Transmission Expansion Advisory Committee

Pittsburgh, PA
May 9, 2006
• Planning 201 Course
• TEAC Draft Charter
• Transmission Upgrade Web Page
• RTEP Baseline Update
• Market Efficiency Analysis Update
• Interconnection Planning Impact Studies
Planning 201 Training Course

PJM’s Regional Transmission Expansion Planning Process

NEXT SESSION -- June 8, 2007
Planning 201 Training Course Topics include…

- Regional Transmission Expansion Plan (RTEP) Process:
  - Scope, Definition and Objectives
  - RTO regulatory/contractual obligations
  - Brief history – evolving to meet RTO needs
  - Stakeholder process

- Baseline development concepts, reliability analyses, 15-year planning horizon

- Load Growth, CETO/CETL, Reserve Margin

- Key planning drivers and assessing their impact:
  - e.g., interconnection requests, long lead-time backbone transmission needs, aging infrastructure, generator deactivation, congestion

- Developing a package of backbone transmission solutions

- Market Efficiency

- DOE National Interest Electric Transmission Corridors (NIETC)
Planning 201 Training Course – Logistics

- **Date:** Friday, June 8, 2007
- **Time:** 9:00 a.m. – 3:00 p.m.
- **In-person:** PJM Visitors Center
  Norristown, PA
- **Virtual:** Yes  (See Registration for details)
- **Registration:**
• MRC and MC approved changes to Operating Agreement concerning the role of the TEAC
• TEAC responsibilities outlined in Schedule 6 of the OA and Manual 14B
  – Provide comments and recommendations on the scope, assumptions and analysis for the RTEP
  – Provide comments and recommendations on RTEP as requested by the PJM Board of Managers
• Draft Charter is consistent with these documents
• Seeking approval of the draft TEAC charter
Transmission System Upgrade Projects: Planned

Upgrades to the transmission system are part of PJM's Regional Transmission Expansion Planning (RTEP) process. An outcome of the RTEP process are these Transmission System Upgrades:

- **Baseline Upgrades** which are PJM required upgrades needed to eliminate reliability violations in order to ensure system reliability.
- **Network Upgrades** which are upgrades to network facilities related to proposed generation projects, upgrades related to merchant transmission or Long Term Firm transmission service requests, or upgrades related to alleviation of unhealable congestion.
- **Transmission Owner Initiated projects** which are generally load growth related upgrade projects originated by the Transmission Owner on PJM monitored facilities and used as inputs to the RTEP models.

Status of Direct Connection facilities related to generator interconnection projects, which are also part of the RTEP, may be found on the PJM website under the Generator Interconnection Queues & Summaries link.

### Engineering / Planning

#### Under Construction

<table>
<thead>
<tr>
<th>Upgrade ID</th>
<th>TO Required Date</th>
<th>TO Projected Date</th>
<th>Driver</th>
<th>Description</th>
<th>Transmission Owner</th>
<th>Status</th>
<th>State</th>
<th>Percent Complete</th>
<th>Cost Estimate</th>
</tr>
</thead>
<tbody>
<tr>
<td>b0003</td>
<td>2/1/2008</td>
<td>2/1/2008</td>
<td>Retirements load Deliverability</td>
<td>Location: East Windsor Equipment: Transmission Desc: Install second 500/230 kV transformer</td>
<td>JCP&amp;L</td>
<td>NJ</td>
<td>60%</td>
<td>9.5M</td>
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<td>n0001</td>
<td>5/1/2006</td>
<td>5/1/2006</td>
<td>A01</td>
<td>Location: Loretto Equipment: Substation Desc: Upgrade 69 kV bus</td>
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<td>MD</td>
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<td>8/1/2009</td>
<td>8/1/2009</td>
<td>A27, A28</td>
<td>Location: Oak Hall Equipment: Transmission Desc: 69 kV bus reconductor</td>
<td>DPL</td>
<td>VA</td>
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<td>T0001</td>
<td>5/1/2006</td>
<td>5/1/2006</td>
<td>PENELEC</td>
<td>Location: Erie South Equipment: Transmission Desc: Install second 345/230 kV transformer</td>
<td>PENELEC</td>
<td>PA</td>
<td>70%</td>
<td>5.6M</td>
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</tbody>
</table>

**Projects:** 6
2007 RTEP Reliability Analysis Update
• On April 19th, the FERC issued orders on cost allocation.
• Cost for 500 kV and above facilities will be allocated on a region-wide basis.
• Cost for facilities that will be energized at voltages below 500 kV will be allocated to those customers who derive the benefits of the upgrade.
• PJM will submit a compliance filing for 500 kV and above facilities.
• The FERC granted a rehearing for below 500 kV facilities.
• Cost allocation for the following upgrades will be determined pending those proceedings.
2007 RTEP Status

