Transmission Expansion Advisory Committee Meeting

October 30, 2006
• 2011 RTEP Baseline Update
• Scenario Planning
• Review of Transmission Alternatives for 2012 through 2021
• 500/230 kV Transformer PRA Recommendations
• Market Efficiency Scope and Assumptions
• RTEP Brochure
• Generator Interconnection Studies
2011 RTEP Retool Results
• PJM completed a retool of the 2011 RTEP analysis to include a 1000 MW transmission service request and all Queue N Interconnection projects.

• The 1000 MW transmission service request and queue N interconnection projects were not included in the 2011 RTEP results discussed at the May 2006 TEAC meeting.

• Once the O queue Impact studies are complete, an additional retool of the 2011 RTEP will be required to accommodate the Queue O interconnection projects. This will need to be completed to provide the reference base system model for the Queue P Impact Studies.
• The retool to include the 1000 MW transmission service request and all Queue N Interconnection projects is only being completed for the year 2011. The results for the 6 to 15 year horizon are not being updated at this time.

• The 6 to 15 year results will be updated next spring as part of the 2012 RTEP analysis.
2011 RTEP Retool Results

PJM Western Region
• In 2010, Harrison – Belmont 500kV is contingency overloaded to 102%  
  – Contingency: Kammer – South Canton 500kV with a stuck breaker at Kammer 500kV that also outages associated equipment at Kammer and South Canton 500kV.  
  – The planned solution is to replace the terminal equipment at Harrison and Belmont 500kV by June 2010 at a cost $90K.

• Advance the need for the replacement of the North Shenandoah 138/115kV transformer to June 2008.
• In 2010, the Cabot 500/138kV transformer #1 is contingency overloaded to 101%
  – Contingency: Keystone – Cabot 500kV and the Cabot 500/138kV transformers #1 and #2
  – The recommended solution is to install a breaker failure auto-restoration scheme at Cabot 500kV by June 2010.

• In 2010, the Bedington #2 and #4 500/138kV transformers are contingency overloaded to 125%
  – Contingency: Bedington – Doubs 500kV and the Bedington 500/138kV transformers #1 and #3.
  – The recommended solution is to install a breaker failure auto-restoration scheme at Bedington 500kV by June 2010.
• In 2010, the Black Oak 500/138kV transformer #3 is contingency overloaded to 114%
  – Contingency: Hatfield - Ronco 500 kV and the Hatfield Generating unit #1
  – The recommended solution is to implement an operating procedure to open the Black Oak 500/138kV transformer #3 for this contingency. There is no cost associated with this solution.

• A total of 22 breaker replacements at the following locations in Allegheny Power are required by December 2007. The replacement cost is $120K each for a total cost of $2.64M.
  – Glen Falls 138kV
  – Marlowe 138kV
  – Mitchell 138kV
  – Trissler 138kV
  – Weirton 138kV

• In 2010, the Wolfs – Frontenac 138kV circuit is contingency overloaded to 122%
  – The recommended solution is to reconductor 2.8 Miles of Wolfs-Frontenac 138kV line 14310 by June 2010 for $3M.
The total estimated cost of new system upgrades for the PJM Western Region through 2011 is approximately $5.6 Million.
• The original cost estimate for the Black Oak 500 kV dynamic reactive device was $35 million. The cost is now estimated at $50 million. The following factors contributed to the increased cost:

  – Accelerated in-service date to December 2007
  – Actual bid estimates higher than expected due to increased material costs, availability of equipment and magnitude of the project.
  – Site development and property acquisition were not part of the original estimate since the initial assessment did not anticipate the need for additional property.
• The solutions to the following two thermal overloads are pending

  – In 2010, the Mahans Lane – Tidd – Weirton 138kV circuit is contingency overloaded at 118%
    • Contingency: Wylie Ridge – Tidd 345kV and Tidd – Collier 345kV

  – In 2010, Mitchell – Shepler Hill 138kV is contingency overloaded to 111%
    • Contingency: Hatfield - Ronco 500 kV and the Hatfield Generating unit #1
2011 RTEP Retool Results

PJM Southern Region
• In 2007, Dooms 500/230 kV transformer overload
  – Contingency: Cunningham – Elmont 500 kV circuit
  – The recommended solution: Add 2nd Dooms 500/230 kV transformer at a cost of $8.0 million.
  – Projected in-service date: June 2007

• In 2010, Pruntytown – Mt. Storm is 500 kV overload
  – Contingency: Black Oak - Bedington 500 kV circuit
  – The recommended solution: Retension 1/10 mile of Pruntytown - Mt. Storm 500 kV at a cost of $0.
  – Projected in-service date: June 2010

• In 2011, a short circuit violation was identified at Loudoun 230 kV bus
  – The recommended solution: Replace one 230 kV breaker at Loudoun 230 kV at a cost of $0.5 Million
  – Projected in-service date: June 2011
• In 2011, the new Suffolk – Fentress 230 kV circuit that was identified as part of the B0329 baseline project has been changed to a new Suffolk – Thrasher 230 kV circuit. There is no cost associated with this change.
These changes resulted in a $8.5 M increase in the cost of Southern Region system upgrades.
2011 RTEP Retool Results

PJM Mid-Atlantic Region
• **In 2008, Linwood – Chichester 230 kV overload**
  – Contingency: Loss of the other Linwood – Chichester 230 kV
  – Install SPS at Chichester 230 kV for $0.10 M
  – Projected in-service date is June 2008.

• **In 2009, Christiana – New Castle 138 kV overload**
  – Contingency: Loss of both Linwood – Chichester 230 kV circuits
  – Upgrade Christiana - New Castle 138kV for $0.25 M
  – Projected in-service date is June 2009.

• **The two upgrades above will replace the existing SPS at the Phillips Island generator.**
• **In 2008, New Freedom 500/230 kV overload**
  - Contingency: N-2 of the other two New Freedom 500/230 kV
  - Install a 4th 500/230 kV transformer and replace 2 - 230 kV breakers for $26 M
  - Projected in-service date is June 2008.
  - This project replaces baseline upgrades B0131 and B0213 which totaled $21.2 M.

• **In 2010, Linden – N. Avenue 138 kV overload**
  - Contingency: Linden – Bayway 1-4 138 kV
  - Reconfigure the Bayway 230 kV substation for $1.5 M
  - Projected in-service date is June 2010.
The following seven upgrades are needed to replace the new Linden – South Waterfront 230 kV circuit that was originally proposed in the 2011 RTEP. The total cost of the new system upgrades are around $27 million.

These upgrades will be modeled in the 2011 basecase that will be used for future interconnection impact studies.

However, due to the recent announced potential retirement of Hudson Unit 2 in Northern PSE&G territory PJM does not plan to remove the new Linden – South Waterfront 230 kV circuit from the RTEP at this time.
• In 2011, Readington – Branchburg 230 kV @ 113%
  – Contingency: Whippany – Roseland 230 kV
  – Reconductor overloaded circuit with 1590 ACSS for $4.3 M
  – Projected in-service date is June 2011.

• In 2011, Readington – Roseland 230 kV @ 102%
  – Contingency: Whippany – Roseland 230 kV
  – Replace Wavetrap of the overloaded circuits for $0.32 M
  – Projected in-service date is June 2011.

• In 2011, Linden – Tosco 230 kV @ 113%
  – Contingency: Deans – W. Hempfeild 230 kV
  – Reconductor overloaded circuit with 1590 ACSS for $0.61 M
  – Projected in-service date is June 2011.
• **In 2011, Athenia - Saddlebrook 230 kV @ 106%**
  – Contingency: Essex – Hudson 230 kV
  – Reconductor river section for $1.5 M
  – Projected in-service date is June 2011.

