Market Efficiency Update

Transmission Expansion Advisory Committee
September 14, 2017
Where we are - Market Efficiency Timeline

Year 0

- Develop Assumptions (Y1, Y5)
- Market Efficiency Analysis (Y1, Y5) (Accelerations and Modifications)
- Identify and evaluate Solution Options (Accelerations and Modifications)
- Final Review with TEAC and approval by Board

Year 1

- Develop Assumptions (Y1, Y5, Y8, Y11, Y15)
- Market Efficiency Criteria Analysis (Y1, Y5, Y8, Y11, Y15)
- Market Efficiency Analysis (Y1, Y5, Y8, Y11, Y15)
- Identify proposed solutions
- Update significant assumptions (Y0, Y4, Y7, Y10, Y14)
- Analysis of market solutions and support of benefits of reliability solutions (Y0, Y4, Y7, Y10, Y14)
- Independent Consultant reviews of buildability
- Adjustments to solution options by PJM on analysis
- Develop Assumptions (Y1, Y5)
- Market Efficiency Analysis (Y1, Y5) (Accelerations and Modifications)
- Identify and evaluate Solution Options (Accelerations and Modifications)
- Final Review with TEAC and approval by Board

12-month cycle

24-month cycle
Abbreviated Market Efficiency Proposal Window
2016-2017 Long Term Proposal Window 1A
2016-2017 Long Term Proposal Window 1A

• Addendum to the 2016-2017 Long Term Proposal Window closed on Feb 2018
  – Will be designated as 2016-2017 Long Term Proposal Window 1A.
  – Opening on September 14, 2017
  – Closing on September 28, 2017.
  – Solicit proposals to address the Tanners Creek - Dearborn 345 kV thermal constraint, which is a Reliability Pricing Model (RPM) constraint.

• Target facility Tanners Creek - Dearborn 345 kV is the next limiting element in the 2020/2021 RPM Base Residual Auction CETL study for the DEOK LDA*.

• All participants of the 2016-2017 Long Term Proposal Window remain eligible to participate.

*After RTEP baseline upgrade b2831 (Upgrade the Tanner Creek - Miami Fort 345 kV circuit) is constructed
Data Access

• Data is available on the PJM website here:

• The access requests should be submitted here:
  – The request should specify access to MISO and Production Cost Model data as well as the 2016-17 RTEP Long Term Proposal Window data.
  – As a reminder, each individual from the organization who will access the Proposal Window data is required to have CEII clearance with PJM. This is in addition to the organization’s CEII clearance.

• Please contact PJM via Proposalwindow-admin@pjm.com with any questions.
Proposed by: PJM

Proposed Solution: After the close of the initial Market Efficiency Proposal Window, a low-cost, high-impact upgrade was identified. Replace terminal equipment at Tanners Creek on Tanners Creek - Dearborn 345 kV line.

**kV Level:** 345 kV  
**In-Service Cost ($M):** $1.5, B/C Ratio = 53.13  
**In-Service Date:** 2021  
**Target Zone:** DEOK  
**ME Constraints:**  
TANNERS CREEK - MIAMI FORT 345 kV

Notes:  
- CETL improvement of 332 MW and very low cost  
- Anticipate request for Board approval in Oct 2017 (pending Window 1A outcome)  
- Designated Entity: AEP (the local TO)  
- Cost Allocation: TBD
2016-2017 Long Term Window
• Market Efficiency Base Case Mid-Cycle Update
  – Base case reposted with updates from stakeholders feedback
  – Olive - Bosserman supplemental project removed from the base case

• Analysis of proposed solutions:  Aug 2017 - Dec 2017 (in-progress)
  – RPM and Interregional Projects analysis 90% completed
  – PPL projects analysis in-progress
  – BGE projects will be analyzed after PPL
  – Any high-value low-risk* type projects may be analyzed in parallel with the above
  – All other regional projects will be analyzed last

• Target determination of recommended projects: Feb 2018
  – RPM projects to be recommended at Oct, 2017 Board meeting
  – Interregional, PPL and high-value low-risk projects at Dec, 2017 Board meeting
  – BGE and other projects to be recommended at Feb, 2018 Board meeting

