Transmission Expansion Advisory Committee

November 3, 2011
Issues Tracking
• Open Issues
  – None

• New Issues
Renewable Integration Study Update
## Wind Capacity Factor

- **Year-round capacity factor Averages by TO Zone**

<table>
<thead>
<tr>
<th>Transmission Owner</th>
<th>Base</th>
<th>4GW Offshore</th>
<th>10GW Offshore</th>
<th>20GW Offshore</th>
<th>4GW Offshore with overlay</th>
<th>20GW Offshore with overlay</th>
</tr>
</thead>
<tbody>
<tr>
<td>Allegheny Power</td>
<td>29.3%</td>
<td>29.1%</td>
<td>29.2%</td>
<td>29.3%</td>
<td>29.2%</td>
<td>29.3%</td>
</tr>
<tr>
<td>American Electric Power</td>
<td>35.3%</td>
<td>34.7%</td>
<td>35.0%</td>
<td>35.3%</td>
<td>35.3%</td>
<td>35.3%</td>
</tr>
<tr>
<td>Atlantic Electric</td>
<td>45.3%</td>
<td>45.4%</td>
<td>45.3%</td>
<td>45.4%</td>
<td>45.4%</td>
<td>45.2%</td>
</tr>
<tr>
<td>Commonwealth Edison Co.</td>
<td>42.7%</td>
<td>34.1%</td>
<td>36.9%</td>
<td>41.6%</td>
<td>44.4%</td>
<td>42.8%</td>
</tr>
<tr>
<td>Dayton Power &amp; Light Co.</td>
<td>29.4%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Delmarva Power &amp; Light Company</td>
<td>44.7%</td>
<td>44.5%</td>
<td>40.8%</td>
<td>27.3%</td>
<td>44.5%</td>
<td>44.0%</td>
</tr>
<tr>
<td>Jersey Central Power &amp; Light Company</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pennsylvania Electric Company</td>
<td>30.5%</td>
<td>30.4%</td>
<td>30.5%</td>
<td>30.7%</td>
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<tr>
<td>PPL Electric Utilities</td>
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<td>29.5%</td>
<td>29.5%</td>
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<tr>
<td>Public Service Electric &amp; Gas Company</td>
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<td></td>
<td></td>
<td></td>
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<tr>
<td>Virginia Power Company</td>
<td>40.4%</td>
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<td>38.1%</td>
<td>24.8%</td>
<td>42.4%</td>
<td>44.0%</td>
</tr>
<tr>
<td>Grand Total</td>
<td>38.1%</td>
<td>35.0%</td>
<td>37.1%</td>
<td>34.3%</td>
<td>39.3%</td>
<td>41.6%</td>
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</table>
- RPM – 4 hour peak capacity factor averages by TO Zone

<table>
<thead>
<tr>
<th>Transmission Owner</th>
<th>Base</th>
<th>4GW Offshore</th>
<th>10GW Offshore</th>
<th>20GW Offshore</th>
<th>4GW Offshore with overlay</th>
<th>20GW Offshore with overlay</th>
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<tr>
<td>Allegheny Power</td>
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<td>15.2%</td>
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<td>15.2%</td>
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<tr>
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<td>22.1%</td>
<td>22.2%</td>
<td>22.3%</td>
<td>22.4%</td>
<td>22.5%</td>
<td>22.4%</td>
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<tr>
<td>Atlantic Electric</td>
<td>41.4%</td>
<td>41.4%</td>
<td>41.4%</td>
<td>41.4%</td>
<td>41.4%</td>
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<tr>
<td>Commonwealth Edison Co.</td>
<td>38.7%</td>
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<td>31.9%</td>
<td>36.4%</td>
<td>40.7%</td>
<td>38.4%</td>
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<td>Delmarva Power &amp; Light Company</td>
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<td>37.8%</td>
<td>26.6%</td>
<td>40.1%</td>
<td>40.5%</td>
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<td>Jersey Central Power &amp; Light Company</td>
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<tr>
<td>Pennsylvania Electric Company</td>
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<td>15.5%</td>
<td>15.5%</td>
<td>15.5%</td>
<td>15.5%</td>
<td>15.5%</td>
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<tr>
<td>PPL Electric Utilities</td>
<td>12.5%</td>
<td>12.5%</td>
<td>12.5%</td>
<td>12.5%</td>
<td>12.5%</td>
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<tr>
<td>Public Service Electric &amp; Gas Company</td>
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<td>51.2%</td>
<td>51.1%</td>
<td>44.4%</td>
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<tr>
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<td>35.4%</td>
<td>24.3%</td>
<td>36.3%</td>
<td>39.8%</td>
</tr>
<tr>
<td>Grand Total</td>
<td>28.9%</td>
<td>26.5%</td>
<td>30.1%</td>
<td>30.3%</td>
<td>31.1%</td>
<td>36.9%</td>
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### Scenario Performance

