Generation Interconnection

Feasibility Study Report

Queue Position AB1-153

Interconnection Customer (IC) has proposed a natural gas generating facility located in Adams County, PA. The installed facilities will have a total capability of 1061.50MW with 985.1MW of this output being recognized by PJM as Capacity. The proposed in-service date for this project is June 1, 2020. **This study does not imply a Metropolitan Edison Company commitment to this in-service date.**

Point of Interconnection

AB1-153 will interconnect with Metropolitan Edison Company transmission system at the Hunterstown 500kV substation.

Cost Summary

A cost summary of the facilities upgrades that are required to connect the AB1-153 generator to existing Hunterstown 500 kV substation is shown in Table 1. Further, a cost summary for the network upgrades that are required to maintain reliability of the Metropolitan Edison Company transmission systems are shown in Table 2. PJM will be responsible for determining the allocation of this total to the Interconnection Customer in compliance with the existing RTEP procedures. Note that all costs given in this report do not include a CIAC (Contribution in Aid of Construction) Federal Income Tax Gross Up charge.

The AB1-153 project will be responsible for the following costs:

Table 1 – Description of Facilities Upgrades	**Amount**
Attachment Facilities	$ 1,257,000
Direct Connection Upgrades	$ 8,641,700
Non-Direct Connection Upgrades	$ 1,757,600
Total Cost	**$ 11,656,300**

In addition, the AB1-153 project may be responsible for a contribution to the following costs:

Table 2 – Description of System Upgrades	**Amount**
New System Upgrades	$ 11,396,200
Previously Identified Network Upgrades	$ 0
Total Cost	**$ 11,396,200**

Cost allocations for these upgrades will be provided in the System Impact Study Report.

Attachment Facilities Cost Estimate

Attachment 1 shows a conceptual one-line diagram of the proposed substation reconfiguration. The Interconnection Customer will be responsible to acquire right-of-way (independent from Metropolitan Edison Company's ROW), construct, own and operate its 500 kV attachment line to the Metropolitan Edison Company Hunterstown 500 kV substation. The POI will be located on the Hunterstown 500 kV (AB1-153) Project attachment line one span from the Metropolitan Edison Company Hunterstown 500 kV substation dead end structure. The Interconnection Customer will also be responsible for acquiring all easements, properties and permits that may be required for the construction of the project connection facilities. When the final Direct Connection ROW is disclosed for the Hunterstown 500 kV (AB1-153) Project, First Energy will finalize the connection design. There was no secondary POI selected by the Interconnection Customer for the Hunterstown 500 kV (AB1-153) Project.

The total preliminary cost estimate for the Attachment work is given in Table 3. These costs do not include CIAC Tax Gross-up.

Table 3 – Description Attachment Facilities	**Amount**
Construct new 500 kV line exit from the AB1-153 project.	$ 1,257,000
Total Cost	**$ 1,257,000**

Direct Connection Cost Estimate

The total preliminary cost estimate for the Direct Connection work is given in Table 4. These costs do not include CIAC Tax Gross-up.

Table 4 – Description of Direct Connection Cost	Amount
Expand Hunterstown 500 kV breaker-and-a-half scheme by adding a new breaker string creating access for new AB1-153 terminal; this includes: - Install three (3) new 500 kV circuit breakers - Relocate the terminals of the two existing 500 kV generator transmission lines - Install new primary and backup line relays - Install new breaker failure relay - Install new line PT's & CT's - Install a new DFR (DAU) to monitor the new line extension to the AB1-153 project - Terminate the new AB1-500 kV Location: Hunterstown 500 kV Substation	$ 8,641,700
Total Cost	**$ 8,641,700**

Non-Direct Connection Cost Estimate

The total preliminary cost estimate for the Non-Direct Connection work is given in Table 5. These costs do not include CIAC Tax Gross-up.

