

Generator Interconnection

This analysis was completed to assess the reliability impact for a new generator interconnecting to the PJM System as a Capacity Resource.

Network Impacts

The Queue T179 project was studied as a 873 MW (capacity) injection into PPL EU's transmission system. Project T179 was studied at two separate points of interconnection: Option 1 was a direct connection to the Steel City 500 kV bus, while Option 2 was direct connection to the Alburdis - Branchburg 500 kV through a three-breaker ring bus. Queue T179 was evaluated for compliance with reliability criteria for summer peak conditions in 2012. Potential network impacts were as follows:

Option 1: Steel City 500kV

Generator Deliverability

(Normal System with all facilities in-service and Single, or N-1, contingencies for the Capacity portion only of the interconnection)

1. The STEELCTY-STEELCTY 500/230kV transformer loads from 78.16% (DC power flow) to 150.53% of its emergency rating (1200MVA) for the single line contingency outage (PJM28A). This project contributes approximately 868.4MW to cause this thermal violation.
2. The STEELCTY-QUARRY 230kV line loads from 76.5% to 135.5% (DC power flow) of its emergency rating (783MVA) for the single line contingency outage (PJM28A). This project contributes approximately 462.3MW to cause this thermal violation.
3. The QUARRY-NORTHWD 230kV line loads from 74.3% to 137.7% (DC power flow) of its emergency rating (641MVA) for the single line contingency outage (PJM28A). This project contributes approximately 406.4MW to cause this thermal violation.
4. The STEELCTY-QUARR-H4 230kV line loads from 68.1% to 119.9% (DC power flow) of its emergency rating (783MVA) for the single line contingency outage (PJM28A). This project contributes approximately 405.1MW to cause this thermal violation.
5. The QUARRY-MTN CRK 230kV line loads from 55.1% to 122.5% (DC power flow) of its emergency rating (588MVA) for the single line contingency outage (PJM28A). This project contributes approximately 396.6MW to cause this thermal violation.
6. The QUARR-H4-QUARRY 230kV line loads from 56.7% to 106.3% (DC power flow) of its emergency rating (783MVA) for the single line contingency outage

(PJM28A). This project contributes approximately 388.6MW to cause this thermal violation.

7. The LENOX-TIFFANY 115kV line loads from 98.7% to 103.5% (DC power flow) of its emergency rating (151MVA) for the single line contingency outage (PN20). This project contributes approximately 7.3MW to cause this thermal violation.

Multiple Facility Contingency

(Double Circuit Tower Line contingencies only for the full energy output. Stuck breaker and bus fault contingencies will be performed for the Impact Study)

8. The ROCKRGE2-C.PIPE12 115kV line loads from 98.81% to 103.14% (DC power flow) of its emergency rating (197MVA) for the tower line outage (NEAST_RPHLRD). This project contributes approximately 8.5MW to cause this thermal violation.

9. The C.PIPE12-GLENARM2 115kV line loads from 96.38% to 100.72% (DC power flow) of its emergency rating (197MVA) for the tower line outage (NEAST_RPHLRD). This project contributes approximately 8.5MW to cause this thermal violation.

Contribution to Previously Identified Overloads

(This project contributes to the following contingency overloads, i.e. "Network Impacts", identified for earlier generation or transmission interconnection projects in the PJM Queue)

10. The LAUREL L-GOUDY115 115kV line loads from 114.53% to 120.44% (DC power flow) of its emergency rating (129MVA) for the single line contingency outage (PN20). This project contributes approximately 7.6MW to the thermal violation.

11. The E.SAYRE-N.WAV115 115kV line loads from 116.50% to 122.25% (DC power flow) of its normal rating (90MVA) for non-contingency condition. This project contributes approximately 5.2MW to the thermal violation.

12. The NEAST317-N.EAST 230/115kV transformer loads from 146.97% to 151.51% (DC power flow) of its emergency rating (378MVA) for the tower line outage (NORTHEAST_RIVERSIDE). This project contributes approximately 17.1MW to the thermal violation.

13. The LACKAWNA-OXBOW 230kV line loads from 162.9% to 168.5% (DC power flow) of its emergency rating (617MVA) for the tower line outage (4PPL). This project contributes approximately 35.0MW to the thermal violation.