• **In 2011, Roseland – W. Caldwell ‘G’ 138 kV @ 102%**
  – Contingency: Roseland – Kearney ‘D’ 230 kV
  – Replace Wavetrap of the overloaded circuits for $0.05 M
  – Projected in-service date is June 2011.

• **In 2011, Kittatinny – Newton 230 kV @ 106%**
  – Contingency: Portland - Greystone 230 kV
  – Reconductor overloaded circuit with 1590 ACSS for $20.0 M
  – Projected in-service date is June 2011.

• **In 2011, Greystone – W Wharton 230 kV @ 106%**
  – Contingency: Gilbert - Morristown 230 kV
  – Potential overload, Still under review by TO
These changes resulted in a $33 million increase in the cost of PJM Mid-Atlantic Region system upgrades.
Cost Allocation for
RTEP Baseline System Upgrades
**Legend for Cost Allocation**

<table>
<thead>
<tr>
<th>Short Name</th>
<th>Full Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>AEC</td>
<td>Atlantic City Electric Company</td>
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<td>AEP</td>
<td>American Electric Company</td>
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<td>APS</td>
<td>Allegheny Power</td>
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<td>BGE</td>
<td>Baltimore Gas and Electric Company</td>
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<td>ComEd</td>
<td>Commonwealth Edison Company</td>
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<td>DPL</td>
<td>Delmarva Power and Light Company</td>
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<td>Dayton</td>
<td>Dayton Power and Light Company</td>
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<td>DL</td>
<td>Duquesne Light Company</td>
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<td>Virginia Electric and Power Company</td>
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<td>JCPL</td>
<td>Jersey Central Power and Light Company</td>
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<td>Neptune Regional Transmission System, LLC</td>
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<td>Public Service Electric and Gas Company</td>
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<td>RECO</td>
<td>Rockland Electric Company</td>
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<td>VFT</td>
<td>East Coast Power, LLC</td>
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## Cost Allocation - RTEP Baseline

