Generation Interconnection
Feasibility Study Report
Queue Position AD2-052

The Interconnection Customer (IC) has proposed a 10 MW (6.7 MWC) solar generating facility to be located near Quinton, Salem County, New Jersey. PJM studied the AD2-052 project into the Atlantic City Electric Company (ACE) system as an injection into the Quinton 12 kV Substation at the T1 transformer and evaluated it for compliance with reliability criteria for summer peak conditions in 2021. The planned in-service date, as requested by the IC during the project kick-off call, is June 30, 2019. This date may not be attainable due to additional required PJM studies and Transmission Owner construction schedules.

Point of Interconnection

The IC requested a distribution level Point of Interconnection. As a result, the AD2-052 project will interconnect with the Atlantic City Electric Company distribution system as follows:

- The first 3.0 MWs of generation will connect to the 69/13 kV T1 transformer at Quinton Substation via a tap of the existing feeder NJ1313.

- The next 5.0 MWs of generation will connect to the 69/13 kV T1 transformer at Quinton Substation via a new express feeder.

- The next 2.0 MWs of generation will connect to a new 69/13 kV 34.5 MVA transformer at Quinton Substation via a new express feeder.

Direct Connection Requirements

Criteria Limits for Distributed Energy Resource (DER) Connections to the ACE, DPL and Pepco Distribution Systems (less than 69kV)

1. Single Phase Limit

Any DER with a capacity that exceeds 100kW shall be a balanced 3 phase system.

2. Voltage Limits

DER's are permitted to cause a voltage fluctuation of up to 2% at the Point of Interconnection, ½ the band width of any voltage regulator at its terminals, and ½ the net dead band of a switched capacitor bank at its connection point. When a DER is at maximum output, it shall not raise the feeder voltage above the ANSI C84.1 or state limit, whichever is more conservative.

3. Existing Distribution Circuit Capacity Limits

The aggregate limit of large (250 kW and over) generators running in parallel with a single, existing distribution circuit is 0.5 MWs on the 4kV, 3MWs on the 12 kV, 6 MWs on the 25 kV, and 10 MWs on the 34 kV.

4. Express Circuit Capacity Limits

Distributed generation installations which exceed the criteria limit for an existing circuit require an express circuit.

The maximum generator size for express circuits, depending on transformer capacity, shall be:

- 4 kV 0.5 MW
- 12 – 13.8 kV 10 MW
- 23 – 25 kV 10 MW
- 33.26 – 34.5 kV 15 MW

5. Distribution Power Transformer Limit
The aggregate limit of large (250 kW and over) generator injection to a single distribution transformer of 22.5 MVA nameplate or larger is 10 MW. Transformers with nameplate ratings lower than 22.5 MVA will be given lower ratings on an individual basis. If the transformer rating is significantly greater than 40 MVA it may be possible to consider a greater generation capacity.

Adding a new transformer will be considered if there is no availability on any of the existing transformers and space is available in an existing substation. Any proposed transformers would be ACE's standard distribution transformer.

6. Express Circuit Length Limit
If there is no space for an additional transformer at the closest substation, the next closest substation will be considered. The length of an express circuit is limited to 5 miles, or for the sake of the feasibility study, 3.8 straight line miles to the substation. This simplification is used because the feasibility study phase does not allow for the time and resources to examine routes in detail (including existing pole lines, easements, ROW, and environmental issues etc.)

7. When a New Substation is Required
If a distribution express circuit can't be built from an existing substation for a project, it will be necessary to construct a new distribution substation with a standard ring bus design. It will be supplied by extending existing transmission lines. It is the developer's responsibility to verify eligibility of this configuration for solar renewable energy certificates.

All limits, given above in MWs, are subject to more detailed study to ensure feasibility.

Transmission Owner Scope of Work

Transmission Owner scope of work required to accommodate 3.0 MW of generation via Feeder NJ1313 from Quinton Substation T1:

1. Extend/reconductor approximately 0.33 miles of the existing single phase section of feeder NJ1313 to three phase to reach the POI.
2. Install a utility operated recloser equipped with the proper relaying and communications.
3. Install utility grade primary metering.
4. Generation telemetry and remote trip capability will be provided to the control center.
5. A detailed, time-based study may be performed during later study phases.
6. Direct transfer trip will be required. Approximately 0.6 miles of 48SM ADSS fiber optic cable was estimated for this report to provide the communication channel from Quinton

Substation to the PV site (note: *this may require secondary zone tree trimming*). 13 kV potential transformers will need to be installed if none already in-service.