14. The BRUNNER-YORKANA 230kV line loads from 141.87% to 147.99% (DC power flow) of its emergency rating (617MVA) for the tower line outage (CONAS_PB). This project contributes approximately 37.7MW to the thermal violation.

15. The OXBOW-N.MESHPN 230kV line loads from 210.11% to 217.14% (DC power flow) of its emergency rating (617MVA) for the tower line outage (CONAS_PB). This project contributes approximately 43.4MW to the thermal violation.
16. The 3 MILE I-TMI 500/230kV transformer loads from 182.44% to 189.53% (DC power flow) of its emergency rating (1077MVA) for the tower line outage (CONAS_PB). This project contributes approximately 76.3MW to the thermal violation.
17. The NOTTINGHAM-NOTTREAC 230kV line loads from 243.90% to 251.84% (DC power flow) of its emergency rating (627MVA) for the tower line outage (CONAS_PB). This project contributes approximately 49.7MW to the thermal violation.
18. The NOTTREAC-PCHBTMTP 230kV line loads from 243.87% to 251.80% (DC power flow) of its emergency rating (627MVA) for the tower line outage (CONAS_PB). This project contributes approximately 49.7MW to the thermal violation.
19. The PCHBTMTP-GRACETON 230kV line loads from 243.87% to 251.80% (DC power flow) of its emergency rating (627MVA) for the tower line outage (CONAS_PB). This project contributes approximately 49.7MW to the thermal violation.
20. The TMI-JACKSON1 230kV line loads from 117.58% to 123.67% (DC power flow) of its emergency rating (599MVA) for the tower line outage (CONAS_PB). This project contributes approximately 36.5MW to the thermal violation.
21. The CNASTONE-N-NWEST 500kV line loads from 202.64% to 209.35% (DC power flow) of its emergency rating (2901MVA) for the tower line outage (CNSTN_NWEST). This project contributes approximately 194.6MW to the thermal violation.
22. The MANOR-GRACETON 230kV line loads from 225.18% to 234.16% (DC power flow) of its emergency rating (531MVA) for the tower line outage (CONAS_PB). This project contributes approximately 47.7MW to the thermal violation.
23. The N.MESHPN-E.TWANDA 230kV line loads from 140.14% to 146.30% (DC power flow) of its emergency rating (554MVA) for the tower line outage (CONAS_PB). This project contributes approximately 34.1MW to the thermal violation.
24. The HOSENSAK-N.BOYTWN 230kV line loads from 125.48% to 132.40% (DC power flow) of its emergency rating (525MVA) for the tower line outage (CONAS_PB). This project contributes approximately 36.3MW to the thermal violation.
25. The OTTERCRK-CONASTON 230kV line loads from 198.99% to 207.17% (DC power flow) of its emergency rating (627MVA) for the tower line outage (CONAS_PB). This project contributes approximately 51.3MW to the thermal violation.

New System Reinforcements

(Upgrades required to mitigate reliability criteria violations, i.e. "Network Impacts", initially caused by the addition of this project generation)

1. To mitigate the reliability criteria violations initially caused by the addition of T179 generation, a new 500 kV line will need to be constructed from Steel City to a new 500 kV three breaker ring bus inserted into the Alburdis-Branchburg 500 kV line as shown in Attachment C. The total estimated cost of these network upgrades is **\$80,670,000** (excluding any applicable state or federal taxes). The 500 kV network upgrade estimate is based on the assumptions stated in the following Transmission and Substation Direct Connection Work sections.

A further breakdown of the network upgrade costs is as follows:

\$ 47,650,000	New 500 kV Transmission Line from Steel City to Alburdis-Branchburg
\$ 5,200,000	Transmission Siting, ROW, Certification
\$ 22,000,000	500 kV Three Breaker Ring Bus in Alburdis-Branchburg Line
\$ 1,820,000	Terminate Alburdis-Branchburg 500 kV line into new ring bus
\$ 4,000,000	<u>New 500 kV Three Breaker Ring Bus Site Acquisition</u>
\$ 80,670,000	Total Network Upgrades: Option 1

After the Interconnection Service Agreement and Construction Service Agreement are signed, the typical time needed to complete the direct connection work is about 48 months (4 years) for the siting work, 36 months (3 years) for the transmission work, and 48 months (4 years) for the substation work. The transmission and substation work can be done concurrently. The transmission and substation design can begin approximately 2 years after the siting process starts at the customer's risk. No construction will commence on the transmission line until PPL EU receives approval from all affected environmental agencies and the PA PUC. **This translates into an approximate 6 year project time frame.** The IPP's requested RIS date of June 2012 is not achievable with this schedule. The projected 6 year project time frame assumes that no public opposition or intervention in the PA PUC Filing. If this should occur, the projected time frame would be extended by an unknown amount of time, 6 months to possibly 2 years, thus affecting the RIS date to an even greater extent.