<table>
<thead>
<tr>
<th>RPS Requirement (% of annual state MWh)</th>
<th>DC</th>
<th>DE</th>
<th>IN</th>
<th>IL</th>
<th>KY</th>
<th>MD</th>
<th>MI</th>
<th>NC</th>
<th>NJ</th>
<th>OH</th>
<th>PA</th>
<th>TN</th>
<th>VA</th>
<th>WV</th>
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<tbody>
<tr>
<td>Base</td>
<td>0%</td>
<td>10%</td>
<td>8%</td>
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<td>6%</td>
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<td>8%</td>
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<td>3%</td>
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<td>8%</td>
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<td>6%</td>
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<tr>
<td>4GW Offshore</td>
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<td>26%</td>
<td>36%</td>
<td>42%</td>
<td>30%</td>
<td>6%</td>
<td>36%</td>
<td>4%</td>
<td>16%</td>
<td>13%</td>
<td>4%</td>
<td>36%</td>
<td>9%</td>
<td>26%</td>
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<tr>
<td>10GW Offshore</td>
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<td>38%</td>
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<td>28%</td>
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<td>4%</td>
<td>30%</td>
<td>11%</td>
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</tr>
<tr>
<td>20GW Offshore</td>
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<td>21%</td>
<td>30%</td>
<td>18%</td>
<td>6%</td>
<td>21%</td>
<td>9%</td>
<td>40%</td>
<td>8%</td>
<td>3%</td>
<td>21%</td>
<td>11%</td>
<td>15%</td>
</tr>
<tr>
<td>4GW Offshore w/ overlay</td>
<td>3%</td>
<td>26%</td>
<td>36%</td>
<td>53%</td>
<td>30%</td>
<td>6%</td>
<td>36%</td>
<td>4%</td>
<td>16%</td>
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<td>4%</td>
<td>36%</td>
<td>9%</td>
<td>26%</td>
</tr>
<tr>
<td>20GW Offshore w/ overlay</td>
<td>3%</td>
<td>96%</td>
<td>21%</td>
<td>30%</td>
<td>18%</td>
<td>8%</td>
<td>21%</td>
<td>16%</td>
<td>49%</td>
<td>8%</td>
<td>3%</td>
<td>21%</td>
<td>17%</td>
<td>15%</td>
</tr>
</tbody>
</table>
Renewable Energy Requirement by State (millions of MWh)

- NJ: 23 MWh
- MD: 17 MWh
- DE: 3 MWh
- DC: 1 MWh
- PA: 14 MWh
- WV: 4 MWh
- VA: 12 MWh
- NC: 2 MWh
- OH: 33 MWh
- IN: 0 MWh
- MI: 0 MWh
- KY: 0 MWh
- TN: 0 MWh
- IL: 32 MWh
2011 RTEP Voltage Analysis
• Study Year: 2016

• PATH and MAPP not modeled in the base case

• Known generation retirement assumptions
  – Potomac River generation
  – Other at-risk generation
Existing Reactive Upgrades

- Conemaugh
- Keystone
- Johnstown
- Jacks Mountain
- West Shore
- Whippany
- Branchburg
- Cox's Corner
- Kemptown
• Test Procedure: NERC category C3 N-1-1 Voltage Test (voltage magnitude and voltage drop)

• Non-convergence for multiple EHV “N-1-1” combinations

• Potential for violations in 2015 and earlier years
Reactive Upgrade Locations Evaluated

- Alburtis 500 kV
- Altoona 230 kV
- Doubs 500 kV
- Hunterstown 500 kV
- Juniata 500 kV
- Loudoun 500 kV
- Mansfield 345 kV
- Meadow Brook 500 kV
- Mt Storm – Valley 500 kV
- Pleasant View 500 kV
- T157 500 kV
Voltage – Performance of Solution Alternatives

Output (MVAR) of reactive devices under N-1-1 conditions

<table>
<thead>
<tr>
<th>N-1-1 500 kV Contingency*</th>
<th>Meadow Brook SVC</th>
<th>Loudoun SVC</th>
<th>Hunterstown SVC</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N-0</td>
<td>N-1</td>
<td>Collapse Point</td>
</tr>
<tr>
<td>Contingency Pair #1</td>
<td>53</td>
<td>379</td>
<td>500</td>
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<td>Contingency Pair #2</td>
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<td>410</td>
<td>500</td>
</tr>
<tr>
<td>Contingency Pair #3</td>
<td>53</td>
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<td>N/A</td>
</tr>
<tr>
<td>Contingency Pair #4</td>
<td>53</td>
<td>127</td>
<td>500</td>
</tr>
<tr>
<td>Contingency Pair #5</td>
<td>53</td>
<td>167</td>
<td>500</td>
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<tr>
<td>Contingency Pair #6</td>
<td>53</td>
<td>190</td>
<td>500</td>
</tr>
<tr>
<td>Contingency Pair #7</td>
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<td>Contingency Pair #8</td>
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<td>Contingency Pair #9</td>
<td>53</td>
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<td>500</td>
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<tr>
<td>Contingency Pair #10</td>
<td>53</td>
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<td>500</td>
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<tr>
<td>Contingency Pair #11</td>
<td>53</td>
<td>468</td>
<td>500</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>N-1-1 500 kV Contingency*</th>
<th>Altoona SVC</th>
<th>Mansfield FSS</th>
<th>Mt. Storm - Valley SVC</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N-0</td>
<td>N-1</td>
<td>Collapse Point</td>
</tr>
<tr>
<td>Contingency Pair #1</td>
<td>7</td>
<td>60</td>
<td>122</td>
</tr>
<tr>
<td>Contingency Pair #2</td>
<td>7</td>
<td>64</td>
<td>120</td>
</tr>
<tr>
<td>Contingency Pair #3</td>
<td>7</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Contingency Pair #4</td>
<td>7</td>
<td>57</td>
<td>250</td>
</tr>
<tr>
<td>Contingency Pair #5</td>
<td>7</td>
<td>81</td>
<td>250</td>
</tr>
<tr>
<td>Contingency Pair #6</td>
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<td>Contingency Pair #7</td>
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</tr>
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<td>250</td>
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<tr>
<td>Contingency Pair #10</td>
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<tr>
<td>Contingency Pair #11</td>
<td>7</td>
<td>40</td>
<td>118</td>
</tr>
</tbody>
</table>

* The specific contingency pairs are considered CEII
• Locations where reactive capability was less effective at resolving criteria violations and increasing transfer capability.
  – Alburtis 500 kV
  – Jacks Mountain 500 kV
  – Juniata 500 kV
  – T157 500 kV

• Recommendation to delay the required in-service date for the Jacks Mountain 500 kV project from 6/1/2014 to beyond the summer of 2016.