- Base case development complete
- N-2 analysis, generator and load deliverability analysis complete
- Development of solutions to identified problems is in progress
- 15 year analysis to identify longer lead time reinforcements complete
- Sensitivity analysis performed for potential generation retirements
• B.L. England Units – not in the model
• Benning Road – included in the model
• Buzzard Point – included in the model
• O66 Merchant transmission project – not in the model
5 Year Analysis Update
First Energy - JCPL Transmission Zone

• N-2 Issues
  – Atlantic – Larrabee 230 kV line overload for the loss of Prospect Road – Smithsburg
  – Atlantic 230 kV line + loss of Atlantic – South River 230 kV line
  – Atlantic-New Prospect Road – Smithsburg 230 kV line overload for the loss of Atlantic – South River 230 kV line + Atlantic – Larrabee 230 kV line

• Solution
  – Working with FE to develop solutions
• Breaker Replacement
  – Replace the North Wales 230 kV circuit breaker #105, the capacitor bank breaker by 6/1/2010
  – The estimated cost to replace this breaker is $500,000
• N-2 Violation

• Solution
  – Install a 138 kV breaker at Roseland and tie the Roseland 138 kV buses.
  – Expected in-service date: 6/1/12
  – Estimated cost: $1.0 million

• N-2 Violation
  – Lawrence – Pleasant Valley 230 kV line overloads for the loss of Branchburg – Deans 500 kV line and Deans 500 / 230 kV transformer + Windsor – Orchard (aka Alloway) 500 kV line

• Solution
  – Replace the wave traps at both Lawrence and Pleasant Valley 230 kV substations.
  – Expected in-service date: 6/1/12
  – Estimated cost: $0.5 million
PSEG Transmission Zone

• N-2 Violation
  – Saddle Brook – Athenia 230 kV line overload for the loss of the 550 MW generator at Bergen 230 kV station + loss of Waldwick – Hillsdale 230 kV line
  
• Solution
  – Add forced oil cooling to increase Rate B by 25%
  – Expected in-service date: 6/1/12
  – Estimated cost: PSEG is working on an estimate.

• N-1 Load deliverability Violation
  – Voltage criteria violation in the Lawrence 230 kV vicinity for multiple single contingency.

• Solution
  – Move the 150 MVAR mobile capacitor from Aldene 230 kV to Lawrence 230 kV substation.
  – Expected in-service date: 6/1/12
  – Estimated cost: $1.5 million
BG&E Transmission Zone

• N-2 Violation
  – Waugh Chapel 230 / 115 kV transformer overloads for the loss of the other two Waugh Chapel 230 / 115 kV transformers
  – Solution
    – Add a fourth 230 / 115 kV transformer, two 230 kV circuit breakers and a 115 kV breaker at Waugh Chapel
    – Estimated cost: $17 million
    – Expected in-service date: 6/1/12

• N-2 Violation
  – Harrisonville – Granite 115 kV line and Harrisonville – Dolfield 115 kV line overloads for the loss of the two Northwest 230 / 115 kV transformers
  – Solution
    – Create two 230 kV ring buses at North West
    – Add two 230 / 115 kV transformers at North West
    – Create a new 115 kV station at North West
    – Estimated cost: $20 million
    – Expected in-service date: 6/1/12
N-2 Violation
- Voltage violation at High Ridge 230 kV vicinity for several N-2 contingencies.

Solution
- Rebuild High Ridge 230 kV substation to Breaker and Half configuration.
- Expected in-service date: 6/1/12
- BGE is working on the cost estimate

N-2 Violation
- Waugh Chapel 500/230 kV #1 transformer overloads for the loss of the other two Waugh Chapel 500/230 kV transformers

Solution
- Replace Waugh Chapel 500/230 kV #1 transformer with three single phase transformers of larger capacity and install 500kV breaker
- Estimated cost: $26 million
- Expected in-service date: 6/1/12
• N-2 Violations

• Solution
  – Build a new substation with two 150 MVA transformers between Dauphin and Hummelstown 230 / 69 kV substations by sectionalizing the Middletown Junction – North Lebanon 230 kV line in the MetEd transmission zone.
  – Expected in-service date: 6/1/12
  – Estimated cost: $24.2 million

• N-2 Violation
  – Voltage criteria violation at Cumberland and West Shore 230 kV substation for the loss of the West Shore – Steelton and Cumberland – Juniata 230 kV circuits.

• Solution
  – Install 130 MVAR capacitor at West Shore 230 kV substation
  – Expected in-service date: 6/1/12
  – Estimated cost: $2.2 million
• N-1 Load Deliverability Violation
  – Lank - Five Points 69 kV overloads for the loss of Indian River - Robinsonville 138 kV
  • Solution
    – Rebuild Lank - Five Points 69 kV
    – Expected in-service date: 6/1/12
    – Estimated cost: $3.4 million

