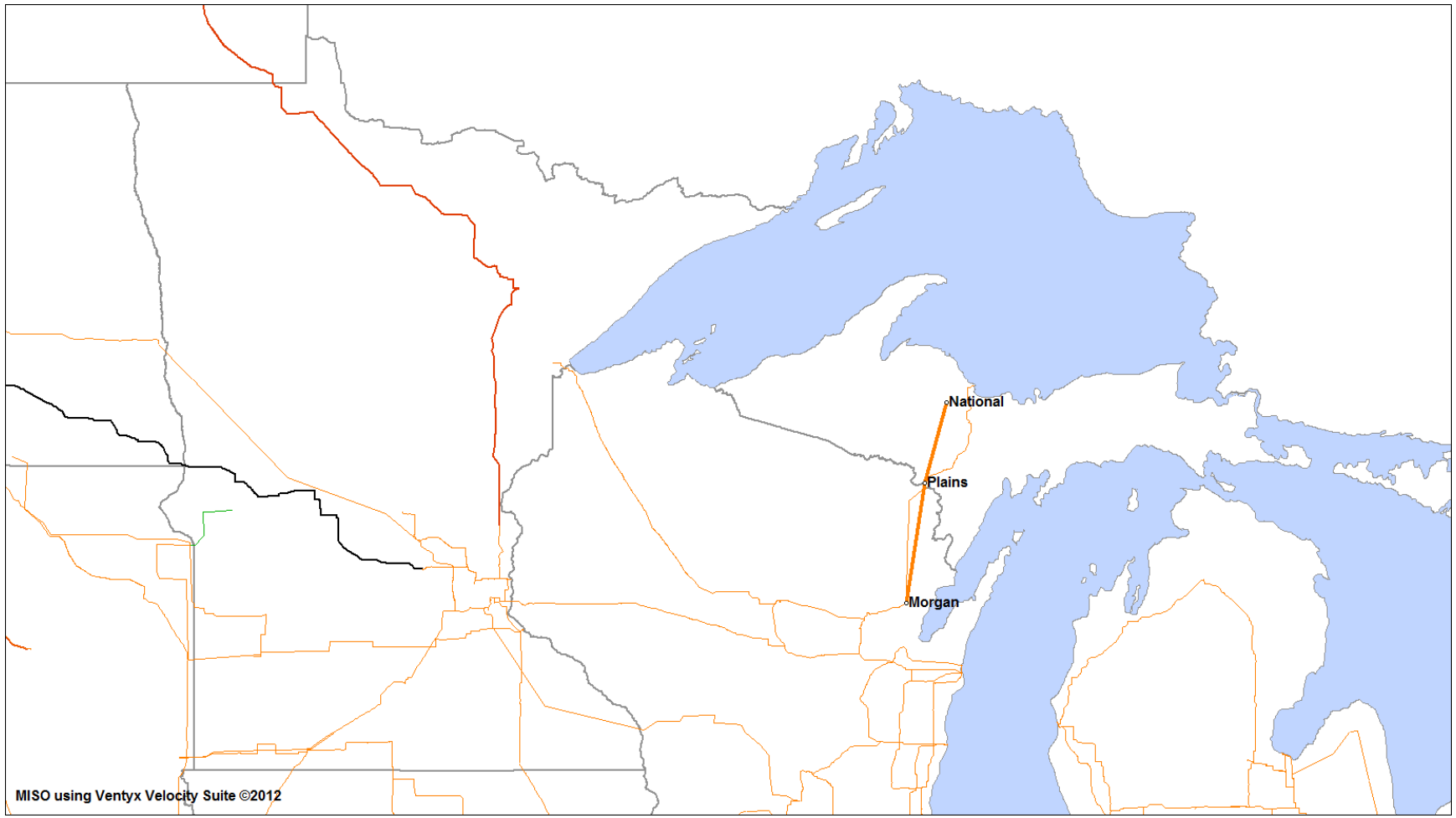
Wisconsin – Upper Michigan Opportunities

- **Congestion from energy trying to get to UP loads and high prices**
- **Highest in HDE futures and Presque Isle retirement**
- **Current topology, MH imports only slightly increase congestion**



- **Primary Binding Constraints**
  - ATC Flow South Interface
  - South Lake Michigan/ComEd
  - McGulpin Interface
- **Interface Flow Across Lake MI (Difficult to Estimate)**
  - BAU: 5,000 GWh (3,330 MW Max; 1,200 MW at 80% duration and 40% CF)
  - HDE: 12,000 GWh (5,000 Max; 2,700 MW at 80% duration and 40% CF)

TRG Supplied Plans (WI/UP)
Morgan – Plains – National 345kV



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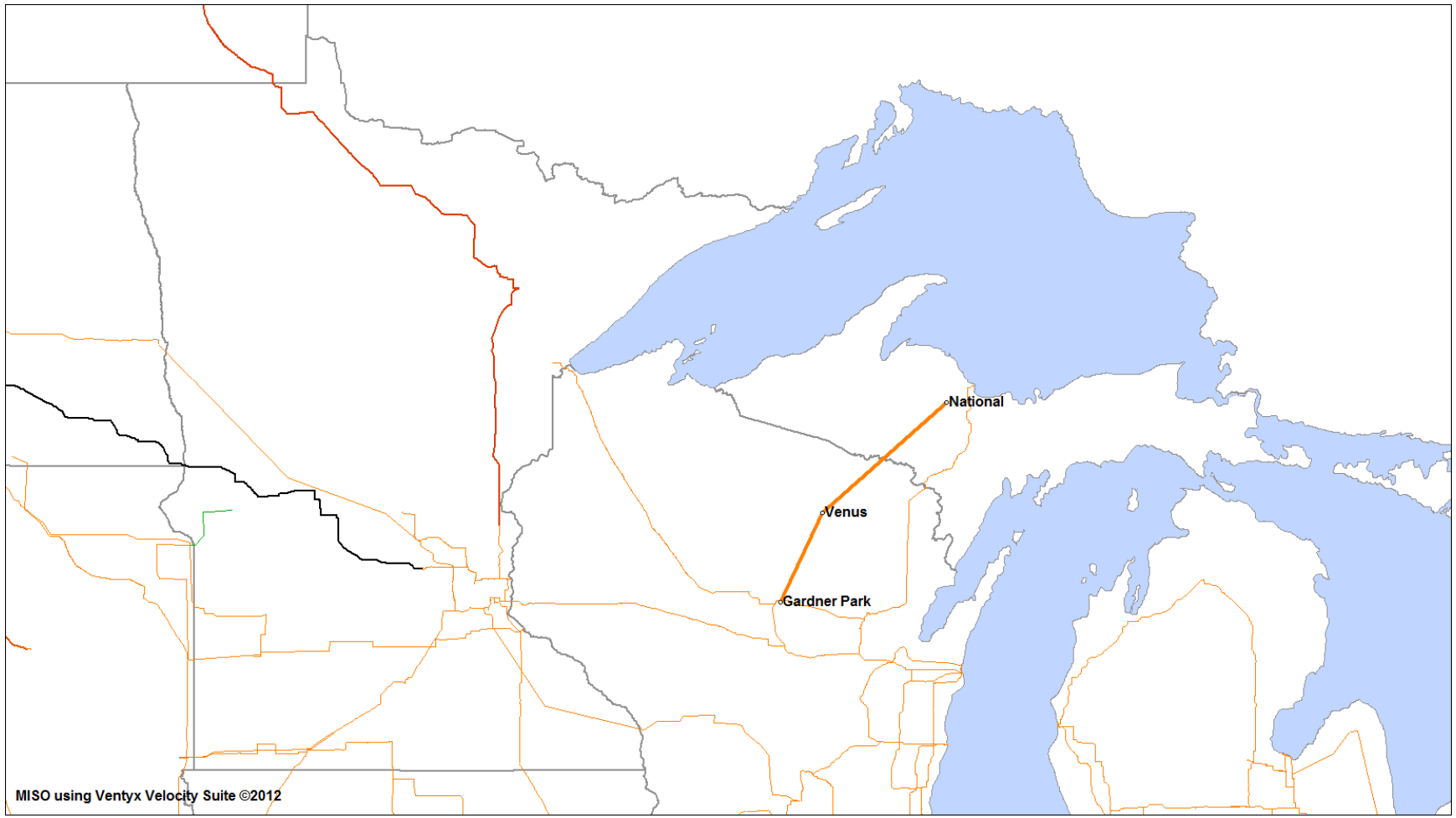
TRG Supplied Plans (WI/UP)
Gardener Park - Venus - National 345kV