500 kV Transmission Line Network Upgrade Work

\$ 47,650,000	New 500 kV Transmission Line from Steel City to Alburdis-Branchburg
\$ 5,200,000	Transmission Siting, ROW, Certification
\$ 1,820,000	<u>Total cost to terminate the Alburdis-Branchburg 500 kV Line into the new ring bus</u>
\$ 54,670,000	Total Transmission Network Upgrades: Option 1

New 500 kV line from Steel City to the Alburdis-Branchburg 500 kV line.

The transmission network upgrade cost includes rebuilding the existing Hosensack-Steel City 500 kV line to double circuit for approximately 5.5 miles out of Steel City then

constructing approximately 2.5 miles of new single circuit 500 kV to the new three breaker ring bus in the Alburdis-Branchburg 500 kV Line as shown in Attachment C. New line construction will be using 2493 kcmil ACAR 2/bundle per phase conductors with 2 19/9 overhead ground wires (OHGW) in a 200 ft R/W. This estimate assumes the existing Hosensack-Steel City 500 kV line can be rebuilt for double circuit for approximately 5.5 miles outside of the Steel City Substation. The ROW for the 5.5 miles of line is only 150 ft. There will be construction challenges and constraints with this width of ROW. The estimate was adjusted to account for these construction challenges.

A new 200 ft R/W would need to be secured for 2.5 miles from Hosensack-Steel City 500 kV line to the new three breaker ring bus in the Alburdis-Branchburg line. PA PUC Certification will be required for this new line in the form of a Full Siting Application. The cost for this filing and the related Siting/ROW work is included in the above cost estimate. This estimate does not include dollars for wetland mitigation, extraordinary permitting, archaeological or cultural mitigation. This estimate includes condemnation for 5 properties. Based on opposition PPL Electric Utilities is currently having for a new 138 kV line in this area, opposition to this line can be anticipated. It is likely more condemnations will be required.

The Alburdis-Branchburg 500 kV line will need to be broken and terminated into the new three breaker ring bus as shown in Attachment B. The cost to terminate the Alburdis-Branchburg 500 kV line into the new ring bus is included in the estimate.

Steel City-Alburdis-Branchburg 500 kV Three Breaker Ring Bus - Direct Connection Work

\$ 22,000,000	Total cost of the new 500 kV three breaker ring bus
\$ 4,000,000	New 500 kV Three Breaker Ring Bus Site Acquisition
\$ 26,000,000	Total Substation Network Upgrades: Option 1

A new three breaker ring bus will be required to tie the new 500 kV line from Steel City into the Alburdis-Branchburg 500 kV line. The ring bus work includes building a new 500 kV yard with two breaker and a half bays (one bay occupied initially) as shown in Attachment B. This estimate includes the cost of acquiring a new 30 acre site for the new ring bus.

This upgrade also mitigates Network Impact number 2, 3, 4, 5, 6.

3. The Northwood – Quarry 230kV line: In addition to the PPL reinforcements shown above, the Northwood – Quarry 230kV line is partially owned by METED. The cost estimate to reinforce/rebuild and reconductor METED’s .6 mile portion of the line is **\$450,000**, and it will take about **3 years** to complete the work.

7. The Lenox – Tiffany 115kV line overload will be alleviated by a PJM operating procedure which will open the Tiffany-Goudey 115kV line to control thermal limits that occur on the Penelec/NY ISO tie lines.

8. BG&E Upgrade requirement to be provided for the Impact Study if required.

9. BG&E Upgrade requirement to be provided for the Impact Study if required.

Contribution to Previously Identified System Reinforcements

(Overloads initially caused by prior Queue positions with additional contribution to overloading by this project. This project may have a % allocation cost responsibility which will be calculated and reported for the Impact Study)

10. The Laurel L – Goudey 115kV line overload will be alleviated by a PJM operating procedure which will open the Tiffany-Goudey 115kV line to control thermal limits that occur on the Penelec/NY ISO tie lines.