• N-1 Load Deliverability Violation
  – Omar - Indian River 138 kV overloads for the loss of Indian River - Bishop 138 kV
  • Solution
    – Replace wave trap at Indian River 138 kV Substation
    – Expected in-service date: 6/1/12
    – Estimated cost: $0.2 million
• Delmarva Criteria Violation
  – Millsboro - Zoar 69 kV
    overloads for the loss of Indian River - Robinsonville 138 kV
• Solution
  – Rebuild Millsboro - Zoar 69 kV
  – Expected in-service date: 12/1/08
  – Estimated cost: $1.8 million
• Delmarva Criteria Violation
  – Church area Voltage violations
    for the loss of both Church 138/69 kV transformers
• Solution
  – Replace Church 138/69 kV
    transformer and add two breakers
  – Expected in-service date: 6/1/09
  – Estimated cost: $4.4 million
  – Note: This upgrade eliminates the need for B0391 project
• Delmarva Criteria Violation
  – Piney Grove - Mt Olive 69 kV overloads and Mt. Olive area voltage violations for the loss of Oak Hall - Wattsville 69 kV

• Solution
  – Build Oak Hall - Wattsville 138 kV line
    – Estimated cost: $2.7 million
  – Add 138/69 kV transformer at Wattsville
    – Estimated cost: $4.1 million
  – Establish 138 kV bus position at Oak Hall
    – Estimated cost: $1.2 million
  – Expected in-service date: 6/1/09
• Delmarva Criteria Violation
  – Worcester - Berlin 69 kV overloads for the loss of Ocean Bay 138/69 kV transformer.
  • Solution
    – Re-tension Worcester - Berlin 69 kV
    – Estimated cost $0.2 million
    – Expected in-service date: 6/1/10

• Delmarva Criteria Violation
  – Taylor – North Seaford 69 kV overloads for the loss of South Harrington 138/69 kV transformer.
  • Solution
    – Re-tension Taylor – North Seaford 69 kV
    – Estimated cost $0.6 million
    – Expected in-service date: 6/1/10
• Replace baseline upgrade B0260
  – Old upgrade
    • Replace Red Lion 230/138 kV transformer for $5 million
  • New upgrade
    – Install a 2nd Red Lion 230/138 kV for $2.523 million
    Hares Corner - Relay Improvement for $0.8 million
    Reybold - Relay Improvement for $0.165 million
    New Castle - Relay Improvement for $0.165 million
    Estimated total cost $3.65 million.
    Expected in-service date is 6/1/2009
• N-1 Load Deliverability Violation
  – Voltage collapse for the loss of the Cumberland – Orchard (a.k.a. Alloway) 230 kV line
• Solution
  – Install a 60 MVAR 230 kV capacitor at Cumberland
  – Expected in-service: 6/1/12
  – Estimated cost: $2.0M
• N-1 Load Deliverability Violation
  – Cumberland – Union 138 kV line overload for the loss of the Dennis 230 / 138 kV transformer
• Solution
  – Complete B0433 to eliminate stranded bus limitation
  – Revise limiting relay setting to bring the line rating up to 483 MVA
  – Estimated cost: $0.0
N-1 Load Deliverability Violation
- Monroe – Landis Tap – Shieldalloy – North Central 69 kV line overload for the loss of the Cumberland – Orchard (a.k.a. Alloway) 230 kV line

Solution
- Reinforce the 138 / 69 kV facilities in the AE/Vineland area.
- Specific plans under review

Note: The Atlantic Electric area analysis was done with BL England out of service. Some plans may be able to be deferred if units are available.
• N-2 Violation
  – Burches Hill – Palmers Corners 230 kV line overload for the loss of the other two Burches Hill – Palmers Corners 230 kV lines

• Solutions
  – Reconductor the four circuits from Burches Hill to Palmers Corner
  – Expected in service date: 6/1/12
  – Estimated cost: $10 million ($2.5 million per circuit)
• Mid-Atlantic Load Deliverability Issue
  – Pleasant View – Dickerson 230 kV line is overloaded for the loss of Possum Point - Burches Hill 500 kV line

• Solution
  – Reconduct the Pleasant View – Dickerson 230 kV circuit
  – Expected in service date: 6/1/2011
  – Estimated cost: $5M
• Generator Deliverability Violation
  – Tidd – Mahans Lane – Weirton
  138 kV line overloaded for the loss of Wylie Ridge – Tidd 345 kV and Tidd – Collier 345 kV tower line

  • Solution
    – Upgrade substation equipment and reconductor the line with 954 ACSR
    – Expected in service date: 6/1/12
    – Estimated cost: $3 million

• N-2 Violation
  – Mitchell – Shepler Hill Junction
  138 kV line overloaded for the loss of Hatfield – Ronco 500 kV line + Hatfield Unit 1

• Solution
  – Reconductor the Mitchell – Shepler Hill Junction 138 kV circuit with 954 ACSR
  – Expected in service date: 6/1/10
  – Estimated cost: $3 million
• Generator Deliverability Violation
  – Albright - Bethelboro 138 kV line is overloaded for the loss of Ronco - Hatfield 500kV and the Hatfield Generating Unit #3.