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TRG Supplied Plans (WI/UP)
Arnold – Livingston 345kV

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TRG Supplied Plans (WI/UP)
National – Livingston 345kV

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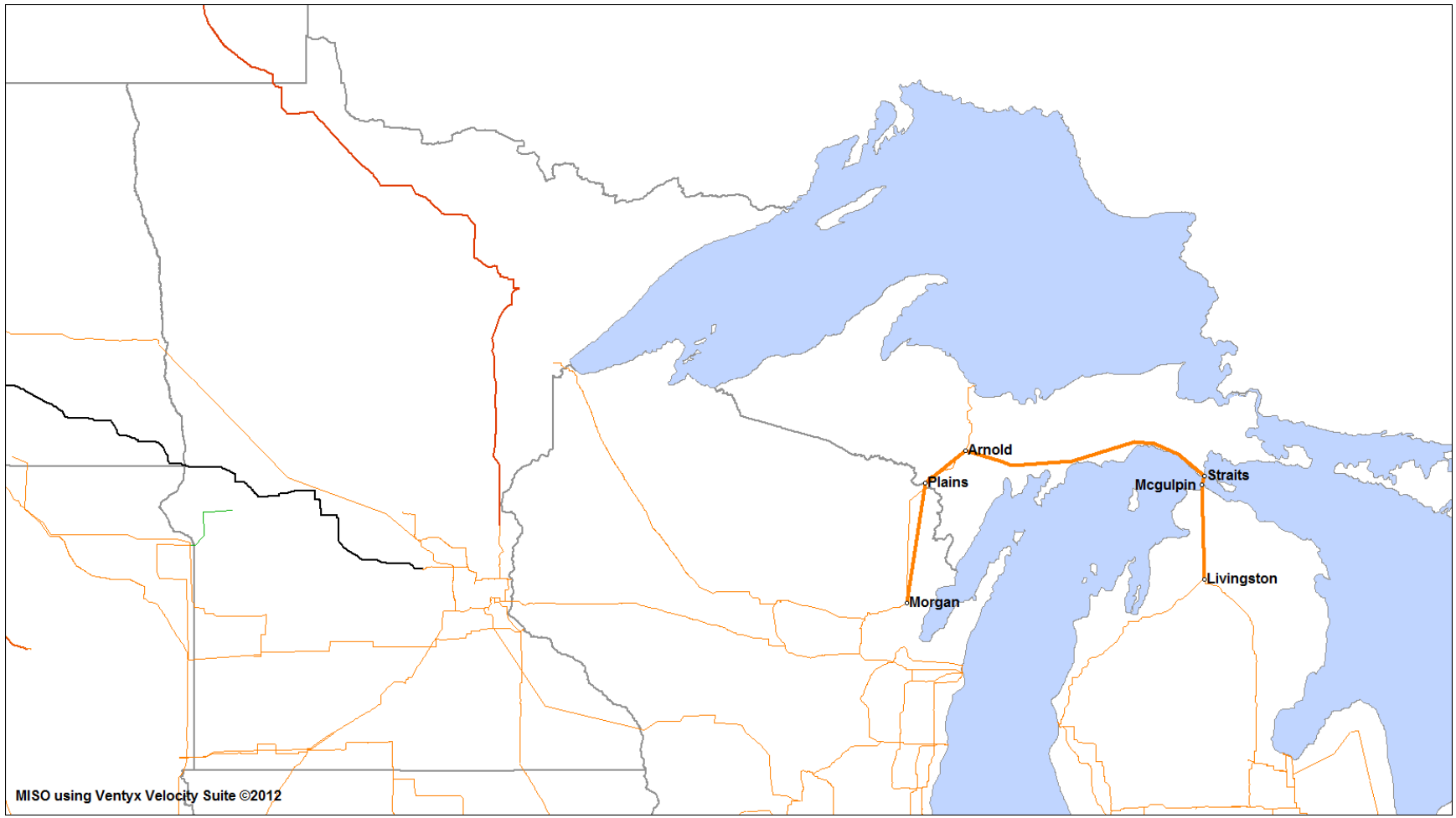
TRG Supplied Plans (WI/UP)
Morgan – Plains – Arnold – Livingston 345kV



