Generation Interconnection Feasibility Study Report

For

PJM Generation Interconnection Request Queue Position X1-078

Werner 230kV

November 2011

Preface

The intent of the feasibility study is to determine a plan, with ballpark cost and construction time estimates, to connect the subject generation to the PJM network at a location specified by the Interconnection Customer. The Interconnection Customer may request the interconnection of generation as a capacity resource or as an energy-only resource. As a requirement for interconnection, the Interconnection Customer may be responsible for the cost of constructing: (1) Direct Connections, which are new facilities and/or facilities upgrades needed to connect the generator to the PJM network, and (2) Network Upgrades, which are facility additions, or upgrades to existing facilities, that are needed to maintain the reliability of the PJM system.

In some instances a generator interconnection may not be responsible for 100% of the identified network upgrade cost because other transmission network uses, e.g. another generation interconnection, may also contribute to the need for the same network reinforcement. The possibility of sharing the reinforcement costs with other projects may be identified in the feasibility study, but the actual allocation will be deferred until the impact study is performed.

The Feasibility Study estimates do not include the feasibility, cost, or time required to obtain property rights and permits for construction of the required facilities. The project developer is responsible for the right of way, real estate, and construction permit issues. For properties currently owned by Transmission Owners, the costs may be included in the study.

General

The Interconnection Customer (IC), has requested 525 MW of Firm Withdrawal Rights for a proposed as AC/DC HVDC Plus converter station. The in-service date for this project is May 1, 2016. **This study does not imply a FirstEnergy commitment to this in-service date.**

Point of Interconnection

X1-078 will interconnect with the Jersey Central Power & Light transmission system at one of two options. Option 1 is to connect at the Werner 230kV substation (JCPL). Option 2 is connect at the Deans 500kV substation (PSEG).

Scope of Work – Werner Substation

As defined by the Interconnection Customer, the attachment of the X1-078 Project to the Jersey Central network will be made by a new 230 kV line connected to the Werner 230 kV substation. This line will extend to the X1-078 Project AC/DC converter substation that will be located on a nearby property. To accommodate this connection, the Werner 230 kV substation must be expanded to a ring bus configuration in compliance with the PJM and FE requirements. From the new bus position created, Jersey Central will extend a line to the first structure beyond the Werner 230 kV substation. This structure will be owned by the Interconnection Customer. The contractual point of interconnection will therefore be located at the Werner 230 kV substation fence line. From this point the Interconnection Customer will construct, own, operate and maintain the connection line to its AC/DC converter substation. A single line diagram is shown below in Figure 1.

Figure 1. Single Line Diagram

The total cost for the work at Werner substation is **$14,650,800**. This estimate does not include CIAC Tax Gross-up. This work includes:

- Attachment Facilities:
  - Construct the termination structure to support the 230kV attachment line from the X1-078 facility

- Direct Connection Facilities
  - Install one (1) 230kV circuit breaker to create a ring bus.
  - Construct a new control building

- Non-Direct Connection Facilities
  - Construct two (2) termination structures to support the converted 115kV transmission lines
  - Install three (3) additional 230kV circuit breakers to expand the ring bus to support the converted 115kV transmission lines
  - Remove all existing 115kV facilities
  - Remove the existing 230-115kV transformer and move to Raritan River substation.
  - Remove the existing 115-34.5kV transformer
  - Install a new 230-34.5kV transformer between the new ring bus and existing 34.5kV facilities
  - Create a new position on the 34.5kV bus to support the new 230-34.5kV transformer

PJM will provide a breakout of the Attachment Facilities, Direct Connection Facilities, and Non-Direct Connection Facilities for the work at Werner during the System Impact Study phase.

For information, note that Jersey Central does not own any property at the Werner substation site. Based on the agreements that were executed when divesting of its generation assets, Jersey Central instead has a permanent easement for all of its existing Werner substation facilities. Therefore it will be a responsibility of the Interconnection Customer to provide all easements and/or properties that will be needed by Jersey Central to expand the Werner substation beyond its existing footprint. The Interconnection Customer will also be responsible for acquiring the properties and permits needed for the facilities on its side of the point of interconnection from the Werner substation.

Revenue Metering and SCADA Requirements

PJM Requirements

The Interconnection Customer will be required to install equipment necessary to provide Revenue Metering (KWH, KVARH) and real time data (KW, KVAR) for IC's generating Resource. See PJM Manuals M-01 and M-14D, and PJM Tariff Sections 24.1 and 24.2.