Estimated Costs			
Quinton T1 - Existing NJ1313 Feeder			
Feeder Extension	0.33	mi.	$151,800
Fiber Installation	0.6	mi.	$34,500
Recloser & Metering			$92,000
SCADA Integration into EMS			$11,500
Power Flow Study			$34,500
Miscellaneous Engineering Costs			$69,000
Approximate Total Cost			$393,300

The estimated time to complete this work is **30 - 42 months** after receipt of a fully executed interconnection agreement.

Transmission Owner (T.O.) Scope of Work

Transmission Owner scope of work required to accommodate 5.0 MW of generation via a new Express Feeder from Quinton Substation T1:

1. Design and construct one new 13 kV feeder with 477 AAC from Quinton Substation the generation site – approximately 0.6 miles.
2. One new 13 kV feeder terminal position will be constructed. This estimate assumes that space is available for this terminal inside of the existing substation footprint.
3. Install a utility operated recloser equipped with the proper relaying and communications.
4. Install utility grade primary metering.
5. Generation telemetry and remote trip capability will be provided to the control center.
6. A detailed, time-based study may be performed during later study phases.
7. Direct transfer trip will be required. Approximately 0.6 miles of 48SM ADSS fiber optic cable was estimated for this report to provide the communication channel from Quinton Substation to the PV site (note: *this may require secondary zone tree trimming*). 13 kV potential transformers will need to be installed if none already in-service.

Estimated Costs			
Quinton T1 - New 13kV Express Feeder			
477 AAC Express Feeder	0.6	mi.	$276,000
Fiber Installation	0.6	mi.	$34,500
Feeder Terminal			$575,000
Recloser & Metering			$92,000
SCADA Integration into EMS			$11,500
Power Flow Study			$34,500
Miscellaneous Engineering Costs			$69,000
Approximate Total Cost			$816,500

The estimated time to complete this work is **30 - 42 months** after receipt of a fully executed interconnection agreement.

Transmission Owner (T.O.) Scope of Work

Transmission Owner scope of work required to accommodate 2.0 MW of generation via a new Express Feeder from a new transformer at Quinton Substation:

1. Design and construct one new 13 kV feeder with 477 AAC from Quinton Substation the generation site – approximately 0.6 miles.
2. One new 13 kV feeder terminal position will be constructed. This estimate assumes that space is available for this terminal inside of the existing substation footprint.
3. Install one new 69/13 kV 34.5 MVA substation transformer at Quinton Substation. This estimate assumes that space is available for this transformer and for all associated switches, breakers, and bus inside of the existing substation footprint.
4. Install a utility operated recloser equipped with the proper relaying and communications.
5. Install utility grade primary metering.
6. Generation telemetry and remote trip capability will be provided to the control center.
7. A detailed, time-based study may be performed during later study phases.
8. Direct transfer trip will be required. Approximately 0.6 miles of 48SM ADSS fiber optic cable was estimated for this report to provide the communication channel from Quinton Substation to the PV site (note: *this may require secondary zone tree trimming*). 69 kV and 13 kV potential transformers will need to be installed.

Estimated Costs			
Quinton New 69/13kV Transformer - New 13kV Express Feeder			
New Substation Transformer			$5,750,000
477 AAC Express Feeder	0.6	mi.	$276,000
Fiber Installation	0.6	mi.	$34,500
Feeder Terminal			$575,000
Substation Relaying & 69 kV PTs			$230,000
Recloser & Metering			$92,000
SCADA Integration into EMS			$11,500
Power Flow Study			$34,500
Miscellaneous Engineering Costs			$69,000
Approximate Total Cost			$7,072,500

The estimated time to complete this work is **36 - 48 months** after receipt of a fully executed interconnection agreement.

