Generation Interconnection
Feasibility Study Report
Queue Position AB2-179

The Interconnection Customer (IC) has proposed a 50 MW (37.6 MW Capacity) solar generating facility to be located in New Castle County, Delaware. PJM studied the AB2-179 project at both a Primary and Secondary Point of Interconnection. The study results are provided below. The planned in-service date, as requested by the IC during the project kick-off call, is October 31, 2017. This date is not attainable due to additional required studies and construction schedules.

Point(s) of Interconnection

The Interconnection Customer requested a Primary and Secondary Point of Interconnection (POI) be evaluated for the AB2-179 project.

Primary Point of Interconnection

PJM studied the AB2-179 project as an injection into the Delmarva Power and Light (DPL) system at the Townsend 138 kV Substation and evaluated it for compliance with reliability criteria for summer peak conditions in 2020. The AB2-179 project will connect with the DPL transmission system at the Townsend Substation.

Transmission Owner Scope of Attachment Facilities Work

Substation Interconnection Estimate

Scope: Build a new 7th position onto the 138 kV 6 position ring bus at Townsend Substation (the future arrangement of Townsend substation will have 6 positions after future construction projects). The new position will be connected to a generator. The project will require the addition of a 138 kV breaker, 3 138 kV disconnect switches, 3 CT/VT combination units, and substation bus.

Estimate: $953,000
Construction Time: 24 months

Major Equipment Included in Estimate:

- Power Circuit Breaker, 138 kV, 2000A, 40kA, 3 cycle Qty. 1
- Disconnect Switch, 138 kV, 2000A, Manual Wormgear, Arcing Horns Qty. 3
- CT/VT Combination Units, 138 kV Qty. 3
- Disconnect Switch Stand, High, 138 kV, Steel Qty. 1
- Disconnect Switch Stand, Low, 138 kV, Steel Qty. 2
- CT/VT Stand, Single Phase, Low, 138 kV, Steel Qty. 3
- Relay Panel, Transmission Line, FL/BU (20”) Qty. 1
- Control Panel, 138 kV Circuit Breaker (10”) Qty. 1
- Bus Support Structure, 3 phase, 138 kV, Steel Qty. 3

Estimate Assumptions:

- Expansion of existing substation to be performed during previous projects.
- Control house is adequate for expansion.

Required Relaying and Communications

New protection relays are required for the new terminal. An SEL-487 will be required for primary protection and an SEL-387 will be required for back-up protection. One 20" relay panel for each line terminal will be required for front line and back-up protection.

An SEL-451 relay on a 20" breaker control panel will be required for the control and operation of each new 138 kV circuit breaker.

The project will require re-wiring and adjustment of existing relay schemes to accommodate the new 138 kV terminal.

The cost of the required relay and communications is included in the Substation Interconnection Estimate.

Metering

Three phase 138 kV revenue metering points will need to be established. DPL will purchase and install all metering instrument transformers as well as construct a metering structure. The secondary wiring connections at the instrument transformers will be completed by DPL's metering technicians. The metering control cable and meter cabinets will be supplied and installed by DPL. DPL will install conduit for the control cable between the instrument transformers and the metering enclosure. The location of the metering enclosure will be determined in the construction phase. DPL will provide both the Primary and the Backup meters. DPL's meter technicians will program and install the Primary & Backup solid state multi-function meters for each new metering position. Each meter will be equipped with load profile, telemetry, and DNP outputs. The IC will be provided with one meter DNP output for each meter. DPL will own the metering equipment for the interconnection point, unless the IC asserts its right to install, own, and operate the metering system.

The Interconnection Customer will be required to make provisions for a voice quality phone line within approximately 3 feet of each Company metering position to facilitate remote interrogation and data collection.

It is the IC's responsibility to send the data that PJM and DPL requires directly to PJM. The IC will grant permission for PJM to send DPL the following telemetry that the IC sends to PJM: real time MW, MVAR, volts, amperes, generator status, and interval MWH and MVARH.
The estimate for DPL to design, purchase, and install metering as specified in the aforementioned scope for metering is included in the Substation Interconnection Estimate.