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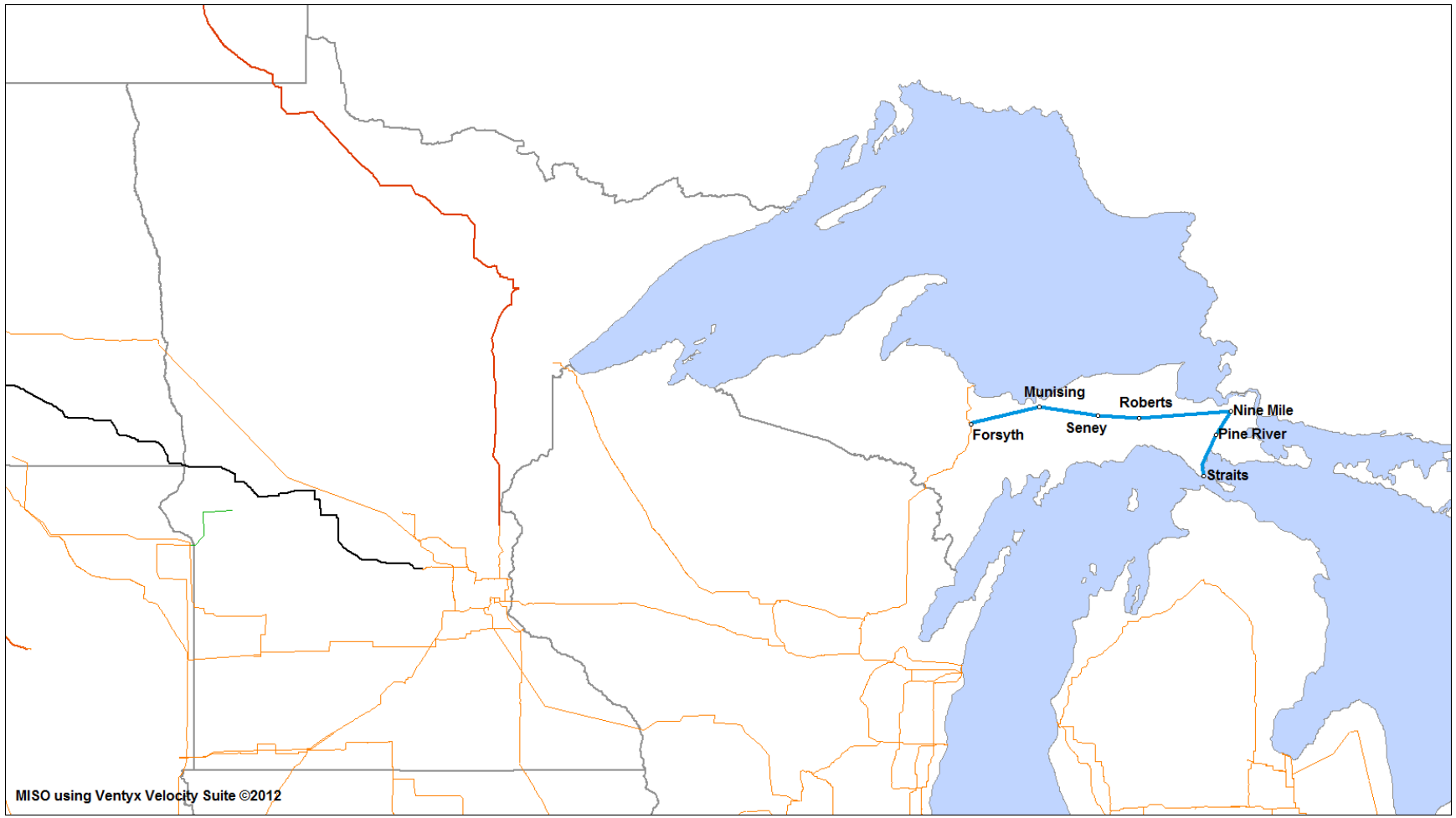
TRG Supplied Plans (WI/UP)
Marquette County - Mackinac County 138kV



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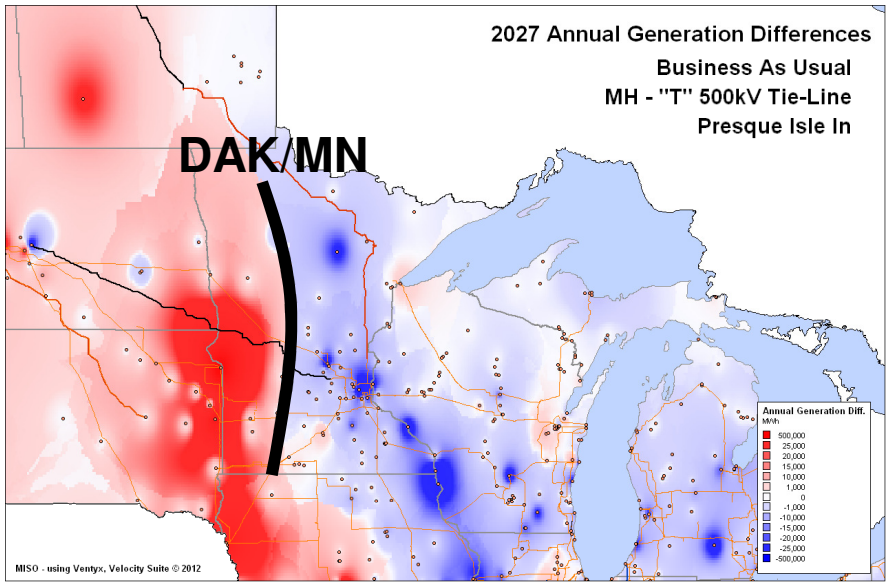
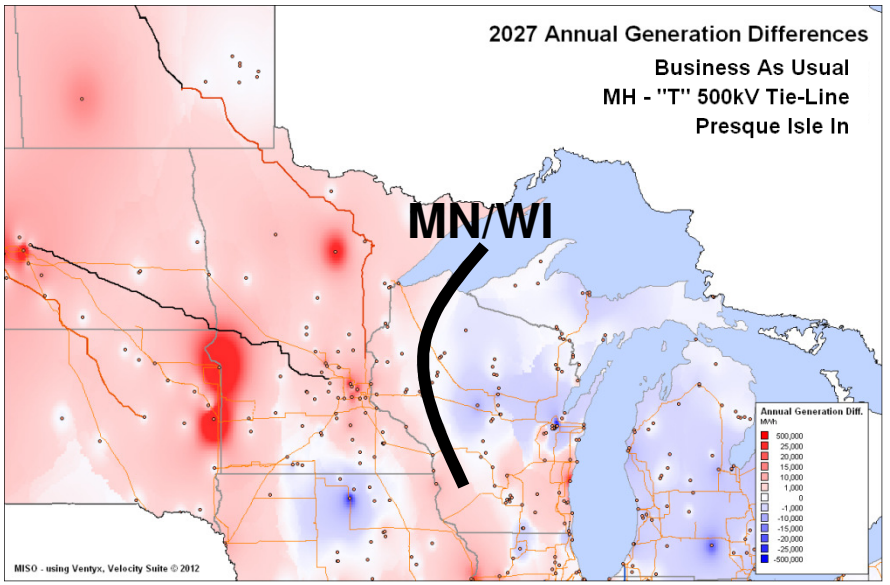
Holistic Plans



Before Mitigating DAK/MN



After Mitigating DAK/MN

- **Next iteration in the process - after mitigating DAK/MN new "interface" is the Minnesota to Wisconsin border**
- **Transport new imports to load and high prices**
- **New primary binding constraints after mitigating DAK/MN**
  - Arrowhead – Stone Lake 345kV; Stinson Phase Shifter
  - South Lake Michigan/ComEd/McGulpin Interface
- **New MN/WI BAU inc. Interface flow: 830 GWh (1,040 MW Max, 200 MW "80%")**