Interconnection Customer Scope of Work

The 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 ACE'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 IC will purchase and install all metering instrument transformers as well as construct a metering structure per ACE's specifications. The secondary wiring connections at the instrument transformers will be completed by the IC's contractors and inspected by ACE, while the secondary wiring work at the metering enclosure will be completed by ACE's Meter technicians. The metering control cable and meter cabinets will be supplied by ACE and installed by the IC's contractors. ACE'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.

Power Factor Requirement

The generators used for this project shall be capable of operating at a power factor (or schedule) specified by ACE in the range of 0.95 leading to 0.95 lagging. It is the responsibility of the developer/customer to obtain equipment that can operate with these requirements while also meeting

all applicable requirements of IEEE and UL standards such as, but not limited to, IEEE 1547 and UL 1741.

For this project, operate inverters at a unity power factor ("PF") of (1.00), not impacting the Volt-ampere reactive ("VARs").

Inverter Requirements (if applicable):

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
- Disturbance Ride through for both Voltage and Frequency
- 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
- Ability to operate on a Volt/VAR schedule
- Ability to maintain a voltage schedule

The inverter shall operate in accordance with the latest IEEE 1547 series of standards that have been approved and use default settings except when specified otherwise by ACE. The PV owner/operator shall cooperate with ACE to implement these capabilities with settings acceptable to ACE. ACE reserves the right to request setting changes in the future if needed to maintain electrical system integrity.

Security Requirements

It is the responsibility of the owner to secure the generator or inverter from any unauthorized access (including physical and remote access) which could alter settings or adversely affect its ability to operate as required. Security measures should include utilizing secure password settings and/or physical locks on cabinet doors.

High Voltage Warning

Typically, voltage received at the meter from the utility can be up to 105% of nominal (without generation on). Normal operating procedures dictate that voltage at the substation be raised to the higher end of an acceptable bandwidth in order to provide adequate supply to distant customers. It is recommended that transformers with no load taps should be used to adjust secondary voltage to avoid the possibility of inverter trips. Failure to account for this may result in lost energy production.

Additional Operating Requirements

1. The Company (Pepco, ACE, and DPL) will require the capability to remotely disconnect the generator from the grid by communication from its System Operations facility. This will be accomplished with a line recloser.

2. It is the Interconnection Customer's responsibility to send the data that PJM and the Company requires directly to PJM. The Interconnection Customer will grant permission for PJM to send the Company the following telemetry that the Interconnection Customer sends to PJM: real time MW, MVAR, volts, amperes, generator breaker status or inverter 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. A mutually acceptable means of interrupting and disconnecting the generator with a visible break, able to be tagged and locked out, shall be worked out with Company Distribution Engineering.

5. Company 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 Company.

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. (AE - AE) The PEDRKTWN-BRIDGPRT 230 kV line (from bus 228312 to bus 228313 ckt 1) loads from 99.59% to 100.31% (**DC power flow**) of its emergency rating (552 MVA) for the line fault with failed breaker contingency outage of 'AE_P4-2 AE47'. This project contributes approximately 3.99 MW to the thermal violation.

   CONTINGENCY 'AE_P4-2 AE47'/*ORCHARD 230 BUS BREAKER NEW2
   DISCONNECT BRANCH FROM BUS 228002 TO BUS 228310 CKT 1/* ORCHARD TO CHURCHTOWN 230 230
   DISCONNECT BRANCH FROM BUS 228002 TO BUS 228207 CKT 1/* ORCHARD TO CUMBERLAND 230 230
   END

   Please refer to Appendix 1 for a table containing the generators having contribution to this flowgate.

2. (AE - AE) The BRIDGPRT-MCKLTON 230 kV line (from bus 228313 to bus 228401 ckt 1) loads from 99.6% to 100.15% (**DC power flow**) of its emergency rating (805 MVA) for the tower line contingency outage of 'AE_P7-1 AE9TOWER'. This project contributes approximately 4.43 MW to the thermal violation.

   CONTINGENCY 'AE_P7-1 AE9TOWER'
   DISCONNECT BRANCH FROM BUS 228314 TO BUS 228211 CKT 1/* CHURCH TO UPITTS 138 KV
   DISCONNECT BRANCH FROM BUS 228310 TO BUS 228002 CKT 1/* CHURCH TO ORCHARD 230 KV
   END

   Please refer to Appendix 2 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. To mitigate the (AE) PEDRKTWN-BRIDGPRT 230 kV line (from bus 228312 to bus 228313 ckt 1) overload will require substation reinforcements at Pedricktown Substation. The estimate to perform this work is **$400,000** and will take approximately **24-32 months** to complete.