Interconnection Customer Scope of Direct Connection Work

The Interconnection Customer is responsible for all design and construction related to activities on their side of the Point of Interconnection. Site preparation, including grading and an access road, as necessary, is assumed to be by the IC. Route selection, line design, and right-of-way acquisition of the direct connect facilities is not included in this report, and is the responsibility of the IC. The IC is

also required to provide revenue metering and real-time telemetering data to PJM in conformance with the requirements contained in PJM Manuals M-01 and M-14 and the PJM Tariff.

DPL Interconnection Customer Scope of Direct Connection Work Requirements

- DPL requires that an IC circuit breaker is located within 500 feet of Townsend substation to facilitate the relay protection scheme between DPL and the IC at the Point of Interconnection (POI).

Special Operating Requirements

1. DPL will require the capability to remotely disconnect the generator from the grid by communication from its System Operations facility. Such disconnection may be facilitated by a generator breaker, or other method depending upon the specific circumstances and the evaluation by DPL.

2. DPL reserves the right to charge the Interconnection Customer operation and maintenance expenses to maintain the Interconnection Customer attachment facilities, including metering and telecommunications facilities, owned by DPL.

Summer Peak Analysis - 2020

Transmission Network Impacts

Potential transmission network impacts are as follows:

Generator Deliverability

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

None

Multiple Facility Contingency

(Double Circuit Tower Line, Fault with a Stuck Breaker, and Bus Fault contingencies for the full energy output)

1. (DP&L - DP&L) The TOWNSEND-MIDLTNTP 138 kV line (from bus 232107 to bus 232106 ckt 1) loads from 87.46% to 97.5% (DC power flow) of its emergency rating (348 MVA) for the tower line contingency outage of 'DBL_4NC'. This project contributes approximately 34.96 MW to the thermal violation.

   CONTINGENCY 'DBL_4NC'/* RED LION-CEDAR CREEK 230;RED LION-CARTANZA 230
   OPEN LINE FROM BUS 231004 TO BUS 232002 CKT 1
   OPEN LINE FROM BUS 231004 TO BUS 232003 CKT 1
   END

Please refer to Appendix 1 for a table containing the generators having contribution to this flowgate.

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. (DP&L - DP&L) The AB2-135 TAP-NMEREDTH 69 kV line (from bus 924820 to bus 232812 ckt 1) loads from 104.33% to 109.71% (DC power flow) of its emergency rating (93 MVA) for the line fault with failed breaker contingency outage of 'DP65_A'. This project contributes approximately 5.0 MW to the thermal violation.

   CONTINGENCY 'DP65_A'/*CHURCH BUS BREAKER /* ADDED DEC_ 22 2009
   DISCONNECT BRANCH FROM BUS 232100 TO BUS 923320 CKT 1/*CHURCH AB1-141 TAP 138
   DISCONNECT BRANCH FROM BUS 232801 TO BUS 923950 CKT 1/*CHURCH AB2-036 TAP 138 138
   END

   Please refer to Appendix 3 for a table containing the generators having contribution to this flowgate.

Summer Peak Load Flow Analysis Reinforcements

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 (DP&L) TOWNSEND-MIDLTNTP 138 kV line (from bus 232107 to bus 232106 ckt 1) overload will require reinforcements to increase the emergency rating of the Townsend to Middletown Tap 138 kV line. Those reinforcements include rebuilding a small section of the circuit and installing new poles and the re-mounting of 138 kV disconnect switches. The estimated cost to perform this work is **$800,000** and will take **18 months** to complete.

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)

1. To mitigate the (DP&L) AB2-135 TAP-NMEREDTH 69 kV line (from bus 924820 to bus 232812 ckt 1) overload will require reinforcements to increase the emergency rating of the AB2-135 to New Meredith 69 kV line. Those reinforcements include rebuilding the circuit including the installation of new poles and a new disconnect switch. The estimated cost to perform this work is **$8,674,000** and will take **3 years** to complete.

Steady-State Voltage Requirements

To be performed during later study phases as required.

Short Circuit

No issues identified.

Stability and Reactive Power Requirement

To be performed during later study phases.

Light Load Analysis - 2020

Light Load Studies to be conducted during later study phases (as required by PJM Manual 14B).