TRG Supplied Plans (Holistic)
Arrowhead – National 345kV

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TRG Supplied Plans (Holistic)
Arrowhead – Arnold – Livingston 345kV

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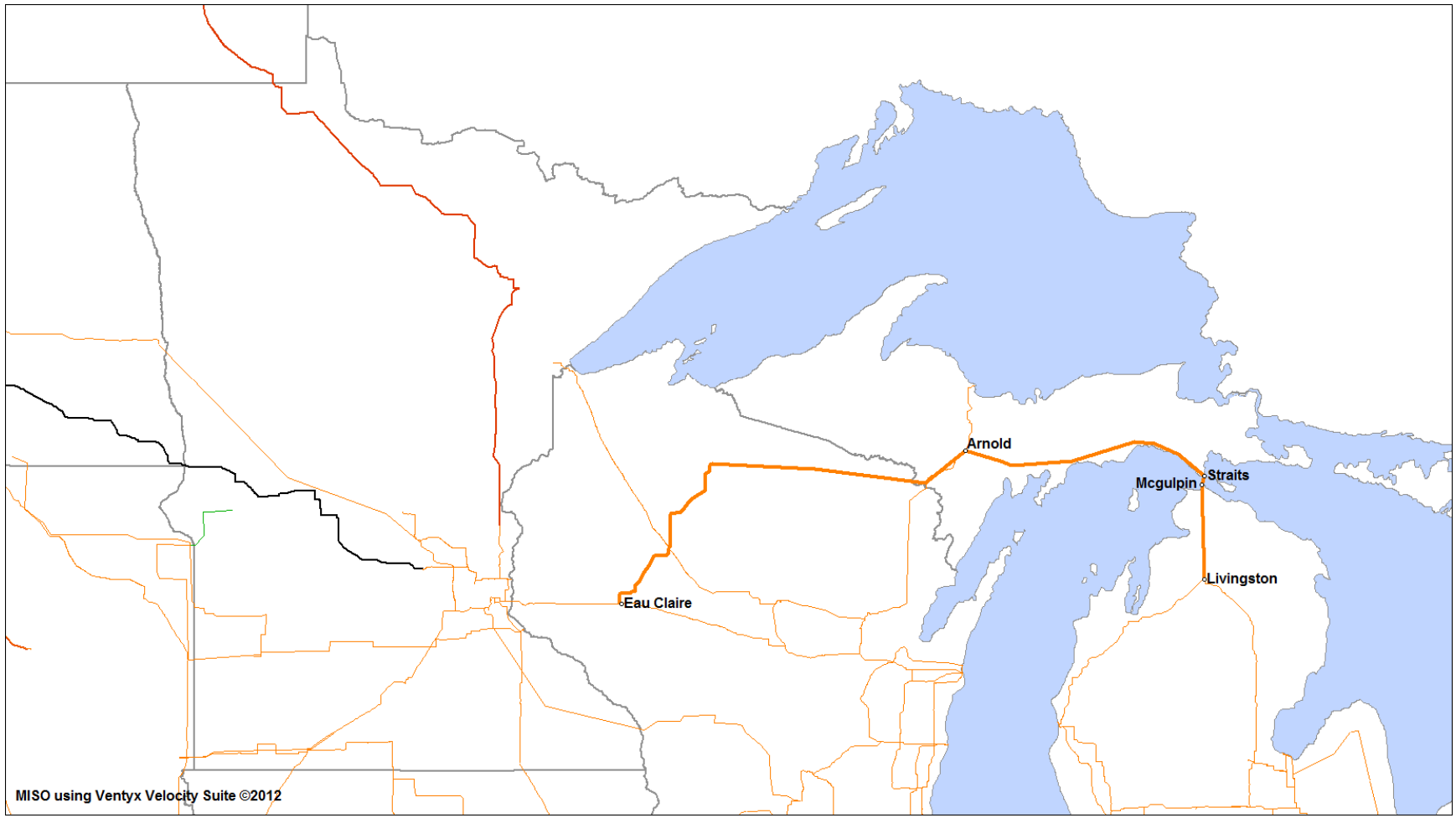
TRG Supplied Plans (Holistic)
Eau Claire – Arnold – Livingston 345kV