*High-value low-risk projects are generally classified as low cost upgrades, with significant B/C, and with minimum competition.
Base Case Mid-Cycle Updates

• TMI nuclear unit retirement: September 2019
• PPL supplemental project correction: Juniata - Cumberland 230 kV line
• Impedance correction: Conemaugh – Rice – Hunterstown
• NIPSCO retirements: Bailey units to retire in 2018
• AMEREN rating corrections
  – Kincaid – Austin 345 kV line
  – Gifford – Paxton 138 kV line
• Olive – Bosserman 138 kV supplemental project removed from the base case
Interregional Projects
Interregional Evaluation Process

- Benefits to each RTO shall be determined by that RTO using their respective regional process and metrics.
- Costs shall be allocated interregional based on pro rata share of benefits, as determined above.
- Projects must meet the B/C criteria in each RTO (based on allocated costs) and identified by both RTOs as the best solution to be recommended to each RTOs board.
- Use 15 year stream of benefits.
- Use average discount rate to move benefits to in service year:
  - PJM: 7.4%
  - MISO: 7.1%
  - Average: 7.25%
Interregional Evaluation Status

• PROMOD simulations:
  – Base Case with Olive – Bosserman 138 kV Supplemental project
  – Base Case without Olive – Bosserman 138 kV Supplemental project
    • Sensitivity Run: Dune Acre Transformer 345/138 kV closed

• Analysis completed 90%
  – Currently performing additional analysis on projects that shifted congestion downstream. This may cause B/C ratio to change, if additional upgrades are required to address congestion created by the project.

• Coordination with MISO
  – PJM discussed simulations results with MISO. Factors considered for project selection: congestion driver, PJM and MISO benefits, additional congestion created by the project.
  – Projects that don’t show MISO benefits will not be considered for further interregional analysis.
  – PJM to share final results with MISO and vice versa.
  – RTOs jointly select the most beneficial project (if any) and inform stakeholders.
## Interregional Projects Results

### Project information

<table>
<thead>
<tr>
<th>Project Id</th>
<th>Submitter</th>
<th>Description</th>
<th>Cost ($M)</th>
<th>Constraint</th>
<th>Base Runs With Olive-Bosserman Dune Acre 345/138 kV open</th>
<th>Sensitivity Run Without Olive-Bosserman Dune Acre 345/138 kV closed</th>
</tr>
</thead>
<tbody>
<tr>
<td>201617_1-10B</td>
<td>Nextera</td>
<td>Build a new 345/138 kV substation (Rolling Prairie) connecting the following an existing 345 kV line to two existing 138 kV lines.</td>
<td>$ 19.25</td>
<td>$ 7.21</td>
<td>0.28 $ 1.71</td>
<td>$ 44.56</td>
</tr>
<tr>
<td>201617_1-12D</td>
<td>AEP NIPSCO</td>
<td>Rebuild the 34.5 kV line between New Carlisle and Silver Lake as 138 kV. Rebuild the Michigan City - Trail Creek-Bosserman 138 kV.</td>
<td>$ 41.86</td>
<td>$ 35.34</td>
<td>1.53 $ 1.41</td>
<td>$ 80.37</td>
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<tr>
<td>201617_1-13H</td>
<td>Transource</td>
<td>Tap the Tanners Creek – Losantville 345 kV line and build a single circuit line to a new 345/138 station (Coyote) next to Wiley.</td>
<td>$ 71.89</td>
<td>$ 27.12</td>
<td>0.28 $ 0.27</td>
<td>$ 25.99</td>
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<tr>
<td>201617_1-17B</td>
<td>AEP Exelon</td>
<td>Meadow Lake – Pike Creek 345 kV Double Circuit Greenfield Line and Pike Creek 345kV Station</td>
<td>$ 197.97</td>
<td>$ 78.68</td>
<td>0.29 $ 0.36</td>
<td>$ 96.59</td>
</tr>
<tr>
<td>201617_1-18S*</td>
<td>Northeast Transmission Development</td>
<td>Build a 345/138 kV substation (&quot;Coffee Creek&quot;) interconnecting Green Acres to Olive 345 kV line and Flint Lake to Luchtman Road 138 kV line.</td>
<td>$ 17.40</td>
<td>$ 12.76</td>
<td>0.54 $ 2.39</td>
<td>1.76* $ 41.68</td>
</tr>
<tr>
<td>201617_1-1A**</td>
<td>WPPI</td>
<td>Provide a second New Carlisle-Olive 138 kV circuit. Upgrade substation equipment at New Carlisle and Olive substations.</td>
<td>$ 2.50</td>
<td>$ 0.58</td>
<td>0.17 $ 3.75</td>
<td>14.35** $ 48.75</td>
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<tr>
<td>201617_1-9A</td>
<td>NIPSCO</td>
<td>Reconstruct existing NIPSCO line sections between AEP Bosserman and Olive 138 kV substations and between AEP Bosserman and New Carlisle 138 kV substations.</td>
<td>$ 8.00</td>
<td>$ -</td>
<td>0 $ 4.84</td>
<td>52.65 $ 1.60</td>
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<tr>
<td>201617_1-9B</td>
<td>NIPSCO</td>
<td>New NIPSCO line section between Thayer and Morrison 138 kV substations.</td>
<td>$ 42.50</td>
<td>$ 7.32</td>
<td>0.13 $ 0.33</td>
<td>18.92 $ 0.87</td>
</tr>
</tbody>
</table>

