

Generation Interconnection Feasibility Study Report Queue Position AB2-135

The Interconnection Customer (IC), has proposed a 75 MW (29.9 MWC) solar generating facility to be located in Millington, Queen Anne's County, Maryland. PJM studied AB2-135 as a 75 MW injection into the Delmarva Power and Light Company (DPL) system at a tap of the Church-New Meredith 69 kV circuit and evaluated it for compliance with reliability criteria for summer peak conditions in 2020. The planned in-service date, as requested by the IC during the project kick-off call, is May 1, 2018. This date is not attainable due to additional required PJM studies and the Transmission Owner's construction schedule.

Point of Interconnection

The Interconnection Customer requested a transmission level interconnection. As a result, AB2-135 will interconnect with the DPL transmission system at a new three breaker ring bus 69 kV substation to be constructed adjacent to the Church-New Meredith 69 kV circuit.

Transmission Owner Scope of Direct Connection Work

Substation Interconnection Estimate

Scope: Build a new 69 kV substation with a 3 position ring bus. Two of the positions on the ring bus will be transmission line terminals for the tie-in of Line 6704 to the substation. The other position will be a terminal configured for the interconnection of a generator.

Estimate: \$3,967,000

Construction Time: 24 months

Major Equipment Included in Estimate:

• Control Enclosure, 20' x 15'	Qty. 1
• Power Circuit Breaker, 69 kV, 2000A, 40kA, 3 cycle	Qty. 3
• Disconnect Switch, 69 kV, 2000A, Manual Wormgear, Arcing Horns	Qty. 9
• CT/VT Combination Units, 69 kV	Qty. 3
• CVT, 69 kV	Qty. 6
• Disconnect Switch Stand, High, 69 kV, Steel	Qty. 5
• Disconnect Switch Stand, Low, 69 kV, Steel	Qty. 4
• CT/VT Stand, Single Phase, Low, 69 kV, Steel	Qty. 3
• CVT Stand, Single Phase, Low, 69 kV, Steel	Qty. 6
• SSVT, 69 kV/240-120 V	Qty. 1
• Relay Panel, Transmission Line, FL/BU (20")	Qty. 3
• Control Panel, 69 kV Circuit Breaker (10")	Qty. 3
• Take-off structure, 69 kV	Qty. 2
• Bus Support Structure, 3 phase, 69 kV, Steel	Qty. 8

Estimate Assumptions:

- Land purchase for the substation is not included.
- A 2.5 acre, relatively square lot is available for use.
- Site clearing and grading performed by Developer.
- Lightning protection (lightning masts) are not required.

Required Relaying and Communications

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.

New protection relays are required for the new line terminals. An SEL-421 will be required for primary protection and an SEL-311C will be required for back-up protection. A 20" relay panel will be required for each transmission line (2 total).

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 69 kV substation.

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

In addition protective relays at the new substation, relay upgrades will need to be performed on the remote ends at Church and Kent substations. An SEL-421 will be required for primary protection and an SEL-311C will be required for back-up protection at each remote end. The estimate to perform this work is **\$300,000** and will take **24 months** to complete.

To accommodate the line protection schemes and relay equipment, fiber communications will need to be added to Circuit 6704 from Church Substation to Kent Substation. The estimate to perform this work is **\$3,150,000** and will take **36 months** to complete. (Note: the overall cost of the fiber communications installation may be less if the system reinforcement work to rebuild Circuit 6704 from AB2-135 to New Meredith Substation is required. The cost will be reassessed in the Impact Study and Facilities Study.)

Metering

Three phase 69 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 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 the new 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 69.02% to 77.71% (DC power flow) of its emergency rating (348 MVA) for the tower line contingency outage of 'DBL_4NC'. This project contributes approximately 30.24 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.

2. (DP&L - DP&L) The TOWNSEND-MIDLTNTP 138 kV line (from bus 232107 to bus 232106 ckt 1) loads from 63.16% to 72.27% (DC power flow) of its emergency rating (348 MVA) for the tower line contingency outage of 'DBL_1NCB_A'. This project contributes approximately 31.71 MW to the thermal violation.

CONTINGENCY 'DBL_1NCB_A'/* #1 & #2 KEENEY-STEELE 230
OPEN LINE FROM BUS 231003 TO BUS 232000 CKT 1
OPEN LINE FROM BUS 231003 TO BUS 923960 CKT 2
END

3. (DP&L - DP&L) The AB2-135 TAP-NMEREDTH 69 kV line (from bus 924820 to bus 232812 ckt 1) loads from 71.2% to 99.02% (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 25.87 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.

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

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&2. 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. Reinforcements will include rebuilding a short section of the circuit including the installation of new poles and the re-mounting of 138 kV disconnect switches. The estimate to perform this work is **\$800,000** and will take **18 months** to complete.
3. 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. Reinforcements include rebuilding of the circuit including the installation of new poles and a new disconnect switch. The estimate to perform this work is **\$8,674,000** and will take **3 years** to complete.