11. The North Waverly – East Sayre 115kV line overload will be alleviated by a PJM operating procedure which will open this line pre-contingency if the contingency scenario mentioned (PN20) occurs.

12. The Northeast 230/115 kV transformer overload requires that the transformer be replaced with a 500MVA unit. The estimated cost to replace the transformer is **\$10.2M**.

13. The Lackawanna – Oxbow 230kV line: The Penelec portion of the upgrade involves the rebuild of 16.33 miles of transmission line as well as substation work at the Oxbow facility. The estimated cost of the Penelec upgrade is **\$19.771M** and it would take **4-5 years** to complete. PPL owns the Lackawanna substation. PPL is assuming that terminal upgrade work would be required at the Lackawanna substation. The estimated cost for the terminal upgrade is **\$500,000**.

14. The Brunner Island – Yorkana 230kV line: Meted owns 12.6 miles of the transmission line and the Yorkana substation. PPL owns .64 miles of the transmission line and the Brunner Island substation. The PPL portion of the line will be rebuilt with 1590 ACSR cable. The cost of the rebuilt and the terminal work at Brunner Island is **\$2M**.

15. The Oxbow – N. Meshopen 230kV line overload require the rebuild of approximately 10.16 miles of transmission line This overload also requires the replacement of a disconnect switch and replacement of substation conductor at Oxbow substation. North Meshoppen substation requires the upgrade/replacement of two (2) CT circuits, substation conductor, and a line/wave trap. The total cost of the upgrade is estimated to be **\$12.939M** and it would take **4-5 years** to complete the work.

16. To mitigate the 3 MILE I-TMI 500/230kV (METED) transformer would require the installation of a second 500/230kV transformer. The estimated cost to perform this work is **\$11.8M** and will take **20 months** to complete.

17. The Nottingham – Peach Bottom line reactor overload can be alleviated by replacing the line reactor. The upgrade will cost about **\$0.2M** and will take about **18 months** to complete.

18. The Nottingham – Peach Bottom 230kV line overload can be alleviated by tearing down and rebuilding the existing 230kV line. This will increase the line rating to 1243N/1410E MVA. This portion of the upgrade will cost **\$40M** and take **4 years** to complete. A second 230kV line will also need to be constructed on new right of way at a cost of **\$40M** and a time estimate of **10 years**. Finally, a new substation will need to be built at Peach Bottom at a cost of **\$10M** and an estimated **4 years** to complete.

19. The Peach Bottom – Graceton 230kV line (PECO and BGE portions) overload can be alleviated by replacing the existing 230kV line with a double circuit 230kV underground cable capable of handling about 1226MVA during emergency conditions. The upgrade will cost about **\$61M** and will take about **48 months** to complete.

20. The TMI – Jackson 230kV overload requires the replacement of 18.05 miles of 230kV line, as well as substation upgrades at both TMI and Jackson. The total estimated cost of this upgrade is **\$10.91M**.

21. The Conastone-North North West overloads can be alleviated by adding a single circuit 500kV line at an estimated cost of **\$109 million** and estimated time of 10 yrs.

Assumptions:

New 200 ft. wide R/W parallels existing Conastone to Northwest R/W

Total R/W length = 19.6 miles

3 - bundle 1,590 kcm conductor

North Northwest located 4 miles north of Northwest

22. The Manor – Graceton 230kV line: PPL owns 14.5 miles of the transmission line and the Manor substation. BGE owns 1.4 miles of the transmission line and the Graceton substation. The PPL portion of the line will be rebuilt with 1590 ACSR cable. The cost of the rebuilt and the terminal work at Manor is **\$36M**.

23. North Meshoppen - East Towanda 230 kV Line - This overload would require the reconductor of approximately 21.66 miles of 230 kV transmission line between North Meshoppen and East Towanda substations. The East Towanda substation would require the replacement of a line/wave trap, disconnect switch, and CT circuit. The North Meshoppen substation would require the upgrade or replacement of two CT circuits as

well as the replacement of substation conductor. The estimated cost of this upgrade is **\$16,245,000**, and it would take **4-5 years** to complete.