Table 5 – Description of Non-Direct Connection Cost	Amount
Relocate the structures for the existing two 500 kV generator lines outside of the Hunderstown substation. Location: Hunderstown – Reliant Generation 500 kV Lines	$ 1,757,600
Total Cost	**$ 1,757,600**

Schedule

It is expected to take a minimum of 18 months of continuous construction from the signing of an Interconnection Construction Service Agreement to complete the upgrades required for the Hunterstown 500 kV (AB1-153) Project. This assumes that the Interconnection Customer will construct all facilities to the point of interconnection at the existing Hunterstown 500 kV substation. A further assumption is that there will be no environmental issues with any of the new properties associated with this project, that there will be no delays in acquiring the necessary permits for implementing the defined direct connection and network upgrades, and that PJM will allow all transmission system outages when requested. The construction timeline will be examined in greater detail in the Facilities Study. A preliminary payment is required for the first

three months of the engineering design work that is related to construction at the new Hunterstown 500 kV substation and the required attachment facilities.

Note that the First Energy findings were made from a conceptual review of this project. A more detailed review of the connection facilities and their cost will be identified in the System Impact Study

Interconnection Customer Requirements

In addition to the Metropolitan Edison Company facilities, the Interconnection Customer will also be responsible for meeting all criteria as specified in the applicable sections of the "FE Requirements for Transmission Connected Facilities" document including:

1. The purchase and installation of the minimum required FE generation interconnection relaying and control facilities. This includes over/under voltage protection, over/under frequency protection, and zero sequence voltage protection relays.

2. The purchase and installation of a 500 kV interconnection metering instrument transformer. FE will provide the ratio and accuracy specifications based on the customer load and generation levels.

3. The purchase and installation of a revenue class meter for each Interconnection Customer unit to measure the power delivered in compliance with the FE standards.

4. A compliance with the FE and PJM generator power factor and voltage control requirements.

5. The execution of a back-up service agreement to serve the customer load supplied from the Metropolitan Edison Company owned 500 kV substation when the Hunterstown 500 kV (AB1-153) Project units are out-of-service.

6. The purchase and installation of supervisory control and data acquisition (SCADA) equipment to provide information in a compatible format to the FE Transmission System Control Center. The RTU, the communications channel and all related equipment will be furnished and maintained by the Interconnection Customer. The RTU must communicate with the FirstEnergy EMS via DNP 3.0 protocol.

7. The following status and metering points will be required:

a. Interconnection breaker position.

b. Generator real and reactive power output measured at the high-side of the generator step-up transformer.

c. Generator voltage at the point of interconnection.

The above requirements are in addition to any metering required by PJM.

Revenue Metering and SCADA Requirements

PJM Requirements

The Interconnection Customer will be required to install equipment necessary to provide Revenue Metering (KWH, KVARH) and real time data (KW, KVAR) for IC's generating Resource. See PJM Manuals M-01 and M-14D, and PJM Tariff Sections 24.1 and 24.2.

Metropolitan Edison Company Requirements

The Interconnection Customer will be required to comply with all FE Revenue Metering Requirements for Generation Interconnection Customers. The Revenue Metering Requirements may be found within the "FirstEnergy Requirements for Transmission Connected Facilities" document located at the following links:

http://www.firstenergycorp.com/feconnect
http://www.pjm.com/planning/design-engineering/to-tech-standards.aspx

Network Impacts

The Queue Project AB1-153 was evaluated as a 1061.5 MW (Capacity 985.1 MW) injection at the Hunterstown 500kV substation in the METED area. Project AB1-153 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). The Study is based on Summer Peak Analysis – 2019. The Study is based on Summer Peak Analysis – 2019. Project AB1-153 was studied with a commercial probability of 53%. Potential network impacts were as follows:

Generator Deliverability

(Single or N-1 contingencies for the Capacity portion only of the interconnection)

1. (PJM500 - METED) The HUNTERTN 500/230 kV transformer (from bus 200026 to bus 204501 ckt 1) loads from 78.24% to 101.55% (**DC power flow**) of its emergency rating (1183 MVA) for the single line contingency outage of 'PJM67'. This project contributes approximately 275.84 MW to the thermal violation.

