Generation Interconnection
Feasibility Study Report
Z1-077

The Interconnection Customer (IC) has proposed a 10 MWE (3.8 MWC) solar powered generating facility to be located in Worcester County, Maryland. PJM studied Z1-077 as a 10 MW (3.8 MWC) injection into the Delmarva Power and Light (DPL) system at the Stockton 69 kV substation and evaluated it for compliance with reliability criteria for summer peak conditions in 2017.

Point of Interconnection

Z1-077 will interconnect with the Delmarva Power and Light transmission system at the Stockton substation. The Point of Interconnection (POI) will be located at a disconnect switch just beyond the fence line of Stockton substation.

Transmission Owner Scope of Work

The scope of work and estimated costs are as follows:

Substation Engineering Estimate:
Scope: Construct a 69 kV line terminal position on the 69 kV ring bus at Stockton Substation. The construction of the 69 kV ring bus during PJM Queue Project Z1-076 is required in order to provide interconnection facilities according to the scope and cost estimate provided. Suspension or withdrawal of Z1-076 would result in additional construction scope and costs to the Z1-077 project equal to the scope and cost estimates provided in the Feasibility Report for Z1-076 "Stockton 1 69 kV".
Estimate: **$1,500,000**
Construction Time: **24 months** (not including outage delays)

Note that it is assumed that the Interconnection Customer would be responsible for land acquisition for all the new facilities, including the substation. The Interconnection Customer 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 $1,500,000 estimate.

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

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 (POI). 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 DPL'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 DPL's specifications. The secondary wiring connections at the instrument transformers will be completed by the interconnection customer's contractors and inspected by DPL, while the secondary wiring work at the metering enclosure will be completed by DPL's meter technicians. The metering control cable and meter cabinets will be supplied by DPL and installed by the interconnection customer's contractors. DPL'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 DPL at time of 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.*

1. (DP&L - DP&L) The RL-KEEN_230 230 kV line (from bus 231004 to bus 231003 ckt 1) loads from 99.95% to 100.11% **(DC power flow)** of its emergency rating (1036 MVA) for the line fault with failed breaker contingency outage of 'PJM17'. This project contributes approximately 3.69 MW to the thermal violation.

   CONTINGENCY 'PJM17' /* RED LION BUS BREAKER TO KEENEY
   DISCONNECT BRANCH FROM BUS 200010 TO BUS 200027 CKT 1 /* KEENEY RED LION 500500
   DISCONNECT BRANCH FROM BUS 200029 TO BUS 200027 CKT 1 /* HOPE CRK RED LION 500500
   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 KINGS CK-LORETTO 138 kV line (from bus 232129 to bus 232127 ckt 1) loads from 101.51% to 103.1% (**DC power flow**) of its emergency rating (351 MVA) for the line fault with failed breaker contingency outage of 'DP59'. This project contributes approximately 5.58 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

   Please refer to Appendix 2 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 required).

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)

1. To mitigate the (DP&L - DP&L) The RL-KEEN 230 kV line (from bus 231004 to bus 231003 ckt 1) overload will require upgrading the D23013 disconnect switch at the Keeney substation to 3000A capacity. The estimated cost to perform this work is **$72,000** and will take 1**8 months** to complete.

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) 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 this interconnection request. Any problems identified below are likely to result in operational restrictions to the project under study. The Interconnection Customer 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.

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

1. (DP&L - DP&L) The PINEY-M HERMON 69 kV line (from bus 232274 to bus 232272 ckt 1) loads from 111.29% to 112.46% (**DC power flow**) of its emergency rating (143 MVA) for

the single line contingency outage of 'LORETO AT1&2'. This project contributes approximately 2.75 MW to the thermal violation.

CONTINGENCY 'LORETO AT1&2'
OPEN LINE FROM BUS 232127 TO BUS 232275 CIRCUIT 1 /LORETTO AT1 138/69
OPEN LINE FROM BUS 232127 TO BUS 232275 CIRCUIT 2 /LORETTO AT2 138/69
END

2. (DP&L - DP&L) The N_CHURCH-PINEY 138 kV line (from bus 232131 to bus 232128 ckt 1) loads from 155.31% to 157.74% (**DC power flow**) of its emergency rating (226 MVA) for the single line contingency outage of 'CKT 13713'. This project contributes approximately 9.06 MW to the thermal violation.