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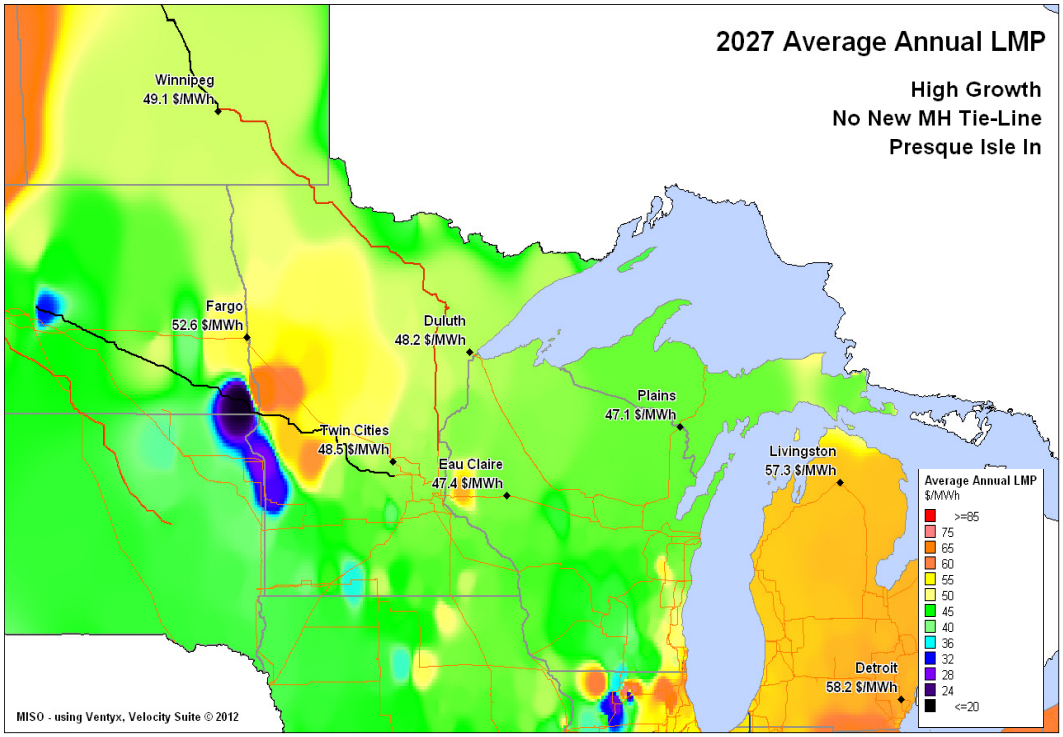
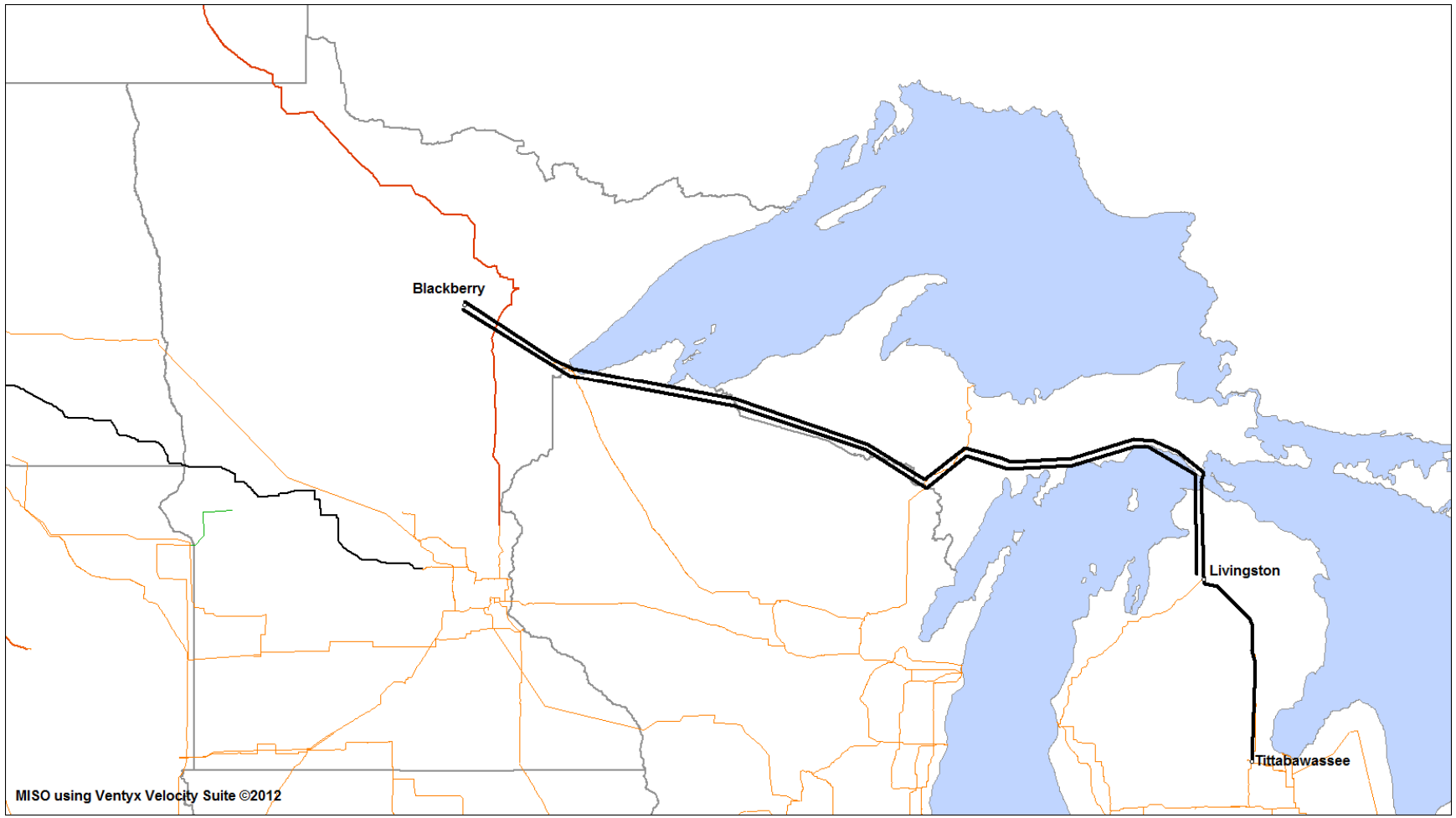
DC Opportunities?

- No DC options submitted by TRG; however, multiple parties expressed interest in exploring opportunities
- In all scenarios highest prices in Michigan
- DC responds to LMP differences and acts on market signals



- AC responds to power angle differences and has a complex flow through the AC system
- DC could help with potential Lake Michigan loop flows
- Should we include DC in analysis? TRG thoughts?
- Subsequent "proposed" lines sized based on Lake Michigan interface flows (HDE: 12,000 GWh)

"Proposed?" Plans (DC)
Blackberry – Livingston/Tittabawassee 500kV DC



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"Proposed?" Plans (DC)
Blackberry – Plains 500kV DC

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"Proposed?" Plans (DC)
Blackberry – Plains – Livingston/Tittab. 500kV DC

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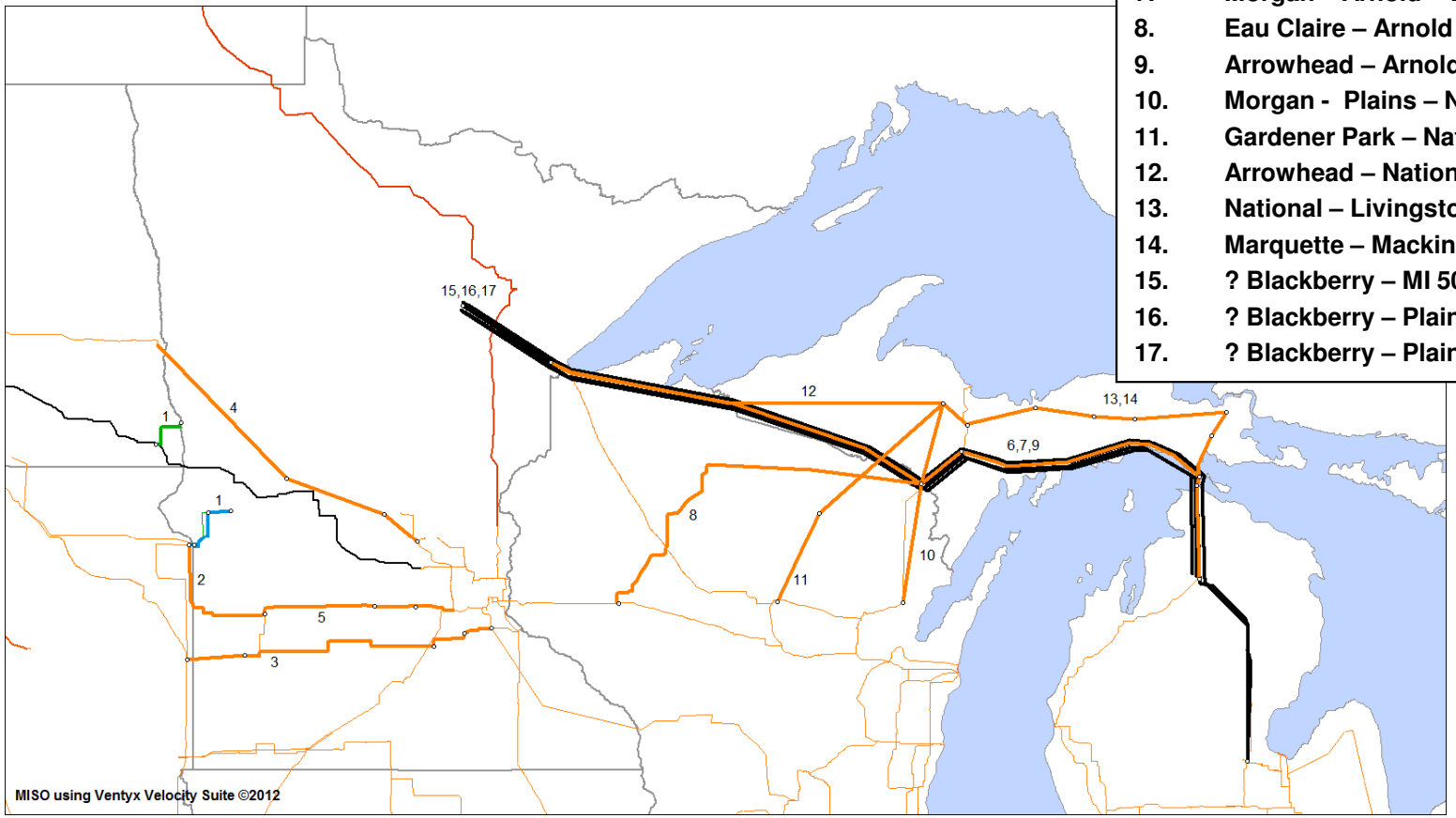
Northern Area Study Options Summary (As of Oct 31, 2012)