FirstEnergy Requirements

The Interconnection Customer will be required to comply with all FE Revenue Metering Requirements for Generation Interconnection Customers. The FirstEnergy Revenue Metering Requirements may be found in the FirstEnergy Requirements for Transmission Connected Facilities document located at the following link:

www.firstenergycorp.com/feconnect
http://www.pjm.com/planning/design-engineering/to-tech-standards.aspx

Network Impacts

Queue project X1-078 was studied as a(n) 525.0 MW Firm withdrawal at PSEG's system. Project X1-078 was evaluated for compliance with reliability criteria for summer peak conditions in 2015.

Potential transmission network impacts are as follows:

Option1: Werner 230kV:

Generator Deliverability

(Single or N-1 contingencies for the Capacity portion only of the interconnection)

1. (JCPL) The Werner-Werner 115/230 kV transformer (from bus 206324 to bus 206313 ckt 1) loads from 67.90% to 113.54% (DC power flow) of its emergency rating (289 MVA)

for the single contingency 'B_CNJ2-SX-#35'. This project contributes approximately 524.36 MW to the thermal violation.

2. (PSEG) The Middlesex Sw. Rack-Lake Nelson I 230 kV line (from bus 218301 to bus 218333 ckt 1) loads from 78.62% to 101.5% (DC power flow) of its emergency rating (831 MVA) for the single contingency 'PS56D'. This project contributes approximately 280.18 MW to the thermal violation.

3. (JCPL) The Red Oak B Bus-Raritan River 230 kV line (from bus 206315 to bus 206305 ckt 1) loads from 95.42% to 104.51% (DC power flow) of its normal rating (869 MVA) for non contingency condition. This project contributes approximately 79.00 MW to the thermal violation.

4. (JCPL) The Raritan River-Werner 115 kV line (from bus 206303 to bus 206324 ckt 1) loads from 51.09% to 172.18% (DC power flow) of its emergency rating (207 MVA) for the single contingency 'B_CNJ2-SX-#35'. This project contributes approximately 462.15 MW to the thermal violation.

Multiple Facility Contingency

(Double Circuit Tower Line contingencies only with full energy output. Stuck Breaker and Bus Fault contingencies will be applied during the Impact Study)

No violations identified.

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.)

5. (JCPL) The Van-Larrabee 230 kV line (from bus 206318 to bus 206294 ckt 1) loads from 104.30% to 105.42% (DC power flow) of its emergency rating (805 MVA) for the tower contingency 'C5_CNJ-DCT-#12'. This project contributes approximately 9.01 MW to the thermal violation.

6. (JCPL) The R11OP2-Red Oak B Bus 230 kV line (from bus 295950 to bus 206315 ckt 1) loads from 104.96% to 121.31% (DC power flow) of its emergency rating (805 MVA) for the single contingency 'B_CNJ2-SX-#37'. This project contributes approximately 131.64 MW to the thermal violation.

7. (BG&E/PL) The Conastone-Otter Creek Switchyard 230 kV line (from bus 220963 to bus 208048 ckt 1) loads from 126.41% to 133.29% (DC power flow) of its emergency rating (531 MVA) for the single contingency 'PJM17'. This project contributes approximately 38.67 MW to the thermal violation.

8. (PJM) The Conastone-Peach Bottom 500 kV line (from bus 200004 to bus 200013 ckt 1) loads from 118.04% to 126.89% (DC power flow) of its emergency rating (2815 MVA) for the single contingency 'PJM76'. This project contributes approximately 171.00 MW to the thermal violation.

9. (PJM) The Peach Bottom-Limerick 500 kV line (from bus 200013 to bus 200024 ckt 1) loads from 108.94% to 112.88% (DC power flow) of its emergency rating (2598 MVA) for the single contingency 'PJM27'. This project contributes approximately 102.17 MW to the thermal violation.

10. (PSEG) The Cox'S Corner-Lumberton 230 kV line (from bus 219107 to bus 219112 ckt 1) loads from 101.64% to 106.84% (DC power flow) of its emergency rating (815 MVA) for the single contingency 'PJM89_A'. This project contributes approximately 42.31 MW to the thermal violation.