24. Hosensack – North Boyertown 230kV Line – This overload would require the reconductoring of approximately 8 miles of 230kV transmission line with 1590 ACRS wire. The existing structures between Hosensack and North Boyertown are insufficient to support a large size wire, so they will also need to be upgraded. For the worst case scenario where all support structures need to be replaced, the estimated cost of the reinforcement is **\$11,760,000**. The upgrade will take approximately **3 years** to complete.

25. The Otter Creek - Conastone 230kV line: PPL owns 12 miles of the transmission line and the Otter Creek substation. BGE owns 4.7 miles of the transmission line and the Conastone substation. The PPL portion of the line will be reconductored with 795 ACSS cable. The cost of the reconductoring and the terminal work at Otter Creek is **\$6M**.

Short Circuit

The following circuit breakers were found to be overduy:

<u>Station</u>	<u>Breaker</u>	<u>Upgrade cost</u>
Branchburg	32H	\$400,000
Branchburg	52H	\$400,000

Option 2: Alburdis - Branchburg 500kV

Generator Deliverability

(Normal System with all facilities in-service and Single, or N-1, contingencies for the Capacity portion only of the interconnection)

1. The LENOX-TIFFANY 115kV line loads from 98.7% to 103.6% (DC power flow) of its emergency rating (151MVA) for the single line contingency outage (PN20). This project contributes approximately 7.3MW to cause this thermal violation.

Multiple Facility Contingency

(Double Circuit Tower Line contingencies only for the full energy output. Stuck breaker and bus fault contingencies will be performed for the Impact Study)

2. The ROCKRGE2-C.PIPE12 115kV line loads from 98.81% to 103.13% (DC power flow) of its emergency rating (197MVA) for the tower line outage (NEAST_RPHLRD). This project contributes approximately 8.5MW to cause this thermal violation.

3. The C.PIPE12-GLENARM2 115kV line loads from 96.38% to 100.71% (DC power flow) of its emergency rating (197MVA) for the tower line outage (NEAST_RPHLRD). This project contributes approximately 8.5MW to cause this thermal violation.

Contribution to Previously Identified Overloads

(This project contributes to the following contingency overloads, i.e. "Network Impacts", identified for earlier generation or transmission interconnection projects in the PJM Queue)

4. The LAUREL L-GOUDY115 115kV line loads from 114.53% to 120.48% (DC power flow) of its emergency rating (129MVA) for the single line contingency outage (PN20). This project contributes approximately 7.7MW to the thermal violation. It must be noted that the same thermal violation (DC power flow: 114.5%) already exists in the 2012 base case.

5. The E.SAYRE-N.WAV115 115kV line loads from 116.49% to 122.26% (DC power flow) of its normal rating (90MVA) for non-contingency condition. This project contributes approximately 5.2MW to the thermal violation. It must be noted that the same thermal violation (DC power flow: 116.5%) already exists in the 2012 base case.

6. The NEAST317-N.EAST 230/115kV transformer loads from 146.98% to 151.52% (DC power flow) of its emergency rating (378MVA) for the tower line outage (NORTHEAST_RIVERSIDE). This project contributes approximately 17.2MW to the thermal violation. It must be noted that the same thermal violation (DC power flow: 146.6%) already exists in the 2012 base case.

7. The LACKAWNA-OXBOW 230kV line loads from 162.9% to 168.7% (DC power flow) of its emergency rating (617MVA) for the tower line outage (4PPL). This project contributes approximately 35.8MW to the thermal violation. It must be noted that the same thermal violation (DC power flow: 199.4%) already exists in the 2012 base case.

8. The OXBOW-N.MESHNP 230kV line loads from 210.11% to 217.22% (DC power flow) of its emergency rating (617MVA) for the tower line outage (CONAS_PB). This project contributes approximately 43.9MW to the thermal violation. It must be noted that the same thermal violation (DC power flow: 210.0%) already exists in the 2012 base case.

9. The BRUNNER-YORKANA 230kV line loads from 141.87% to 147.90% (DC power flow) of its emergency rating (617MVA) for the tower line outage (CONAS_PB). This project contributes approximately 37.2MW to the thermal violation. It must be noted that the same thermal violation (DC power flow: 141.9%) already exists in the 2012 base case.

10. The 3 MILE I-TMI 500/230kV transformer loads from 182.44% to 189.41% (DC power flow) of its emergency rating (1077MVA) for the tower line outage (CONAS_PB). This project contributes approximately 75.1MW to the thermal violation. It must be noted that the same thermal violation (DC power flow: 182.3%) already exists in the 2012 base case.