<table>
<thead>
<tr>
<th>UpgradeID</th>
<th>Description</th>
<th>Cost ($ Millions)</th>
<th>In-Service Date</th>
<th>Construction Responsibility</th>
<th>Recommended Cost Responsibility</th>
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<tbody>
<tr>
<td>b0213.1</td>
<td>Replace New Freedom 230kV breaker BS2-6</td>
<td>$0.38</td>
<td>6/1/2008</td>
<td>PSEG</td>
<td>AEC (35%) / JCPL (14%) / Neptune (1%) / PECO (24%) / PSEG (26%)</td>
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<td>b0213.3</td>
<td>Replace New Freedom 230kV breaker BS2-8</td>
<td>$0.38</td>
<td>6/1/2008</td>
<td>PSEG</td>
<td>AEC (35%) / JCPL (14%) / Neptune (1%) / PECO (24%) / PSEG (26%)</td>
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<td>b0249</td>
<td>Install 28 MVAR of 69kV bus capacitors at Bells Mill</td>
<td>$0.72</td>
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<td>PEPCO</td>
<td>PEPCO (100%)</td>
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<td>b0382</td>
<td>Cambridge Sub - Close through to Todd Substation</td>
<td>$1.49</td>
<td>6/1/2009</td>
<td>DPL</td>
<td>DPL (100%)</td>
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<td>b0383</td>
<td>Wye Mills AT-1 and AT-2 138/69kV Replacements</td>
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<td>b0384</td>
<td>Replace Indian River AT-20 (400 MVA)</td>
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<td>b0385</td>
<td>Oak Hall to New Church (13765) Upgrade</td>
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<td>b0386</td>
<td>Cheswold/Kent (6768) Rebuild</td>
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<td>b0387</td>
<td>N. Seaford - Add a 2nd 138/69kV autotransformer</td>
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<td>DPL</td>
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<td>Indian River AT-1 and AT-2 138/69kV Replacements</td>
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<td>b0390</td>
<td>Rehoboth/Lewes (6751-1 &amp; 6751-2) upgrade</td>
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<td>b0392</td>
<td>East New Market Sub - Establish a 69kV Bus Arrangement</td>
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<td>b0393</td>
<td>Replace terminal equipment at Harrison 500kV and Belmont 500kV</td>
<td>$0.09</td>
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<td>Dominion (100%)</td>
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<td>b0394</td>
<td>Reconductor 2.8 Miles of Wolfs-Frontenac 138kV line 14310</td>
<td>$3.00</td>
<td>6/1/2010</td>
<td>ComEd</td>
<td>ComEd (100%)</td>
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<td>b0395</td>
<td>Replace Hudson 230kV breaker BS4-5</td>
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<td>b0396</td>
<td>Replace Hudson 230kV breaker BS1-6</td>
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<td>Replace Hudson 230kV breaker BS5-6</td>
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<td>PSEG (100%)</td>
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<td>UpgradeID</td>
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<td>Cost ($ Millions)</td>
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<td>Replace Roseland 230kV breaker BS 6-7</td>
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<td>b0401.4</td>
<td>Replace Roseland 138kV breaker T-1320</td>
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<td>Replace Roseland 138kV breaker P-1316</td>
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<td>b0401.7</td>
<td>Replace Roseland 138kV breaker 220-4</td>
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<td>b0401.8</td>
<td>Replace W. Orange 138kV breaker 132-4</td>
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<td>b0402.1</td>
<td>Replace Whitpain 230kV breaker #245</td>
<td>$0.50</td>
<td>6/1/2010</td>
<td>PECO</td>
<td>PECO (100%)</td>
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<td>b0402.2</td>
<td>Replace Whitpain 230kV breaker #255</td>
<td>$0.50</td>
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<td>PECO</td>
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<td>b0403</td>
<td>2nd Dooms 500/230kV transformer addition</td>
<td>$8.00</td>
<td>6/1/2009</td>
<td>Dominion</td>
<td>AEC (1%) / APS (2%) / BGE (8%) / DPL (2%) / DVP (59%) / JCPL (3%) / ME (2%) / PECO (5%) / PEPCO (10%) / PPL (3%) / PSEG (5%)</td>
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<td>b0404.1</td>
<td>Replace South Reading 230kV breaker 107252</td>
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<td>Replace South Reading 230kV breaker 100652</td>
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<td>$0.12</td>
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<td>Replace Mitchell 138kV breaker &quot;Charlerio #2&quot;</td>
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<td>Replace Mitchell 138kV breaker &quot;Charlerio #1&quot;</td>
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<td>Replace Mitchell 138kV breaker &quot;Union Jct&quot;</td>
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<td>UpgradeID</td>
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<td>Cost ($ Millions)</td>
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<td>APS</td>
<td>APS (100%)</td>
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<td>$0.12</td>
<td>6/1/2008</td>
<td>APS</td>
<td>APS (100%)</td>
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<td>b0407.8</td>
<td>Replace Marlowe 138kV breaker &quot;138 kV bus tie&quot;</td>
<td>$0.12</td>
<td>6/1/2008</td>
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<tr>
<td>b0408.1</td>
<td>Replace Trissler 138kV breaker &quot;Belmont 604&quot;</td>
<td>$0.12</td>
<td>6/1/2008</td>
<td>APS</td>
<td>APS (100%)</td>
</tr>
<tr>
<td>b0408.2</td>
<td>Replace Trissler 138kV breaker &quot;Edgelawn 90&quot;</td>
<td>$0.12</td>
<td>6/1/2008</td>
<td>APS</td>
<td>APS (100%)</td>
</tr>
<tr>
<td>b0409.1</td>
<td>Replace Weirton 138kV breaker &quot;Wylie Ridge 210&quot;</td>
<td>$0.12</td>
<td>6/1/2006</td>
<td>APS</td>
<td>APS (100%)</td>
</tr>
<tr>
<td>b0409.2</td>
<td>Replace Weirton 138kV breaker &quot;Wylie Ridge 216&quot;</td>
<td>$0.12</td>
<td>12/31/2006</td>
<td>APS</td>
<td>APS (100%)</td>
</tr>
<tr>
<td>b0410</td>
<td>Replace Glen Falls 138kV breaker &quot;McAlpin 30&quot;</td>
<td>$0.12</td>
<td>6/1/2007</td>
<td>APS</td>
<td>APS (100%)</td>
</tr>
<tr>
<td>b0411</td>
<td>Install 4th 500/230kV transformer at New Freedom</td>
<td>$22.00</td>
<td>6/1/2008</td>
<td>PSEG</td>
<td>AEC (35%) / JCPL (14%) / Neptune (1%) / PECO (24%) / PSEG (26%)</td>
</tr>
<tr>
<td>b0412</td>
<td>Retension Pruntytown - Mt. Storm 500kV to a 3502 MVA rating</td>
<td>$0.00</td>
<td>6/1/2010</td>
<td>Dominion</td>
<td>Dominion (100%)</td>
</tr>
<tr>
<td>b0413</td>
<td>Install SPS at Chichester</td>
<td>$0.10</td>
<td>6/1/2008</td>
<td>PECO</td>
<td>PECO (100%)</td>
</tr>
<tr>
<td>b0414</td>
<td>Upgrade the Christiana - New Castle 138kV circuit</td>
<td>$0.25</td>
<td>6/1/2009</td>
<td>DPL</td>
<td>DPL (100%)</td>
</tr>
<tr>
<td>b0415</td>
<td>Increase the temperature ratings of the Edgemoore - Christiana - New Castle 138kV by replacing six transmission poles</td>
<td>$0.00</td>
<td>6/1/2008</td>
<td>DPL</td>
<td>DPL (100%)</td>
</tr>
<tr>
<td>b0418</td>
<td>Install a breaker failure auto-restoration scheme at Cabot 500kV for the failure of the #6 breaker</td>
<td>$0.00</td>
<td>6/1/2010</td>
<td>APS</td>
<td>APS (100%)</td>
</tr>
<tr>
<td>b0419</td>
<td>Install a breaker failure auto-restoration scheme at Bedington 500kV for the failure of the #1 and #2 breakers</td>
<td>$0.00</td>
<td>6/1/2010</td>
<td>APS</td>
<td>APS (100%)</td>
</tr>
<tr>
<td>UpgradeID</td>
<td>Description</td>
<td>Cost ($ Millions)</td>
<td>In-Service Date</td>
<td>Construction Responsibility</td>
<td>Recommended Responsibility</td>
</tr>
<tr>
<td>-----------</td>
<td>-----------------------------------------------------------------------------------------------------------------------------------------------</td>
<td>-------------------</td>
<td>-----------------</td>
<td>-----------------------------</td>
<td>-----------------------------</td>
</tr>
<tr>
<td>b0420</td>
<td>Operating Procedure to open the Black Oak 500/138kV transformer #3 for the loss of Hatfield - Ronco 500kV and the Hatfield #3 Generation</td>
<td>$0.00</td>
<td>6/1/2010</td>
<td>APS</td>
<td>APS (100%)</td>
</tr>
<tr>
<td>b0421</td>
<td>Operating Procedure to open the Black Oak 500/138kV transformer #3 for the loss of Hatfield - Ronco 500kV and Fort Martin - Ronco 500kV and the Fort Martin #1 Generation</td>
<td>$0.00</td>
<td>6/1/2010</td>
<td>APS</td>
<td>APS (100%)</td>
</tr>
<tr>
<td>b0423</td>
<td>Reconductor Readington (2555) - Branchburg (4962) 230kV circuit w/ 1590 ACSS</td>
<td>$4.30</td>
<td>6/1/2011</td>
<td>JCPL</td>
<td>PSEG (98%) / VFT (2%)</td>
</tr>
<tr>
<td>b0424</td>
<td>Replace Readington wavetrap on Readington (2555) - Roseland (5017) 230kV circuit</td>
<td>$0.16</td>
<td>6/1/2011</td>
<td>JCPL</td>
<td>PSEG (100%)</td>
</tr>
<tr>
<td>b0425</td>
<td>Reconductor Linden (4996) - Tosco (5190) 230kV circuit w/ 1590 ACSS (Assumes operating at 220 degrees C)</td>
<td>$2.18</td>
<td>6/1/2011</td>
<td>PSEG</td>
<td>PSEG (64%) / VFT (36%)</td>
</tr>
<tr>
<td>b0426</td>
<td>Reconductor Tosco (5190) - G22_MTX5 (90220) 230kV circuit w/ 1590 ACSS (Assumes operation at 220 degrees C)</td>
<td>$0.61</td>
<td>6/1/2011</td>
<td>PSEG</td>
<td>PSEG (64%) / VFT (36%)</td>
</tr>
<tr>
<td>b0427</td>
<td>Reconductor Athenia (4954) - Saddle Brook (5020) 230kV circuit river section</td>
<td>$1.50</td>
<td>6/1/2011</td>
<td>PSEG</td>
<td>PSEG (100%)</td>
</tr>
<tr>
<td>b0428</td>
<td>Replace Roseland wavetrap on Roseland (5019) - West Caldwell G (5089) 138kV circuit</td>
<td>$0.05</td>
<td>6/1/2011</td>
<td>PSEG</td>
<td>PSEG (100%)</td>
</tr>
<tr>
<td>b0429</td>
<td>Reconductor Kittatinny (2553) - Newton (2535) 230kV circuit w/ 1590 ACSS</td>
<td>$20.00</td>
<td>6/1/2011</td>
<td>JCPL</td>
<td>AEC (3%) / DPL (2%) / JCPL (34%) / Neptune (3%) / PECO (5%) / PSEG (49%) / RECO (2%) / VFT (2%)</td>
</tr>
</tbody>
</table>
Preliminary 10 Year Reactive Planning Results
• The PJM Planning Committee in August 2006 approved including reactive planning for a 10 year RTEP model.

• The analysis focuses on the 345 kV, 500 kV and 765 kV systems to determine the more global PJM reactive requirements in year 10 (2016).

• The analysis is limited to areas in the PJM system where thermal problems were identified in the 6 through 15 year analysis. For the 2011 RTEP, all thermal problems in years 6 through 15 were identified in the Mid-Atlantic Region.
PJM completed both a Mid-Atlantic and Eastern Mid-Atlantic load deliverability voltage analysis for 2016. These tests were selected because they were the principle driver for a majority of the thermal overloads identified in years 6 through 15. The high load levels (90/10) modeled in the load deliverability studies are also the conditions when PJM typically sees voltage issues on the system.

PJM identified the need for approximately 9000 MVAR of reactive devices by 2016 in order to provide for an adequate voltage profile under n-0 and n-1 conditions.

An additional 1000 MVAR of reactive upgrades were provided by the Transmission Owners as part of the base system model update for 2016.
• The combination of the Transmission Owner supplied reactive plans and the PJM identified reactive need results in over 10000 MVAR of reactive devices required prior to 2016.

• No analysis was completed to determine the mix of static versus dynamic devices.

  • If the entire 10000 MVAR were static devices (capacitors), the cost would be estimated around $200 million.
  • If 20% of the 10000 MVAR were dynamic and 80% were static, the cost would be estimated around $360 million.