11. (PECO) The Cooper-Peach Bottom 230 kV line (from bus 214089 to bus 213869 ckt 1) loads from 119.25% to 127.79% (DC power flow) of its emergency rating (485 MVA) for the single contingency 'PJM17'. This project contributes approximately 41.42 MW to the thermal violation.

12. (JCPL) The Red Oak B Bus-Raritan River 230 kV line (from bus 206315 to bus 206305 ckt 1) loads from 118.37% to 130.81% (DC power flow) of its emergency rating (1068 MVA) for the single contingency 'B_CNJ2-SX-#37'. This project contributes approximately 132.89 MW to the thermal violation.

13. (AP/PJM) The Kemptown-EMORY GR500 500 kV line (from bus 235632 to bus 200101 ckt 1) loads from 115.57% to 120.34% (DC power flow) of its emergency rating (2901 MVA) for the single contingency 'PJM67'. This project contributes approximately 129.83 MW to the thermal violation.

14. (AP/PJM) The Kemptown-EMORY GR500 500 kV line (from bus 235632 to bus 200101 ckt 1) loads from 126.59% to 131.91% (DC power flow) of its normal rating (2338 MVA) for non contingency condition. This project contributes approximately 124.35 MW to the thermal violation.

15. (BG&E/PECO) The Graceton-Cooper 230 kV line (from bus 220964 to bus 214089 ckt 1) loads from 121.74% to 130.28% (DC power flow) of its emergency rating (485 MVA) for the single contingency 'PJM17'. This project contributes approximately 41.42 MW to the thermal violation.

Short Circuit

(Summary of impacted circuit breakers)

No violations identified.

Steady-State Voltage Requirements

(Summary of the VAR requirements based upon the results of the steady-state voltage studies)

No violations identified.

Stability and Reactive Power Requirement for Low Voltage Ride Through

(Summary of the VAR requirements based upon the results of the dynamic studies)

No violations identified.

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 overload on Werner-Werner 115/230 kV transformer, FirstEnergy has proposed to construct a new 230kV line between Werner and Freneau using 1590 Kcmil 54/19 ACSR. This new line will use an existing 34.5kV line path. The existing 34.5kV facilities will be moved as needed to accommodate the new line. The Freneau substation will be expanded to create a three breaker, 230kV ring bus. The protective relays at Freneau, Atlantic, Parlin will be upgraded to support the new ring bus. The upgrade is estimated to cost **$62,791,900**.

2. To mitigate the overload on Middlesex Sw. Rack-Lake Nelson I 230 kV line, FirstEnergy has proposed to replace 0.7 miles of 1590 Kcmil ACSR with 1590 Kcmil 54/19 ACSS/AW on the 230kV line I1023 (between Middlesex Tap and Lake Nelson). The upgrade is estimated to cost **$873,500**. In addition, the upgrade identified in "Red Oak A Bus-Raritan River 230 kV line" will further mitigate the overload on the Middlesex Sw. Rack-Lake Nelson I 230 kV line.

3,12. To mitigate the overload on the Red Oak B Bus-Raritan River 230 kV line, FirstEnergy has proposed to replace 2.58 miles of 1590Kcmil 45/7ACSR with 1590 Kcmil 54/19 ACSR/AW bundled conductor on the 230kV line G1047 (between Raritan River and Red Oak B). The upgrade is estimated to cost **$10,057,100**. This overload has been caused by a prior project. Cost allocations for this upgrade will be determined during the System Impact Study phase.

4. To mitigate the overload on Raritan River-Werner 115 kV line, FirstEnergy has proposed to convert the existing 115kV line between Werner and Raritan River to 230kV. In addition, FirstEnergy will also install a 230-115kV transformer to support the remaining 115kV facilities at Raritan River. The new line will use 1590 Kcmil 54/19 ACSR. The Raritan River substation will be expanded to support the new 230kV line and a 230-115kV transformer will be moved from Werner to Raritan River to supply the existing 115kV facilities. The upgrade is estimated to cost **$17,071,000**.

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.)

5. To mitigate the overload on the Van-Larrabee 230 kV line, FirstEnergy has proposed to replace 7.6 miles of 1590 Kcmil 45/7 ACSR with 1590 KCmil 54/19 ACSR on the

230kV line B1042-1 (between Van Hiseville and Larabee), replace a 2000 amp line trap with a 3000 amp line trap, and replace a bus connection with bundled 1590 Kcmil 54/19 ACSR.. The upgrade is estimated to cost **$2,996,500**. This overload has been caused by a prior project. Cost allocations for this upgrade will be determined during the System Impact Study phase.

