Generation Interconnection
Feasibility Study Report
Queue Position Y2-059

The Interconnection Customer (IC) has proposed a 20 MWE (7.6 MWC; 20 MW MFO) solar powered generating facility to be located in Somerset County, Maryland. PJM studied Y2-059 as a 20 MW injection into the Delmarva Power and Light (DPL) system at a tap of the Kingston-Westover 69kV circuit and evaluated the project for compliance with reliability criteria for summer peak conditions in 2016.

Point(s) of Interconnection

Y2-059 will interconnect with the Delmarva Power and Light system at the new 69kV three-breaker ring bus substation to be constructed adjacent to the Kings Creek-Crisfield 69kV circuit. The Point of Interconnection will be located at a disconnect switch just beyond the fence line of the new substation.

Transmission Owner Scope of Work

The scope of work and estimated costs to interconnect Y2-059 is as follows:

Attachment Facilities:

Substation Engineering Estimate:
Scope: Construct a 69kV three-breaker ring bus substation, inclusive of a terminal position for the queue project on the Kings Creek - Crisfield 69kV line.
Estimate: $3,100,000
Construction Time: 24 – 36 months

Note that it is assumed that the developer would be responsible for land acquisition for all the new facilities, including the substation. 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 $3.1M estimate.

Transmission Engineering Estimate:
Scope: Cut circuit 6725 in and out of a new substation and install a single 1-way motor operated switch on the back side. Install two (2) self-supporting steel poles with anchor bolt foundations, four (4) post construction tangent structures, one (1) steel switch pole, and short span to PHI substation.
Estimate: $520,000
Construction Time: 24 months

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

Note: the above cost does not include the Contribution in Aid of Construction (CIAC) tax.

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 to 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 DPL metering position to facilitate remote interrogation and data collection.

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.

The IC will be required to install metering and telemetry equipment to provide revenue metering and real-time telemetry data to PJM. The requirements for this equipment are listed in Appendix 2, Section 8 of Attachment O to the PJM Tariff, as well as PJM Manuals 01 and 14D. Protective relaying and metering design and installation must comply with PHI's Applicable Standards.

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 form-c pulse outputs. 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.

Inverter Requirements and Capabilities

The inverter at the DG location shall have the following capabilities:

- Voltage flicker reduction through dynamic VAR or fixed PF response
- Ramp rate control
- SCADA communications
- Curtailment or other mitigation ability if high voltage were to occur
- Low voltage and system disturbance ride through
- Ability to receive and respond to a transfer trip signal
- Ability to adjust PF or VARs based on utility signal
- Ability to Adjust Real Power Output based on utility signal

The inverter shall operate in accordance with the IEEE 1547 series of standards that have been approved. While inverters should be capable of voltage stabilization thru dynamic VAR response and capable of low voltage and system disturbance ride through, neither of these capabilities shall be implemented until such time that the IEEE 1547 series of standards are revised and approved to include standards for these capabilities. At such time as these revised standards become available, the PV owner/operator shall cooperate with the Company (the 'Company' referring to ACE, DPL, or PEPCO) to implement these capabilities with settings acceptable to the Company. Until such time, the inverters shall operate at a fixed power factor between 0.95 leading and 0.95 lagging which will be supplied by the Company.

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. The PINEY_69-M HERMON 69 kV line (from bus 232274 to bus 232272 ckt 1) loads from 130.47% to 133.03% (DC power flow) of its emergency rating (143 MVA) for the line fault with

failed breaker contingency outage of CONTINGENCY DESCRIPTION ('DP15'). This project contributes approximately 3.67 MW to the thermal violation. *Please refer to Appendix 1 for a table containing the generators having contribution to this flowgate.*

2. The KINGS CK-LORETTO 138 kV line (from bus 232129 to bus 232127 ckt 1) loads from 143.53% to 148.88% (DC power flow) of its emergency rating (351 MVA) for the line fault with failed breaker contingency outage of CONTINGENCY DESCRIPTION ('DP59'). This project contributes approximately 18.76 MW to the thermal violation. *Please refer to Appendix 2 for a table containing the generators having contribution to this flowgate.*

Short Circuit

No issues identified.