2. To mitigate the (AE) BRIDGPRT-MCKLTON 230 kV line (from bus 228313 to bus 228401 ckt 1) overload, it will require increasing the emergency rating of the Bridgeport to Mickleton 230 kV line by rebuilding the circuit. The rebuild will include the installation of new poles, foundations, insulators, and conductor. It will also require substation reinforcements at Bridgeport Substation. The estimate to perform this work is **$19,300,000** and will take approximately **36-48 months** to complete.

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

Short Circuit

No issues identified.

Stability and Reactive Power Requirement

To be performed during later study phases.

Light Load Analysis - 2021

Light Load Studies to be conducted during later study phases (as required by PJM Manual 14B).

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.

None

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

If required, the deposit will be $50,000 and take approximately 8 months to complete.

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. All New Service Queue Requests, through the end of the Queue under study, that are contributors to a flowgate will be listed in the Appendices. Please note that there may be contributors that are subsequently queued after the queue

under study that are not listed in the Appendices. Although this information is not used "as is" for cost allocation purposes, it can be used to gage the impact of other projects/generators.

It should be noted the project/generator MW contributions presented in the body of the report and appendices sections are full contributions, whereas the loading percentages reported in the body of the report, take into consideration the commercial probability of each project as well as the ramping impact of "Adder" contributions.

Appendix 1

(AE - AE) The PEDRKTWN-BRIDGPRT 230 kV line (from bus 228312 to bus 228313 ckt 1) loads from 99.59% to 100.31% (**DC power flow**) of its emergency rating (552 MVA) for the line fault with failed breaker contingency outage of 'AE_P4-2 AE47'. This project contributes approximately 3.99 MW to the thermal violation.

CONTINGENCY 'AE_P4-2 AE47' /*ORCHARD 230 BUS BREAKER NEW2
DISCONNECT BRANCH FROM BUS 228002 TO BUS 228310 CKT 1 /* ORCHARD TO CHURCHTOWN 230 230
DISCONNECT BRANCH FROM BUS 228002 TO BUS 228207 CKT 1 /* ORCHARD TO CUMBERLAND 230 230
END

Bus Number	*Bus Name*	*Full Contribution*
936411	*AD2-052 C*	*2.67*
936412	*AD2-052 E*	*1.32*
937292	*AD2-170 E*	*0.39*
LTF	*AMIL*	*0.09*
LTF	*BAYOU*	*0.33*
LTF	*BIG_CAJUN1*	*0.51*
LTF	*BIG_CAJUN2*	*1.03*
228166	*BLE#4 ST*	*9.93*
LTF	*BLUEG*	*0.55*
LTF	*CALDERWOOD*	*0.17*
LTF	*CANNELTON*	*0.1*
228201	*CARL#2CT*	*1.71*
LTF	*CARR*	*0.11*
LTF	*CATAWBA*	*0.11*
228309	*CCLP NUG*	*31.66*
LTF	*CELEVELAND*	*0.32*
LTF	*CHEOAH*	*0.16*
LTF	*CHILHOWEE*	*0.06*
LTF	*CHOCTAW*	*0.34*
LTF	*CLIFTY*	*2.28*
LTF	*COTTONWOOD*	*1.32*
LTF	*DEARBORN*	*0.28*
LTF	*EDWARDS*	*0.17*