• Solution
  – Albright - Bethelboro 138 kV circuit will be upgraded by raising limiting structures and replacing terminal equipment in 12-2010
  – Estimated cost: $0.8 Million
• N-2 Thermal Violation
  – Carson – Oakland 138 kV line overload for the loss of Cheswick Unit 1 + loss of Arsenal 345 / 138 kV transformer
  – Arsenal – Brunot Island 345 kV line overloaded for the loss of the other Arsenal – Brunot Island circuit over normal rating

• Solution
  – Reviewing alternatives with DLCO

• Generator Deliverability Violation
  – Cheswick - Logan's Ferry 138 kV overloads for category C contingencies involving the loss of the parallel circuit

• Solution
  – Reconductor the circuits by June 1, 2012 for $2,400,000.
• Short Circuit Violation
  – Cook 345 kV breakers M2 and N2 are overstressed
• Solution
  – Replace Cook 345 kV breakers M2 and N2
  – Estimated In-Service Date: 6-1-09
  – Estimated Cost: $1.4 M
**Exelon – ComEd Transmission Zone**

- **Generator Deliverability Violation**
  - Oswego – Montgomery 138 kV line overloaded for the loss of Wolfs – Oswego 138 kV
- **Solution**
  - Increase rating of 138 kV line 14304 between Oswego and Montgomery
  - Estimated cost: $2.25 Million

- **N-2 and Load Deliverability Voltage Violations**
  - East Frankfort, Joliet, and Will County 138 kV areas
- **Solution**
  - Install 115.2 MVAR cap at Libertyville – Est. cost: $2.3 M
  - Install 57.6 MVAR cap at Prospect Heights – Est. cost: $1.2 M
  - Install 115.2 MVAR cap at Will County – Est. cost: $2.3 M
  - Install 115.2 MVAR cap at Joliet – Est. cost: $2.3 M
  - Install 115.2 MVAR cap at East Frankfort – Est. cost: $2.3 M
  - Expected in service date 6/1/12
• Generator Deliverability Violation
  – Byron – Wempletown 345 kV line overloaded for a tower contingency

• Solution
  – Advance existing baseline upgrade for second Byron – Wempletown 345 kV circuit from 2014 to 2012
  – Expected cost $14.5 Million
Dominion Transmission Zone

• N-2 Violation
  – Voltage violation at Fredricksburg area 230 kV buses for the loss of Four Rivers – Fredricksburg 230 kV + Possum Point – Garrisonville 230 kV

• Solution
  – Install a 150 MVAR 230 kV capacitor at Fredricksburg
  – Expected in-service date: 6/1/12
  – Estimated cost: $1.2 million
• N-2 Violation
  – Voltage violation at Pratts 115 kV for the loss of Gordonsville – Louisa Ct 230 kV + Gordonsville – Charlottesville 230 kV

• Solution
  – Install a 25 MVAR 115 kV capacitor at Somerset
  – Expected in-service date: 6/1/12
  – Estimated cost: $0.5 million
Dominion Transmission Zone

• N-2 Violation
  – Voltage violation at Northwest 230 kV for the loss of Chesterfield
  – Southwest 230 kV + Northwest – Elmont 230 kV

• Solution
  – Install a 150 MVAR 230 kV capacitor at Northwest
  – Expected in-service date: 6/1/12
  – Estimated cost: $1.2 million
• Mid-Atlantic Load Deliverability
  – Dooms – Lexington 500 kV line overloads for the loss of Bath County – Valley 500 kV

• Solution
  – Replace the wave traps at both Lexington and Dooms
  – Expected in-service date: 6/1/12
  – Estimated cost: $0.3 million
• Dominion Criteria Violation
  – Endless Caverns 230 / 115 kV transformer overloads for the loss of Dooms – Grottoes 230 kV

• Solution
  – Add a second Endless Caverns 230 / 115 kV transformer
  – Expected in-service date: 6/1/10
  – Estimated cost: $6 million
Dominion Transmission Zone

- **Dominion Criteria Violation**
  - Edinburg – Mt. Jackson 115 kV overloads for the loss of Cunningham – Elmont 500 kV

- **Solution**
  - Reconductor 9.4 miles of the Edinburg – Mt. Jackson 115 kV line
  - Expected in-service date: 6/1/10
  - Estimated cost: $5 million
• Dominion Criteria Violation
  – Newport News – Chuckatuck 230 kV overloads for the loss of Surry – Winchester 230 kV

• Solution
  – Reconductor 2.4 miles of the Newport News – Chuckatuck 230 kV line
  – Expected in-service date: 6/1/12
  – Estimated cost: $3 million
Dominion Transmission Zone

• Tower line outage & Dominion Criteria Violation
  – Tower line outage – Morrisville to Marsh Run overloads 115 kV network in the area.
  – Loudoun 500 / 230 kV transformer overloads for loss of the other transformer.