CONTINGENCY 'PJM67'
DISCONNECT BRANCH FROM BUS 200026 TO BUS 200004 CKT 1 /*
HUNTERTN CNASTONE 500 500
END

2. (METED - METED) The 27HUNTRSTN-27HUNTRST1 230 kV line (from bus 204501 to bus 204575 ckt 1) loads from 84.64% to 107.73% (**DC power flow**) of its emergency rating

(1195 MVA) for the single line contingency outage of 'PJM67'. This project contributes approximately 275.84 MW to the thermal violation.

```
CONTINGENCY 'PJM67'
  DISCONNECT BRANCH FROM BUS 200026 TO BUS 200004 CKT 1          /*
HUNTERTN CNASTONE 500 500
  END
```

Please refer to Attachment 3 for a table containing the generators having contribution to this flowgate.

Multiple Facility Contingency

(Double Circuit Tower Line, Fault with a Stuck Breaker, and Bus Fault contingencies for the full energy output)

1. (PJM500 - METED) The HUNTERTN 500/230 kV transformer (from bus 200026 to bus 204501 ckt 1) loads from 79.48% to 104.59% (**DC power flow**) of its emergency rating (1183 MVA) for the line fault with failed breaker contingency outage of 'CNSTN_L'. This project contributes approximately 297.14 MW to the thermal violation.

```
CONTINGENCY 'CNSTN_L'                                  /* CONASTONE L (500-2/5013)
BREAKER
  DISCONNECT BRANCH FROM BUS 220963 TO BUS 200004 CKT 1          /*
CONASTONE 500-2 TRANSFORMER
  DISCONNECT BRANCH FROM BUS 200004 TO BUS 200026 CKT 1          /* CKT #5013
CONASTONE TO HUNTERSTOWN
  END
```

Please refer to Attachment 4 for a table containing the generators having contribution to this flowgate.

2. (METED - METED) The 27HUNTRSTN-27HUNTRST1 230 kV line (from bus 204501 to bus 204575 ckt 1) loads from 81.54% to 106.41% (**DC power flow**) of its emergency rating (1195 MVA) for the line fault with failed breaker contingency outage of 'CNSTN_L'. This project contributes approximately 297.14 MW to the thermal violation.

```
CONTINGENCY 'CNSTN_L'                                  /* CONASTONE L (500-2/5013)
BREAKER
  DISCONNECT BRANCH FROM BUS 220963 TO BUS 200004 CKT 1          /*
CONASTONE 500-2 TRANSFORMER
```

DISCONNECT BRANCH FROM BUS 200004 TO BUS 200026 CKT 1 /* CKT #5013 CONASTONE TO HUNTERSTOWN
END

3. (PJM500 - PJM500) The AB1-003 TAP-KEYSTONE 500 kV line (from bus 930030 to bus 200011 ckt 1) loads from 87.05% to 109.08% (**DC power flow**) of its emergency rating (3011 MVA) for the line fault with failed breaker contingency outage of 'PJM11BG'. This project contributes approximately 691.68 MW to the thermal violation.

CONTINGENCY 'PJM11BG' /* CONASTONE BREAKER L (TIE BREAKER)
DISCONNECT BRANCH FROM BUS 200026 TO BUS 200004 CKT 1 /* HUNTERTN CNASTONE 500500
DISCONNECT BRANCH FROM BUS 200026 TO BUS 204501 CKT 1 /* HUNTERTN HUNTRSTN 500230
DISCONNECT BRANCH FROM BUS 200004 TO BUS 220963 CKT 1 /* CNASTONE CONASTNE 500230
END

Please refer to Attachment 4 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

Steady-State Voltage Requirements

(Results of the steady-state voltage studies should be inserted here)

To be determined

Short Circuit

(Summary of impacted circuit breakers)

AB1-153 did not cause any breakers to become newly over duty and did not have a > 3% contribution to any existing over duty breakers.

Affected System Analysis & Mitigation

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.

1. (PJM500 - PJM500) The HUNTERTN-CNASTONE 500 kV line (from bus 200026 to bus 200004 ckt 1) loads from 75.76% to 100.73% (**DC power flow**) of its emergency rating (2815 MVA) for the single line contingency outage of 'PJM20A_CONEMAGH-KEYSTONE_B'. This project contributes approximately 716.5 MW to the thermal violation.