6. To mitigate the overload on the R11OP2-Red Oak B Bus 230 kV line, FirstEnergy has proposed to _replace 1.1 miles of 1590 Kcmil 45/7 ACSR with 1590 Kcmil 54/19 ACSS/AW on the 230kV line G1047 (between South River Junction and Red Oak B). The upgrade is estimated to cost **$947,000**. This overload has been caused by a prior project. Cost allocations for this upgrade will be determined during the System Impact Study phase.

7. To mitigate the overload on the Conastone-Otter Creek Switchyard 230 kV line, BG&E and PPL have proposed the following:

   PPL: A project to re-conductor Manor-Conastone with 1590 ACSR is underway. This project will equip the line to handle 653/793 MVA (Summer Normal/Emergency). The total estimated cost for this project is **$17,000,000** and will be completed by October 2013.

   BG&E: The BG&E portion of the Conastone to Otter Creek line can be upgraded by reconducting from Gorsuch Mills to the Pennsylvania State Line (change of ownership to PPL). The existing circuit 2302 conductor is 1,590 kcmil 45/7 ACSR from Conastone to Gorsuch Mills and 795 kcm 30/19 ACSR from Gorsuch Mills to the PA State Line.

   Assumptions:

   - Reconductor with 1,590 kcm ACSR from Gorsuch Mills to PA line to match capability of remainder of line.
   - Length of this line section is 1.7 miles.
   - Towers can be reinforced instead of replaced.
   - Based on previous estimate by R.W.M. for PJM (B48) study on circuit 22008

   The estimated cost of this upgrade is **$700,000**. Estimated construction time is 36 months.

   This overload has been caused by a prior project. Cost allocations for this upgrade will be determined during the System Impact Study phase.

8. To mitigate the overload on Conastone-Peach Bottom 500 kV line, PJM has proposed to construct a new 500kV line between Conastone and Peach Bottom with a rating of 2939 (normal) and 3733 (emergency). The upgrade is estimated to cost **$56,700,000** and will take 7 years to complete. This overload has been caused by a prior project. Cost allocations for this upgrade will be determined during the System Impact Study phase.

11. To mitigate the overload on Cooper-Peach Bottom 230 kV line, PECO has proposed to reconductor line 220-08 from PB Tap to Cooper Substation to get a minimum summer

emergency rating of 741 MVA. The line is approximately 1.4 miles long. The estimated cost to perform this work is **$1,000,000**, and will require 24 months to complete. This overload has been caused by a prior project. Cost allocations for this upgrade will be determined during the System Impact Study phase.

13,14. The two breaker bay at Conastone for the Brighton line is over the continuous rating. Upgrade Conastone bay with two 4000A breakers, four 4000A breaker disconnects and a 4000 A line switch need to be either. **$3,000,000** take 24-36 months to complete. New rating 3710. This overload has been caused by a prior project. Cost allocations for this upgrade will be determined during the System Impact Study phase.

15. To mitigate the overload on Graceton-Cooper 230 kV line, PECO and BG&E have proposed the following:

PECO: Reconductor Line 220-93 from Cooper Substation to Graceton Substation to get a minimum summer emergency rating of 725 MVA. The line is approximately 4 miles long. This cost is for the PECO portion only. The estimated cost to perform this wrk is **$2,800,000**, and will require 24 months to complete.
BGE: A double circuit line will be built with 1033.5kcmil ACSR creating one circuit by connecting the two lines into one. Rating for 2 – 1033.5kcmil 45/7 ACSR (Ortolan) at 125°C = 968/1227MVA SN/SE. BGE ownership is for 1.85 miles and the rebuild of 11 structures. It would be built as a double circuit line with the conductors jumpered across at the terminal ends. The line construction is estimated at $3,000,000. Two breakers ($400,000/breaker) would need to be replaced at Graceton for a cost of $800,000. An additional cost of $200,000 would also be incurred for 4 breaker disconnects and line connections to cover thermal. The project is estimated to take 30 months to complete: 12 months for the CPCN process & design and an additional 18 months for construction. The total cost of the project is estimated at **$4,000,000**.

This overload has been caused by a prior project. Cost allocations for this upgrade will be determined during the System Impact Study phase.