Note: Queue project AB2-133 is not expected to have cost responsibility for this network upgrade due to cost allocation rules.

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

Steady-State Voltage Requirements

To be performed during later study phases.

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).

Facilities Study Estimate

7 months: \$100,000

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 88.57% to 105.0% (DC power flow) of its emergency rating (159 MVA) for the single line contingency outage of 'CKT 13808'. This project contributes approximately 26.11 MW to the thermal violation.

CONTINGENCY 'CKT 13808'

DISCONNECT BUS 232106/MOUNT PLEASANT - MIDDLETOWN - TOWNSEND 138

DISCONNECT BUS 232804/MIDDLETOWN 138

END

2. (DP&L - DP&L) The AB2-036 TAP-OIL_CITY 138 kV line (from bus 923950 to bus 232801 ckt 1) loads from 90.52% to 106.95% (DC power flow) of its emergency rating (159 MVA) for the single line contingency outage of 'CKT 13808'. This project contributes approximately 26.11 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 AB2-135 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 AB2-135 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 AB2-135 project.

Appendices

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 gauge 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 69.02% to 77.71% (DC power flow) of its emergency rating (348 MVA) for the tower line contingency outage of 'DBL_4NC'. This project contributes approximately 30.24 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

<i>Bus Number</i>	<i>Bus Name</i>	<i>Full Contribution</i>
232900	DEMECSMY	2.15
232851	DUP-SFR1	0.41
232902	EASTMUNI	3.41
232923	MR1	3.36
232924	MR2	3.36
232910	NRG_G1	2.44
232911	NRG_G2	2.44
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	2.44
901014	W1-004 E	2.44
901024	W1-005 E	2.44
901034	W1-006 E	2.44
901411	W1-062	2.29
907052	X1-032 E	0.79
907324	X1-096 E	25.63

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	9.79
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	1.12
921603	AA1-141 E	1.84
921872	AA2-069	104.8
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	37.02
923282	AB1-137 C	2.79
923283	AB1-137 E	1.2

923322	<i>AB1-141 C OP</i>	5.3
923323	<i>AB1-141 E OP</i>	2.47
923332	<i>AB1-142 C OP</i>	5.3
923333	<i>AB1-142 E OP</i>	2.47
923452	<i>AB1-162 C OP</i>	2.4
923453	<i>AB1-162 E OP</i>	3.92
923602	<i>AB1-176 C</i>	1.29
923603	<i>AB1-176 E</i>	2.12
923902	<i>AB2-030 E</i>	0.79
923921	<i>AB2-032 C</i>	5.34
923922	<i>AB2-032 E</i>	2.51
923931	<i>AB2-033 C</i>	1.41
923932	<i>AB2-033 E</i>	0.56
923951	<i>AB2-036 C</i>	13.81
923952	<i>AB2-036 E</i>	22.54
923961	<i>AB2-037 C</i>	14.98
923962	<i>AB2-037 E</i>	24.45
924191	<i>AB2-063 C</i>	2.87
924192	<i>AB2-063 E</i>	4.69
924361	<i>AB2-084 C</i>	0.75
924362	<i>AB2-084 E</i>	1.22
924461	<i>AB2-095 C</i>	2.27
924462	<i>AB2-095 E</i>	3.7
924681	<i>AB2-120 C OP</i>	7.49
924682	<i>AB2-120 E OP</i>	12.21
924781	<i>AB2-130 C OP</i>	7.73
924782	<i>AB2-130 E OP</i>	12.62
924801	<i>AB2-133 C OP</i>	14.2
924802	<i>AB2-133 E OP</i>	19.08
924821	<i>AB2-135 C</i>	12.05
924822	<i>AB2-135 E</i>	18.18
924831	<i>AB2-136 C OP</i>	5.19
924832	<i>AB2-136 E OP</i>	7.37
924881	<i>AB2-142 C</i>	1.14
924882	<i>AB2-142 E</i>	1.85
924891	<i>AB2-143 C OP</i>	3.37
924892	<i>AB2-143 E OP</i>	5.5
924971	<i>AB2-153 C</i>	2.98
924972	<i>AB2-153 E</i>	4.87
925071	<i>AB2-164 C OP</i>	1.5
925072	<i>AB2-164 E OP</i>	2.44
925081	<i>AB2-165 C OP</i>	1.5
925082	<i>AB2-165 E OP</i>	2.44
925091	<i>AB2-166 C</i>	0.4
925092	<i>AB2-166 E</i>	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 71.2% to 99.02% (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 25.87 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

<i>Bus Number</i>	<i>Bus Name</i>	<i>Full Contribution</i>
910821	X3-066 C	0.05
910822	X3-066 E	0.44
915751	Y3-033	0.72
915752	Y3-033	4.8
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