Generation Interconnection Feasibility Study Report Queue Position Z1-117

The Interconnection Customer (IC) has proposed a 10 MWE (5.88 MWC; 10 MW MFO) solar powered generating facility to be located in Somerset County, Maryland and Accomack County, Virginia. PJM studied Z1-117 as a 10 MW injection into the Delmarva Power and Light (DPL) system and evaluated the project for compliance with reliability criteria for summer peak conditions in 2017. The planned in-service date, as stated in the Attachment N, is June 1, 2016.

Point(s) of Interconnection

The Interconnection Customer requested a Primary and Secondary Point of Interconnection (POI) be evaluated for the Z1-117 project. The Primary POI selected was a direct connection into the Kings Creek 69 kV substation. The Secondary POI selected was a direct connection into the Loretto 25 kV substation. The study results are provided in the Transmission Network Impacts section below.

Primary POI Option

Z1-117 will interconnect with the Delmarva Power and Light transmission system at the 69 kV bus at Kings Creek substation. The Point of Interconnection (POI) will be located at a disconnect switch just beyond the fence line of the Kings Creek substation.

Attachment Facilities

DPL is currently working on a reliability improvement project at Kings Creek substation scheduled to be completed by May 31st, 2017. DPL will be unable to accommodate the request to connect to the Kings Creek 69kV substation bus until this work has been completed. It is highly unlikely that the project can be accelerated to allow an interconnection at Kings Creek substation by 6/1/2016. The following attachment facilities estimate is assuming that the reliability improvement work by DPL at Kings Creek substation has been completed.

Transmission Owner Scope of Work

The scope of work and estimated costs for the direct connection facilities is as follows:

Substation Engineering Estimate:
Scope: Construct a 69 kV terminal position at Kings Creek substation. Construction is to include the addition of one 69 kV circuit breaker, three 69 kV disconnect switches, 69 kV bus equipment, protection and control relays, secondary equipment, support structures, foundations, cable trenches, and conduit. Construction will require site expansion of the substation to accommodate the new 69 kV terminal position.
Estimate: $2,500,000
Construction Time: 24 months, plus any outage delays.

Note that it is assumed that the developer would be responsible for land acquisition for all the new facilities, including the substation, if required. The developer would also be responsible for the necessary permits to construct these facilities (zoning, storm water management,

environmental, etc.) as well as site clearing/grading and entrance road construction. These costs are not included in the estimate.

Note: If location of generator is greater than 500 feet from substation, circuit breaker will be necessary

Interconnection Customer Scope of Work

The Interconnection Customer (IC) 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.

Protective relaying and metering design and installation must comply with PHI's applicable standards. 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.

The Interconnection Customer will purchase and install all metering instrument transformers as well as construct a metering structure per PHI's specifications. The secondary wiring connections at the instrument transformers will be completed by the interconnection customer's contractors and inspected by PHI, while the secondary wiring work at the metering enclosure will be completed by PHI's Meter technicians. The metering control cable and meter cabinets will be supplied by PHI and installed by the interconnection customer's contractors. PHI's meter technicians will program and install two solid state multi-function meters (Primary & Backup) for the new metering position. Each meter will be equipped with load profile, telemetry, and DNP output. The ownership of metering equipment purchased or installed by the IC shall be transferred to the Transmission Owner at Commercial Operation, unless the IC asserts its right to install, own and operate the metering system.

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, a line recloser, or other method depending upon the specific circumstances and the evaluation by DPL.

2. It is the Interconnection Customer's responsibility to send the data that PJM and DPL requires directly to PJM. The Interconnection Customer will grant permission for PJM to send DPL the following telemetry that the Interconnection Customer sends to PJM: real time MW, MVAR, volts, amperes, generator/status, and interval MWH and MVARH.

3. 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.

4. 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.

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, Line with Failed 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)

1. (DP&L - DP&L) The KINGS CK-LORETTO 138 kV line (from bus 232129 to bus 232127 ckt 1) loads from 112.42% to 115.09% (**DC power flow**) of its emergency rating (351 MVA) for the line fault with failed breaker contingency outage of 'DP59'. This project contributes approximately 9.37 MW to the thermal violation.

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CONTINGENCY 'DP59'                                  /*PINEY GROVE BUS BREAKER
DISCONNECT BRANCH FROM BUS 232131 TO BUS 232128 CKT 1          /*PINEY
GROVE NEW CHURCH 138 138
DISCONNECT BRANCH FROM BUS 232007 TO BUS 232128 CKT 1          /*PINEY
GROVE PINEY GROVE 230 138
END
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Please refer to Appendix 1 for a table containing the generators having contribution to this flowgate.