Stability Analysis

Not required due to project size.

Light Load Analysis

Not required for solar projects.

Other Charges

DPL reserves the right to charge the Interconnection Customer Operation and Maintenance expenses to maintain the Interconnection Customer's Attachment Facilities, including metering and telecommunications facilities which are owned by DPL.

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.

1. To mitigate the PINEY_69-M HERMON 69 kV line (from bus 232274 to bus 232272 ckt 1) overload will require the following:
    - Reconductor the Mt. Hermon-Piney Grove 69kV circuit
    - Replace stranded bus
    - Replace circuit breaker
    - Replace three disconnect switches at Mt. Hermon

The estimated cost to perform this work is **$4,800,000** and will take **30 months** to complete.

2. To mitigate the KINGS CK-LORETTO 138 kV line (from bus 232129 to bus 232127 ckt 1) overload will require the following:
    - Reconductor the Kings Creek –Loretto 138kV circuit
    - Replace four circuit breakers
    - Replace four disconnect switches

    The estimated cost to perform this work is **$6,750,000** and will take **30 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. The M OLIVE1-PINEY_69 69 kV line (from bus 232839 to bus 232274 ckt 1) loads from 97.66% to 101.24% (DC power flow) of its emergency rating (87 MVA) for the single line contingency outage of CONTINGENCY DESCRIPTION ('CKT 13713'). This project contributes approximately 3.11 MW to the thermal violation.

2. The LORET_69-FRUITLND 69 kV line (from bus 232275 to bus 232288 ckt 1) loads from 100.62% to 102.24% (DC power flow) of its emergency rating (137 MVA) for the single line contingency outage of CONTINGENCY DESCRIPTION ('CKT 6728'). This project contributes approximately 2.21 MW to the thermal violation.

3. The LORETTO 138/69 kV transformer (from bus 232127 to bus 232275 ckt 1) loads from 105.85% to 106.12% (DC power flow) of its emergency rating (71 MVA) for the single line contingency outage of CONTINGENCY DESCRIPTION ('CKT 6728'). This project contributes approximately 1.17 MW to the thermal violation.

4. The KINGS CK-LORETTO 138 kV line (from bus 232129 to bus 232127 ckt 1) loads from 106.77% to 112.44% (DC power flow) of its normal rating (275 MVA) for non-contingency condition. This project contributes approximately 15.6 MW to the thermal violation.

5. The FRUITLND-PEMBERTN 69 kV line (from bus 232288 to bus 232273 ckt 1) loads from 112.9% to 116.79% (DC power flow) of its emergency rating (91 MVA) for the single line

contingency outage of CONTINGENCY DESCRIPTION ('CKT 13780'). This project contributes approximately 3.54 MW to the thermal violation.

6. The PINEY138-LORETTO 138 kV line (from bus 232128 to bus 232127 ckt 1) loads from 123.16% to 127.05% (DC power flow) of its emergency rating (159 MVA) for the single line contingency outage of CONTINGENCY DESCRIPTION ('CKT 13713'). This project contributes approximately 6.19 MW to the thermal violation.

7. The LORETTO-PINEY138 138 kV line (from bus 232127 to bus 232128 ckt 1) loads from 129.11% to 134.15% (DC power flow) of its emergency rating (159 MVA) for the single line contingency outage of CONTINGENCY DESCRIPTION ('CKT 13764'). This project contributes approximately 8.01 MW to the thermal violation.

8. The KENNEY-M OLIVE1 69 kV line (from bus 232277 to bus 232839 ckt 1) loads from 131.98% to 136.43% (DC power flow) of its emergency rating (70 MVA) for the single line contingency outage of CONTINGENCY DESCRIPTION ('CKT 13713'). This project contributes approximately 3.11 MW to the thermal violation.