Delivery of Energy Portion of Interconnection Request

PJM also studied the delivery of the energy portion of this interconnection request. Any 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 Merchant Transmission Interconnection request.
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 will study all overload conditions associated with the overloaded element(s) identified.

1. (DP&L - DP&L) The OIL_CITY-STEEL138 138 kV line (from bus 232801 to bus 232103 ckt 1) loads from 114.14% to 128.69% (DC power flow) of its emergency rating (159 MVA) for the single line contingency outage of 'CKT 13808'. This project contributes approximately 23.14 MW to the thermal violation.

   CONTINGENCY 'CKT 13808'
   DISCONNECT BUS 232106/MOUNT PLEASANT - MIDDLETOWN - TOWNSEND 138
   DISCONNECT BUS 232804/MIDDLETOWN 138
   END

   The overload will likely be mitigated following PJM Supplemental Project s0821

2. (DP&L - DP&L) The AB2-036 TAP-OIL_CITY 138 kV line (from bus 923950 to bus 232801 ckt 1) loads from 116.03% to 130.58% (DC power flow) of its emergency rating (159 MVA) for the single line contingency outage of 'CKT 13808'. This project contributes approximately 23.14 MW to the thermal violation.

   CONTINGENCY 'CKT 13808'
   DISCONNECT BUS 232106/MOUNT PLEASANT - MIDDLETOWN - TOWNSEND 138
   DISCONNECT BUS 232804/MIDDLETOWN 138

END

Delmarva Power and Light Costs
Cost estimates will further be refined as a part of the Impact Study and Facilities Study for this project. The Interconnection Customer will be responsible for all costs incurred by DPL in connection with the AB2-179 project. Such costs may include, but are not limited to, any transmission system assets currently in DPL's rate base that are prematurely retired due to the AB2-179 project. PJM shall work with DPL to identify these retirement costs and any additional expenses. DPL reserves the right to reassess issues presented in this document and, upon appropriate justification, submit additional costs related to the AB2-179 project.

Secondary Point of Interconnection

PJM studied the AB2-179 project into the Delmarva Power and Light (DLP) system as a tap of the Keeney-Steele #2 138 kV circuit and evaluated it for compliance with reliability criteria for summer peak conditions in 2020.

Summer Peak Analysis - 2020

Transmission Network Impacts

Potential transmission network impacts are as follows:

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

None

Multiple Facility Contingency
(Double Circuit Tower Line, Fault with a Stuck Breaker, and Bus Fault contingencies for the full energy output)

None

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)

None

Delivery of Energy Portion of Interconnection Request
PJM also studied the delivery of the energy portion of this interconnection request. Any 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 Merchant Transmission Interconnection request.
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 will study all overload conditions associated with the overloaded element(s) identified.

None

Appendices
(Primary Point of Interconnection)

The following appendices contain additional information about each flowgate presented in the body of the report. For each appendix, a description of the flowgate and its contingency was included for convenience. However, the intent of the appendix section is to provide more information on which projects/generators have contributions to the flowgate in question. Although this information is not used "as is" for cost allocation purposes, it can be used to gage other generators impact.
It should be noted the generator contributions presented in the appendices sections are full contributions, whereas in the body of the report, those contributions take into consideration the commercial probability of each project.

Appendix 1

(DP&L - DP&L) The TOWNSEND-MIDLTNTP 138 kV line (from bus 232107 to bus 232106 ckt 1) loads from 87.46% to 97.5% (DC power flow) of its emergency rating (348 MVA) for the tower line contingency outage of 'DBL_4NC'. This project contributes approximately 34.96 MW to the thermal violation.

```
CONTINGENCY 'DBL_4NC'                                   /* RED LION-CEDAR CREEK
230;RED LION-CARTANZA 230
  OPEN LINE FROM BUS 231004 TO BUS 232002 CKT 1
  OPEN LINE FROM BUS 231004 TO BUS 232003 CKT 1
  END
```

Bus Number	*Bus Name*	*Full Contribution*
232900	*DEMECSMY*	*2.15*
232851	*DUP-SFR1*	*0.41*
232902	*EASTMUNI*	*3.4*
232923	*MR1*	*3.36*
232924	*MR2*	*3.36*
232910	*NRG_G1*	*2.43*
232911	*NRG_G2*	*2.43*
292089	*T-011*	*0.17*
297076	*V2-028 C*	*0.09*
297077	*V2-028 E*	*0.75*
904212	*V4-022E*	*0.61*
232813	*VAUGHN*	*0.15*