Notes:  

*201617_1-18S does not fully solve Olive – Bosserman congestion driver.  
** WPPI interest in 201617_1-1A is limited to submitting the project description. If approved this upgrade will be assigned to the incumbent TO (AEP).
Re-evaluation of Approved Market Efficiency Projects
(2014/15 RTEP Window)
Re-evaluation of Market Efficiency Projects - Process

• Applies to market efficiency projects approved during the 2014/15 RTEP Window
• Using the Market Efficiency Base Case Mid-Cycle Update
• Analysis performed individually, one project at a time

Reevaluation Study Process
  – Create a new base case by removing/reversing the topology related to the approved market efficiency project
  – Measure the impact of adding back the approved market efficiency project
  – Measure benefits for 15-year period starting with the in-service date
  – For RPM projects also measure the capacity benefits
  – Calculate the new B/C ratios

• Projects must meet the B/C criterion of 1.25
• All projects analyzed so far pass the B/C ratios.

• Baseline project b2728, Loretto – Wilton 345 kV, does not need reevaluation due to new in-service date of 12/31/2017

• Baseline project b2696, Krendale to Shanor Manor 138 kV upgrade, work in-progress
## Reevaluation Results

<table>
<thead>
<tr>
<th>PJM Window Project ID</th>
<th>Baseline#</th>
<th>Type</th>
<th>Area</th>
<th>Constraint</th>
<th>Cost (Smill)</th>
<th>In-Service Date</th>
<th>B/C 2014/15 Window</th>
<th>BC Reevaluation 2017</th>
</tr>
</thead>
<tbody>
<tr>
<td>201415_1-2A</td>
<td>b2690</td>
<td>Upgrade</td>
<td>PPL/BGE</td>
<td>Safe Harbor to Graceton 230 kV</td>
<td>$1.10</td>
<td>2019</td>
<td>14.4</td>
<td>1.72</td>
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<tr>
<td>201415_1-2B</td>
<td>b2691</td>
<td>Upgrade</td>
<td>ME/PPL</td>
<td>Brunner Island to Yorkana 230 kV</td>
<td>$3.10</td>
<td>2019</td>
<td>22.2</td>
<td>2.84</td>
</tr>
<tr>
<td>201415_1-4I</td>
<td>b2697.1-2</td>
<td>Upgrade</td>
<td>AEP</td>
<td>Fieldale to Thornton 138 kV</td>
<td>$0.75</td>
<td>2019</td>
<td>101.2</td>
<td>9.47</td>
</tr>
<tr>
<td>201415_1-4J</td>
<td>b2698</td>
<td>Upgrade</td>
<td>AEP</td>
<td>Jacksons Ferry to Cloverdale 765 kV</td>
<td>$0.50</td>
<td>2019</td>
<td>62</td>
<td>46.18</td>
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<tr>
<td>201415_1-9A*</td>
<td>b2743.1-8, b2752.1-7</td>
<td>Upgrade</td>
<td>APS/BGE</td>
<td>AP-South</td>
<td>$340.60*</td>
<td>2020</td>
<td>2.48</td>
<td>1.30</td>
</tr>
<tr>
<td>201415_1-10B</td>
<td>b2693</td>
<td>Upgrade</td>
<td>COMED</td>
<td>Wayne to South Elgin 138 kV</td>
<td>$0.10</td>
<td>2019</td>
<td>6.4</td>
<td>in-progress</td>
</tr>
<tr>
<td>201415_1-10J</td>
<td>b2692.1-2</td>
<td>Upgrade</td>
<td>COMED</td>