Short Circuit

No overstressed breakers were identified.

Stability and Low Voltage Ride Through Analysis

Will be performed during the System Impact study phase of the project (if necessary).

Light Load Analysis

(Light Load Studies to be conducted during later study phases (applicable to wind, coal, nuclear, and pumped storage projects).

Not required.

New System Reinforcements

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

None

Contribution to Previously Identified System Reinforcements

(Overloads initially caused by prior Queue positions with additional contribution to overloading by this project. Cost allocation for these overloads will be provided in the System Impact Study Report.

1. To mitigate the (DP&L - DP&L) The KINGS CK-LORETTO 138 kV line (from bus 232129 to bus 232127 ckt 1) overload will require upgrading the conductor on the Kings Creek-Loretto 138 kV 13713 circuit. The estimated cost to perform this work is **$8,165,000** and will take **48 months** to complete.

Potential Congestion due to Local Energy Deliverability

(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 below. There is no guarantee of full deliverability 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 identified overloaded element(s). As a result of the aggregate energy resources in the area, the following violations were identified:

These are ***not*** required reliability upgrades.

1. (DP&L - DP&L) The N_CHURCH-PINEY138 138 kV line (from bus 232131 to bus 232128 ckt 1) loads from 105.28% to 106.36% (**DC power flow**) of its normal rating (172 MVA) for non-contingency condition. This project contributes approximately 1.87 MW to the thermal violation.

2. (DP&L - DP&L) The LORETTO-PINEY138 138 kV line (from bus 232127 to bus 232128 ckt 1) loads from 95.34% to 97.85% (**DC power flow**) of its emergency rating (159 MVA) for the single line contingency outage of 'CKT 13764'. This project contributes approximately 4.0 MW to the thermal violation.

   CONTINGENCY 'CKT 13764'
   OPEN LINE FROM BUS 232131 TO BUS 232128 CIRCUIT 1 /NEW CHURCH - PINEY GROVE 138
   END

3. (DP&L - DP&L) The KENNEY-M OLIVE1 69 kV line (from bus 232277 to bus 232839 ckt 1) loads from 105.25% to 107.47% (**DC power flow**) of its emergency rating (70 MVA) for the single line contingency outage of 'CKT 13713'. This project contributes approximately 1.56 MW to the thermal violation.

   CONTINGENCY 'CKT 13713'
   OPEN LINE FROM BUS 232129 TO BUS 232127 CIRCUIT 1 /KINGS CREEK - LORETTO 138
   END

4. (DP&L - DP&L) The FRUITLND-PEMBERTN 69 kV line (from bus 232288 to bus 232273 ckt 1) loads from 96.09% to 97.3% (**DC power flow**) of its emergency rating (91 MVA) for the single line contingency outage of 'CKT 6728'. This project contributes approximately 1.11 MW to the thermal violation.

   CONTINGENCY 'CKT 6728'
   OPEN LINE FROM BUS 232272 TO BUS 232274 CIRCUIT 1 /MOUNT HERMON - PINEY GROVE 69
   DISCONNECT BUS 230912 / PINEY GROVE 69 CAP
   END

5. (DP&L - DP&L) The N_CHURCH-PINEY138 138 kV line (from bus 232131 to bus 232128 ckt 1) loads from 171.39% to 175.12% (**DC power flow**) of its emergency rating (226 MVA) for the single line contingency outage of 'CKT 13713'. This project contributes approximately 8.42 MW to the thermal violation.

   CONTINGENCY 'CKT 13713'
   OPEN LINE FROM BUS 232129 TO BUS 232127 CIRCUIT 1 /KINGS CREEK - LORETTO 138
   END

6. (DP&L - DP&L) The KINGS CK 138/69 kV transformer (from bus 232276 to bus 232129 ckt 1) loads from 237.73% to 254.68% (**DC power flow**) of its normal rating (59 MVA) for non-contingency condition. This project contributes approximately 10.0 MW to the thermal violation.

Secondary POI Option

PJM studied Z1-117 as a 10 MW injection into the Loretto substation.

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, Line with Failed 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

Short Circuit

No overstressed breakers were identified.

Light Load Analysis

(Light Load Studies to be conducted during later study phases (applicable to wind, coal, nuclear, and pumped storage projects).

Not required.

New System Reinforcements

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

None

Contribution to Previously Identified System Reinforcements

(Overloads initially caused by prior Queue positions with additional contribution to overloading by this project. Cost allocation for these overloads will be provided in the System Impact Study Report.

None

Potential Congestion due to Local Energy Deliverability

(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 below. There is no guarantee of full deliverability 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 identified overloaded element(s). As a result of the aggregate energy resources in the area, the following violations were identified:

These are ***not*** required reliability upgrades.

