Generation Interconnection
Feasibility Study Report
Queue Position AE1-038

The Interconnection Customer (IC), has proposed a 20 MW (8.4 MW Capacity) solar generating facility to be located in Kent County, Delaware. At the IC's request, PJM studied the AE1-038 project at both a Primary and Secondary Point of Interconnection. The project was studied at a commercial probability of 53% with the results provided below. The planned in-service date, as requested by the IC during the project kick-off call, is October 31, 2020. This date may not be attainable due to required PJM studies (System Impact and Facilities) and the Transmission Owner's construction schedule.

Point(s) of Interconnection

The Interconnection Customer requested a Primary and Secondary Point of Interconnection (POI) be evaluated for the AE1-038 project.

Primary Point of Interconnection

PJM studied the AE1-038 project as an injection into the Delmarva Power and Light Company (DPL) transmission system at the Cartanza 230 kV Substation (PSSE bus #232003) and evaluated it for compliance with reliability criteria for summer peak conditions in 2022. The AE1-038 project will connect with the DPL transmission system at the Cartanza 230 kV Substation via a new line terminal.

Transmission Owner Scope of Attachment Facilities Work

Substation Interconnection Estimate

Scope: Build a new position onto the 230 kV bus at Cartanza Substation. The new position will be connected to the AE1-038 generator. The project will require the addition of one (1) 230 kV breaker, three (3) 230 kV disconnect switches, three (3) CT/VT combination units, and substation bus.

Estimate: $3,800,000
Construction Time: 24-42 months

Major Equipment Included in Estimate:

- 3000A Power Circuit Breaker, 230 kV, 3 cycle — Qty. 1
- Disconnect Switch, 230 kV Motor Operated Device — Qty. 3
- Double 1590 ACSR (325') — Qty. 1
- Insulators, 230 kV — Qty. 3
- Disconnect Switch Stand, Low, 230 kV, Steel — Qty. 1
- Relay Panel, Transmission Bus, FL/BU (20") — Qty. 1
- Control Panel, 230 kV Circuit Breaker (10") — Qty. 1
- Take-off structure, 230 kV — Qty. 2
- 230 kV Lightning Arresters — Qty. 3
- 230 kV Lightning Arresters Stands — Qty. 3

Estimate Assumptions:

- Room in Control Enclosure for New Relay Panel.
- Fiber optic cable necessary is 1,000 linear feet.
- Developer to purchase additional land for substation expansion.
- Existing AC & DC systems are adequate.
- Existing Ground grid and storm water management will need to be expanded.

Required Relaying and Communications

New protection relays are required for the new terminals.

New protection relays are required for the new terminals.

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 generator terminal will be required for front line and back-up protection.

An SEL-451 relay on a 10" breaker control panel will be required for the control and operation of each new 230 kV circuit breaker (1 total).

The project will require re-wiring and adjustment of existing relay schemes to accommodate the new 230 kV substation.

Metering

Three phase 230 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 IC 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 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 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.

DPL Interconnection Customer Scope of Direct Connection Work Requirements:

- DPL requires that an IC circuit breaker is located within 500 feet of the DPL 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 - 2022

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)

ID	FROM BUS#	FROM BUS	FROM BUS AREA	TO BUS#	TO BUS	TO BUS AREA	CKT ID	CONT NAME	Type	Rating MVA	PRE PROJECT LOADING %	POST PROJECT LOADING %	AC|DC	MW IMPACT
59216	232003	CARTANZA	DP&L	232013	SILVER RUN	PJM	1	DPL_P1_2_CKT 23033	single	790.0	100.25	101.31	DC	8.38

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)

None

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)

ID	Index	Facility	Upgrade Description	Cost
59216	1	**CARTANZA 230.0 kV - SILVER RUN 230.0 kV Ckt 1**	Description : Upgrade terminal equipment at Cartanza & Silver Run Substations will be required to mitigate this overload. Time Estimate : 28.0 Months Cost : $1,800,000	$1,800,000
		TOTAL COST	**$1,800,000**	

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 as required.

Light Load Analysis - 2022

To be performed during later study phases (as required by PJM Manual 14B).

Facilities Study Estimate

(If a Facilities Study is required, provide the estimated duration and cost estimate to perform Facilities Study)

The deposit would be $100,000 and is estimated to take 8 months to complete.

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.