LTF	*ELMERSMITH*	*0.28*
LTF	*FARMERCITY*	*0.11*
LTF	*G-007*	*0.01*
LTF	*GIBSON*	*0.19*
LTF	*HAMLET*	*0.37*
228334	*MANNMILG*	*0.6*
LTF	*MORGAN*	*0.55*
LTF	*NEWTON*	*0.42*
LTF	*O-066*	*1.52*
228307	*PCLP GT*	*9.09*
228306	*PCLP STM*	*9.1*
LTF	*PRAIRIE*	*0.82*
228343	*QUINTN#1*	*0.15*
LTF	*RENSSELAER*	*0.09*
LTF	*ROSETON*	*0.65*
LTF	*ROWAN*	*0.22*
LTF	*SANTEETLA*	*0.05*
LTF	*SMITHLAND*	*0.07*
LTF	*TATANKA*	*0.2*
LTF	*TILTON*	*0.2*
LTF	*TRIMBLE*	*0.11*
LTF	*TVA*	*0.25*
LTF	*UNIONPOWER*	*0.25*
292063	*V1-021 E*	*0.03*
297082	*V2-035 C*	*0.04*
297083	*V2-035 E*	*0.38*
297090	*V2-041 E*	*0.29*
297103	*V2-046 C*	*0.45*
297104	*V2-046 E*	*4.42*
904532	*V4-054 E*	*2.67*
902092	*W1-130E*	*0.75*
903963	*W3-175*	*47.08*
918891	*AA1-108*	*107.86*
931191	*AB1-169A C*	*65.63*
931192	*AB1-169A E*	*2.98*
924531	*AB2-102 C*	*23.57*
924532	*AB2-102 E*	*0.52*

Appendix 2

(AE - AE) The BRIDGPRT-MCKLTON 230 kV line (from bus 228313 to bus 228401 ckt 1) loads from 99.6% to 100.15% (**DC power flow**) of its emergency rating (805 MVA) for the tower line contingency outage of 'AE_P7-1 AE9TOWER'. This project contributes approximately 4.43 MW to the thermal violation.

CONTINGENCY 'AE_P7-1 AE9TOWER'
DISCONNECT BRANCH FROM BUS 228314 TO BUS 228211 CKT 1 /* CHURCH TO UPITTS 138 KV
DISCONNECT BRANCH FROM BUS 228310 TO BUS 228002 CKT 1 /* CHURCH TO ORCHARD 230 KV
END

Bus Number	*Bus Name*	*Full Contribution*
936411	*AD2-052 C*	*2.97*
936412	*AD2-052 E*	*1.46*
937292	*AD2-170 E*	*0.38*
LTF	*AMIL*	*0.13*
LTF	*BAYOU*	*0.48*
LTF	*BIG_CAJUN1*	*0.73*
LTF	*BIG_CAJUN2*	*1.48*
LTF	*BLUEG*	*0.8*
LTF	*CALDERWOOD*	*0.25*
LTF	*CANNELTON*	*0.14*
228201	*CARL#2CT*	*1.67*
LTF	*CARR*	*0.17*
LTF	*CATAWBA*	*0.16*
228309	*CCLP NUG*	*35.92*
LTF	*CELEVELAND*	*0.46*
LTF	*CHEOAH*	*0.23*
LTF	*CHILHOWEE*	*0.08*
LTF	*CHOCTAW*	*0.49*
LTF	*CLIFTY*	*3.27*
LTF	*COTTONWOOD*	*1.89*
LTF	*DEARBORN*	*0.4*
LTF	*EDWARDS*	*0.24*
LTF	*ELMERSMITH*	*0.4*
LTF	*FARMERCITY*	*0.16*
LTF	*G-007*	*0.38*
LTF	*GIBSON*	*0.27*
LTF	*HAMLET*	*0.52*
228304	*LOGAN*	*36.63*
228334	*MANNMILG*	*0.68*
LTF	*MORGAN*	*0.79*
LTF	*NEWTON*	*0.61*
LTF	*O-066*	*2.93*
228307	*PCLP GT*	*9.78*
228306	*PCLP STM*	*9.8*
LTF	*PRAIRIE*	*1.17*
228343	*QUINTN#1*	*0.16*
LTF	*RENSSELAER*	*0.13*
LTF	*ROSETON*	*0.96*

LTF	*ROWAN*	*0.32*
LTF	*SANTEETLA*	*0.07*
LTF	*SMITHLAND*	*0.09*
LTF	*TATANKA*	*0.29*
LTF	*TILTON*	*0.29*
LTF	*TRIMBLE*	*0.15*
LTF	*TVA*	*0.35*
LTF	*UNIONPOWER*	*0.35*
297103	*V2-046 C*	*0.5*
297104	*V2-046 E*	*4.97*
904532	*V4-054 E*	*2.54*
903963	*W3-175*	*54.27*
918891	*AA1-108*	*124.34*