• The Jacks Mountain need date will be re-evaluated as part of the 2012 RTEP.
Recommended Reactive Upgrade Locations for Inclusion in RTEP

- Altoona 230 kV
- Doubs 500 kV
- Hunterstown 500 kV
- Loudoun 500 kV
- Mansfield 345 kV
- Meadow Brook 500 kV
- Mt. Storm - Valley 500 kV
- Pleasant View 500 kV
<table>
<thead>
<tr>
<th>Location</th>
<th>Recommended Reinforcement*</th>
<th>Required In-service Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Altoona 230 kV</td>
<td>250 MVAR SVC</td>
<td></td>
</tr>
<tr>
<td>Doubs 500 kV</td>
<td>300 MVAR switched shunt and an increase (~50 MVAR) in size of existing switched shunt</td>
<td>6/1/2014</td>
</tr>
<tr>
<td>Hunterstown 500 kV</td>
<td>500 MVAR SVC</td>
<td></td>
</tr>
<tr>
<td>Loudoun 500 kV</td>
<td>450 MVAR SVC and 300 MVAR switched shunt</td>
<td>The required in-service dates will be adjusted pending detailed analysis of 2014-2016 period.</td>
</tr>
<tr>
<td>Mansfield 345 kV</td>
<td>100 MVAR FSS and two 100 MVAR switched shunt</td>
<td></td>
</tr>
<tr>
<td>Meadow Brook 500 kV</td>
<td>600 MVAR SVC</td>
<td></td>
</tr>
<tr>
<td>Mt. Storm - Valley 500 kV</td>
<td>250 MVAR SVC</td>
<td></td>
</tr>
<tr>
<td>Pleasant View 500 kV</td>
<td>150 MVAR switched shunt</td>
<td></td>
</tr>
</tbody>
</table>

* SVC ability to absorb reactive power will be determined pending consultation with equipment manufacturers
Designation of Construction Responsibility

- **Dominion**
  - 450 MVAR SVC and 300 MVAR Switched Shunt at Loudoun 500 kV
  - 150 MVAR Switched Shunt at Pleasant View 500 kV

- **FirstEnergy**
  - 500 MVAR SVC at Hunterstown 500 kV
  - 250 MVAR SVC at Altoona 230 kV
  - 100 MVAR Fast Switched Shunt and 200 MVAR Switched Shunt at Mansfield 345 kV
  - 300 MVAR Switched Shunt at Doubs 500 kV and an increase (~50 MVAR) in size of existing Switched Shunt at Doubs 500 kV

- **Primary Power**
  - 600 MVAR SVC at Meadow Brook 500 kV
  - 250 MVAR SVC at a new station on the existing Mt. Storm – Valley 500 kV transmission facility
The reactive upgrades will be presented to the PJM Board in December 2011 for approval and inclusion in the RTEP.
PJM Baseline Reliability Update
- Light Load Criteria Violation

- The Cloverdale 500/345KV transformer 6A and 6B are overloaded for loss of the Mt. Strom – Valley 500KV line or the Bath – Valley 500KV line or the North Anna unit #1 or the North Anna unit #2; The Cloverdale 765/345KV transformer is overloaded for various contingencies such as the loss of the Mt. Strom – Valley 500KV line or the Bath – Valley 500KV line or the North Anna unit #1.

- Advance the baseline upgrade B1660 to Install a 765/500 kV transformer at Cloverdale from 6/1/2015 to 3/1/2014
• Light Load Criteria Violation

• The East Frankfort – Crete “Blue” 345kV line is overloaded for the loss of the Wilton – Dumont 765kV line

• Solution:
  – Pending additional review of sag limitations
    • Reconductor approximately 12.51 miles of East Frankfort – Crete 345 kV line 6607
    • Alternatively raise tower structures
    • B1773

• Estimated Project Cost: $10M

• Expected IS date: 3/1/2014
ComEd Transmission Zone

- Light Load Criteria Violation

- The Crete – St. John 345 kV line is overloaded for the loss of the Wilton - Dumont 765 kV line

- Solution:
  - Pending additional review of sag limitations, reconductor approximately 11.75 miles of Crete – St. John 345kV (B1774.1)
  - Reconductor approximately 1 mile of Crete – St. John 345kV in NIPS/MISO. Further coordination with NIPS/MISO is necessary (B1174.2)

- Estimated Project Cost:
  - $9.5 M -- B1174.1
  - $0.75M – B1174.2

- Expected IS date: 3/1/2014
ComEd Transmission Zone

- Light Load Criteria Violation

- The Nelson – Electric Junction 345 kV line is overloaded for the loss of Cherry Valley – Silver Lake “Red” 345 kV line

- Reconductor approximately 16 miles from Nelson to Electric Junction 345kV; Replace associated terminal equipment (B1772)

- Estimated Project Cost: $16.3M

- Expected IS date: 3/1/2014
• Light Load Criteria Violation

• The Cloverdale – Lexington 500 KV line is overloaded for each of the following single contingencies:
  – Mt. Storm – Valley 500KV
  – Bath – Valley 500KV
  – North Anna unit #1
  – North Anna unit #2

• Proposed Solution:
  – Wreck and rebuild 7 miles of the Dominion owned section of Cloverdale – Lexington 500 KV

• Estimated Project Cost: $18 M

• Expected IS date: 3/1/2014
Penelec Transmission Zone

• N-1-1 Voltage Violation:
• Voltage Drop violation in the Erie Vicinity for a loss of various Penelec contingencies.
• Proposed Solution:
  - Install a 75 MVAR cap bank at the Four Mile 230 kV bus (B1769).
  - Install a 50 MVAR cap bank at the Buffalo Road 115kV bus (B1770).
• Estimated Project Cost:
  $ 0.95 M
  $ 0.75 M
• Expected IS Date:
  6/1/2016
• Basecase Category C:
  • Voltage drop violation on several 138 kV PPL substations for a line fault on Alburtis – Breinigsville 500 kV circuit and stuck breaker at Breinigsville 500 kV substation.