<td>Cordova to Nelson 345 kV</td>
<td>$24.60</td>
<td>2019</td>
<td>1.9</td>
<td>1.59</td>
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<tr>
<td>201415_1-10D</td>
<td>b2728</td>
<td>Upgrade</td>
<td>COMED</td>
<td>Loretto-Wilton 345 kV (RPM)</td>
<td>$11.50</td>
<td>2019</td>
<td>64.5</td>
<td>New In-Service Date: 12/31/2017</td>
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<tr>
<td>201415_1-11H</td>
<td>b2694</td>
<td>Upgrade</td>
<td>PECO</td>
<td>Peach Bottom 500 kV</td>
<td>$9.70</td>
<td>2019</td>
<td>3</td>
<td>5.70</td>
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<tr>
<td>201415_1-12A</td>
<td>b2689.1-2</td>
<td>Upgrade</td>
<td>DUQ</td>
<td>Dravosburg to West Mifflin 138 kV</td>
<td>$11.18</td>
<td>2018</td>
<td>2</td>
<td>2.63</td>
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<tr>
<td>201415_1-13E</td>
<td>b2695</td>
<td>Upgrade</td>
<td>DPL</td>
<td>Worcester to Ocean Pines (I) 69 kV</td>
<td>$2.40</td>
<td>2019</td>
<td>65.3</td>
<td>10.14</td>
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<tr>
<td>201415_1-18G</td>
<td>b2688.1-3</td>
<td>Upgrade</td>
<td>APS</td>
<td>Taneytown to Carroll 138 kV</td>
<td>$5.20</td>
<td>2019</td>
<td>90.1</td>
<td>8.50</td>
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<tr>
<td>201415_1-18I</td>
<td>b2696</td>
<td>Upgrade</td>
<td>APS/ATSI</td>
<td>Krendale to Shanor Manor 138 kV</td>
<td>$0.60</td>
<td>2019</td>
<td>123.4</td>
<td>78.88</td>
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<tr>
<td>Optimal Caps</td>
<td>b2729</td>
<td>Upgrade</td>
<td>DOM</td>
<td>AP-South</td>
<td>$8.98</td>
<td>2019</td>
<td>15.4</td>
<td>2.16</td>
</tr>
</tbody>
</table>

Note: * 201415_1-9A B/C ratio calculation based on the original cost. Cost of project currently under review and will be updated as necessary.
## Next Steps

### Milestone Schedule 2016 - 2017

<table>
<thead>
<tr>
<th>Milestone</th>
<th>Schedule</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proposed RPM projects analysis</td>
<td>Sept – Oct 2017</td>
</tr>
<tr>
<td>Proposed projects analysis - Interregional, PPL and high value low cost projects</td>
<td>Sept – Dec 2017</td>
</tr>
<tr>
<td>Proposed projects analysis - BGE and other</td>
<td>Oct 2017 – Dec 2017</td>
</tr>
<tr>
<td>Acceleration Analysis</td>
<td>Oct – Dec 2017</td>
</tr>
<tr>
<td>Final TEAC Review and Board Recommendation</td>
<td>Feb 2018</td>
</tr>
</tbody>
</table>

PJM TEAC – 9/14/2017
Appendix A - Interregional Projects Descriptions
AEP/COMED/NIPSCO Interregional Proposals

- **7 Projects:**
  - 1-1A, 1-9A, 1-9B, 1-10B, 1-12D, 1-17B, 1-18S

- **Cost:**
  - From $1.00 M to $197.97 M

- **ME Constraints:**
  - BOSSERMAN - OLIVE 138 kV
  - PAXTON - GIFFORD 138 kV
DEOK Interregional