232919	*VN10*	*0.57*
901004	*W1-003 E*	*0.89*
901014	*W1-004 E*	*0.89*
901024	*W1-005 E*	*0.89*
901034	*W1-006 E*	*0.89*
901411	*W1-062*	*2.28*
907052	*X1-032 E*	*0.79*
907324	*X1-096 E*	*18.27*
910571	*X3-008 C*	*0.32*
910572	*X3-008 E*	*2.68*
910591	*X3-015 C*	*0.3*
910592	*X3-015 E*	*2.51*
910821	*X3-066 C*	*0.17*
910822	*X3-066 E*	*1.41*
913361	*Y1-079 C*	*0.24*
913362	*Y1-079 E*	*1.96*
913411	*Y1-080 C*	*0.05*
913412	*Y1-080 E*	*0.43*
915751	*Y3-033*	*1.46*
915752	*Y3-033*	*9.76*
920543	*Y3-054 E*	*2.48*
915541	*Y3-058 C*	*0.22*
915542	*Y3-058 E*	*1.86*
920582	*Z1-076 C*	*1.05*
920583	*Z1-076 E*	*1.71*
920592	*Z1-077 C*	*0.75*
920593	*Z1-077 E*	*1.22*
916281	*Z1-081 C*	*0.2*
916282	*Z1-081 E*	*1.65*
917082	*Z2-012 E*	*2.44*
920763	*Z2-076 E*	*0.4*
920773	*Z2-077 E*	*0.4*
920812	*Z2-097 C*	*1.57*
920813	*Z2-097 E*	*0.65*
921122	*AA1-059 C*	*0.84*
921123	*AA1-059 E*	*0.33*
921142	*AA1-061 C*	*2.87*
921143	*AA1-061 E*	*1.41*
921442	*AA1-110 C*	*1.78*
921443	*AA1-110 E*	*0.89*
921592	*AA1-140 C*	*1.51*
921593	*AA1-140 E*	*2.47*
921602	*AA1-141 C*	*1.13*
921603	*AA1-141 E*	*1.84*
921872	*AA2-069*	*104.81*

922213	*AA2-129 E*	*3.94*
922222	*AA2-130*	*0.39*
922752	*AB1-056 C OP*	*12.79*
922753	*AB1-056 E OP*	*36.43*
922762	*AB1-057 C*	*12.99*
922763	*AB1-057 E*	*37.03*
923282	*AB1-137 C*	*2.79*
923283	*AB1-137 E*	*1.2*
923322	*AB1-141 C OP*	*5.3*
923323	*AB1-141 E OP*	*2.47*
923332	*AB1-142 C OP*	*5.3*
923333	*AB1-142 E OP*	*2.47*
923452	*AB1-162 C OP*	*2.4*
923453	*AB1-162 E OP*	*3.92*
923602	*AB1-176 C*	*1.29*
923603	*AB1-176 E*	*2.12*
923902	*AB2-030 E*	*0.79*
923921	*AB2-032 C*	*5.34*
923922	*AB2-032 E*	*2.51*
923931	*AB2-033 C*	*1.41*
923932	*AB2-033 E*	*0.56*
923951	*AB2-036 C*	*13.81*
923952	*AB2-036 E*	*22.54*
923961	*AB2-037 C*	*14.99*
923962	*AB2-037 E*	*24.45*
924191	*AB2-063 C*	*2.87*
924192	*AB2-063 E*	*4.69*
924361	*AB2-084 C*	*0.75*
924362	*AB2-084 E*	*1.22*
924461	*AB2-095 C*	*2.27*
924462	*AB2-095 E*	*3.7*
924681	*AB2-120 C OP*	*7.49*
924682	*AB2-120 E OP*	*12.21*
924781	*AB2-130 C OP*	*7.73*
924782	*AB2-130 E OP*	*12.62*
924801	*AB2-133 C OP*	*14.2*
924802	*AB2-133 E OP*	*19.08*
924821	*AB2-135 C*	*12.06*
924822	*AB2-135 E*	*18.18*
924831	*AB2-136 C OP*	*5.19*
924832	*AB2-136 E OP*	*7.37*
924881	*AB2-142 C*	*1.14*
924882	*AB2-142 E*	*1.85*
924891	*AB2-143 C OP*	*3.37*
924892	*AB2-143 E OP*	*5.5*