11. The NOTTINGHAM-NOTTREAC 230kV line loads from 243.90% to 252.23% (DC power flow) of its emergency rating (627MVA) for the tower line outage (CONAS_PB). This project contributes approximately 52.2MW to the thermal violation. It must be noted that the same thermal violation (DC power flow: 243.7%) already exists in the 2012 base case.

12. The NOTTREAC-PCHBTMTMTP 230kV line loads from 243.87% to 252.20% (DC power flow) of its emergency rating (627MVA) for the tower line outage (CONAS_PB). This project contributes approximately 52.2MW to the thermal violation. It must be noted that the same thermal violation (DC power flow: 243.6%) already exists in the 2012 base case.

13. The PCHBTMTMTP-GRACETON 230kV line loads from 243.87% to 252.20% (DC power flow) of its emergency rating (627MVA) for the tower line outage (CONAS_PB). This project contributes approximately 52.2MW to the thermal violation. It must be noted that the same thermal violation (DC power flow: 243.6%) already exists in the 2012 base case.

14. The TMI-JACKSON1 230kV line loads from 117.58% to 123.59% (DC power flow) of its emergency rating (599MVA) for the tower line outage (CONAS_PB). This project contributes approximately 36.0MW to the thermal violation. It must be noted that the same thermal violation (DC power flow: 117.6%) already exists in the 2012 base case.

15. The MANOR-GRACETON 230kV line loads from 225.18% to 233.97% (DC power flow) of its emergency rating (531MVA) for the tower line outage (CONAS_PB). This project contributes approximately 46.7MW to the thermal violation. It must be noted that the same thermal violation (DC power flow: 225.0%) already exists in the 2012 base case.

16. The N.MESHPN-E.TWANDA 230kV line loads from 140.14% to 146.37% (DC power flow) of its emergency rating (554MVA) for the tower line outage (CONAS_PB). This project contributes approximately 34.5MW to the thermal violation. It must be noted that the same thermal violation (DC power flow: 140.1%) already exists in the 2012 base case.

17. The HOSENSAK-N.BOYTN 230kV line loads from 125.48% to 132.24% (DC power flow) of its emergency rating (525MVA) for the tower line outage (CONAS_PB). This project contributes approximately 35.5MW to the thermal violation. It must be noted that the same thermal violation (DC power flow: 125.5%) already exists in the 2012 base case.

18. The OTTERCRK-CONASTON 230kV line loads from 198.99% to 207.06% (DC power flow) of its emergency rating (627MVA) for the tower line outage (CONAS_PB). This project contributes approximately 50.6MW to the thermal violation. It must be noted that the same thermal violation (DC power flow: 198.8%) already exists in the 2012 base case.

New System Reinforcements

(Upgrades required to mitigate reliability criteria violations, i.e. “Network Impacts”, initially caused by the addition of this project generation)

1. The Lenox – Tiffany 115kV line overload will be alleviated by a PJM operating procedure which will open the Tiffany-Goudey 115kV line to control thermal limits that occur on the Penelec/NY ISO tie lines.
2. BG&E Upgrade requirement to be provided for the Impact Study if required.
3. BG&E Upgrade requirement to be provided for the Impact Study if required.

Contribution to Previously Identified System Reinforcements

(Overloads initially caused by prior Queue positions with additional contribution to overloading by this project. This project may have a % allocation cost responsibility which will be calculated and reported for the Impact Study)