PJM used $20,000 / MVAR for static and $100,000 / MVAR for the estimates.
Review of Scenario Planning Results
Scenario Planning Results

- Load Forecast for Economic Growth Uncertainty
- Circulation
- Generation Scaling Sensitivity
• Load forecast for economic growth uncertainty – this scenario has the potential to advance system upgrades in the 6 to 10 year plan. Identification of new upgrades are not within the scope of this scenario.

• It is expected that the load forecast to account for economic growth uncertainty would be around a 2% increase by year 10.

• Generally speaking this would advance most of the overloads identified in years 6 through 10 by a year or two.

• PJM will not complete detailed analysis for this scenario in 2006 since the recommended system upgrades to resolve the problems identified in years 6 through 15 are not expected to be determined until early in 2007.

• Refinement of the required in-service date based on scenario planning results will be factored in once the system upgrades are determined.
• A PJM Planning Committee working group developed a circulation model which was approved by the PJM Planning Committee in July 2006.

• The circulation model will be applied to the 2011 RTEP basecase and any new overloads due to the PJM generator deliverability test will be identified and system upgrades will be included in the RTEP.

• Preliminary results indicate the potential for four overloads in the ComEd territory. PJM will work with ComEd to finalize these results. No other problems were identified.
• PJM increased existing and ISA generation above their actual capabilities during the 6 to 15 year analysis. This was done in order to provide sufficient generation to meet load + losses + firm interchange.

• Generation was scaled above their capabilities for years 2016 through 2021 (years 10 through 15).

• For scenario planning a sensitivity is to be performed to use generation that has received an Impact Study and has not withdrawn instead of increasing existing and ISA generation above their capabilities.

• The generation scaling scenario can only advance or defer new transmission or ROW acquisition in years 6 through 15 that was previously identified in the RTEP.
PJM completed the generation scaling sensitivity analysis.

The majority of overloads that occur after 2018 are accelerated by 2 years.

This occurs because the mix of generation at the Impact Study stage introduces an increased west to east flow on the PJM system (more Impact Study generation in the Western and Southern Region than in the Mid-Atlantic Region).

PJM does not plan to accelerate any system upgrades at this time since the recommended system upgrades to resolve the problems identified in years 6 through 15 are not expected to be determined until early in 2007.

Refinement of the required in-service date based on scenario planning results will be factored in once the system upgrades are determined.
Summary of RTEP Status
• Reactive Planning indicates the need for over 10000 MVAR of reactive devices to be installed between 2011 and 2016 at a cost estimate exceeding $200 million.

• Including the economic growth uncertainty is expected to advance most overloads identified in years 6 through 10 by one to two years.

• Including the generation scaling sensitivity is expected to advance most overloads identified in years 10 through 15 by two years.

• Hudson unit 2 (608 MW) which is located in Northern New Jersey recently notified PJM of their potential retirement.

• Queue O Interconnection projects will need to be included in the 2011 RTEP basecase once their Impact Studies are complete.

• PJM identified 2900 MW of previously modeled firm transmission service out of PJM to MISO which does not have a corresponding reservation into the MISO system.
• All additional results so far indicate that the Northern New Jersey and Western / Central Interface problems will occur several years earlier than previously identified.

• Additional studies will need to be completed to refine the required in-service date and to determine the recommended system upgrades.
Review of Transmission Alternatives for Years 6 through 15
There are two areas with problems identified on the PJM system through 2021 that still require transmission solutions.

• Northern New Jersey – there were 17 overloads identified. The majority of these were on the 230 kV system and occurred from 2015 through 2021. The Transmission Owners have provided upgrades to relieve a few of the problems but new transmission is still expected to be needed to resolve the overall import issue into Northern New Jersey.

• Western / Central Interface – Overloads on three 500 kV circuits along the PJM Western and Central interfaces occur in 2019 and 2020.
## Northern New Jersey Overloads

<table>
<thead>
<tr>
<th>Test Resulting in Highest Overload</th>
<th>Year That Facility Loading Exceeds Conductor Rating</th>
<th>Overloaded Facility</th>
</tr>
</thead>
<tbody>
<tr>
<td>Load Deliverability</td>
<td>2015</td>
<td>East Windsor - Smithburg 230 kV</td>
</tr>
<tr>
<td>Generator Deliverability</td>
<td>2015</td>
<td>Greystone - Whippany 230 kV</td>
</tr>
<tr>
<td>Load Deliverability</td>
<td>2016</td>
<td>Cox's Corner - Lumberton 230 kV</td>
</tr>
<tr>
<td>Load Deliverability</td>
<td>2016</td>
<td>Branchburg - Readington 230 kV</td>
</tr>
<tr>
<td>Load Deliverability</td>
<td>2016</td>
<td>Whippany - Roseland 230 kV</td>
</tr>
<tr>
<td>Load Deliverability</td>
<td>2016</td>
<td>Kittatinny - Pohatcong 230 kV</td>
</tr>
<tr>
<td>Load Deliverability</td>
<td>2016</td>
<td>Hosensack - Elroy 500 kV</td>
</tr>
<tr>
<td>Generator Deliverability</td>
<td>2016</td>
<td>Atlantic - Larrabee 230 kV</td>
</tr>
<tr>
<td>Load Deliverability</td>
<td>2016</td>
<td>Lumberton - Cookstown 230 kV</td>
</tr>
<tr>
<td>Load Deliverability</td>
<td>2017</td>
<td>Branchburg - Flagtown 230 kV</td>
</tr>
<tr>
<td>Load Deliverability</td>
<td>2017</td>
<td>Flagtown - Somerville 230 kV</td>
</tr>
<tr>
<td>Generator Deliverability</td>
<td>2017</td>
<td>Somerville - Bridgewater 230 kV</td>
</tr>
<tr>
<td>Load Deliverability</td>
<td>2017</td>
<td>Martins Creek - Portland 230 kV</td>
</tr>
<tr>
<td>Generator Deliverability</td>
<td>2019</td>
<td>Portland - Kittatinny 230 kV</td>
</tr>
<tr>
<td>Generator Deliverability</td>
<td>2019</td>
<td>Portland - Greystone 230 kV</td>
</tr>
<tr>
<td>Load Deliverability</td>
<td>2020</td>
<td>Pleasant Valley - Lawrence 230 kV</td>
</tr>
<tr>
<td>Load Deliverability</td>
<td>2021</td>
<td>Readington - Roseland 230 kV</td>
</tr>
</tbody>
</table>
System Upgrade Needed by June 2015 (9 years)
## Western & Central Interface Overloads

<table>
<thead>
<tr>
<th>Test Resulting in Highest Overload</th>
<th>Year That Facility Loading Exceeds Conductor Rating</th>
<th>Overloaded Facility</th>
</tr>
</thead>
<tbody>
<tr>
<td>Load Deliverability</td>
<td>2019</td>
<td>Airydale - Juniata 500 kV Circuit 1</td>
</tr>
<tr>
<td>Load Deliverability</td>
<td>2019</td>
<td>Airydale - Juniata 500 kV Circuit 2</td>
</tr>
<tr>
<td>Load Deliverability</td>
<td>2020</td>
<td>Keystone - Conemaugh 500 kV</td>
</tr>
</tbody>
</table>
Western & Central Interface Overloads

System Upgrade Needed by June 2019 (13 years)
Summary of Transmission Alternatives