CONTINGENCY 'PJM20A_CONEMAGH-KEYSTONE_B'
DISCONNECT BRANCH FROM BUS 930030 TO BUS 200011 CKT 1 /* AB1-003_TAP KEYSTONE 500 500
END

2. (PJM500 - METED) The HUNTERTN 500/230 kV transformer (from bus 200026 to bus 204501 ckt 1) loads from 78.97% to 104.09% (**DC power flow**) of its emergency rating (1183 MVA) for the single line contingency outage of 'PJM67'. This project contributes approximately 297.23 MW to the thermal violation.

CONTINGENCY 'PJM67'
DISCONNECT BRANCH FROM BUS 200026 TO BUS 200004 CKT 1 /* HUNTERTN CNASTONE 500 500
END

3. (METED - METED) The 27HUNTRSTN-27HUNTRST1 230 kV line (from bus 204501 to bus 204575 ckt 1) loads from 81.04% to 105.91% (**DC power flow**) of its emergency rating

(1195 MVA) for the single line contingency outage of 'PJM67'. This project contributes approximately 297.23 MW to the thermal violation.

CONTINGENCY 'PJM67'
DISCONNECT BRANCH FROM BUS 200026 TO BUS 200004 CKT 1 /*
HUNTERTN CNASTONE 500 500
END

Light Load Analysis - 2019

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

System Reinforcements

Short Circuit

(Summary form of Cost allocation for breakers will be inserted here if any)

AB1-153 did not cause any breakers to become newly over duty and did not have a > 3% contribution to any existing over duty breakers.

Stability and Reactive Power Requirement

(Results of the dynamic studies should be inserted here)

To be determined

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)

Generator Deliverability

1. (PJM500 - METED) The HUNTERTN 500/230 kV transformer (from bus 200026 to bus 204501 ckt 1) loads from 78.24% to 101.55% (**DC power flow**) of its emergency rating (1183

MVA) for the single line contingency outage of 'PJM67'. This project contributes approximately 275.84 MW to the thermal violation.

Reinforcement: Install a second 500/230 kV transformer & reactor at Hunterstown.
Cost: $11,396,200
Time: 18 months

As identified, there are criteria violations that are directly attributable to the Hunterstown 500 kV (AB1-153) Project. A definition of the network upgrades required to mitigate the identified contingency overloads and their estimated cost is defined in Table 6. The costs shown do not include CIAC Tax Gross-up.

Table 6 – Description	**Amount**
- Add a string of breakers to the 230 kV ring bus, expanding the ring bus into a breaker-and-a-half scheme. - Install a second 500/230 kV 729 MVA Transmformer & 230 kV Reactor - Install two, new 230 kV circuit breaker - - Relocate the Hunterstown – Jackson 230 kV line terminal - Relocate the terminal on the 500 kV side of the 500/230 kV #1 Transformer	$ 11,396,200
Total Cost	**$ 11,396,200**

2. (METED - METED) The 27HUNTRSTN-27HUNTRST1 230 kV line (from bus 204501 to bus 204575 ckt 1) loads from 84.64% to 107.73% (**DC power flow**) of its emergency rating (1195 MVA) for the single line contingency outage of 'PJM67'. This project contributes approximately 275.84 MW to the thermal violation.

Reinforcement: Same as Generator Deliverability #1

Multiple Facility Contingency

1. (PJM500 - METED) The HUNTERTN 500/230 kV transformer (from bus 200026 to bus 204501 ckt 1) loads from 79.48% to 104.59% (**DC power flow**) of its emergency rating (1183 MVA) for the line fault with failed breaker contingency outage of 'CNSTN_L'. This project contributes approximately 297.14 MW to the thermal violation.

Reinforcement: Same as Generator Deliverability #1

2. (METED - METED) The 27HUNTRSTN-27HUNTRST1 230 kV line (from bus 204501 to bus 204575 ckt 1) loads from 81.54% to 106.41% (**DC power flow**) of its emergency rating (1195 MVA) for the line fault with failed breaker contingency outage of 'CNSTN_L'. This project contributes approximately 297.14 MW to the thermal violation.