- **1 Project:**
  - 1-13H

- **Cost:**
  - $71.88 M

- **ME Constraint:**
  - TANNERS CREEK - MIAMI FORT 345 kV

- **2020/2021 RPM BRA Results**
  - DEOK LDA binding with Tanners Creek - Miami Fort 345KV as limiting CETL constraint
### Project ID: 201617_1-1A

**Proposed by:** WPPI

**Proposed Solution:** Interregional


<table>
<thead>
<tr>
<th>kV Level: 138 kV</th>
</tr>
</thead>
<tbody>
<tr>
<td>In-Service Cost ($M): $2.5</td>
</tr>
<tr>
<td>In-Service Date: 2019</td>
</tr>
<tr>
<td>Target Zone: AEP</td>
</tr>
</tbody>
</table>

**ME Constraints:**

OLIVE - BOSSERMAN 138 kV

**Notes:**

PJM TEAC – 9/14/2017
Project ID: NIPSCO 1-9A

Proposed by: NIPSCO

Proposed Solution: Interregional Reconductor existing NIPSCO line section between AEP Bosserman and Olive 138 kV substations. Reconductor existing NIPSCO line section between AEP Bosserman and New Carlisle 138 kV substations.

kV Level: 138 kV

In-Service Cost ($M): $8.00

In-Service Date: 2019

Target Zone: AEP NIPSCO

ME Constraints:
OLIVE - BOSSERMAN 138 kV

Notes:

PJM TEAC – 9/14/2017
### Project ID: 201617_1-9B

**Proposed by:** NIPSCO

**Proposed Solution:** Greenfield, Interregional  
New NIPSCO line section between Thayer and Morrison 138 kV substations.

<table>
<thead>
<tr>
<th>kV Level:</th>
<th>138 kV</th>
</tr>
</thead>
<tbody>
<tr>
<td>In-Service Cost ($M):</td>
<td>$42.50</td>
</tr>
<tr>
<td>In-Service Date:</td>
<td>2022</td>
</tr>
<tr>
<td>Target Zone:</td>
<td>AML ComEd NIPSCO</td>
</tr>
</tbody>
</table>

**ME Constraints:**  
PAXTON - GIFFORD 138 kV

**Notes:**  
PJM TEAC – 9/14/2017
Proposed by: Nextera

Proposed Solution: Greenfield, Interregional
Cut the University Park - Olive 345 kV and tie into a new 345/138 kV substation (Rolling Prairie). Cut the Maple - New Carlisle 138 kV and Maple - LNG 138 kV lines and tie into the new substation.

kV Level: 138 kV
In-Service Cost ($M): $19.2
In-Service Date: 2021
Target Zone: AEP

ME Constraints:
BOSSERMAN - OLIVE 138 kV

Notes:

PJM TEAC – 9/14/2017
Project ID: 201617_1-12D

Proposed by: AEP NIPSCO

Proposed Solution: Interregional

Terminate Olive-Bosserman 138 kV line at New Carlisle. Rebuild the 34.5 kV line between New Carlisle and Silver Lake as double circuit 138 kV, operating one circuit as 34.5 kV while extending the other at 138 kV with a new circuit to Liquid Carbonics. Establish an Olive-Liquid Carbonics-Bosserman 138 kV line. Rebuild the Michigan City-Trail Creek-Bosserman 138 kV.

kV Level: 138 kV

In-Service Cost ($M): $41.86

In-Service Date: 2021

Target Zone: AEP

ME Constraints:
OLIVE - BOSSERMAN 138 kV

Notes:

PJM TEAC – 9/14/2017

AEP NIPSCO 1-12D
Project ID: 201617_1-13H

Proposed by: Transource

Proposed Solution: Greenfield, Interregional
Tap the Tanners Creek - Losantville 345 kV line and build a new 345 kV switchyard (York). Tap the Miami Fort - Woodsdale 345 kV line and build a new 345/138 kV substation (Coyote) next to Wiley 138kV switchyard. Build a new 345 kV line between York and Coyote stations. Expand Wiley 138 kV switchyard by tying the Coyote 345/138 kV transformer into the Wiley 138 kV yard. Loop the Morgan-Fairfield 138 kV line into Wiley 138 kV station. Install a new 345/138 kV transformer at Foster substation.