**Alternative 1**
Keystone - Sunbury 500 kV
Susquehanna - Lackawanna - Jefferson - Roseland 500 kV

**Alternative 2**
Keystone - Sunbury 500 kV
Bossards - Martins Creek - Portland - Jefferson - Roseland 500 kV

**Alternative 3**
Keystone - TMI 500 kV
Susquehanna - Lackawanna - Jefferson - Roseland 500 kV

**Alternative 4**
Keystone - TMI 500 kV
Bossards - Martins Creek - Portland - Jefferson - Roseland 500 kV

**Alternative 5**
Kammer - TMI 500 kV
Susquehanna - Lackawanna - Jefferson - Roseland 500 kV

**Alternative 6**
Kammer - TMI 500 kV
Bossards - Martins Creek - Portland - Jefferson - Roseland 500 kV

**Alternative 7**
Keystone - Farmers Valley - Lackawanna - Jefferson - Roseland 500 kV

**Alternative 8**
Possum Point - Calvert Cliffs - Salem 500 kV

**Alternative 9**
Wylie Ridge - Prexy 500 kV
Mt. Storm - Bedington - Kemptown 500 kV
Kemptown - Rock Springs - Hope Creek 500 kV

**Alternative 10**
Amos - Kemptown - Deans 765 kV

**Alternative 11**
Amos - Kemptown 765 kV
Kemptown - Rock Springs - Hope Creek 500 kV

**Alternative 12**
Kammer - TMI 765 kV
Susquehanna - Lackawanna - Jefferson - Roseland 500 kV

**Alternative 13**
Kammer - TMI 765 kV
Bossards - Martins Creek - Portland - Jefferson - Roseland 500 kV
Summary of Transmission Alternatives

**Alternative 14:**
Amos - Kemptown 765 kV  
Bossards - Jefferson - Roseland 500 kV

**Alternative 15:**
Kammer / South Canton - Keystone 765 kV  
Amos - Kemptown 765 kV  
Keystone - Sunbury 500 kV  
Bossards - Jefferson - Roseland 500 kV

**Alternative 16:**
Kammer / South Canton - Keystone 765 kV  
Amos - Kemptown 765 kV  
Keystone - TMI 500 kV  
Bossards - Jefferson - Roseland 500 kV

**Alternative 17:**
Amos - Kemptown - Possum Point 765 kV  
Possum Point - Vienna - Salem 500 kV

**Alternative 18:**
Amos - Kemptown - Deans 765 kV  
Bossards - Jefferson - Roseland 500 kV

**Alternative 19:**
Open Dooms - Elmont at Cunningham 500 kV  
Dooms - Cunningham - Ladysmith 500 kV  
Joshua Falls - Elmont 500 kV  
Bossards - Jefferson - Roseland 500 kV

**Alternative 20:**
Axton - Clover 765 kV  
Bossards - Jefferson - Roseland 500 kV

**Alternative 21:**
Amos - Kemptown 765 kV  
Calvert Cliffs - Indian River 500 kV

**Alternative 22:**
Bristers - Possum Point 500 kV  
Possum Point - Vienna - Salem 500 kV

**Alternative 23:**
Kammer - 502 Junction 765 kV  
502 Junction - Hampshire - Bedington  
Bedington - Hunterstown - TMI 500 kV  
Bossards - Jefferson - Roseland 500 kV

**Alternative 24:**
Kammer - 502 Junction 765 kV  
502 Junction - Hunterstown - TMI 500 kV  
Bossards - Jefferson - Roseland 500 kV

**Alternative 25:**
Kammer / South Canton - Keystone 765 kV  
Keystone - TMI 500 kV  
Bossards - Jefferson - Roseland 500 kV

**Alternative 25a:**
Open Dooms - Elmont at Cunningham 500 kV  
Dooms - Cunningham - Ladysmith 500 kV  
Joshua Falls - Elmont 500 kV  
Bossards - Jefferson - Roseland 500 kV

**Alternative 25b:**
Kammer / South Canton - Keystone 765 kV  
Keystone - TMI 500 kV  
Bossards - Jefferson - Roseland 500 kV

**Alternative 26:**
Kammer - Prexy 765 kV  
Prexy - White Valley - Conemaugh - TMI 500 kV  
Bossards - Jefferson - Roseland 500 kV

**Alternative 27:**
Possum Point - Vienna - Salem 500 kV  
Joshua Falls - Possum Point 500 kV

**Alternative 28:**
Possum Point - Vienna - Salem 500 kV  
Joshua Falls - Possum Point 500 kV

**Alternative 29:**
Possum Point - Vienna - Salem 500 kV  
Joshua Falls - Ladysmith 500 kV
The following is a list of transmission alternatives that will not be pursued at this time because they do not solve the fundamental reliability problems that have been identified in years 6 through 15.

<table>
<thead>
<tr>
<th>Western / Central Problems</th>
<th>Northern New Jersey Problems</th>
<th>AP South Interface</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alternative 9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Alternative 10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Alternative 11</td>
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<td>Alternative 17</td>
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<td>Alternative 19</td>
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<tr>
<td>Alternative 20</td>
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<td>Alternative 21</td>
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<tr>
<td>Alternative 27</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Alternative 28</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Alternative 29</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The alternative provides a significant benefit.
The alternative has some positive benefit.
The alternative provides a negative or minimal benefit.
The list below provides a $ per kW transfer ratio for the remaining Transmission Alternatives. Alternatives 5 and 6 will not be pursued further at this time because they provide much less transfer capability per $ than the other remaining alternatives.

<table>
<thead>
<tr>
<th>Alternative</th>
<th>Transfer Increase (MW)</th>
<th>Cost Estimate (in Millions)</th>
<th>$ / kW</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alternative 13</td>
<td>4169</td>
<td>$1,600</td>
<td>384</td>
</tr>
<tr>
<td>Alternative 12</td>
<td>4253</td>
<td>$1,650</td>
<td>388</td>
</tr>
<tr>
<td>Alternative 16</td>
<td>6454</td>
<td>$3,100</td>
<td>480</td>
</tr>
<tr>
<td>Alternative 24</td>
<td>2412</td>
<td>$1,200</td>
<td>498</td>
</tr>
<tr>
<td>Alternative 15</td>
<td>5947</td>
<td>$3,050</td>
<td>513</td>
</tr>
<tr>
<td>Alternative 26</td>
<td>2410</td>
<td>$1,250</td>
<td>519</td>
</tr>
<tr>
<td>Alternative 14</td>
<td>3541</td>
<td>$2,100</td>
<td>593</td>
</tr>
<tr>
<td>Alternative 25b</td>
<td>2068</td>
<td>$1,300</td>
<td>629</td>
</tr>
<tr>
<td>Alternative 4</td>
<td>1187</td>
<td>$800</td>
<td>674</td>
</tr>
<tr>
<td>Alternative 3</td>
<td>1245</td>
<td>$850</td>
<td>683</td>
</tr>
<tr>
<td>Alternative 25a</td>
<td>1655</td>
<td>$1,250</td>
<td>755</td>
</tr>
<tr>
<td>Alternative 1</td>
<td>988</td>
<td>$800</td>
<td>810</td>
</tr>
<tr>
<td>Alternative 2</td>
<td>875</td>
<td>$750</td>
<td>857</td>
</tr>
<tr>
<td>Alternative 7</td>
<td>931</td>
<td>$1,200</td>
<td>1289</td>
</tr>
<tr>
<td>Alternative 18</td>
<td>2370</td>
<td>$3,250</td>
<td>1371</td>
</tr>
<tr>
<td>Alternative 8</td>
<td>418</td>
<td>$1,200</td>
<td>2871</td>
</tr>
<tr>
<td>Alternative 6</td>
<td>318</td>
<td>$1,050</td>
<td>3302</td>
</tr>
<tr>
<td>Alternative 5</td>
<td>328</td>
<td>$1,100</td>
<td>3354</td>
</tr>
</tbody>
</table>
• To summarize, transmission alternatives 5, 6, 9, 10, 11, 17, 19, 20, 21, 22, 23, 27, 28 and 29 will not be pursued further at this time as alternatives to resolve the RTEP baseline identified problems in years 6 through 15.