• Proposed Solution:
  Install a new 500 kV circuit breaker at Wescosville (B1788).
  This project replaces the B1601.

• Estimated Project Cost: $2.1 M

• Expected IS Date: 6/1/2016
PPL Transmission Zone

- N-1-1 Voltage Violation:
- Voltage drop violation at Columbia 230 kV for the loss of Eldred – Sunbury 230 kV and Columbia – Montour 230 kV circuits.
- Proposed Solution:
  Install a 90 MVAR capacitor at the Frackville 230 kV bus (B1740).
- Estimated Project Cost: $3 M
- Expected IS Date: 6/1/2016
- N-1-1 Voltage Violation.
- Voltage collapse in the Lumberton and Cookstown vicinity for the loss of the Cox’s Corner – Lumberton and Cookstown – Van Hiseville 230 kV circuits.
- Proposed Solution: Re-configure the Cox’s Corner and Lumberton 230 kV substations and build a second 230 kV circuit from Cox’s Corner – Lumberton (B1787).
- Estimated Project Cost: $46 M
- Required IS Date: 6/1/2016
Short Circuit Upgrades
The Brambleton 230kV breakers '2045T2094," '2094T2095," '201T2045," and '20102," are overstressed

Significant Driver: Install a 2nd 500/230 kV transformer at Brambleton (b1698)

Proposed Solution: Replace Brambleton 230kV breakers '2045T2094," '2094T2095," '201T2045," and '20102," (b1698.1-b1698.4)

Estimated Project Cost: $215 K per breaker

Expected IS Date: 6/1/2016
Proposed 2011 RTEP Upgrades presented at Previous TEAC meetings
Region with thermal issues

- NERC Category B Violations

- Problem: The 2016 summer base case indicates the following deficiencies:
  - An outage of Line #255 (North Anna – Louisa 230kV) overloads Line #11 (Gordonsville – Orange 115kV)
  - An outage of Line #255 (North Anna – Louisa 230kV) overloads Line #11 (Gordonsville – Orange 115kV)
  - System evaluated without the Warren generation per Dominion Planning Criteria

- Potential Solution –
  1. Wreck and rebuild Line #11 from Gordonsville – Orange 115 kV for higher capacity (230 kV Construction)
  2. Convert Paytes Substation to 230 kV and move load to a new North Anna to Oak Green 230 kV Line
  3. Build a second Gordonsville to North Anna 230 kV Line
Dominion Transmission Zone

Proposed Solution:
Option 1 - Wreck and rebuild 2.1 mile section of Line #11 section between Gordonsville and Somerset.

Expected IS Date: 6/1/2016

*Note: Estimated Project Costs do not include cost of right-of-way (ROW) or land purchases.
Region with thermal issues

- NERC Category B & C Violations (Generation Deliverability & DVP Analysis)
- Studied with drought conditions: (Kerr Dam, Gaston and Roanoke Rapids generation off line)
- Problem:
  - An N-1 outage of Line #556 (Clover – Carson 500 kV) overloads Line #33 (Halifax – Chase City 115 kV)
  - An N-1-1 outage of Line 556 (Clover-Carson 500 kV) and Line #127 (Halifax - Buggs Island 115 kV) overloads Line #33
  - An N-1-1 outage of Line #556 (Clover-Carson 500 kV) and Line #36 (Chase City – Buggs Island 115 kV) overloads Line #33
  - PJM Operations is currently experiencing loading issues on Line 33 (Halifax – Chase City 115 kV)
Proposed Solution:

Option 1 is the best long-term solution based on economics and because it rebuilds a two pole wood H frame line built in 1957. Investigating the use of dynamic rating technology to increase rating of line #33 from Halifax – Chase City 115 kV during the years prior to construction.

Expected IS Date: 6/1/2016
Region with thermal issues

- **NERC Category B Violation**

- **Problem:** The 2016 summer base case indicates the following deficiencies:
  - An outage of Line #90 breaker at Kerr overloads Line #22 from Eatons Ferry – Carolina 115kV
  - Surry 230 kV generation offline per Dominion Planning Criteria

- **Proposed Solution** –
  - Wreck and rebuild remaining section of Line #22, 19.5 miles and replace two pole H frame construction built in 1930.

- **Expected IS Date:** 6/1/2016

- **Estimated Project Cost:** $ 25.0 M
Region with thermal issues

- NERC Category B Violations

- Problem: The 2016 summer base case indicates the following deficiencies:
  - An outage of Line #81 (Battleboro – Carolina 115kV) breaker at Carolina overloads Line #123 (Rocky Mt – Battleboro 115kV)
  - Progress Energy Transmission Operating Procedure opens the 115 kV (tie line) breaker at Rocky Mt.

- Proposed Solution –
  - Split 230 kV Line #2056 (Hornertown to Rocky Mount) and double tap line to Battleboro Substation. Expand station, install a 230 kV 3 breaker ring bus at Battleboro and install a 230-115kV (224 MVA) transformer.

- Expected IS Date: 6/1/2016

- Estimated Project Cost: $ 8.0 M
Region with thermal issues

- NERC Category B Violations
- Problem: The 2016 summer base case indicates the following deficiencies:
  - An outage of Line #2012 (Roanoke Valley – Earleys 230 kV) line overloads a segment of Line #54 (Carolina to Woodland 115kV) without Surry 230 kV generation available per Dominion planning criteria.