Reinforcement: Same as Generator Deliverability #1

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)
(Summary form of Cost allocation for transmission lines and transformers will be inserted here if any)

None

New System Reinforcements

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

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)
(Summary form of Cost allocation for transmission lines and transformers will be inserted here if any)

Additional Interconnection Customer Responsibilities:

1. An Interconnection Customer entering the New Services Queue on or after October 1, 2012 with a proposed new Customer Facility that has a Maximum Facility Output equal to or greater than 100 MW shall install and maintain, at its expense, phasor measurement units (PMUs). See Section 8.5.3 of Appendix 2 to the Interconnection Service Agreement as well as section 4.3 of PJM Manual 14D for additional information.

2. The Interconnection Customer may be required to install and/or pay for metering as necessary to properly track real time output of the facility as well as installing metering which shall be used for billing purposes. See Section 8 of Appendix 2 to the Interconnection Service Agreement as well as Section 4 of PJM Manual 14D for additional information.

3. The Interconnection Customer seeking to interconnect a wind generation facility shall maintain meteorological data facilities as well as provide that meteorological data which is required per item 5.iv. of Schedule H to the Interconnection Service Agreement.

4. The Interconnection Customer may be required to coordinate with other generators that are connected to the substation bus regarding any outages that may be required to implement the upgrades on the ringbus. For those elements of the upgrades that are shared by the generating entities, there may be an agreement necessary between their companies for the maintenance and sharing of the equipment before an Interconnection Service Agreement can be crafted.

Note to Attachments 3 and 4

FLOWGATE DETAILS

Attachments 3 and 4 contain additional information about each flowgate presented in the body of the report. For each attachment, a description of the flowgate and its contingency was included for convenience. However, the intent of the attachment 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 attachment sections are full contributions, whereas in the body of the report, those contributions take into consideration the commercial probability of each project.

Attachment 3

Generator Deliverability Flowgate Contingency

(METED - METED) The 27HUNTRSTN-27HUNTRST1 230 kV line (from bus 204501 to bus 204575 ckt 1) loads from 84.64% to 107.73% (DC power flow) of its emergency rating (1195 MVA) for the single line contingency outage of 'PJM67'. This project contributes approximately 275.84 MW to the thermal violation.

CONTINGENCY 'PJM67'
DISCONNECT BRANCH FROM BUS 200026 TO BUS 200004 CKT 1 /* HUNTERTN CNASTONE 500 500
END

Bus Number	*Bus Name*	*Full Contribution*
200030	*CONE G1*	*4.86*
200031	*CONE G2*	*4.92*
200058	*HUNTR101*	*4.01*
200059	*HUNTR201*	*4.01*
200060	*HUNTR301*	*4.01*
200061	*HUNTR401*	*7.68*
918591	*AA1-076 C OP*	*172.9*
930031	*AB1-003 OP*	*76.38*
931041	*AB1-153 C*	*275.84*

Attachment 4

Multiple Facility Flowgate Contingency

(PJM500 - METED) The HUNTERTN 500/230 kV transformer (from bus 200026 to bus 204501 ckt 1) loads from 79.48% to 104.59% (**DC power flow**) of its emergency rating (1183 MVA) for the line fault with failed breaker contingency outage of 'CNSTN_L'. This project contributes approximately 297.14 MW to the thermal violation.

CONTINGENCY 'CNSTN_L' /* CONASTONE L (500-2/5013) BREAKER
DISCONNECT BRANCH FROM BUS 220963 TO BUS 200004 CKT 1 /* CONASTONE 500-2 TRANSFORMER
DISCONNECT BRANCH FROM BUS 200004 TO BUS 200026 CKT 1 /* CKT #5013 CONASTONE TO HUNTERSTOWN
END

Bus Number	*Bus Name*	*Full Contribution*
200058	*HUNTR101*	*4.01*
200059	*HUNTR201*	*4.01*
200060	*HUNTR301*	*4.01*
200061	*HUNTR401*	*7.68*
918591	*AA1-076 C OP*	*172.85*
918592	*AA1-076 E OP*	*8.64*
931041	*AB1-153 C*	*275.75*
931042	*AB1-153 E*	*21.39*