1. (DP&L - DP&L) The LORET_69-FRUITLND 69 kV line (from bus 232275 to bus 232288 ckt 1) loads from 96.74% to 99.1% (**DC power flow**) of its emergency rating (137 MVA) for the single line contingency outage of 'CKT 6728'. This project contributes approximately 3.23 MW to the thermal violation.

   CONTINGENCY 'CKT 6728'
   OPEN LINE FROM BUS 232272 TO BUS 232274 CIRCUIT 1 /MOUNT HERMON - PINEY GROVE 69
   DISCONNECT BUS 230912 / PINEY GROVE 69 CAP
   END

2. (DP&L - DP&L) The LORETTO 138/69 kV transformer (from bus 232127 to bus 916690 ckt 1) loads from 95.15% to 97.05% (**DC power flow**) of its emergency rating (159 MVA) for the single line contingency outage of 'CKT 13764_B'. This project contributes approximately 3.03 MW to the thermal violation.

   CONTINGENCY 'CKT 13764_B'
   OPEN LINE FROM BUS 916720 TO BUS 232128 CIRCUIT 1 /NEW CHURCH - PINEY GROVE 138
   END

3. (DP&L - DP&L) The FRUITLND-PEMBERTN 69 kV line (from bus 232288 to bus 232273 ckt 1) loads from 96.09% to 99.63% (**DC power flow**) of its emergency rating (91 MVA) for the single line contingency outage of 'CKT 6728'. This project contributes approximately 3.23 MW to the thermal violation.

CONTINGENCY 'CKT 6728'
OPEN LINE FROM BUS 232272 TO BUS 232274 CIRCUIT 1 /MOUNT HERMON - PINEY GROVE 69
DISCONNECT BUS 230912 / PINEY GROVE 69 CAP
END

4. (DP&L - DP&L) The PINEY138 138/69 kV transformer (from bus 916690 to bus 232128 ckt 1) loads from 95.15% to 97.05% (**DC power flow**) of its emergency rating (159 MVA) for the single line contingency outage of 'CKT 13764_B'. This project contributes approximately 3.03 MW to the thermal violation.

   CONTINGENCY 'CKT 13764_B'
   OPEN LINE FROM BUS 916720 TO BUS 232128 CIRCUIT 1 /NEW CHURCH - PINEY GROVE 138
   END

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 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

1. (DP&L - DP&L) The KINGS CK-LORETTO 138 kV line (from bus 232129 to bus 232127 ckt 1) loads from 112.42% to 115.09% (**DC power flow**) of its emergency rating (351 MVA) for the line fault with failed breaker contingency outage of 'DP59'. This project contributes approximately 9.37 MW to the thermal violation.

   CONTINGENCY 'DP59' /*PINEY GROVE BUS BREAKER
   DISCONNECT BRANCH FROM BUS 232131 TO BUS 232128 CKT 1 /*PINEY GROVE NEW CHURCH 138 138
   DISCONNECT BRANCH FROM BUS 232007 TO BUS 232128 CKT 1 /*PINEY GROVE PINEY GROVE 230 138
   END

Bus Number	Bus Name	Full Contribution
232905	BAYVIEW1	0.36
232926	CRISFLD1	0.34
232912	OH NUG1	1.39
232913	OH NUG2	1.37
232914	OH NUG3	1.39

232915	OH NUG4	1.39
232916	OH NUG5	1.39
232917	OH NUG6	1.38
232918	OH NUG7	1.38
886231	T-144 C	8.96
886232	T-144 E	8.78
232921	TASLEY2G	0.98
904210	V4-022 C	0.06
904212	V4-022 E	2.54
904631	V4-064 C	6.23
904632	V4-064 E	10.16
900001	W1-003 C	6.39
900002	W1-003 E	10.43
900011	W1-004 C	6.39
900012	W1-004 E	10.43
900021	W1-005 C	6.39
900022	W1-005 E	10.43
900031	W1-006 C	6.39
900032	W1-006 E	10.43
907072	X1-032 E	3.6
907321	X1-096 C	18.28
907322	X1-096 E	122.34
910662	X3-040 E	14.75
914451	Y2-108	1.87
914461	Y2-109	0.02
916301	Z1-076 C	3.5
916302	Z1-076 E	5.71
916311	Z1-077 C	2.12
916312	Z1-077 E	3.46
916511	Z1-100	3.5
916521	Z1-101	3.5
916531	Z1-102	3.5
916541	Z1-103	3.5
916552	Z1-104 E	18.75
916661	Z1-117 C OP1	5.51
916662	Z1-117 E OP1	3.86