- Proposed Solution
  - Reconductor segment of Line #54 (Carolina to Woodland 115kV) to a minimum of 300 MVA. Most of the 27 miles of line are on the same structures with Line # 2012. Preliminary Engineering review indicates that the structures will not need to be replaced due to the reconductoring.

- Expected IS Date: 6/1/2016

- Estimated Project Cost $ 18.0 M
Region with voltage issues

- NERC Category B Violations
- Problem: The 2016 summer base case indicates the following deficiencies:
  - An outage of Line #41 (Kitty Hawk – Colington 115 kV) causes low voltage magnitude on the Outer Banks. Voltages less than 88%
  - An outage of the SVC at Colington causes low voltage magnitude on the Outer Banks. Voltages less than 88%

- Proposed Solution –
  - Install 115 kV 25 MVAR capacitor bank at Kitty Hawk Substation

- Estimated Project Cost $ 0.7 M
- Expected IS Date: 6/1/2016
Region with thermal issues

- NERC Category B Violations
- Problem: The 2016 summer base case indicates the following deficiencies:
  - An outage of Wharton 115 kV Capacitor bank cause low voltage magnitude at Pantego (92.5%)

- Proposed Solution –
  - Split Wharton 115 kV capacitor bank into two smaller units
  - Add additional reactive support in area by correcting power factor at Pantego 115 kV DP and Five Points 115 kV DP to minimum of 0.973

- Expected IS Date: 6/1/2016

- Estimated Project Cost: $ 1.0 M
Baseline analysis and Generation Deliverability Test:

Overload on the Reybold – Motiva 138 kV circuit for the normal system and for the single loss of the Reybold 138/69 transformer.

Proposed Solution:
Replace CT at Reybold 138 kV substation (B1604).

Estimated Project Cost:
$ 0.08 M

Expected IS Date:
6/1/2016
• N-1-1 Violation:

• Overload on Keeney – Glasgow 138 kV circuit for several N-1-1 contingencies including loss of the Colora – Cecil 230kV and Raybold – Lums 138 kV circuits.

• Proposed Solution:
Replace strand bus and disconnect switch at Glasgow 138 kV substation (B1723).

• Estimated Project Cost:
$ 0.075 M

• Expected IS Date:
6/1/2016
• N-1-1 Thermal Violation

• Thermal overload of the Harley Davidson – Pleasureville 115 kV line for the loss of the Yorkana 230/115 kV Transformer #3; also, for the loss of the Yorkana - Brunner Island 230 kV line and the Yorkana 230/115 kV Transformer #1

• Proposed Solution:
Reconductor 2.4 miles of existing 556 and 795 ACSR from Harley Davidson to Pleasureville 115 kV with 795 ACSS to raise the ratings (B1727).

• Estimated Project Cost: $2.056 M

• Expected IS Date: 6/1/2016
• N-1-1 Thermal Violation

• The Waneeta 230/138 kV transformer is overloaded for several N-1-1 contingencies including the loss of the Holmesburg 230/138 kV transformer #8 and the Emilie – Neshaminy 138 kV circuit.

• Proposed Solution:
Install a second Waneeta 230/138 kV transformer on a separate bus section (B1717).

• Estimated Project Cost:
$6.5 M

• Expected IS Date:
6/1/2016
• N-1-1 Voltage Violation.
• Voltage drop and Voltage magnitude violations at Cromby and Perkiomen 138 kV substations for the loss of the Perkiomen – Heaton 138 kV and Upper Providence - Perkiomen 230 kV circuits.
• Proposed Solution: Install 39 MVAR capacitor at the Cromby 138 kV bus.
• Estimated Project Cost: $1.5 M
• Required IS Date: 6/1/2016
• PPL EU Reliability Principles and Practices:
  • Overload of the West Shore 230/69 kV Transformer #1 or #2 for the loss of the either transformer.
  • Recommended Solution: Install a 3rd West Shore 230/69 kV Transformer (B1756).
  • Estimated Project Cost: $9.0 M
  • Expected IS Date: 6/1/2016
• PPL EU Reliability Principles and Practices:
• Overload on the Clinton 230/69 kV Transformer #2 for the loss of the Montour-Elimsport and Clinton-Elimsport 230 kV double circuit tower line.
• Recommended Solution: Install a 230 kV motor-operated air-break switch on the Clinton-Elimsport 230 kV line (B1757).
  Estimated Project Cost: $1.0 M
• Expected IS Date: 6/1/2015
• PPL EU Reliability Principles and Practices:
  • Overload on the Columbia-Danville 69 kV line for the Breaker failure of the Montour bay 3T 230 kV breaker.
  • Recommended Solution: Rebuild 1.65 miles of the Columbia-Danville 69 kV line (B1758). Estimated Project Cost: $1.7 M
• Expected IS Date: 6/1/2015
• PPL EU Reliability Principles and Practices:
  Greater than 5% voltage drop on Clinton and Sunbury 69 kV lines for the loss of Milton 230 kV (Montour-Sunbury line).
• Recommended Solution: Install a 69 kV 16.2 MVAR Cap at Milton substation (B1759).
  Estimated Project Cost: $0.88 M
• Expected IS Date: 6/1/2013
• PPL EU Reliability Principles and Practices:
  Overload on the Stanton T2 and T1 230/69 kV transformers for outage of Mountain-Stanton 230 kV line with stuck breaker at Stanton and outage of Stanton-Susquehanna #2 230 kV line with stuck breaker at Stanton.

• Recommended Solution:
  Install motor operated devices on the existing disconnect switches that are located on each side of all four 230 kV CBs at Stanton (B1760).