924971	*AB2-153 C*	*2.98*
924972	*AB2-153 E*	*4.87*
925071	*AB2-164 C OP*	*1.5*
925072	*AB2-164 E OP*	*2.44*
925081	*AB2-165 C OP*	*1.5*
925082	*AB2-165 E OP*	*2.44*
925091	*AB2-166 C*	*0.4*
925092	*AB2-166 E*	*0.7*
925101	*AB2-167 C*	*1.05*
925102	*AB2-167 E*	*1.72*
925151	*AB2-172 C OP*	*4.11*
925152	*AB2-172 E OP*	*6.7*
925231	*AB2-177 C*	*0.49*
925232	*AB2-177 E*	*0.81*
925251	*AB2-179 C OP*	*26.29*
925252	*AB2-179 E OP*	*8.67*
925261	*AB2-180 C*	*2.8*
925262	*AB2-180 E*	*1.2*
925271	*AB2-185 C OP*	*4.42*
925272	*AB2-185 E OP*	*1.89*
925311	*AB2-192 C OP*	*1.5*
925312	*AB2-192 E OP*	*2.44*

Appendix 3

(DP&L - DP&L) The AB2-135 TAP-NMEREDTH 69 kV line (from bus 924820 to bus 232812 ckt 1) loads from 104.33% to 109.71% (DC power flow) of its emergency rating (93 MVA) for the line fault with failed breaker contingency outage of 'DP65_A'. This project contributes approximately 5.0 MW to the thermal violation.

```
CONTINGENCY 'DP65_A'                                    /*CHURCH BUS BREAKER /* ADDED
DEC_ 22 2009
  DISCONNECT BRANCH FROM BUS 232100 TO BUS 923320 CKT 1          /*CHURCH AB1-
141 TAP 138
  DISCONNECT BRANCH FROM BUS 232801 TO BUS 923950 CKT 1          /*CHURCH AB2-
036 TAP 138 138
  END
```

Bus Number	*Bus Name*	*Full Contribution*
910821	*X3-066 C*	*0.05*
910822	*X3-066 E*	*0.44*
915751	*Y3-033*	*0.71*
915752	*Y3-033*	*4.78*
916281	*Z1-081 C*	*0.1*

916282	*Z1-081 E*	*0.81*
920812	*Z2-097 C*	*0.77*
920813	*Z2-097 E*	*0.32*
921442	*AA1-110 C*	*0.87*
921443	*AA1-110 E*	*0.43*
923452	*AB1-162 C OP*	*0.74*
923453	*AB1-162 E OP*	*1.21*
923602	*AB1-176 C*	*0.4*
923603	*AB1-176 E*	*0.66*
923951	*AB2-036 C*	*8.08*
923952	*AB2-036 E*	*13.18*
924191	*AB2-063 C*	*0.89*
924192	*AB2-063 E*	*1.45*
924801	*AB2-133 C OP*	*6.96*
924802	*AB2-133 E OP*	*9.35*
924821	*AB2-135 C*	*10.31*
924822	*AB2-135 E*	*15.56*
924891	*AB2-143 C OP*	*1.65*
924892	*AB2-143 E OP*	*2.7*
925251	*AB2-179 C OP*	*3.76*
925252	*AB2-179 E OP*	*1.24*

Appendices
(Secondary Point of Interconnection)

The following appendices contain additional information about each flowgate presented in the body of the report. For each appendix, a description of the flowgate and its contingency was included for convenience. However, the intent of the appendix section is to provide more information on which projects/generators have contributions to the flowgate in question. Although this information is not used "as is" for cost allocation purposes, it can be used to gage other generators impact.
It should be noted the generator contributions presented in the appendices sections are full contributions, whereas in the body of the report, those contributions take into consideration the commercial probability of each project.

None