1. Upgrade Hankinson- Wahepton 230 kV and Big Stone – Morris 115kV
2. Big Stone – Hazel 345kV
3. Brookings – Hampton 345kV
4. Fargo – Monticello 345kV
5. Convert: Hazel – Blue Lake 345kV
6. Arnold – Livingston 345kV
7. Morgan – Arnold – Livingston 345kV
8. Eau Claire – Arnold – Livingston 345
9. Arrowhead – Arnold – Livingston 345
10. Morgan - Plains – National 345kV
11. Gardener Park – National 345kV
12. Arrowhead – National 345kV
13. National – Livingston 345kV
14. Marquette – Mackinac Cnty 138kV
15. ? Blackberry – MI 500kV DC
16. ? Blackberry – Plains 500kV DC
17. ? Blackberry – Plains – MI 500kV DC



Lines are for illustrative purposes only, actual line routing may differ

Work Plan

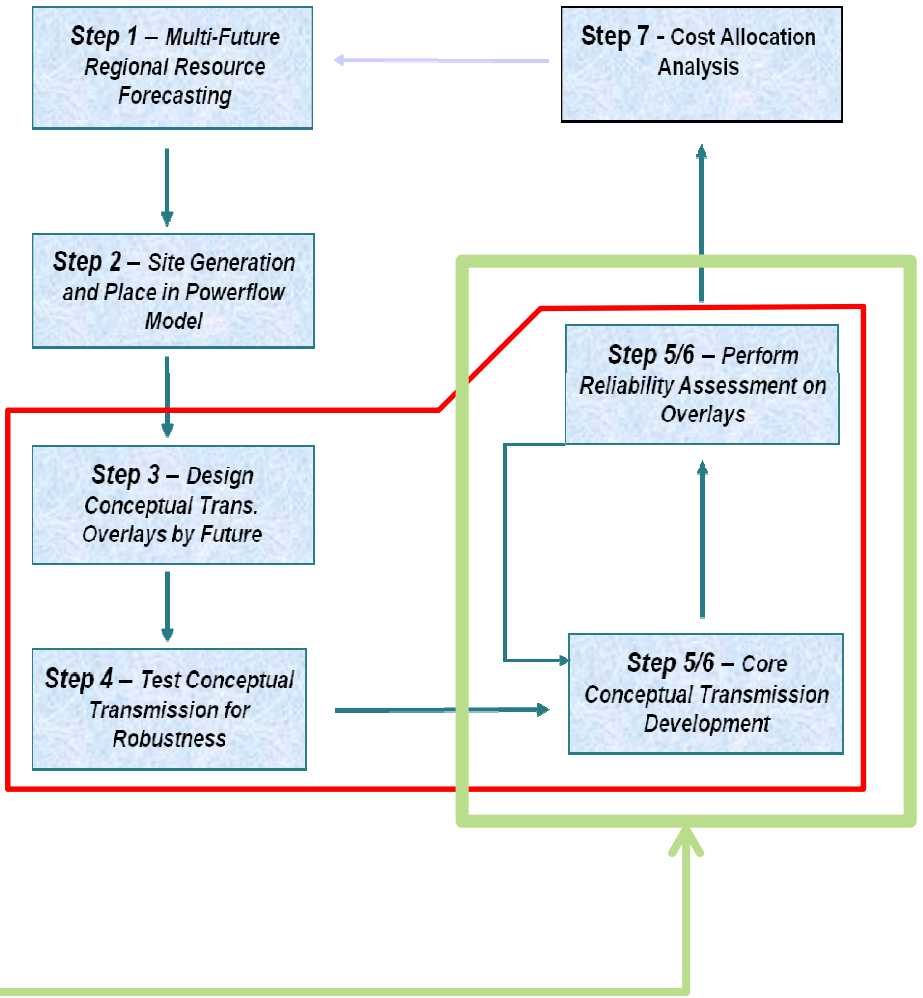
- **All submitted plans will be evaluated for study year 2027 economic benefits under selected scenarios**
- **Plans will be refined, or combined into portfolios – goal is to narrow down the number of options**
- **Plans further analyzed for economic benefits for study years 2017 and 2022**
- **Best-fit refined plans/portfolios will be evaluated for reliability**
- **Iterative refinement between reliability and economics**
- **Dec 7th meeting will fall amidst refinement and testing process**
- **All results will be posted and communicated to the entire TRG via email**

Reliability Analysis

- **Reliability No Harm Tests**
  - No degradation of system reliability with addition of transmission plans
  - Analyze underbuild requirements
  - Identify any additional reliability improvements
- **Steady State (Thermal) Study**
  - Looking for overloads and voltage violations under contingency
- **Voltage Stability Study**
  - Identify voltage collapse conditions under high transfer
- **Transient Stability Study**
  - Looking for issues in seconds after disturbance

Reliability Next Steps

- **Refined plans from economic analysis will be added to powerflow models**
- **No Harm tests will be performed**
- **Transmission plan additions/improvements will be fed back to economics**