• Solution
  – Convert the Remington – Sowego 115 kV line to 230 kV
  – Add a new 230 kV line from Sowego – Gainsville
  – Add a Sowego 230 / 115 kV transformer
  – Estimated cost $30 million
Backbone Upgrades
• Build a new 765 kV transmission line from the John Amos substation to Bedington substation and extend a twin circuit 500 kV line to a new substation in Kemptown near the Doubs-Brighton and Brighton-Conastone 500 kV lines.
• 15 year analysis shows that this alternative has the greatest impact on the overloads shown on the previous page.
• This line also reduces the flow on the Kammer 765 kV which was heavily overload for Mid-Atlantic load deliverability.
• Expected in service:  6/1/12
• Approximate cost: $ 1.8 Billion
<table>
<thead>
<tr>
<th>Overloaded Facility</th>
<th>Base Case</th>
<th>Amos - Bedington 765kV - Kemptown 500kV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Keystone - Airydale 500 kV</td>
<td>2012</td>
<td>&gt; 2022</td>
</tr>
<tr>
<td>Keystone - Conemaugh 500 kV</td>
<td>2012</td>
<td>&gt; 2022</td>
</tr>
<tr>
<td>Mt. Storm - Doubs 500 kV</td>
<td>2012</td>
<td>2022</td>
</tr>
<tr>
<td>Airydale - Juniata 500 kV</td>
<td>2013</td>
<td>2021</td>
</tr>
<tr>
<td>Airydale - Juniata 500 kV</td>
<td>2013</td>
<td>2021</td>
</tr>
<tr>
<td>Pruntytown - Mt. Storm 500 kV</td>
<td>2015</td>
<td>&gt; 2022</td>
</tr>
<tr>
<td>Harrison - Pruntytown 500 kV</td>
<td>2016</td>
<td>&gt; 2022</td>
</tr>
<tr>
<td>Lexington - Dooms 500 kV</td>
<td>2017</td>
<td>&gt; 2022</td>
</tr>
<tr>
<td>Loudon - Pleasant View 500 kV</td>
<td>2017</td>
<td>&gt; 2022</td>
</tr>
<tr>
<td>Greenland Gap - Meadowbrook 500 kV</td>
<td>2020</td>
<td>&gt; 2022</td>
</tr>
<tr>
<td>Mt. Storm - Greenland Gap 500 kV</td>
<td>2020</td>
<td>&gt; 2022</td>
</tr>
<tr>
<td>Hosensack - Elroy 500 kV</td>
<td>2021</td>
<td>&gt; 2022</td>
</tr>
<tr>
<td>Bath County - Valley 500 kV</td>
<td>2022</td>
<td>&gt; 2022</td>
</tr>
</tbody>
</table>
Northern New Jersey Overloads

• Build a new 500 kV transmission line from Susquehanna – Lackawanna – Jefferson – Roseland.
• Solution resolves most of the overloads shown on the previous page.
• Terminal equipment limitations still need to be examined as conductor limits were used in the analysis.
• Expected in service: 6/1/12
• Approximate cost: $350M
## Northern New Jersey Overload Reduction

<table>
<thead>
<tr>
<th>Overloaded Facility</th>
<th>Base Case</th>
<th>Susquehanna - Roseland 500kV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Greystone – Whippany 230 kV</td>
<td>2013</td>
<td>&gt; 2022</td>
</tr>
<tr>
<td>Larrabee – Atlantic 230 kV</td>
<td>2013</td>
<td>&gt; 2022</td>
</tr>
<tr>
<td>Branchburg – Flagtown 230 kV</td>
<td>2013</td>
<td>&gt; 2022</td>
</tr>
<tr>
<td>Flagtown – Somerville 230 kV</td>
<td>2013</td>
<td>&gt; 2022</td>
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<tr>
<td>East Windsor – Smithburg 230 kV</td>
<td>2014</td>
<td>2018</td>
</tr>
<tr>
<td>Hosensack – Elroy 500 kV</td>
<td>2014</td>
<td>&gt; 2022</td>
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<tr>
<td>Cedar Grove F – Roseland 230 kV</td>
<td>2015</td>
<td>2016</td>
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<tr>
<td>Whippany – Roseland 230 kV</td>
<td>2015</td>
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<tr>
<td>Kittatinny – Pohatcong 230 kV</td>
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<td>Bushkill – Kittatinny 230 kV</td>
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<td>Roseland – Cedar Grove B 230 kV</td>
<td>2016</td>
<td>2017</td>
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<tr>
<td>Overloaded Facility</td>
<td>Base Case</td>
<td>Susquehanna - Roseland 500kV</td>
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<tr>
<td>Gilbert – Morristown 230 kV</td>
<td>2017</td>
<td>&gt; 2022</td>
</tr>
<tr>
<td>Readington – Roseland 230 kV</td>
<td>2017</td>
<td>&gt; 2022</td>
</tr>
<tr>
<td>Pleasant Valley – Lawrence 230 kV</td>
<td>2018</td>
<td>2022</td>
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<tr>
<td>Cox’s Corner – Lumberton 230 kV</td>
<td>2018</td>
<td>2022</td>
</tr>
<tr>
<td>Kittatinny – Newton 230 kV</td>
<td>2018</td>
<td>&gt; 2022</td>
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<tr>
<td>Gilbert – Glenn Gardner 230 kV</td>
<td>2018</td>
<td>&gt; 2022</td>
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<tr>
<td>Branchburg – Readington 230 kV</td>
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<td>&gt; 2022</td>
</tr>
<tr>
<td>Portland – Martins Creek 230 kV</td>
<td>2019</td>
<td>&gt; 2022</td>
</tr>
<tr>
<td>Somerville – Bridgewater 230 kV</td>
<td>2019</td>
<td>&gt; 2022</td>
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<tr>
<td>Cedar Grove F – Clifton K 230 kV</td>
<td>2019</td>
<td>2018</td>
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<tr>
<td>Glen Gardner – Chester 230 kV</td>
<td>2020</td>
<td>&gt; 2022</td>
</tr>
<tr>
<td>Smithburg – New Prospect 230 kV</td>
<td>2020</td>
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<tr>
<td>Alburtis - Branchburg 500 kV</td>
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<td>&gt; 2022</td>
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<tr>
<td>West Wharton - Greystone J 230 kV</td>
<td>2021</td>
<td>&gt; 2022</td>
</tr>
</tbody>
</table>
• One phase of the Kammer 765 / 500 kV transformer failed earlier this spring and was replaced with the spare.
• There is currently no spare available.
• RTEP analysis shows this transformer is overloaded in 2012 for the Mid-Atlantic load deliverability test.
• Loading on the transformer is reduced with the addition of the Amos – Bedington – Kemptown circuit.
• Upgrading this transformer will be required if delays are experienced in construction of the new line.
• Given these issues, analysis to evaluate purchasing a new larger transformer is underway.
Reliability Issues – Washington D.C.