Estimated Project Cost: $0.54 M

• Expected IS Date: 11/30/2012
PPL Transmission Zone

- PPL EU Reliability Principles and Practices:
  - Exceeds maximum allowable load drop guidelines for the loss of Blooming Grove-Jackson 69 kV line; Loss of Peckville-Jackson 69 kV Line.
- Recommended Solution:
  Build a new Paupack-North 230 kV Line (Approximately 21 miles) (B1761).
- Estimated Project Cost: $37.1 M
- Expected IS Date: 11/30/2015
• PPL EU Reliability Principles and Practices:

• Exceeds maximum allowable load drop guidelines for the loss of Blooming Grove-West Damascus 69 kV line; Loss of Blooming Grove-Honesdale 69 kV Line.

• Recommended Solution:
Replace 3.7 miles of the existing 230 kV Blooming Grove-Peckville line by building 8.4 miles of new 230 kV circuit onto the Lackawanna-Hopatcong 500 kV tower-line (B1762).

Estimated Project Cost: $2.4 M

• Expected IS Date: 11/30/2015
• PPL EU Reliability Principles and Practices:
• Exceeds maximum allowable load drop guidelines for the loss of Blooming Grove-West Damascus 69 kV line; Loss of Blooming Grove-Honesdale 69 kV Line.
• Recommended Solution: Re-terminate the Peckville-Jackson and the Peckville-Varden 69 kV lines from Peckville into Lackawanna (B1763).
  Estimated Project Cost: $3.4 M
• Expected IS Date: 11/30/2015
• PPL EU Reliability Principles and Practices:
  • Exceeds maximum allowable load drop guidelines for the loss of Blooming Grove-West Damascus 69 kV line; Loss of Blooming Grove-Honesdale 69 kV Line.
• Recommended Solution: Build a new 230-69 kV Substation (Paupack) (B1764).
  Estimated Project Cost: $19.5 M
• Expected IS Date: 11/30/2015
• PPL EU Reliability Principles and Practices:
• Low bus voltages on the Blooming Grove-West Damascus 69 kV line for normal system operation.
• Recommended Solution:
  Install a 16.2 MVAR capacitor bank at Bohemia 69-12 kV substation (B1765).
  Estimated Project Cost: $0.6 M
• Expected IS Date: 6/1/2013
PPL EU Reliability Principles and Practices:
Exceeds maximum allowable load drop guidelines for the loss of the double circuit Siegfried-Quarry #1 & #2 line.
Recommended Solution: Reconductor/rebuild 3.3 miles of the Siegfried-Quarry #1 & #2 lines (B1766).
Estimated Project Cost: $4.94 M
Expected IS Date: 6/1/2015
• PPL EU Reliability Principles and Practices:
  • Overload on Quarry 230/69 kV Transformers for various breaker failure scenarios.
  • Recommended Solution: Install six motor-operated disconnect switches at Quarry substation (B1767).
  Estimated Project Cost: $0.54 M
• Expected IS Date: 6/1/2013
• The Pumphrey 115 kV breakers '110521 DR'' and '110521 DR'' are overstressed
• Proposed Solution: Revise the reclosing for Pumphrey 115 kV breakers '110521 DR'' and '110521 DR'' (b1785-B1786)
• Estimated Project Cost: $0
• Expected IS Date: 6/1/2016
- The Essex 230 kV breaker '22H' is overstressed.
- Proposed Solution: Advance n1237 (Replace Essex 230 kV breaker '22H' with 80kA) (b1749)
- Estimated Project Cost: $50 K
- Expected IS Date: 6/1/2012
• The Hudson 230 kV breaker '1HB' is overstressed
• Proposed Solution: Advance n0666.5 (Replace Hudson 230 kV breaker '1HB' with 80 kA (without TRV cap, so actually 63 kA)) (b1750)
• Estimated Project Cost: $50 K
• Expected IS Date: 6/1/2012
PSEG Transmission Zone

- The Hudson 230 kV breaker '2HB' is overstressed
- Proposed Solution: Advance n0666.10 (Replace Hudson 230 kV breaker '1HB' with 80 kA (without TRV cap, so actually 63 kA)) (b1752)
- Estimated Project Cost: $50 K
- Expected IS Date: 6/1/2012
PSEG Transmission Zone

- The Hudson 230 kV breaker '2HA' is overstressed
- Proposed Solution: Advance n0666.3 (Replace Hudson 230 kV breaker '1HB' with 80 kA (without TRV cap, so actually 63 kA)) (b1751)
- Estimated Project Cost: $50 K
- Expected IS Date: 6/1/2012
• The Marion 138 kV breakers „7PM,“, „3PM,“, and „6PM,“ are overstressed
• Proposed Solution: Delay the relay time to increase the contact parting time to 2.5 cycles for Marion 138 kV breakers „7PM,“, „3PM,“, and „6PM,“ (b1753-b1755)
• Estimated Project Cost: $0
• Expected IS Date: 6/1/2012
ATSI Transmission Zone

- Operational Performance
- Perform reconfiguration at Richland 138kV that will permit the removal of the existing Richland SPS
- Add new 138kV line exit (includes circuit breaker and associated relay/terminal equipment) to the Richland K bus; Relocate the Lockwood Road 138kV line from the L bus to the new line exit off the K bus (B1771).
- Estimated Project Cost: $0.623M
- Expected IS date: 6/1/2012
The following breakers are overstressed:

- Eastlake 138 kV breakers:
  - "46-B-36"
  - "46-B-35"
  - "46-B-31"
  - "46-B-34"
  - "46-B-21"
  - "46-B-27"
  - "46-B-18"
  - "46-B-24"
  - "46-B-33"
  - "46-B-32"

Proposed Solution:
- Revise the reclosing of each of the Eastlake 138 kV breakers

Estimated Project Cost:
- $10 K per breaker

Expected IS Date:
- 12/25/2012
• The following breaker is overstressed:
  – Fowles 138 kV breaker '64-B-9'