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

(DP&L - DP&L) The RL_230-KEEN_230 230 kV line (from bus 231004 to bus 231003 ckt 1) loads from 99.95% to 100.11% (**DC power flow**) of its emergency rating (1036 MVA) for the line fault with failed breaker contingency outage of 'PJM17'. This project contributes approximately 3.69 MW to the thermal violation.

CONTINGENCY 'PJM17' /* RED LION BUS BREAKER TO KEENEY
DISCONNECT BRANCH FROM BUS 200010 TO BUS 200027 CKT 1 /* KEENEY RED LION 500500
DISCONNECT BRANCH FROM BUS 200029 TO BUS 200027 CKT 1 /* HOPE CRK RED LION 500500
END

Bus Number	Bus Name	Full Contribution
231131	BLOOM ENRGY	14.97
231902	DC CT7	1.69
232900	DEMECSMY	0.95
232616	GEN FOOD	0.32
231911	HR5	3.5
231912	HR6	3.5
231913	HR7	3.5
231914	HR8	5.31
232906	IR3	71.09
232923	MR1	0.35
232924	MR2	0.35
232922	MR3	2.12
232901	NORTHST	0.81
886231	T-144 C	3.63
886232	T-144 E	3.56
297076	V2-028 C	0.76
297077	V2-028 E	1.23
904212	V4-022 E	1.14
904631	V4-064 C	2.79
904632	V4-064 E	4.55
900001	W1-003 C	2.79
900002	W1-003 E	4.55
900011	W1-004 C	2.79
900012	W1-004 E	4.55
900021	W1-005 C	2.79
900022	W1-005 E	4.55
900031	W1-006 C	2.79
900032	W1-006 E	4.55
901411	W1-062	1.04
901491	W1-070 C	2.78
901492	W1-070 E	4.54
903341	W3-032A 1	3.21
903351	W3-032A 2	3.21
904791	W3-160 C	1.52
904792	W3-160 E	2.48
907072	X1-032 E	1.45
907211	X1-074	221.17
907321	X1-096 C	7.04
907322	X1-096 E	47.09
907581	X1-097	0.55
909191	X2-066	239.49
909201	X2-067	174.54
910571	X3-008 C	2.36
910572	X3-008 E	3.85

910591	X3-015 C	2.4
910592	X3-015 E	3.91
910662	X3-040 E	6.61
910672	X3-041 E	3.78
910762	X3-066 E	0.97
910792	X3-071 E	2.52
910822	X3-077 E	2.42
912202	X4-040 E	0.75
913361	Y1-079 C	0.95
913362	Y1-079 E	1.54
913371	Y1-080 C	0.42
913372	Y1-080 E	0.68
914451	Y2-108	0.72
915101	Y3-033 C OP1	4.58
915102	Y3-033 E OP1	30.64
915302	Y3-054 E	5.26
915321	Y3-058 C	2.04
915322	Y3-058 E	3.32
916171	Z1-057	0.78
916301	Z1-076 C	2.31
916302	Z1-076 E	3.77
916311	Z1-077 C	1.4
916312	Z1-077 E	2.29

Appendix 2

(DP&L - DP&L) The KINGS CK-LORETTO 138 kV line (from bus 232129 to bus 232127 ckt 1) loads from 101.51% to 103.1% (**DC power flow**) of its emergency rating (351 MVA) for the line fault with failed breaker contingency outage of 'DP59'. This project contributes approximately 5.58 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	1.38
232914	OH NUG3	1.39
232915	OH NUG4	1.39

232916	OH NUG5	1.39
232917	OH NUG6	1.39
232918	OH NUG7	1.38
886231	T-144 C	8.96
886232	T-144 E	8.78
232921	TASLEY2G	0.99
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