- Since the 2007 RTEP base case was developed, Benning Road and Buzzard Point generating stations have announced their intent to retire (approximately 800 MW total).
- These retirements will require transmission enhancements to address thermal and reactive issues.
- Evaluating a number of upgrades that will be required to reinforce the area.
- Evaluating backbone alternatives along with previously identified solutions.
- Analysis of the various alternatives will continue into this summer.
- These additional enhancements will be presented at a future TEAC.
• With Susquehanna – Lackawanna – Jefferson Roseland 500 kV circuit all NNJ overloads are resolved through 2015
• PJM performed sensitivity analyses to determine what additional overloads may be expected.
• The diagram shows additional overloads that result from a large withdrawal of power at Bergen 230 kV
• Over half of the 23 overloads identified occur prior to 2015
• The diagram shows additional overloads that result from the deactivation of the Hudson #2 unit

• Over half of the 18 overloads identified occur prior to 2015
The diagram shows additional overloads that result from the deactivation of the Oyster Creek unit.

Over one fourth of the 16 overloads identified occur prior to 2015.
Alternative Backbone Solutions Under Consideration
Next Steps

• Develop cost estimates for remaining upgrades
• Complete the reliability analysis for Southwest Mid-Atlantic area including the impact of Benning Road and Buzzard Point generation
• Develop recommendation for Kammer 765/500 kV transformer
• Continue to analyze New Jersey issues
• Reactive Analysis
• Sensitivity Analysis
Interconnection Planning Impact Studies
Dominion Impact Studies Results
<table>
<thead>
<tr>
<th>Queue</th>
<th>MW</th>
<th>Fuel Type</th>
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<th>Network Upgrade</th>
<th>Cost</th>
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</thead>
<tbody>
<tr>
<td>P27</td>
<td>13</td>
<td>Methane</td>
<td>N0559</td>
<td>Reconductor 1.1 mi of overhead 3-ph 34.5kV distribution line from 1/0 Al to 477 kcm Al. Replace 350 ft of 1/0 underground 1/0 Al with 1000 kcm Al conductor. Replace line fuse device with 3-ph electronic line recloser. Install DTT and associated protective relay work at Winchester substation.</td>
<td>$387,720</td>
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<tr>
<td>Q09</td>
<td>2.5</td>
<td>Hydro</td>
<td>-</td>
<td>No Upgrades</td>
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<tr>
<td>Q32</td>
<td>30</td>
<td>Biomass</td>
<td>-</td>
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<td>$0</td>
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<tr>
<td>Q69</td>
<td>12</td>
<td>Methane</td>
<td>N0560</td>
<td>Replace 3-ph hydraulic recloser with 3-ph electronic recloser with DTT capability. Install DTT and associated protective relay work at Shacklefords substation. Reconductor 0.38 mi of 3-ph circuit from #2 to 1/0 Al. Reconductor 0.9 mi of 3-ph circuit from #2 to 1/0 Al.</td>
<td>$550,000</td>
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<tr>
<td>Q70</td>
<td>11</td>
<td>Methane</td>
<td>N0561</td>
<td>Replace 3-ph fuses with 3-ph recloser. Install DTT and associated protective relay work at Lawrenceville substation. Reconductor 1.1 mi of 3-ph 34.5kV distribution line from #4 to 1/0 Al.</td>
<td>$490,000</td>
</tr>
<tr>
<td>Q71</td>
<td>2</td>
<td>Methane</td>
<td>N0562</td>
<td>Removal of two 1-ph step-down transformers. Replace two 1-ph recloser arrangements with 3-ph reclosers with DTT capability. Convert 2 mi of 2-ph four wire distribution circuit to 3-ph four wire 34.5kV. Install three step-down transformers. Replace 25 line transformers. Install DTT at Cranes Corner substation. Three phase 2000 feet of existing single phase line to POI.</td>
<td>$235,000</td>
</tr>
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Met Ed Impact Studies Results
<table>
<thead>
<tr>
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<tr>
<td>Q45</td>
<td>3.2</td>
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<td>n0452</td>
<td>South Reading Substation – Install DTT to Pioneer Crossing Substation</td>
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<td>n0453</td>
<td>Birdsboro Substation – Install DTT to Pioneer Crossing Generation Substation</td>
<td>$65,000</td>
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<td>n0455</td>
<td>Replace relays on the Birdsboro terminal of the 817 69 kV line</td>
<td>$70,000</td>
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<td>n0456</td>
<td>69 kV Trans. Tap – Install 3-way SCADA controlled motor operated switches</td>
<td>$215,000</td>
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<tr>
<td>Q59</td>
<td>9</td>
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JCPL Impact Studies Results
JCPL Interconnection Projects