• Proposed Solution:
  – Revise the reclosing of Fowles 138 kV breaker „64-B-9"

• Estimated Project Cost:
  – $10 K

• Expected IS Date:
  – 12/25/2012
The following breaker is overstressed:
- Pleasant Valley 138 kV breaker '194-B-5'

Proposed Solution:
- Revise the reclosing of Pleasant Valley 138 kV breaker '194-B-5'

Estimated Project Cost:
- $10 K

Expected IS Date:
- 12/25/2012
The following breakers are overstressed:
- Bluebell 138 kV breaker '301-B-9''
- Bluebell 138 kV breaker '301-B-8''

Proposed Solution:
- Revise the reclosing of Bluebell 138 kV breaker '301-B-9''
- Revise the reclosing of Bluebell 138 kV breaker '301-B-8''

Estimated Project Cost:
- $10 K per breaker

Expected IS Date:
- 12/25/2012
The following breaker is overstressed:
- East Akron 138 kV breaker '36-B-22'

Proposed Solution:
- Revise the reclosing of East Akron 138 kV breaker '36-B-22'

Estimated Project Cost:
- $10K

Expected IS Date:
- 12/25/2012
• The following breaker is overstressed:
  – Avon Lake 138 kV breaker '10-B-12'

• Proposed Solution:
  – Replace Avon Lake 138 kV breaker '10-B-12'

• Estimated Project Cost:
  – TBD

• Expected IS Date: TBD
The following breaker is overstressed:
  - Pleasant Valley 138 kV breaker '194-B-7"

Proposed Solution:
  - Replace Pleasant Valley 138 kV breaker '194-B-7"

Estimated Project Cost:
  - TBD

Expected IS Date: TBD
• The following breaker is overstressed:
  – Brady 138 kV breaker '1003-B-6'

• Proposed Solution:
  – Replace Brady 138 kV breaker '1003-B-6'

• Estimated Project Cost:
  – $150 K

• Expected IS Date:
  – 12/25/2012
• The following breakers are overstressed:
  – East Akron 138 kV breaker '36-B-56''
  – East Akron 138 kV breaker '36-B-40''
  – East Akron 138 kV breaker '36-B-45'

• Proposed Solution:
  – Replace East Akron 138 kV breaker '36-B-56''
  – Replace East Akron 138 kV breaker '36-B-40''
  – Replace East Akron 138 kV breaker '36-B-45'

• Estimated Project Cost:
  – $150 K per breaker

• Expected IS Date:
  – 12/25/2012
The following breaker is overstressed:
- Greenfield 138 kV breaker '501-B-68'

Proposed Solution:
- Replace Greenfield 138 kV breaker '501-B-68'

Estimated Project Cost:
- $150 K

Expected IS Date:
- $12/25/2012
- The following breaker is overstressed:
  - Masury 138 kV breaker '103-B-118'

- Proposed Solution:
  - Replace Masury 138 kV breaker '103-B-118'

- Estimated Project Cost:
  - $150 K

- Expected IS Date:
  - 12/25/2012
The following breakers are overstressed:
- Roberts 138 kV breaker '601-B-26"
- Roberts 138 kV breaker '601-B-113"
- Roberts 138 kV breaker '601-B-13'

Proposed Solution:
- Replace Roberts 138 kV breaker '601-B-26"
- Replace Roberts 138 kV breaker '601-B-113"
- Replace Roberts 138 kV breaker '601-B-13'

Estimated Project Cost:
- $150 K per breaker

Expected IS Date:
- 12/25/2012
The following breakers are overstressed:
- Sammis 138 kV breakers:
  - '780-B-44''
  - '780-B-45''
  - '780-B-9''
  - '780-B-75''

Proposed Solution:
- Replace Sammis 138 kV breaker '780-B-44''
- Replace Sammis 138 kV breaker '780-B-45''
- Replace Sammis 138 kV breaker '780-B-9''
- Replace Sammis 138 kV breaker '780-B-75''

Estimated Project Cost:
- $150 K per breaker

Expected IS Date:
- 12/25/2012
The following breakers are overstressed:

- Greenfield 138 kV breakers:

Significant Driver:
- Build new Hayes 345/138 kV substation with new 138 kV lines to: Greenfield #1, Greenfield #2, and Avery (b1281)

Proposed Solution:
- Replace the following Greenfield 138 kV breakers:
  - "501-B-1"
  - "501-B-21"
  - "501-B-227"
  - "501-B-23"
  - "501-B-242"
  - "501-B-36"
  - "501-B-38"
  - "501-B-40"

Estimated Project Cost:
- $175 K per breaker

Expected IS Date:
- 12/25/2015
AEP Transmission Zone

- AEP Transmission Planning Guideline (TP-000001) Violation

- The Momentary Permanent Outage Index (MPOI) rating for South Princeton - Switchback 138 kV line is 398.92, greater than the 200 threshold

- Install two 138kV breakers and two 138kV circuit switchers at South Princeton Station. Install one 138kV breaker and one 138kV circuit switcher at Switchback Station. (B1780)

- Estimated Project Cost: $3M

- Expected IS date: 10/1/2013
AEP Transmission Zone

- AEP Transmission Planning Guideline (TP-000001) Violation
- Momentary Permanent Outage Index (MPOI) rating for South Baileysville - Tazewell 138 kV line is 288.3, greater than the 200 threshold
- Install three 138kV breakers and a 138kV circuit switcher at Trail Fork Station in Pineville, WV. (B1781)
- Estimated Project Cost: $4.5M
- Expected IS date: 3/1/2013
AEP Transmission Zone

• AEP Transmission Planning Guideline (TP-000001) Violation

• The Forced Outage Index (FOI) rating for London – Carbondale 46kV line is 25.9, greater than the 6 threshold