• These alternatives may be considered at a future date depending on whether any fatal flaws are identified with the other sixteen alternatives.
• The original FCITC results that were discussed in July and August for the transmission alternatives used a source of Western Region generation.

• PJM received a request to also perform the FCITC analysis using a source of both Western and Southern Region generation.

• Results of this analysis for the Transmission Alternatives on the “A” list follows.
## Transmission Alternatives – FCITC Comparison

<table>
<thead>
<tr>
<th>Western Region Generation as Source</th>
<th>Western and Southern Region Generation as Source</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Transfer Increase (MW)</strong></td>
<td><strong>Transfer Increase (MW)</strong></td>
</tr>
<tr>
<td>Alternative 1</td>
<td>988</td>
</tr>
<tr>
<td>Alternative 2</td>
<td>875</td>
</tr>
<tr>
<td>Alternative 3</td>
<td>1245</td>
</tr>
<tr>
<td>Alternative 4</td>
<td>1187</td>
</tr>
<tr>
<td>Alternative 7</td>
<td>931</td>
</tr>
<tr>
<td>Alternative 8</td>
<td>418</td>
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<td>Alternative 25b</td>
<td>2068</td>
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<td>Alternative 26</td>
<td>2410</td>
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## Transmission Alternatives – “A” List

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<tr>
<th>Alternative</th>
<th>Description of Alternative</th>
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<tr>
<td>Alternative 1</td>
<td>Keystone - Sunbury 500 kV and Susquehanna - Lackawanna - Jefferson - Roseland 500 kV</td>
</tr>
<tr>
<td>Alternative 2</td>
<td>Keystone - Sunbury 500 kV and Bossards - Martins Creek - Portland - Jefferson - Roseland 500 kV</td>
</tr>
<tr>
<td>Alternative 3</td>
<td>Keystone - TMI 500 kV and Susquehanna - Lackawanna - Jefferson - Roseland 500 kV</td>
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<tr>
<td>Alternative 4</td>
<td>Keystone - TMI 500 kV and Bossards - Martins Creek - Portland - Jefferson - Roseland 500 kV</td>
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<td>Alternative 7</td>
<td>Keystone - Farmers Valley - Lackawanna - Jefferson - Roseland 500 kV</td>
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<tr>
<td>Alternative 8</td>
<td>Possum Point - Calvert Cliffs - Salem 500 kV</td>
</tr>
<tr>
<td>Alternative 12</td>
<td>Kammer - TMI 765 kV and Susquehanna - Lackawanna - Jefferson - Roseland 500 kV</td>
</tr>
<tr>
<td>Alternative 13</td>
<td>Kammer - TMI 765 kV and Bossards - Martins Creek - Portland - Jefferson - Roseland 500 kV</td>
</tr>
<tr>
<td>Alternative 14</td>
<td>Amos - Kemptown 765 kV and Bossards - Martins Creek - Portland - Jefferson - Roseland 500 kV</td>
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<tr>
<td>Alternative 15</td>
<td>Kammer / South Canton - Keystone 765 kV, Amos - Kemptown 765 kV and Alternative 2</td>
</tr>
<tr>
<td>Alternative 16</td>
<td>Kammer / South Canton - Keystone 765 kV, Amos - Kemptown 765 kV and Alternative 4</td>
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<tr>
<td>Alternative 18</td>
<td>Amos - Kemptown - Deans 765 kV and Bossards - Martins Creek - Portland - Jefferson - Roseland 500 kV</td>
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<tr>
<td>Alternative 24</td>
<td>Kammer - 502 Junction 765 kV, 502 Junction - Hunterstown - TMI 500 kV and Bossards - Martins Creek - Portland - Jefferson - Roseland 500 kV</td>
</tr>
<tr>
<td>Alternative 25a</td>
<td>Kammer / South Canton - Keystone 765 kV and Alternative 2</td>
</tr>
<tr>
<td>Alternative 25b</td>
<td>Kammer / South Canton - Keystone 765 kV and Alternative 4</td>
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<tr>
<td>Alternative 26</td>
<td>Kammer - Prexy 765 kV, Prexy - White Valley - Conemaugh - TMI 500 kV and Bossards - Martins Creek - Portland - Jefferson - Roseland 500 kV</td>
</tr>
</tbody>
</table>
• Siting Feasibility Study for line sections in “A” list alternatives that were not previously requested.
  
  - Kammer/South Canton – Keystone 765 kV
  - Kammer – 502 Junction 765 kV
  - Kammer – Prexy 765 kV

• Review of 500 kV, 765 kV or double circuit 500 kV construction

• Review impact of significant generation changes

• Market Efficiency Analysis
• Generation Interconnection studies – evaluate the extent to which projects may support interconnection requests (IGCC, Nuclear, other).

• Identify any underlying related network upgrades

• Refine project cost estimates for use in cost/benefit analysis

• Cost allocation procedures
  • reliability / market efficiency
  • generator interconnections
Presented by:
Ken Seiler
• PJM Performed Transformer Probability Risk Assessment (PRA) Study

• Risk = Probability of Failure x Consequence
  – Probability based upon PJM developed hazard rates
  – Consequence is un-hedgagle congestion
    • Increased system production costs associated with the loss of a transformer bank
    • Based on 2009 system

• PRA
  – Determines risk exposure
  – Risk provided in annual dollars
  – Shows value of spares to mitigate risk
PJM 500/230 Risk Overview

Current
- Total Exposed Risk: $553M
- Existing Spares Risk Mitigation: $396M

2009 RTEP
- Current Exposed Risk: $157M
- RTEP Risk Mitigation: $65M

PRA
- Post-RTEP Exposed Risk: $92M
- Seven PRA Spares Risk Mitigation: $75M

Optimal PRA PJM 2009 Risk Exposure: $17M
SUMMARY

The table lists the 7 spare transformer units recommended by PJM to mitigate $75M of annual risk.

PJM needs to perform additional analysis on EHV considering the Conastone unit, which may relieve Alburtis from needing a spare.

Additionally, PJM recommends the following spare transfers be evaluated:

1. Purchase a Keystone spare instead of moving the Hosensack spare to Keystone based on the condition of the Hosensack spare.

2. Move a lower risk Dominion site spare to Elmont.

3. Move the Chalk Point spare to Burches Hill.

<table>
<thead>
<tr>
<th>PRA Spare Recommendations</th>
<th>Spare Value</th>
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<tbody>
<tr>
<td>Keeney</td>
<td>$31.69</td>
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<tr>
<td>Whitpain</td>
<td>$17.37</td>
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<tr>
<td>Deans</td>
<td>$6.83</td>
</tr>
<tr>
<td>Juniata</td>
<td>$6.66</td>
</tr>
<tr>
<td>Keeney</td>
<td>$6.33</td>
</tr>
<tr>
<td>Keystone</td>
<td>$3.86</td>
</tr>
<tr>
<td>Peach Bottom*</td>
<td>$1.82</td>
</tr>
<tr>
<td>Risk Reduction</td>
<td>$74.57</td>
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</table>

*Existing TOI project w/ expected completion 12/06
PRA Related Activities

• Common transformer specification

• Logistics study

• Expansion of PRA to other equipment
Market Efficiency Analysis
Preliminary Input Assumptions
Objectives

- Identify reliability upgrades having economic benefit if accelerated or modified
- Identify new transmission upgrades having economic benefits
- Identify economic benefits associated with “hybrid” transmission upgrades
  - upgrades which resolve reliability issues but are intentionally designed in a more robust manner to provide economic benefits in addition to resolving those reliability issues
High-Level Description