ID	FROM BUS#	FROM BUS	FROM BUS AREA	TO BUS#	TO BUS	TO BUS AREA	CKT ID	CONT NAME	Type	Rating MVA	PRE PROJECT LOADING %	POST PROJECT LOADING %	AC|DC	MW IMPACT
59215	232003	CARTANZA	DP&L	232013	SILVER RUN	PJM	1	DPL_P1_2_CKT 23033	operation	790.0	100.25	102.78	DC	19.95
59225	232003	CARTANZA	DP&L	232004	MILF_230	DP&L	1	CKT 23032B	operation	804.0	98.51	100.99	DC	19.95

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 AE1-038 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 AE1-038 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 AE1-038 project.

Secondary Point of Interconnection

PJM studied the AE1-038 project into the Delmarva Power and Light (DPL) system at the Cartanza 69 kV Substation (PSSE bus #232243) and evaluated it for compliance with reliability criteria for summer peak conditions in 2022.

Summer Peak Analysis - 2022

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)

ID	FROM BUS#	FROM BUS	FROM BUS AREA	TO BUS#	TO BUS	TO BUS AREA	CKT ID	CONT NAME	Type	Rating MVA	PRE PROJECT LOADING %	POST PROJECT LOADING %	AC|DC	MW IMPACT
59447	232003	CARTANZA	DP&L	232013	SILVER RUN	PJM	1	DPL_P1_2_CKT 23033	single	790.0	100.25	101.31	DC	8.38
58902	232243	CARTZ_69	DP&L	232003	CARTANZA	DP&L	2	DPL_P1_3_CARTANZA AT1	single	28.0	128.62	158.59	DC	8.39

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.

ID	FROM BUS#	FROM BUS	FROM BUS AREA	TO BUS#	TO BUS	TO BUS AREA	CKT ID	CONT NAME	Type	Rating MVA	PRE PROJECT LOADING %	POST PROJECT LOADING %	AC|DC	MW IMPACT
59446	232003	CARTANZA	DP&L	232013	SILVER RUN	PJM	1	DPL_P1_2_CKT 23033	operation	790.0	100.25	102.78	DC	19.95
59455	232003	CARTANZA	DP&L	232004	MILF_230	DP&L	1	CKT 23032B	operation	804.0	98.51	100.99	DC	19.95
58901	232243	CARTZ_69	DP&L	232003	CARTANZA	DP&L	2	DPL_P1_3_CARTANZA AT1	operation	28.0	128.64	200.01	DC	19.98

Primary POI Flow Gate Details

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.

Index 1

ID	FROM BUS#	FROM BUS	FROM BUS AREA	TO BUS#	TO BUS	TO BUS AREA	CKT ID	CONT NAME	Type	Rating MVA	PRE PROJECT LOADING %	POST PROJECT LOADING %	AC|DC	MW IMPACT
59216	232003	CARTANZA	DP&L	232013	SILVER RUN	PJM	1	DPL_P1_2_CKT 23033	single	790.0	100.25	101.31	DC	8.38

Bus #	Bus	MW Impact
232003	CARTANZA	53.06
232616	GEN FOOD	2.61
232901	NORTHST	7.9
232922	MR3	17.52
919831	AA2-069	449.9
938251	AE1-038 C O1	8.38
BAYOU	BAYOU	0.26
BIG_CAJUN1	BIG_CAJUN1	0.4
BIG_CAJUN2	BIG_CAJUN2	0.81
BLUEG	BLUEG	1.24
CALDERWOOD	CALDERWOOD	0.14
CANNELTON	CANNELTON	0.08
CARR	CARR	0.09
CATAWBA	CATAWBA	0.09
CHEOAH	CHEOAH	0.12
CHILHOWEE	CHILHOWEE	0.04
CHOCTAW	CHOCTAW	0.27
COFFEEN	COFFEEN	0.13
COTTONWOOD	COTTONWOOD	1.03
DEARBORN	DEARBORN	0.22
DUCKCREEK	DUCKCREEK	0.29
EDWARDS	EDWARDS	0.13
ELMERSMITH	ELMERSMITH	0.13
FARMERCITY	FARMERCITY	0.09
GIBSON	GIBSON	0.05
HAMLET	HAMLET	0.29
NEWTON	NEWTON	0.34
PRAIRIE	PRAIRIE	0.64
RENSSELAER	RENSSELAER	0.07
SANTEETLA	SANTEETLA	0.04
SMITHLAND	SMITHLAND	0.05
TATANKA	TATANKA	0.16
TILTON	TILTON	0.16
TRIMBLE	TRIMBLE	0.14
TVA	TVA	0.43
UNIONPOWER	UNIONPOWER	0.19