4. The Laurel L – Goudey 115kV line overload will be alleviated by a PJM operating procedure which will open the Tiffany-Goudey 115kV line to control thermal limits that occur on the Penelec/NY ISO tie lines.
5. The North Waverly – East Sayre 115kV line overload will be alleviated by a PJM operating procedure which will open this line pre-contingency if the contingency scenario mentioned (PN20) occurs.
6. The Northeast 230/115 kV transformer overload requires that the transformer be replaced with a 500MVA unit. The estimated cost to replace the transformer is **\$10.2M**.
7. The Lackawanna – Oxbow 230kV line: The Penelec portion of the upgrade involves the rebuild of 16.33 miles of transmission line as well as substation work at the Oxbow facility. The estimated cost of the Penelec upgrade is **\$19.771M** and it would take **4-5 years** to complete. PPL owns the Lackawanna substation. PPL is assuming that terminal upgrade work would be required at the Lackawanna substation. The estimated cost for the terminal upgrade is **\$500,000**.
8. The Oxbow – N. Meshopen 230kV line overload require the rebuild of approximately 10.16 miles of transmission line This overload also requires the replacement of a disconnect switch and replacement of substation conductor at Oxbow substation. North Meshoppen substation requires the upgrade/replacement of two (2) CT circuits, substation conductor, and a line/wave trap. The total cost of the upgrade is estimated to be **\$12.939M** and it would take **4-5 years** to complete the work.
9. The Brunner Island – Yorkana 230kV line: Meted owns 12.6 miles of the transmission line and the Yorkana substation. PPL owns .64 miles of the transmission line and the Brunner Island substation. The PPL portion of the line will be rebuilt with 1590 ACSR cable. The cost of the rebuilt and the terminal work at Brunner Island is **\$2M**.
10. To mitigate the 3 MILE I-TMI 500/230kV (METED) transformer would require the installation of a second 500/230kV transformer. The estimated cost to perform this work is **\$11.8M** and will take **20 months** to complete.
11. The Nottingham – Peach Bottom line reactor overload can be alleviated by replacing the line reactor. The upgrade will cost about **\$0.2M** and will take about **18 months** to complete.
12. The Nottingham – Peach Bottom 230kV line overload can be alleviated by tearing down and rebuilding the existing 230kV line. This will increase the line rating to 1243N/1410E MVA. This portion of the upgrade will cost **\$40M** and take **4 years** to complete. A second 230kV line will also need to be constructed on new right of way at a cost of **\$40M** and a time estimate of **10 years**. Finally, a new substation will need to be built at Peach Bottom at a cost of **\$10M** and an estimated **4 years** to complete.

13. The Peach Bottom – Graceton 230kV line (PECO and BGE portions) overload can be alleviated by replacing the existing 230kV line with a double circuit 230kV underground cable capable of handling about 1226MVA during emergency conditions. The upgrade will cost about **\$61M** and will take about **48 months** to complete.

14. The TMI – Jackson 230kV overload requires the replacement of 18.05 miles of 230kV line, as well as substation upgrades at both TMI and Jackson. The total estimated cost of this upgrade is **\$10.91M**.

15. The Manor – Graceton 230kV line: PPL owns 14.5 miles of the transmission line and the Manor substation. BGE owns 1.4 miles of the transmission line and the Graceton substation. The PPL portion of the line will be rebuilt with 1590 ACSR cable. The cost of the rebuilt and the terminal work at Manor is **\$36M**.

16. North Meshoppen - East Towanda 230 kV Line - This overload would require the reconductor of approximately 21.66 miles of 230 kV transmission line between North Meshoppen and East Towanda substations. The East Towanda substation would require the replacement of a line/wave trap, disconnect switch, and CT circuit. The North Meshoppen substation would require the upgrade or replacement of two CT circuits as well as the replacement of substation conductor. The estimated cost of this upgrade is **\$16,245,000**, and it would take **4-5 years** to complete.

17. Hosensak – North Boyertown 230kV Line – This overload would require the reconductoring of approximately 8 miles of 230kV transmission line with 1590 ACRS wire. The existing structures between Hosensak and North Boyertown are insufficient to support a large size wire, so they will also need to be upgraded. For the worst case scenario where all support structures need to be replaced, the estimated cost of the reinforcement is **\$11,760,000**. The upgrade will take approximately **3 years** to complete.

18. The Otter Creek - Conastone 230kV line: PPL owns 12 miles of the transmission line and the Otter Creek substation. BGE owns 4.7 miles of the transmission line and the Conastone substation. The PPL portion of the line will be reconducted with 795 ACSS cable. The cost of the reconductoring and the terminal work at Otter Creek is **\$6M**.

Short Circuit

The following circuit breakers were found to be overduty:

<u>Station</u>	<u>Breaker</u>	<u>Upgrade/Replacement cost</u>
Branchburg	32H	\$400,000
Branchburg	52H	\$400,000
Branchburg	72H	\$400,000
Alburtis	Branchburg E	\$1,000,000
Alburtis	Cap 1	\$1,000,000
Alburtis	Cap 2	\$1,000,000

Alburtis	Hosensack 3E	\$1,000,000
Alburtis	Westcostville East G	\$1,000,000