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<td>Q22</td>
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Legend

- Merchant Projects
- Substations
- Queues
  - Status Code:
    - ACTIVE
    - IS-NC
    - ISP
    - UC
- Voltage (kV):
  - 230
  - 345
  - 500
  - 765
- Transmission Lines
  - Voltage (kV):
    - 230
    - 345
    - 500
    - 765
PPL Impact Studies Results
AEC Impact Studies Results
AEC Interconnection Projects

<table>
<thead>
<tr>
<th>Queue</th>
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Penelec Impact Studies Results
## Penelec Interconnection Projects

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<th>Upgrade ID</th>
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<th>Network Upgrade</th>
<th>Cost (M)</th>
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<tbody>
<tr>
<td>O17</td>
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<td>508</td>
<td>Wind</td>
<td>Support Queue O17 115kV interconnection switchyard</td>
<td>0.20</td>
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<tr>
<td></td>
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<td>509</td>
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<td>Queue O17 115kV transmission tap (0.1 miles)</td>
<td>0.250</td>
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<tr>
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<td></td>
<td>510</td>
<td></td>
<td>Somerset 115kV substation upgrades for O17</td>
<td>0.310</td>
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<tr>
<td></td>
<td></td>
<td>511</td>
<td></td>
<td>Allegheny 115kV substation upgrades for O17</td>
<td>0.310</td>
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<td>Wind</td>
<td>Support Queue O18 115kV interconnection switchyard</td>
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<td>O18</td>
<td>65</td>
<td>503</td>
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<td>Queue O18 115kV transmission tap (0.1 miles)</td>
<td>0.250</td>
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<tr>
<td></td>
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<td>Hilltop 115kV substation upgrades</td>
<td>0.20</td>
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<td>505</td>
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<td>Rachel Hill 115kV substation upgrades</td>
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<td>506</td>
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<td>Claysburg 115kV substation upgrades</td>
<td>0.310</td>
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<tr>
<td></td>
<td></td>
<td>507</td>
<td></td>
<td>Hilltop to O18 to Rachel fiber optic installation (23 miles)</td>
<td>1.044</td>
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<td></td>
<td>33</td>
<td>512</td>
<td>Wind</td>
<td>Support Queue O19 115kV interconnection switchyard</td>
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<td>O19</td>
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<td>513</td>
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<td>Queue O19 115kV transmission tap (0.1 miles)</td>
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<td>514</td>
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<td>Somerset 115kV substation upgrades for O19</td>
<td>0.310</td>
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<td></td>
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<td>Allegheny 115kV substation upgrades for O19</td>
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<tr>
<td></td>
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<td>516</td>
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<td>Fiber optic between O19 and O17 interconnection switchyards</td>
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<td>O38</td>
<td>50</td>
<td>517</td>
<td>Wind</td>
<td>Bear Rock substation upgrades</td>
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</table>
### Penelec Interconnection Projects