Energy Portion of Interconnection Request

PJM also studied the delivery of the energy portion of the surrounding generation. Any potential problems identified below are likely to result in operational restrictions to the project under study. The developer can proceed with network upgrades to eliminate the operational restriction at their discretion by submitting a Transmission Interconnection request.

Note: Only the most severely overloaded conditions are listed. There is no guarantee of full delivery of energy for this project by fixing only the conditions listed in this section. With a Transmission Interconnection Request, a subsequent analysis will be performed which analyzes all overload conditions associated with the overloaded element(s) identified. As a result of the aggregate energy resources in the area, the following violations were identified.

No violations identified.

OPTION2: Deans 500kV:

Generator Deliverability

(Single or N-1 contingencies for the Capacity portion only of the interconnection)

No violations identified.

Multiple Facility Contingency

(Double Circuit Tower Line contingencies only with full energy output. Stuck Breaker and Bus Fault contingencies will be applied during the Impact Study)

No violations identified.

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.)

1. (PJM) The Rock Springs-Keeney 500 kV line (from bus 200051 to bus 200010 ckt 1) loads from 100.35% to 103.96% (DC power flow) of its emergency rating (3014 MVA) for the single contingency 'PJM40'. This project contributes approximately 109.08 MW to the thermal violation.

2. (PECO) The Cooper-Peach Bottom 230 kV line (from bus 214089 to bus 213869 ckt 1) loads from 119.36% to 128.03% (DC power flow) of its emergency rating (485 MVA) for the single contingency 'PJM17'. This project contributes approximately 42.06 MW to the thermal violation.

3. (BG&E/PL) The Conastone-Otter Creek Switchyard 230 kV line (from bus 220963 to bus 208048 ckt 1) loads from 124.32% to 131.21% (DC power flow) of its emergency rating (531 MVA) for the single contingency 'PJM17'. This project contributes approximately 38.73 MW to the thermal violation.

4. (PJM) The Conastone-Peach Bottom 500 kV line (from bus 200004 to bus 200013 ckt 1) loads from 123.32% to 133.05% (DC power flow) of its emergency rating (2815 MVA) for the single contingency 'PJM77'. This project contributes approximately 174.60 MW to the thermal violation.

5. (PJM) The Peach Bottom-Limerick 500 kV line (from bus 200013 to bus 200024 ckt 1) loads from 113.14% to 117.05% (DC power flow) of its emergency rating (2598 MVA) for the single contingency 'PJM27'. This project contributes approximately 104.16 MW to the thermal violation.

6. (AP/PJM) The Kemptown-EMORY GR500 500 kV line (from bus 235632 to bus 200101 ckt 1) loads from 120.42% to 124.95% (DC power flow) of its emergency rating (2901 MVA) for the single contingency 'PJM67'. This project contributes approximately 131.57 MW to the thermal violation.

7. (AP/PJM) The Kemptown-EMORY GR500 500 kV line (from bus 235632 to bus 200101 ckt 1) loads from 126.41% to 131.79% (DC power flow) of its normal rating (2338 MVA) for non contingency condition. This project contributes approximately 125.90 MW to the thermal violation.

8. (BG&E/PECO) The Graceton-Cooper 230 kV line (from bus 220964 to bus 214089 ckt 1) loads from 121.86% to 130.53% (DC power flow) of its emergency rating (485 MVA) for the single contingency 'PJM17'. This project contributes approximately 42.06 MW to the thermal violation.

Short Circuit

(Report over-dutied breakers.)

None required.

New System Reinforcements

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

None 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.)

None required.

Steady-State Voltage Requirements

(Summary of the VAR requirements based upon the results of the steady-state voltage studies)

No violations identified.

Stability and Reactive Power Requirement for Low Voltage Ride Through

(Summary of the VAR requirements based upon the results of the dynamic studies)

No violations identified.

Energy Portion of Interconnection Request

PJM also studied the delivery of the energy portion of the surrounding generation. Any potential problems identified below are likely to result in operational restrictions to the project under study. The developer can proceed with network upgrades to eliminate the operational restriction at their discretion by submitting a Transmission Interconnection request.

Note: Only the most severely overloaded conditions are listed. There is no guarantee of full delivery of energy for this project by fixing only the conditions listed in this section. With a Transmission Interconnection Request, a subsequent analysis will be performed which analyzes all overload conditions associated with the overloaded element(s) identified. As a result of the aggregate energy resources in the area, the following violations were identified.

No violations identified.