9. The N_CHURCH-PINEY138 138 kV line (from bus 232131 to bus 232128 ckt 1) loads from 147.29% to 149.41% (DC power flow) of its normal rating (172 MVA) for non-contingency condition. This project contributes approximately 3.63 MW to the thermal violation.

10. The N_CHURCH-PINEY138 138 kV line (from bus 232131 to bus 232128 ckt 1) loads from 222.13% to 229.58% (DC power flow) of its emergency rating (226 MVA) for the single line contingency outage of CONTINGENCY DESCRIPTION ('CKT 13713'). This project contributes approximately 16.85 MW to the thermal violation.

11. The KINGS CK 138/69 kV transformer (from bus 232276 to bus 232129 ckt 1) loads from 235.19% to 269.08% (DC power flow) of its normal rating (59 MVA) for non-contingency condition. This project contributes approximately 20.0 MW to the thermal violation.

12. The X1-096 TAP-WESTOVER 69 kV line (from bus 907400 to bus 232842 ckt 1) loads from 369.5% to 422.13% (DC power flow) of its normal rating (38 MVA) for non-contingency condition. This project contributes approximately 20.0 MW to the thermal violation.

13. The WESTOVER-KINGS_69 69 kV line (from bus 232842 to bus 232276 ckt 1) loads from 578.29% to 661.62% (DC power flow) of its normal rating (24 MVA) for non-contingency condition. This project contributes approximately 20.0 MW to the thermal violation.

Appendix 1

Bus Number	Bus Name	Full Contribution
232905	BAYVIEW1	.06
232926	CRISFLD1	.04
232912	OH NUG1	.24
232913	OH NUG2	.23
232914	OH NUG3	.24
232915	OH NUG4	.24
232916	OH NUG5	.24
232917	OH NUG6	.23
232918	OH NUG7	.23
886231	T-144 C	2.03
886232	T-144 E	1.99
232921	TASLEY2G	.17
900131	V4-022 C	.44
900132	V4-022 E	.72
904631	V4-064 C	1.77
904632	V4-064 E	2.89
901001	W1-003 C	1.74
901002	W1-003 E	2.83
901011	W1-004 C	1.74
901012	W1-004 E	2.83
901021	W1-005 C	1.74
901022	W1-005 E	2.83
901031	W1-006 C	1.74
901032	W1-006 E	2.83
901041	W1-008 C	1.77
901042	W1-008 E	2.89
903481	W3-054AC	2.87
903482	W3-054AE	19.23
907052	X1-032 E	.8
907401	X1-096 C	3.58
907402	X1-096 E	23.95
910671	X3-040 C	.91
910672	X3-040 E	6.07
913041	Y1-008 C	1.51
913042	Y1-008 E	10.12
914151	Y2-059 C	1.4
914152	Y2-059 E	2.28

Appendix 2

Bus Number	Bus Name	Full Contribution
232905	BAYVIEW1	.22
232926	CRISFLD1	.21
232912	OH NUG1	.85
232913	OH NUG2	.84
232914	OH NUG3	.85
232915	OH NUG4	.85
232916	OH NUG5	.85
232917	OH NUG6	.85
232918	OH NUG7	.84
886231	T-144 C	8.93
886232	T-144 E	8.75
232921	TASLEY2G	.6
900131	V4-022 C	1.54
900132	V4-022 E	2.52
904631	V4-064 C	6.18
904632	V4-064 E	10.08
901001	W1-003 C	6.34
901002	W1-003 E	10.35
901011	W1-004 C	6.34
901012	W1-004 E	10.35
901021	W1-005 C	6.34
901022	W1-005 E	10.35
901031	W1-006 C	6.34
901032	W1-006 E	10.35
901041	W1-008 C	6.18
901042	W1-008 E	10.08
903481	W3-054AC	10.04
903482	W3-054AE	67.19
907052	X1-032 E	3.6
907401	X1-096 C	18.29
907402	X1-096 E	122.4
910671	X3-040 C	3.17
910672	X3-040 E	21.22
913041	Y1-008 C	5.28
913042	Y1-008 E	35.36
914151	Y2-059 C	7.13
914152	Y2-059 E	11.63