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- Welcome, Roll Call, and Review Agenda 9:00 AM
- Recap September 21st Meeting 9:05 AM
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  - TSR Update
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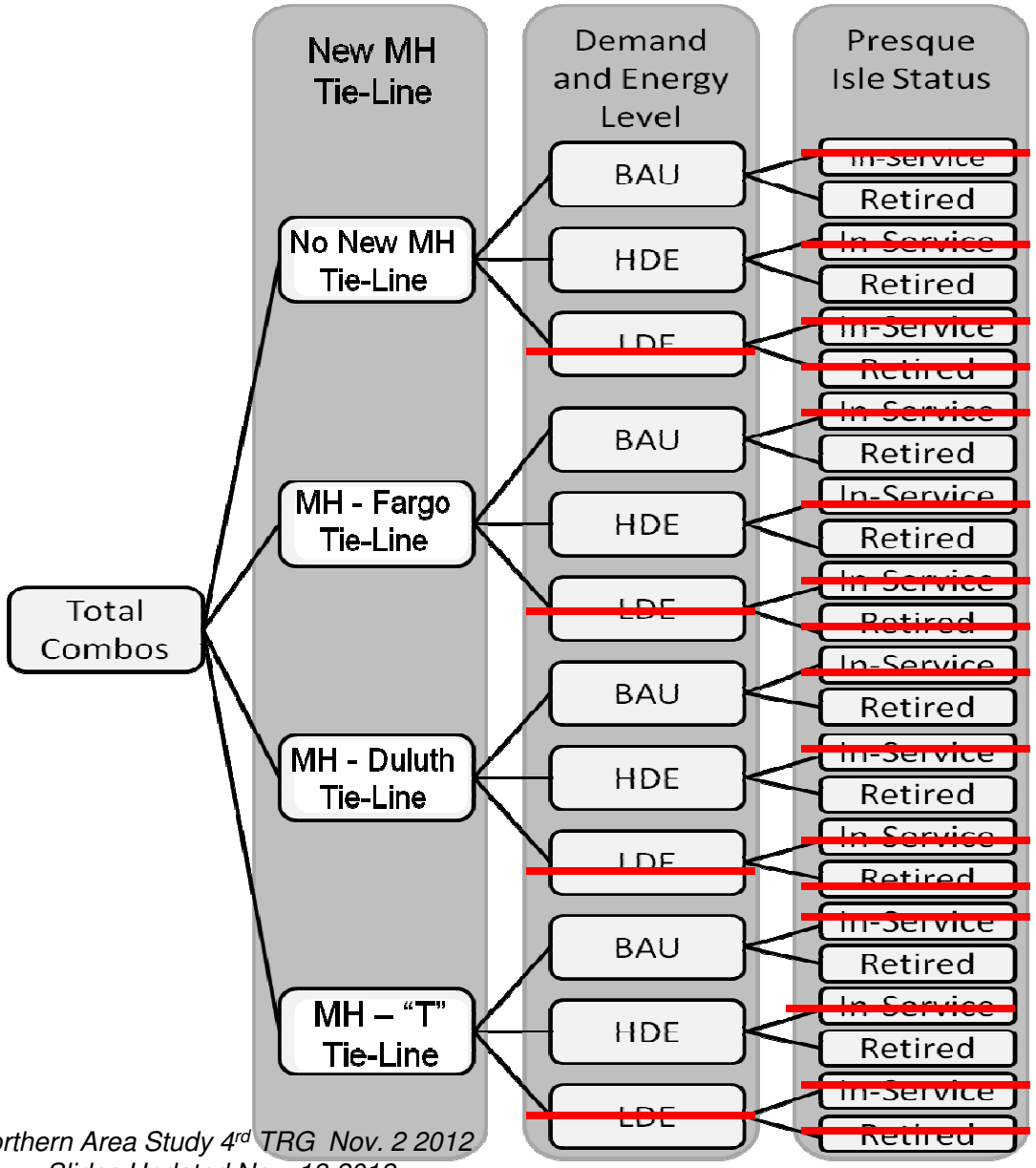
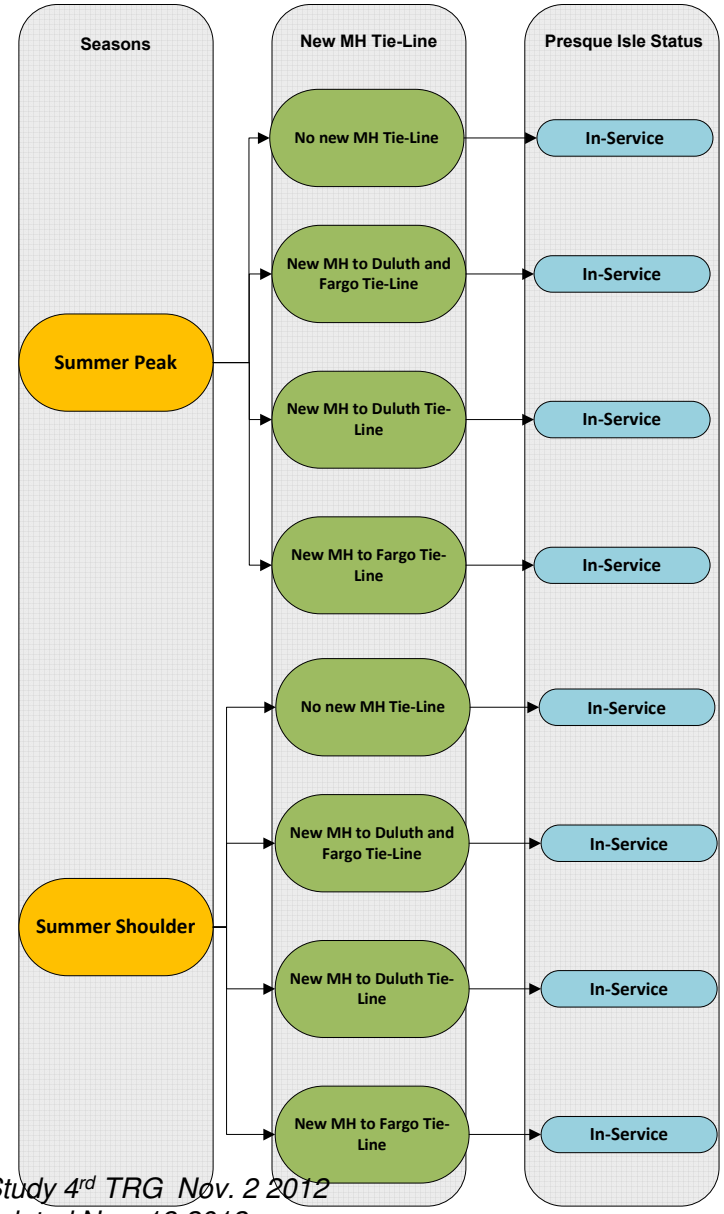
Economic Scenarios Selection

- **Current problem: Too many scenarios for testing all transmission plans**
- **Maximum scenarios for economic testing is 8**
- **Proposal:**
  - Eliminate LDE Scenario?
    - Report will clearly say that under LDE future the was little to no economic benefits
  - Only test one Presque Isle in-service status?
    - Which status?
    - Final plans will be evaluated under both scenarios
- **Please provide feedback by Nov. 9th**