kV Level: 138/345 kV
In-Service Cost ($M): $71.89
In-Service Date: 2021
Target Zone: DEOK

ME Constraints:
TANNERS CREEK - MIAMI FORT 345 kV

Notes:

PJM TEAC – 9/14/2017
Project ID: 201617_1-17B

Proposed by: AEP Exelon

Proposed Solution: Greenfield, Interregional
Build a new 345 kV switchyard (Pike Creek). Build a new Meadow Lake - Pike Creek 345 kV double circuit line. Loop the Bloom - Davis Creek 345 kV line and Burnham - Davis Creek 345 kV line into Pike Creek switchyard.

kV Level: 345 kV
In-Service Cost ($M): $197.97
In-Service Date: 2021
Target Zone: ComEd

ME Constraints:
OLIVE - BOSSERMAN 138 kV + RPM Benefits

Notes:

PJM TEAC – 9/14/2017
Project ID: 201617_1-18S

Proposed by: Northeast Transmission Development

Proposed Solution: Greenfield, Interregional
Tap the Green Acres - Olive 345 kV line and build a new 345/138 kV substation (Coffee Creek). Loop the Flint Lake to Luchtman Road 138 kV line into Coffee Creek.

kV Level: 138/345 kV
In-Service Cost ($M): $17.4
In-Service Date: 2021
Target Zone: AEP

ME Constraints:
OLIVE - BOSSERMAN 138 kV

Notes:
Appendix B - AEP Supplemental Project
Olive – Bosserman 138 kV
AEP Supplemental Project

• AEP has planned a supplemental project that impacts the Olive – Bosserman market efficiency constraint

• Supplemental projects are:
  – Not needed for reliability criteria, market efficiency, or operational performance
  – Funded wholly by Transmission Owner
  – No PJM approval needed

• This supplemental project is NOT included in the mid-cycle update of the Market Efficiency base case.
Supplemental Project: Olive-Bosserman 138 kV
Previously Presented at 4/13/2017 TEAC and 4/21/2017 Western SRTEAC

Problem Statement/Driver:
The LaPorte Junction - New Carlisle 34.5 kV circuit has a vintage from 1930s and is wood pole construction. Between 2010-2015, ~2 million customer minutes of interruption (CMI) were recorded at Silver Lakes station. There are 183 open conditions, 95 of which are category A conditions on the ~20 mile long line.

Indiana and Michigan Power Company has requested to convert Silver Lake and Springville to 138 kV operation.

This project would also resolve congestion on the Olive-Bosserman 138 kV identified during MISO-PJM JOA market efficiency studies in addition to addressing the potential overload identified on this facility during the PJM 2021 RTEP. It was submitted (without the new distribution station additions) to the PJM reliability and market efficiency windows.

Recommended Solution:
Construct two 138/12 kV distribution stations, Bootjack and Marquette, to replace Silver Lake 34.5 kV and Springville 69 kV stations. (S1279.1)
Cut the existing Olive – Bosserman line into New Carlisle station. (S1279.2)
Rebuild sections of the LaPorte Junction-New Carlisle/New Buffalo 34.5 kV line to 138 kV to establish Bootjack-Olive 138 kV circuit. (S1279.3)
Install a three way phase over phase switch, called Kuchar, near Liquid Carbonics station and construct a new 138 kV line between Bootjack and Kuchar. (S1279.4)
Construct a 138 kV extension to Marquette station by tapping the Bosserman-Liquid Carbonics 138 kV line. (S1279.5)

Alternatives:
Rebuild ~20 mile long New Carlisle – LaPorte Junction 34.5 kV utilizing existing line ROW corridor. This alternative was not selected because it did not provide the operational flexibility & efficiency and customer service benefits provided by the preferred option. Estimated cost: ~$32M

Cost Estimate: $36.786M
Projected IS date: 12/1/2019
Status: Conceptual
Revision History

- V1 – 9/8/2017 – Original Version Posted to PJM.com
- V2 – 9/12/2017 – Slide 17 corrections
  - 9A in-service date from 2021 to 2020
  - added note regarding 9A cost review