<table>
<thead>
<tr>
<th>Queue</th>
<th>MW</th>
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<th>Fuel Type</th>
<th>Network Upgrade</th>
<th>Cost (M)</th>
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</thead>
<tbody>
<tr>
<td>O48**</td>
<td>37.8</td>
<td>464*</td>
<td>Wind</td>
<td>Addition of fiber optic terminal equipment at Rockwood 115kV substation</td>
<td>0.035</td>
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<tr>
<td></td>
<td></td>
<td>465*</td>
<td>Wind</td>
<td>Addition of fiber optic terminal equipment at Meyersdale North substation</td>
<td>0.035</td>
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<tr>
<td></td>
<td></td>
<td>466*</td>
<td></td>
<td>Fiber optic line between Rockwood and Meyersdale North</td>
<td>0.700</td>
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<tr>
<td>R40**</td>
<td>37.8</td>
<td>518</td>
<td>Wind</td>
<td>Support Queue O48/R40 115kV interconnection switchyard and tap</td>
<td>0.450</td>
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<tr>
<td></td>
<td></td>
<td>521</td>
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<td>Arnold REC 115kV substation upgrades for O48/R40</td>
<td>0.005</td>
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<tr>
<td></td>
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<td>522</td>
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<td>Berkley Flats WF 115kV substation upgrades for O48/R40</td>
<td>0.005</td>
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<tr>
<td></td>
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<td>523</td>
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<td>Garrett Tap - Garret substation 115kV circuit</td>
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<td>Rockwood 115kV substation disconnect switch replacement</td>
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<td>Somerset 115kV substation disconnect switch replacement</td>
<td>0.060</td>
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<tr>
<td>O52</td>
<td>100</td>
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<td>Wind</td>
<td>O52 115kV interconnection switchyard</td>
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<td>541</td>
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<td>O52 115kV transmission tap (0.1 miles)</td>
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<td>542</td>
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<td>Potter 115kV substation upgrades</td>
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<td>543</td>
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<td>Niles Valley or N36 115kV substation upgrades</td>
<td>0.115</td>
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<tr>
<td></td>
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<td>545</td>
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<td>Fiber Optic between Potter, O52, and Niles Valley</td>
<td>0.525</td>
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<tr>
<td>O56</td>
<td>125</td>
<td>535</td>
<td>Wind</td>
<td>O56 115kV interconnection switchyard</td>
<td>0.200</td>
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<tr>
<td></td>
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<td>536</td>
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<td>O56 115kV transmission tap (0.1 miles)</td>
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<td></td>
<td></td>
<td>537</td>
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<td>Claysburg 115kV substation upgrades</td>
<td>0.210</td>
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<td>538</td>
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<td>Fiber Optic between Claysburg and O56 (12.54 miles)</td>
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<tr>
<td></td>
<td></td>
<td>539</td>
<td></td>
<td>Altoona 230 kV line wave trap replacement</td>
<td>0.115</td>
</tr>
</tbody>
</table>

** note: projects O48 and R40 are combined

* note: upgrades 464, 465 and 466 are shared 50/50 by projects L13 and O48/R40
<table>
<thead>
<tr>
<th>Queue</th>
<th>MW</th>
<th>Upgrade ID</th>
<th>Fuel Type</th>
<th>Network Upgrade</th>
<th>Cost (M)</th>
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</thead>
<tbody>
<tr>
<td>O59</td>
<td>99</td>
<td>546</td>
<td>Wind</td>
<td>Support N36 115kV interconnection switchyard new connection</td>
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<td>N36 115kV interconnection switchyard ring bus expansion</td>
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<td>549</td>
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<td>Niles Valley 115kV substation upgrades</td>
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<td></td>
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<td>550</td>
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<td>Ansonia to Gains 34kV reconductoring (5.37 miles)</td>
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<td>Ansonia to Wellsboro 34kV reconductoring (9.47 miles)</td>
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<td>Communication equipment if O59 proceeds O52 or N36</td>
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<td>O72</td>
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<td>Wind</td>
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<td>O72 115kV transmission tap (0.1 miles)</td>
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<td>I13 115kV substation upgrades</td>
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<td>Fiber Optic O72 to I13 (3.1 miles)</td>
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<td>Altoona 230 kV line wave trap replacement</td>
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<td>Johnstown 115kV substation breaker replacement on Bon Air line</td>
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<td>Hooversville 115kV substation breaker replacement on Central City West line</td>
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APS Impact Studies Results
### APS Interconnection Projects

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<th>Queue</th>
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<th>Cost</th>
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<td>O45</td>
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<tr>
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<td>R75</td>
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<td>No Upgrades</td>
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### Legend
- **Merchant Projects**
- **Substations**
- **Queues**
  - ACTIVE
  - IS-NC
  - ISP
  - UC
- **Transmission Lines**
  - 230 kV
  - 345 kV
  - 500 kV
  - 766 kV
DQE Impact Studies Results
DQE Interconnection Projects

Legend

- Merchant Projects
- Substations
  - Voltage (kV)
    - 230
    - 345
    - 500
    - 765
- Transmission Lines
  - Voltage (kV)
    - 230
    - 346
    - 500
    - 765

Queues

Status Code

- ACTIVE
- IS-NC
- ISP
- UC
AEP Impact Studies Results
AEP Interconnection Projects

<table>
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<tr>
<td>P44</td>
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<td>Diesel</td>
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Legend:
- Star: Merchant Projects
- Substations
- Queues Status Code:
  - ACTIVE
  - IS-NC
  - ISP
  - UC
- Voltage (kV):
  - 230
  - 346
  - 500
  - 765
- Transmission Lines Voltage (kV):
  - 230
  - 345
  - 500
  - 765

Map showing various substations and networks with associated Queues.