Reliability Scenario Selection

- **Thermal Study**
  - All the proposed Scenarios
  - Looking for your input to reduce the number of scenarios
- **Voltage Stability Study**
  - "Worst case scenario" will be studied
  - Looking for your input to pick the worst case scenario
- **Transient Stability Study**
  - "Worst case scenario" will be studied



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Refresh Generic Transmission Line Costs

- **Updates provided by TRG. Thank you.**
- **Additional updates for other states?**
- **Used to calculate benefit to cost ratios for conceptual plans – allows comparison between options**
- **TRG supplied project costs will be used in NAS if available**

Updated Transmission Line Estimates ($M/mile)

TRG supplied based on actual and estimations CapX Group 1 permitting and construction

kV	WI	MN	DAK
115	$1.10	$1.00	$0.75
161	$1.30	$1.25	$0.90
230	$1.70	$1.60	$1.25
345	$2.90	$2.70	$2.30
345-2	$3.50	$3.25	$3.00
500	$3.40	$3.20	$2.80
765	$4.50	$4.00	$3.50

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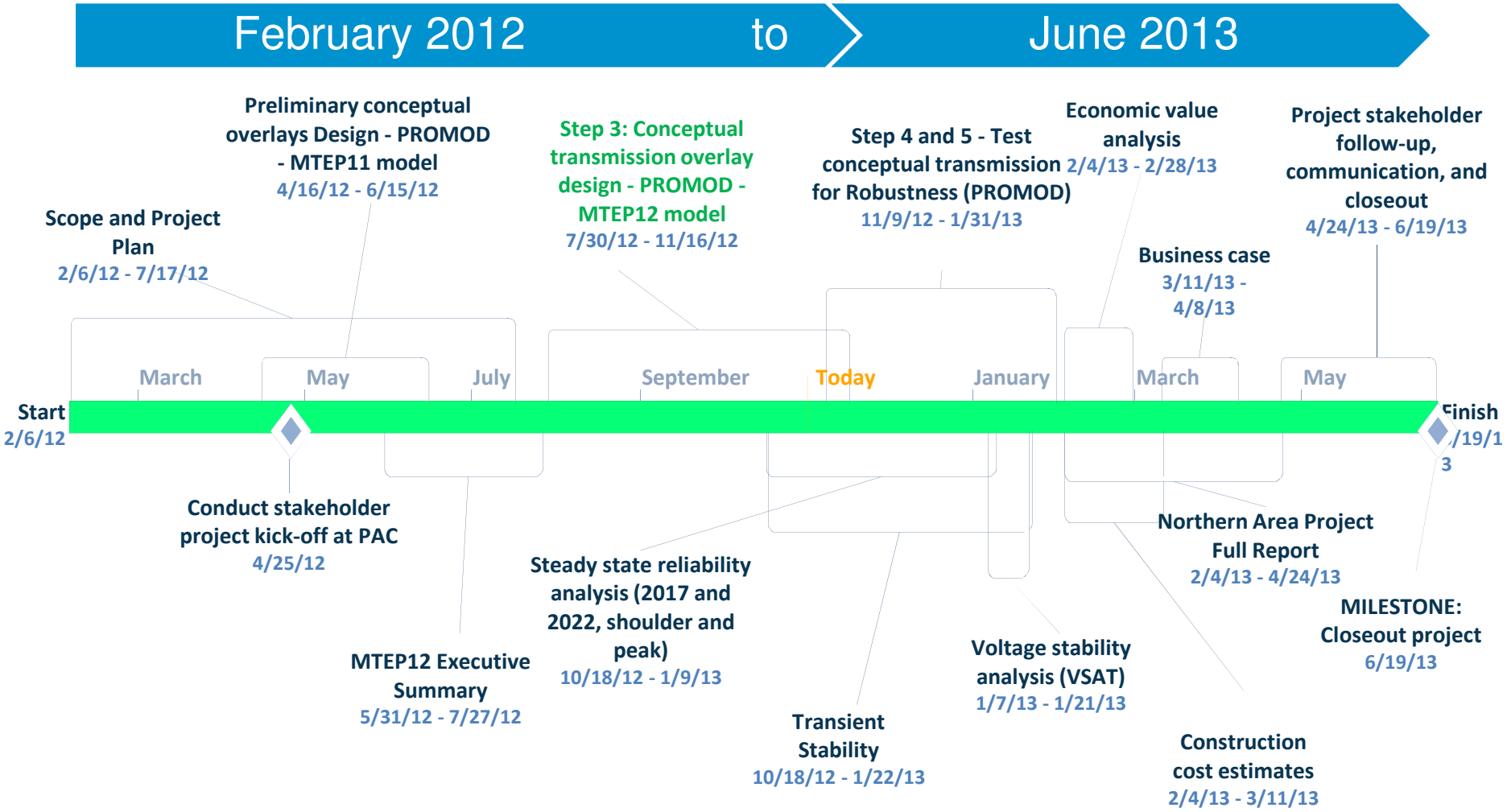
Northern Area Study Project Plan

Task Name	Start	Finish
NORTHERN AREA STUDY PROJECT	**2/6/12**	**7/3/13**
☑ **Scope Development**	**2/6/12**	**7/17/12**
☑ **Preliminary conceptual overlays Design - PROMOD - MTEP11 (POC)**	**4/16/12**	**6/15/12**
Step 3: Conceptual transmission overlay design - PROMOD - MTEP12	**7/30/12**	**11/16/12**
Step 4 & 5 - Test conceptual transmission for Robustness (PROMOD)	**11/9/12**	**1/31/13**
Step 6 – Reliability Analysis	**10/18/12**	**1/22/13**
Steady State Reliability Analysis (2017 and 2022, shoulder & peak)	**10/18/12**	**1/9/13**
Transient Stability Screening	**10/18/12**	**1/22/13**
Voltage stability analysis (VSAT)	**1/7/13**	**1/21/13**
Step 5 - Consolidate and Sequence	**1/31/13**	**2/4/13**
Economic value analysis (final production cost calculation)	**2/4/13**	**2/28/13**
Construction cost estimates	**2/4/13**	**3/11/13**
Business case analysis	**3/11/13**	**4/8/13**
☑ **MTEP 12 Executive Summary**	**5/31/12**	**7/27/12**
Northern Area Project Full Report	**2/4/13**	**4/24/13**
Project stakeholder follow-up, communication, and closeout	**4/24/13**	**6/19/13**

Northern Area Study Timeline



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What's Next?

- MISO
  - Send TRG full list of transmission options and selected scenarios (after November 9th)
  - Provide TRG results as they become available
- TRG
  - Supply additional transmission plans by November 9th
  - Supply scenario selection feedback by November 9th
  - Supply feedback on Kewaunee retirement by November 9th
  - Provide additional updates to generic $/mi transmission costs

- Next meeting tentatively scheduled for December 7th

Contact Information

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- **Presque Isle Retirement Sensitivity Analysis**
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