- Analysis conducted using a market simulation tool which models the hourly security-constrained commitment and dispatch of generation over future annual periods
- Economic benefits of transmission upgrades are determined by comparing results of simulations which include the study upgrade to results of simulations which do not include the study upgrade
- NPV of annual benefits will be compared to the NPV of the upgrade revenue requirement to determine if the upgrade is cost beneficial
Market Simulation Input Data

- PROMOD IV model from New Energy Associates (NEA)
- Underlying input data contained in NEA’s Powerbase
- Input data includes generating units and unit characteristics, fuel costs, emissions costs, load forecasts and power flow model
- NEA Powerbase data based on a variety of sources including Platts, EIA, NYMEX, Evomarkets.com, EPA, FERC, NERC, etc.
- RTEP 2011 Powerflow Base Case
  - Key RTEP upgrades will be removed or added to this case based on in-service date to develop the powerflow base cases for each study year
• Base input assumptions regarding generating unit characteristics, fuel costs, emissions costs, load forecasts from NEA Powerbase
• Sensitivity analysis:
  – High/Low fuel prices
  – High/Low demand
  – High/Low future generation scenarios
  – High/Low emissions costs
  – High/Low discount rates
Fuel Price Scenarios

- Powerbase base fuel prices based on NYMEX futures prices and long-run forecasts from Platts and the Energy Information Administration (EIA)
- High and low fuel price cases based on forecast information from the EIA’s Annual Energy Outlook 2006
- The ratios of high and low price cases to the reference price case were obtained from the EIA forecast and applied to the base fuel costs from NEA’s Powerbase
Fuel Price Scenarios

Gas Price Assumptions

In $/MMBtu

Low
Base
High

YEAR

Fuel Price Scenarios

Oil-H Price Assumptions

YEAR

in $/MMBtu

Low

Base

High
Fuel Price Scenarios

Oil-L Price Assumptions

YEAR

Low
Base
High

in $/MMBtu

Coal Price Assumptions

This graph is developed using data provided by Platts, a division of the McGraw-Hill Companies, Inc. It cannot be reproduced, distributed or sold without the express written permission of Platts.
• PJM zonal peak and zonal energy forecast from PJM source
  – Base load/energy scenario based on 50/50 forecast
  – High load/energy scenario based on 90/10 forecast
  – Low load/energy scenario based on 10/90 forecast

• Peak load and energy forecast for regions outside of PJM from Powerbase

• For years 2016 and 2021, new generation additions will be modeled under the high load scenarios in order to maintain the IRM level of the base base

• Generation capacity additions of about 11,000 MW will be added to the western, eastern and southern regions of the PJM system in proportion to the regional location and regional generation type of future generation projects in Generation Interconnection Queues M through Q.
## Load/Energy Scenarios

### Forecast PJM Peak Loads (MW)

<table>
<thead>
<tr>
<th>Scenario</th>
<th>2007</th>
<th>2010</th>
<th>2013</th>
<th>2016</th>
<th>2021</th>
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<tr>
<td>High</td>
<td>144,542</td>
<td>152,934</td>
<td>160,390</td>
<td>167,058</td>
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<tr>
<td>Base</td>
<td>135,747</td>
<td>143,628</td>
<td>150,630</td>
<td>156,893</td>
<td>165,117</td>
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<tr>
<td>Low</td>
<td>124,888</td>
<td>132,138</td>
<td>138,580</td>
<td>144,342</td>
<td>151,906</td>
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### Forecast PJM Energy (GWh)

<table>
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<th>Scenario</th>
<th>2007</th>
<th>2010</th>
<th>2013</th>
<th>2016</th>
<th>2021</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>733,670</td>
<td>765,559</td>
<td>795,241</td>
<td>826,420</td>
<td>872,942</td>
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<tr>
<td>Base</td>
<td>722,549</td>
<td>754,156</td>
<td>783,476</td>
<td>814,337</td>
<td>860,336</td>
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<tr>
<td>Low</td>
<td>713,000</td>
<td>744,319</td>
<td>773,506</td>
<td>804,047</td>
<td>849,760</td>
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</table>
Future Generation Scenarios

• Base generation scenario includes all existing generation plus ISA generation
  – Adequate at meeting peak load through study period
  – Not adequate at meeting installed requirement in later years (installed margin = 12% (2013), 7% (2016) and 2% (2021))

• High generation scenario includes generation additions needed to maintain the PJM Installed Requirement.
  – 5,200 MW, 12,400 MW and 21,600 MW will be added to the 2013, 2016 and 2021 base cases, respectively
  – new generation added to PJM regions in proportion to the regional location and regional generation type of future generation projects in Generation Interconnection Queues M through Q
• Low generation scenario removes from the high scenario generating units in system locations where PJM believes there is a potential reliability risk if generation retires
  – estimate of units that are candidates to retire is based on an assessment of three categories: unit age, units that may be impacted by future environmental regulations and units that have announced or are rumored to be considering retirement
  – Preliminary assessment has identified approximately 7,000 MW of generation that could be retired by 2010 and that pose a potential reliability risk if retired (5,000 MW in eastern PJM and 2,000 MW in western PJM)
Figure 5 - 15 Year PJM RTO Reserve Margins

MW

200000
190000
180000
170000
160000
150000
140000
130000
120000
110000
100000


Year

PJM RTO Diversified Load (MW)  PJM RTO Reserve Requirement (MW)  PJM RTO In-Service + ISA Generation (MW)
Figure 6 - Installed Generation MW for Future Generation Scenarios
Emissions Costs Scenarios

- Powerbase emissions allowance prices from variety of sources including Platt’s BASECASE, Evomarkets.com, and EPA studies
- Powerbase emissions release rates from a variety of sources including Platt’s BASECASE, EPA CEMS data and EPA studies
- High and low emissions cost scenarios based on statistical analysis of daily historical SO2 and NOx spot prices
- Based on this analysis, PJM determined that a doubling of the base costs and a halving of the base costs provides reasonable estimates of high and low cost scenarios
Figure 7 - SO2 Emission Allowance Price Assumptions

Note: Beginning in 2010, the CAIR legislation requires that generators in 22 states in the east surrender two Title IV SO2 allowances for every ton emitted. This is modeled in the Powerbase database by assigning these units with a separate CAIR SO2 allowance price which is twice the allowance prices shown in this figure.
**Figure 8 - NOx Emission Allowance Price Assumptions**

*Note:* Beginning in 2009, the SIP Call program is replaced by CAIR NOx programs that are split into seasonal and annual trading programs. Figure 8 shows the addition of these programs for generators covered by both programs (during ozone season only).
**Emissions Costs Scenarios**

Figure 9 - Hg Emission Allowance Price Assumptions

- **$/Ton**
- **Year**
- **Note:** Mercury regulation begins in 2010 with the CAMR legislation.
The net present value of annual benefits for 10, 20 and 30 years will be compared to the net present value of the upgrade revenue requirement for 10, 20 and 30 years to determine if the upgrade is cost beneficial.

Sensitivity of this comparison to the discount rate used to calculate the net present value of annual project benefits will be conducted.