• Install a 46kV Moab at Montgomery Station facing Carbondale (on the London – Carbondale 46kV circuit). (B1782)

• Estimated Project Cost: $0.3M

• Expected IS date: 9/1/2012
• AEP Transmission Planning Guideline TP-000001 Violation

• The Momentary Permanent outage Index (MPOI) rating for South Bluefield – Lonesome Pine 138 kV line is 310, greater than the 200 threshold

• Add two 138kV Circuit Breaker and two 138kV Circuit Switchers on the Lonesome Pine – South Bluefield 138kV Line. (B1783)

• Estimated Project Cost: $1M

• Expected IS date: 11/1/2015
- Basecase Analysis Voltage Violation
- Low voltage magnitude at Clifford 138kV bus for the loss of the Boxwood – Reusens 138KV line.
- Install a 52.8 MVar capacitor bank at the Clifford 138kV Station. (B1784)
- Estimated Project Cost: $2M
- Expected IS date: 6/1/2016
The following breakers are overstressed:

- Sorenson 138 kV breakers
- McKinley 138 kV breaker
  - "L1"

Significant Driver:
- Establish Sorenson 345/138 kV station as a 765/345 kV station (b1659)

Proposed Solution:
- Replace the following breakers at Sorensen and McKinley
- Sorenson 138 kV breakers
- McKinley 138 kV breaker
  - "L1"
  - (b1659.1-b1659.12)

Estimated Project Cost:
- $800 K per breaker

Expected IS Date:
- 6/1/2016
• The following Beatty 138 kV breakers are overstressed
  – '2C(IPP)', '1E', '2E', '3C', and '2W'
  – Proposed Solution: Replace Beatty 138 kV breakers
    – '2C(IPP)', '1E', '2E', '3C', and '2W'
    – (B1741-B1745)
• Estimated Project Cost: $800 K per breaker
• Expected IS Date: 6/1/2015
• The St. Claire 138 kV breaker „8“ is overstressed
• Proposed Solution: Replace St. Clair 138 kV breaker „8“ (b1746)
• Estimated Project Cost: $800 K
• Expected IS Date: 6/11/2015
• The Cloverdale 138 kV breakers „C,” and „D1“ are overstressed
• Proposed Solution: Replace Cloverdale 138 kV breakers „C,” and „D1(B1747-B1748)
• Estimated Project Cost: $800 K per breaker
• Expected IS Date: 6/11/2015
• Light Load Criteria Violation

• The W GLOW – Wurno 138KV is overloaded for the loss of the Cloverdale – Jackson Ferry 765KV line with the stuck breaker at Jackson Ferry 765kV bus

• Advance the baseline upgrade B1498 to Replace 138 kV risers at Wurno Station from 6/1/2015 to 3/1/2014

• Required Project Cost: $0
ComEd Transmission Zone

- Light Load Criteria Violation

- Marengo; RT – Pleasant Valley; R 138 kV line is overloaded for the loss of Cherry Valley – Silver Lake “Red” 345 kV line.

- Solution:
  - Reconductor 10.7 miles of Marengo – Pleasant Valley 138kV
  - Replace associated terminal and protective equipment
  - B1775

- Estimated Cost: $8.5 M

- Required IS date: 3/1/2014
ComEd Transmission Zone

- Light Load Criteria Violation
- McGirr Road – H440; RT 138 kV line is overloaded for the loss of the Nelson – P20 “Blue” 345 kV line or the P20 – Electric Junction “Blue” 345 kV line.
- Reconductor 0.157 miles McGirr Road – H440; RT 138 kV line of 477 ACSR (B1776)
- Estimated Cost: $0.35M
- Required IS date: 3/1/2014
• Light Load Criteria Violation

• Marengo; BT– Woodstock; B 138 kV line is overload for the loss of the Cherry Valley – Silver Lake “Red” 345 kV line.

• Solution:
  – Reconductor approximately 11.5 miles
  – Replace associated terminal equipment
  – B1777

• Estimated Cost: $8.85 M

• Required IS date: 3/1/2014
• Light Load Criteria Violation

• The Steward TSS 186 – Haumesser Road “Blue” 138 kV line is overload for the loss of the Nelson – P20 “Blue” 345 kV line or the P20 – Electric Junction “Blue” 345 kV line.

• Reconductor 7.181 miles of 477 ACSR & upgrade station conductor at TSS 186 Steward (B1778)

• Estimated Cost: $11.4 M

• Required IS date: 3/1/2014
• Light Load Criteria Violation

• Kickapoo Creek; B – Marseilles Tap On LaSalle - Streator Line L6102 ; T 138 kV line is overload for the loss of the LaSalle – Kickapoo “Blue” 138 kV line.

• Reconductor 5.242 miles Kickapoo Creek – Marseilles Tap 138kV line of 477 ACSR (B1779)

• Estimated Cost: $8.3 M

• Required IS date: 3/1/2014
Supplemental Projects
- Supplemental Project
- Replace the Transformer 84 345 kV MOD with a circuit switcher at TSS 144 Wayne. (S0363)
- This project is being done to facilitate switching for maintenance so that the transformer can be removed from service without taking 345 kV line 14419 (Wayne – Aurora) out of service along with the customer substation fed from that line.
- Estimate Cost: $0.45M
- Projected IS date: 12/31/2012
• Supplemental Project
• Replace the Transformer 81 MOD with a circuit switcher at ESS H-471 Sterling Steel. (S0364)
• This is to avoid having to take out 345 kV line 15504 (H-471 to Nelson) to de-energize the transformer.
  Estimate Cost: $0.05M
• Projected IS date: 06/01/2012
• Baseline upgrade solutions in this presentation will be Proposed to the PJM Board in December 2011 for approval and inclusion in the RTEP.

• Email RTEP@pjm.com with any comments or questions