MN Valley – Blue Lake 230kV Corridor Outlet Study Review

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Background

- 230kV corridor from Granite Falls to the SE corner of the Twin Cities was one of the facilities that limited outlet with Brookings line to 1900 MW

- Upgrade of this line is thought to be the next project for facilitation of regional generation delivery needs
Scope

- Wind outlet gained by use of the MN Valley – Blue Lake 230kV corridor to assist achieving the RES milestones, while paving the way for future plans
  - Endpoint definition on SW Twin Cities end
    - Double circuit 345 kV
    - 500 kV (abandoned)
    - 765 kV
  - For each configuration:
    - How much capability?
    - Underlying facilities?
Model Development – Corridor & RES Milestone Studies

- Based off the 2007 MTEP models
  - Non-MISO member models cut in from MRO models
  - MTEP07 created 2013 and 2018 peak and off-peak cases
  - Averaged load growth between 2013 and 2018 models
  - Conservation impacts accounted for
- Future Generation Locations
  - MISO queue
  - Resource planner input
- Load Profile
- Transfer Levels
  - High simultaneous transfers off peak
  - MRO defined on peak transfers
- PSSE/MUST – ACCC, TLTG
## Wind Sources

<table>
<thead>
<tr>
<th>Substation</th>
<th>MW Additional</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corridor Study</td>
<td></td>
</tr>
<tr>
<td>Yankee</td>
<td>150</td>
</tr>
<tr>
<td>Fenton</td>
<td>150</td>
</tr>
<tr>
<td>Lyon Co.</td>
<td>300</td>
</tr>
<tr>
<td>Nobles</td>
<td>200</td>
</tr>
<tr>
<td>Brookings</td>
<td>400</td>
</tr>
<tr>
<td>Granite Falls</td>
<td>300</td>
</tr>
<tr>
<td>Morris</td>
<td>200</td>
</tr>
<tr>
<td>Big Stone</td>
<td>300</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>2000</strong></td>
</tr>
</tbody>
</table>
Preliminary Results

- Base case assumes 1900 MW SW MN renewable outlet capability in addition to 922 MW at Pleasant Valley (total 2822 MW)
- From the standpoint of space (physical in and around substation) Blue Lake is acceptable electrical termination for 345 kV double circuit
- 500 kV not studied due to its electrical similarity to double-circuit 345 kV.
- 765 kV studied as high-voltage option
Preliminary Results (cont.)

- Generation was sunk over the entire MISO footprint based on merit order of generation.
- Big Stone II’s queue position was assumed to be used by either Big Stone II or an equivalent amount (MW) of other generation.
  - Assumption based on the large amount of generation interconnection interest in the immediate area, mainly wind interconnections.
PRELIMINARY Summer Peak results

- Two areas were studied
  - One is use of the Granite Falls-Blue Lake corridor
  - One is Granite Falls-South Dakota needs
- Underlying Facilities
  - RES Milestone meeting vs. off peak market sales
    - “Minnesota Facilities” needed to serve Minnesota load and meet MN RES 2016 milestone
    - “Market Facilities” needed to serve Midwest ISO load, especially during off-peak periods
Summer Peak results

- Recommended facilities:
  - Double circuit
    - Big Stone – Hazel – Panther – McLeod – Blue Lake 345 kV
    - Big Stone - Hazel - Blue Lake 345 kV
  - Conversion of Panther and McLeod Substations to 345 kV
  - Projected delivery capability of approximately 2000 MW achievable with relatively minor system improvements.
To date, analysis has been done assuming no Big Stone II transmission facilities.

Further analysis will be done assuming the Big Stone II transmission facilities:
- 345 kV line from Big Stone to Hazel Creek
- 230 kV line from Big Stone to Morris

Either case will assume additional 600 MW of generation at Big Stone.
Next Steps

- ProMod analysis of final recommendation
- Sensitivity to be run against CapX 2020 Group I “upsize” plan
- Optimization and Stability analysis
- Loss analysis
- Write report
2016 RES Milestone Study Review

Daniel Kline, Xcel Energy
Michael Cronier, Xcel Energy
Scope

- Identify transmission alternatives to facilitate meeting RES milestones while ensuring a reliable transmission system
- Evaluate system impacts of generation resources beyond west-central Minnesota
  - Corridor study focused on west-central Minnesota
- Identify and address transmission constraints
Model Development

- Models will focus on 2016 delivery
  - Approx. 4800 MW total wind for MN load (35% CF)
- Generation locations
  - MISO queue to determine queued generation by county (as indication of interest)
  - Resource planning input to be considered
  - Dispersed scenario
- Based on MN Valley – Blue Lake 230 kV Corridor Outlet Study models
Model Development

- Two Sink Assumptions:
  - 35% Twin Cities, 65% Other
  - 65% Twin Cities, 35% Other
    - TC: High Bridge, Riverside, Black Dog
    - Other: ALTE, Ameren, FE, METC, WE

- Sources:
  - Dispersed (Based on DRG Results)
  - ND Zone Case
  - SE MN Zone Case
  - SW MN Zone Case
  - Fargo to Rochester generation arc
DRG Scenario