The high, base and low discount rate will be 10%, 9% and 8%, respectively.
RTEP Brochure

October 2006 Edition
October 2006 Edition
Updated Content

- RTEP Process Flow
- RTEP Plan
- 5-year Planning
- 15-Year Planning
Interconnection Planning
Impact Study Results
## Impact Study Completion Review

<table>
<thead>
<tr>
<th>Queue</th>
<th>Project Name</th>
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<th>MW</th>
<th>MWC</th>
<th>In-Service</th>
<th>Fuel</th>
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<td>N33</td>
<td>Afton 138kV</td>
<td>APS</td>
<td>60</td>
<td>12</td>
<td>12/1/2008</td>
<td>Wind</td>
<td>WV</td>
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<td>135</td>
<td>27</td>
<td>12/15/2008</td>
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<td>P44</td>
<td>City of Columbus</td>
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<td>7</td>
<td>7</td>
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<tr>
<td>Q09</td>
<td>Emporia</td>
<td>Dominion</td>
<td>3</td>
<td>3</td>
<td>4/1/2006</td>
<td>Hydro</td>
<td>VA</td>
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<td>Q12</td>
<td>Fox River Heights 12kV</td>
<td>ComEd</td>
<td>2</td>
<td>2</td>
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<td>Methane</td>
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<td>Q13</td>
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<td>Q29</td>
<td>Zion 12kV</td>
<td>ComEd</td>
<td>6</td>
<td>5</td>
<td>3/1/2007</td>
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<td>30</td>
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<td>Q66</td>
<td>Beecher Energy - Distribution Center #36</td>
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<td>LaGrange Park - West Chester Sexton Energy</td>
<td>ComEd</td>
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<td>Dominion</td>
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<td>6/1/2007</td>
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### Queue Withdrawals

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<td>Heartland Grand Ridge</td>
<td>ComEd</td>
<td>IL</td>
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<tr>
<td>M20</td>
<td>Chestnut Valley 25kV</td>
<td>APS</td>
<td>PA</td>
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<tr>
<td>M22</td>
<td>Cambria Slope 115kV</td>
<td>PENELEC</td>
<td>PA</td>
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<tr>
<td>O02</td>
<td>Glendon 34.5kV</td>
<td>PPL</td>
<td>PA</td>
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<tr>
<td>O14</td>
<td>Black Oak - Bedinton RTU</td>
<td>APS</td>
<td>MD</td>
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<tr>
<td>O15</td>
<td>Black Oak - Hatfield Wave Trap</td>
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<tr>
<td>O55</td>
<td>Peckville 69kV</td>
<td>PPL</td>
<td>PA</td>
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<tr>
<td>P02</td>
<td>Ohio Central 138kV</td>
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<td>OH</td>
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<td>WV</td>
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Black Oak
Beryl
Westvaco
Mt Zion
Albright
Cross
School
POI
500 kV
138 kV
new
82 Wind Turbines will be connected to the 34.5 kV bus
37 Wind Turbines will be connected to the 34.5 kV bus.
Impact Studies in ComEd region
Q66 Beecher Energy 2 MW

Chicago Heights
TSS

DC F36
Goodenow Road

F365

POI

Legend

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<tr>
<th>Queues</th>
<th>Fuel Type</th>
<th>Substations Voltage</th>
<th>Trans Lines Voltage</th>
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<td>765kV</td>
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<td>Coal</td>
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<td>500kV</td>
<td>500</td>
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<td>Diesel</td>
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<td>345kV</td>
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<td>Methane</td>
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<td>230kV</td>
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<tr>
<td>Natural Gas</td>
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<td>138kV</td>
<td>138</td>
</tr>
<tr>
<td>Wind</td>
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<td>115kV</td>
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</tr>
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<tr>
<td></td>
<td></td>
<td>34.5kV</td>
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</tr>
</tbody>
</table>
Q67 LaGrange Park 4 MW

- **Substations**: Lagrange Park
- **Voltage**: 138 kV, 12 kV
- **Fuel Type**: New (TYP)
- **POI**: Bellwood TSS, McCook TSS

**Legend**:
- **BioMass**, **Coal**, **Diesel**, **Methane**, **Natural Gas**, **Wind**
- **Substations**:
  - 765 kV
  - 69 kV
  - 34.5 kV
- **Trans Lines**:
  - 765 V
  - 69 V
  - 34.5 V

**Network Diagram**:
- **138 kV**: Bellwood TSS, LaGrange Park, McCook TSS
- **12 kV**: POI
- **New (TYP)**: Q67 LaGrange Park - Westchester 12 kV 3.5 MW
Q14 Hegewisch 7 MW

TSS 55
Hegewisch
Calumet Transfer
Burnham TSS
POI
Q14 Hegewisch 12 kV 6.6. MW

138 kV
12 kV
new
(TYP)
Z5541

Legend

Queues

Fuel Type

BioMass
Coal
Diesel
Methane
Natural Gas
Wind

Substations Voltage

Transmission Voltage

765 kV
500 kV
345 kV
230 kV
138 kV
115 kV
69 kV
34.5 kV
Q12 Fox River Heights 2 MW

POI
Q12 Fox River Heights 12 kV 1.6 MW
DC W10
Fox River Heights
Q12

Legend
Queues
Fuel Type
- Biomass
- Coal
- Diesel
- Methane
- Natural Gas
- Wind

Substations
Voltage
- 765 kV
- 500 kV
- 345 kV
- 230 kV
- 138 kV
- 115 kV
- 69 kV
- 34.5 kV

Transmission Lines
Voltage
- 765 kV
- 500 kV
- 345 kV
- 230 kV
- 138 kV
- 115 kV
- 69 kV
- 34.5 kV
Impact Studies in ComEd region
Q17 Northbrook 7 MW

- Q17 Northbrook 12 kV 6.6 MW
- TDC 212 Northbrook 138 kV 12 kV new POI
- TDC 258 Elmwood (TYP) (TYP)

Legend:

- Queues
  - Fuel Type
    - BioMass
    - Coal
    - Diesel
    - Methane
    - Natural Gas
    - Wind

- Substations
  - Voltage
    - 765 kV
    - 500 kV
    - 345 kV
    - 230 kV
    - 138 kV
    - 115 kV
    - 69 kV
    - 34.5 kV

- Lines
  - Voltage
    - 765 kV
    - 500 kV
    - 345 kV
    - 230 kV
    - 138 kV
    - 115 kV
    - 69 kV
    - 34.5 kV
Q67 LaGrange Park 4 MW

Legend

Queues
Fuel Type
- BioMass
- Coal
- Diesel
- Methane
- Natural Gas
- Wind

Substations
Voltage
- 765kV
- 600kV
- 345kV
- 230kV
- 138kV
- 115kV
- 89kV
- 34.5kV

Trans Lines
Voltage
- 765
- 600
- 345
- 230
- 138
- 115
- 89
- 34.5

Bellwood TSS
McCook TSS
Bellwood TSS
McCook TSS

TSS
Lagrange Park

D3417

Q67 LaGrange Park - Westchester
12 kV
3.5 MW

138 kV
12 kV
new

POI

Chicago Castings
Columbus Park
La Grange Park
Electro-Motive
Kearney Test Lab
G.C.W.R.D Mainstream

Hawthorne
Ridgeland
Berwyn

Natoma
Portage 2
Galewood
Hanson Park
Humboldt Park
Rockwell
Congress
Grant

Dearborn
L.C. Air Rights

Medical Center
Kingsbury Ohio

Forest Park
Oak Park

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Q14 Hegewisch 7 MW

Calumet Transfer

TSS 55 Hegewisch

Burnham TSS

138 kV
12 kV
new

Z5541

POI

Q14 Hegewisch 12 kV 6.6. MW
Q15 Woodridge 7 MW

POI

Q15 Woodridge 12 kV
6.6 MW

TDC 216

Woodridge
138 kV
12 kV
new
(TYP)

Will
Country
Lisle
TSS

Will
Country
Lisle
TSS

W596

Q15 Woodridge 12 kV
6.6 MW
Appendix A
State Summary as of Oct 30/06:
- Queue Projects
- Network upgrades
- Baseline upgrades