Contingency Name	Contingency Definition

DPL_P1_2_CKT 23033	CONTINGENCY 'DPL_P1_2_CKT 23033' OPEN LINE FROM BUS 232003 TO BUS 232004 CIRCUIT 1 /CARTANZA - MILFORD 230 END
CKT 23032B	CONTINGENCY 'CKT 23032B' OPEN LINE FROM BUS 232013 TO BUS 232003 CIRCUIT 1 /SILVER RUN - CARTANZA 230 END

Secondary POI Flow Gate Details

Index 1

ID	FROM BUS#	FROM BUS	FROM BUS AREA	TO BUS#	TO BUS	TO BUS AREA	CKT ID	CONT NAME	Type	Rating MVA	PRE PROJECT LOADING %	POST PROJECT LOADING %	AC|DC	MW IMPACT
59447	232003	CARTANZA	DP&L	232013	SILVER RUN	PJM	1	DPL_P1_2_CKT 23033	single	790.0	100.25	101.31	DC	8.38

Bus #	Bus	MW Impact
232003	CARTANZA	53.06
232616	GEN FOOD	2.61
232901	NORTHST	7.9
232922	MR3	17.52
919831	AA2-069	449.9
938251	AE1-038 C O2	8.38
BAYOU	BAYOU	0.26
BIG_CAJUN1	BIG_CAJUN1	0.4
BIG_CAJUN2	BIG_CAJUN2	0.81
BLUEG	BLUEG	1.24
CALDERWOOD	CALDERWOOD	0.14
CANNELTON	CANNELTON	0.08
CARR	CARR	0.09
CATAWBA	CATAWBA	0.09
CHEOAH	CHEOAH	0.12
CHILHOWEE	CHILHOWEE	0.04
CHOCTAW	CHOCTAW	0.27
COFFEEN	COFFEEN	0.13
COTTONWOOD	COTTONWOOD	1.03
DEARBORN	DEARBORN	0.22
DUCKCREEK	DUCKCREEK	0.29
EDWARDS	EDWARDS	0.13
ELMERSMITH	ELMERSMITH	0.13
FARMERCITY	FARMERCITY	0.09
GIBSON	GIBSON	0.05
HAMLET	HAMLET	0.29
NEWTON	NEWTON	0.34
PRAIRIE	PRAIRIE	0.64
RENSSELAER	RENSSELAER	0.07

Bus #	Bus	MW Impact
SANTEETLA	SANTEETLA	0.04
SMITHLAND	SMITHLAND	0.05
TATANKA	TATANKA	0.16
TILTON	TILTON	0.16
TRIMBLE	TRIMBLE	0.14
TVA	TVA	0.43
UNIONPOWER	UNIONPOWER	0.19

Index 2

ID	FROM BUS#	FROM BUS	FROM BUS AREA	TO BUS#	TO BUS	TO BUS AREA	CKT ID	CONT NAME	Type	Rating MVA	PRE PROJECT LOADING %	POST PROJECT LOADING %	AC|DC	MW IMPACT
58902	232243	CARTZ_69	DP&L	232003	CARTANZA	DP&L	2	DPL_P1_3_CARTANZA AT1	single	28.0	128.62	158.59	DC	8.39

Bus #	Bus	MW Impact
232616	GEN FOOD	2.61
232901	NORTHST	7.91
232922	MR3	17.54
938251	AE1-038 C O2	8.39
BAYOU	BAYOU	0.09
BIG_CAJUN1	BIG_CAJUN1	0.14
BIG_CAJUN2	BIG_CAJUN2	0.28
BLUEG	BLUEG	0.43
CALDERWOOD	CALDERWOOD	0.05
CANNELTON	CANNELTON	0.03
CARR	CARR	0.03
CATAWBA	CATAWBA	0.03
CHEOAH	CHEOAH	0.04
CHILHOWEE	CHILHOWEE	0.02
CHOCTAW	CHOCTAW	0.09
COFFEEN	COFFEEN	0.05
COTTONWOOD	COTTONWOOD	0.36
DEARBORN	DEARBORN	0.08
DUCKCREEK	DUCKCREEK	0.1
EDWARDS	EDWARDS	0.05
ELMERSMITH	ELMERSMITH	0.05
FARMERCITY	FARMERCITY	0.03
GIBSON	GIBSON	0.02
HAMLET	HAMLET	0.1
NEWTON	NEWTON	0.12
PRAIRIE	PRAIRIE	0.22
RENSSELAER	RENSSELAER	0.03
SANTEETLA	SANTEETLA	0.01
SMITHLAND	SMITHLAND	0.02
TATANKA	TATANKA	0.05
TILTON	TILTON	0.05
TRIMBLE	TRIMBLE	0.05
TVA	TVA	0.15

Bus #	Bus	MW Impact
UNIONPOWER	UNIONPOWER	0.07