- With CapX Group I facilities in service, attempt to meet 2016 RES milestone using DRG projects
- 10 to 40 MW in size
- Wind and biomass fuel types
- Use single site findings from June 16 DRG study as starting point
DRG Scenario Method

- Using agreed upon models, run screening analysis to determine individual site capabilities in outstate planning zones.
- Determine list of sites – avoid sites with same limiting contingency
- Site 2000 MW of dispersed generation (2000 MW DRG + 2800 in base model = 4800 MW)
- Determine list of upgrades necessary to accommodate added DRG
DRG Scenario Results

- ~2800 MW *theoretical* capacity identified
- Many Northwest/West Central sites eliminated due to Dorsey transformer overload
DRG Scenario Results

- 2000 MW DRG achieved with significant transmission constraints needing to be addressed
  - Lakefield – Adams 161 kV overloads
  - Eau Claire – Arpin 345 kV overloads
  - Eau Claire 345/161 kV transformers
  - Numerous lower voltage overloads

- Recurring contingencies causing overloads
  - Adams – Hazelton 345 kV
  - Adams 345/161 kV Transformers
  - Adams – Pleasant Valley 345 kV Line
  - Eau Claire – Arpin 345 kV (with and w/o KNG-ECL)
  - Arrowhead Phase Shifter
Wind Sources – ND Zone

- Corridor generation dispatch included in addition to 2016 locations
- Assumptions to be shifted for sensitivity (stress) cases
  - Coyote – 10%
  - Balta – 15%
  - Prairie – 20%
  - Ellendale – 25%
  - Maple River – 30%

*Note that Big Stone II outlet facilities are displayed on map but were excluded from analysis.
Preliminary Results – ND Zone

Legend
- Generation Source
- Area/Line with Overloads
- Substation with Overloads
- Recommended Line

*Note that Big Stone II outlet facilities are displayed on map but were excluded from analysis.
Recommendations – ND Zone

Legend
- Blue: Generation Source
- Orange: Area/Line with Overloads
- Red: Substation with Overloads
- Blue Line: Recommended Line

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Wind Sources – SE MN Zone

- Corridor generation dispatch included in addition to 2016 locations
- Assumptions to be shifted for sensitivity (stress) cases
  - Adams – 1/3
  - Byron – 1/3
  - Hazelton – 1/3

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Preliminary Results – SE MN Zone

*Note that Big Stone II outlet facilities are displayed on map but were excluded from analysis.
Recommendations – SE MN Zone

*Note that Big Stone II outlet facilities are displayed on map but were excluded from analysis.
Wind Sources – SW MN Zone

- Corridor generation dispatch included in addition to 2016 locations
- Assumptions to be shifted for sensitivity (stress) cases
  - Big Bend – 1/3
  - Yankee – 1/3
  - Fenton – 1/3

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Preliminary Results – SW MN Zone

Legend
- Generation Source
- Area/Line with Overloads
- Substation with Overloads
- Recommended Line

*Note that Big Stone II outlet facilities are displayed on map but were excluded from analysis.
Recommendations – SW MN Zone

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## Wind Sources – Wide Area

<table>
<thead>
<tr>
<th>2016 Study (additional)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Adams</td>
<td>300</td>
</tr>
<tr>
<td>Pleasant Valley</td>
<td>300</td>
</tr>
<tr>
<td>Byron</td>
<td>400</td>
</tr>
<tr>
<td>Maple River</td>
<td>200</td>
</tr>
<tr>
<td>Ellendale</td>
<td>500</td>
</tr>
<tr>
<td>Inman</td>
<td>300</td>
</tr>
<tr>
<td>West Faribault</td>
<td>200</td>
</tr>
<tr>
<td>Jackson</td>
<td>200</td>
</tr>
<tr>
<td>Karlstad</td>
<td>100</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>4500</strong></td>
</tr>
</tbody>
</table>

- Corridor generation dispatch to be included in addition to 2016 locations
- Assumptions to be shifted for sensitivity (stress) cases
Wind Sources – Wide Area

*Note that Big Stone II outlet facilities are displayed on map but were excluded from preliminary analysis.
Aggregate Preliminary Results

*Note that Big Stone II outlet facilities are displayed on map but were excluded from preliminary analysis.
Operational/Constructability Study

- Rebuild of Minnesota Valley – Blue Lake corridor will substantially limit generation outlet during construction
  - Assessing options to address constructability
    - Adjacent construction
    - Fargo – Brookings 345 kV
    - CapX Group I upsize (string second circuits)
ProMOD Study Work

- In conjunction with engineers at MISO and RGO ProMOD efforts
- Determination of optimal Corridor facilities list
- Using Corridor facilities as baseline, determine feasibility of additional developments
- Perform additional analysis of constructability issue above
Detailed Investigations

- Sensitivity to be run against CapX Group I upsize proposal
- Dynamic Stability – Begin in late September
- Costing
  - DRG – cost to complete necessary improvements
  - Facility-by-facility costs for other recommended projects
- Losses
2025 RES Study Review

Amanda King, Xcel Energy
John Weber, MRES and Scott Nickels (RPU)
Other study initiatives are impacting 2025 study assumptions

- MISO RGOS
- RIGO Study
- CapX Group I upsizing
- Corridor Study
- 2016 Study

Final model assumptions are under development