Generation Interconnection Feasibility Study Report Queue Position AD2-028

Interconnection Customer has proposed a 150 MW solar and battery storage generating facility to be located in the Franklin County, Pennsylvania. PJM recognizes 76.3 MW as Capacity Interconnection Rights for this project.

The following table shows the net energy and capacity contribution by fuel type:

	Solar	**Battery**	**Total MW**
MFO [1]	100	50	150
CIR [2]	68	8.33	76.3

[1] MFO stands for Maximum Facility Output, which is a defined term in the Tariff.
[2] CIR stands for Capacity Interconnection Rights, which is a defined term in the Tariff.

The proposed in-service date is June 30, 2019. **This study does not imply a West Penn Power ("Transmission Owner") commitment to this in-service date.**

Point of Interconnection ("POI")

The AD2-028 interconnection project will tap the McConnellsburg – Texas Eastern 6 138 kV transmission line by building a new 3 breaker substation located about 7.3 miles from McConnellsburg and 9.31 miles from Texas Eastern 6 substations. The POI will be located at the substation's exist side to solar plant. Please refer to Appendix 2 for a one-line diagram of this project.

Network Impacts

The Queue Project AD2-028 was evaluated as a 150.0 MW (Capacity 76.3 MW) injection tapping the McConnellsburg to Texas Eastern 6 138kV line in the APS area. Project AD2-028 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AD2-028 was studied with a commercial probability of 53%. Potential network impacts were as follows:

Summer Peak Analysis - 2021

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. (AP - AP) The 01RINGLD-01WOLFSVILLE 138 kV line (from bus 235505 to bus 237323 ckt 1) loads from 97.73% to 105.66% (**DC power flow**) of its emergency rating (192 MVA) for the tower line contingency outage of 'AP-P7-1-PE-230-004'. This project contributes approximately 15.23 MW to the thermal violation.

```
CONTINGENCY 'AP-P7-1-PE-230-004'                    /* 120
  DISCONNECT BRANCH FROM BUS 235459 TO BUS 235543 CKT 1      /* 01DOUBS 230 01FROSTN 230
  DISCONNECT BRANCH FROM BUS 235506 TO BUS 235543 CKT 1      /* 01RINGLD 230 01FROSTN 230
  DISCONNECT BRANCH FROM BUS 235543 TO BUS 235544 CKT 1      /* 01FROSTN 230 01BOONES 230
  DISCONNECT BRANCH FROM BUS 235488 TO BUS 235494 CKT 1      /* 01MONOCY 230 01OLDFRM 230
  DISCONNECT BRANCH FROM BUS 235494 TO BUS 235506 CKT 1      /* 01OLDFRM 230 01RINGLD 230
  END
```

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

2. (AP - AP) The 01WOLFSVILLE-01CATOCT 138 kV line (from bus 237323 to bus 235452 ckt 1) loads from 95.33% to 103.26% (**DC power flow**) of its emergency rating (192 MVA) for the tower line contingency outage of 'AP-P7-1-PE-230-004'. This project contributes approximately 15.23 MW to the thermal violation.

```
CONTINGENCY 'AP-P7-1-PE-230-004'                    /* 120
  DISCONNECT BRANCH FROM BUS 235459 TO BUS 235543 CKT 1      /* 01DOUBS 230 01FROSTN 230
  DISCONNECT BRANCH FROM BUS 235506 TO BUS 235543 CKT 1      /* 01RINGLD 230 01FROSTN 230
  DISCONNECT BRANCH FROM BUS 235543 TO BUS 235544 CKT 1      /* 01FROSTN 230 01BOONES 230
  DISCONNECT BRANCH FROM BUS 235488 TO BUS 235494 CKT 1      /* 01MONOCY 230 01OLDFRM 230
  DISCONNECT BRANCH FROM BUS 235494 TO BUS 235506 CKT 1      /* 01OLDFRM 230 01RINGLD 230
  END
```

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

3. (PENELEC - PENELEC) The 26ROXBURY 138/115 kV transformer (from bus 200532 to bus 200520 ckt 2) loads from 86.52% to 100.26% (**DC power flow**) of its emergency rating (150 MVA) for the line fault with failed breaker contingency outage of 'ME_P4-500-002H'. This project contributes approximately 20.61 MW to the thermal violation.

```
CONTINGENCY 'ME_P4-500-002H'                    /* HUNTERSTOWN 500 KV STUCK CB - CBB11392
  DISCONNECT BRANCH FROM BUS 200026 TO BUS 200004 CKT 1      /* HUNTERTN 500 CNASTONE 500
  DISCONNECT BRANCH FROM BUS 200026 TO BUS 204501 CKT 1      /* HUNTERTN 500 27HUNTRSTN 230
  END
```

Please refer to Appendix 5 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

To be determined during the system impact phase.

Short Circuit

None

Affected System Analysis & Mitigation

NYISO Impacts:

NYISO Impacts to be determined during later study phases (as applicable).

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

Light Load Analysis - 2021

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

System Reinforcements

Short Circuit

None

Stability and Reactive Power Requirement

To be determined during the system impact phase.

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)

Multiple Facility Contingency

1. (AP - AP) The 01RINGLD-01WOLFSVILLE 138 kV line (from bus 235505 to bus 237323 ckt 1) loads from 97.73% to 105.66% (**DC power flow**) of its emergency rating (192 MVA) for the tower line contingency outage of 'AP-P7-1-PE-230-004'. This project contributes approximately 15.23 MW to the thermal violation.

APS:
Overload will be mitigated by baseline projects:

1) Reconfigure the Ringgold 230 kV substation to double bus double breaker scheme (PJM Upgrade Id: b2743.6). The scheduled in-service date is 06/01/2020.
2) Replace the two Ringgold 230/138 kV transformers (PJM Upgrade Id: b2743.6.1). The scheduled in-service date is 06/01/2020.
3) Rebuild/Reconductor the Ringgold - Catoctin 138 kV circuit and upgrade terminal equipment on both ends (PJM Upgrade Id: b2743.7). The scheduled in-service date is 06/01/2020.
4) Replace Ringgold Substation 138 kV breakers '138 BUS TIE' and 'RCM0' with 40 kA breakers (PJM Upgrade Id: b2743.8). The scheduled in-service date is 06/01/2020.
5) Install two new 230 kV positions at Ringgold for 230/138 kV transformers (PJM Upgrade Ids: b2970.1). The scheduled in-service date is 06/01/2020.
6) Install new 230 kV position for Ringgold – Catoctin 230 kV line (PJM Upgrade Ids: b2970.2). The scheduled in-service date is 06/01/2020.
7) Install one new 230 kV breaker at Catoctin substation. (PJM Upgrade Ids: b2970.3). The scheduled in-service date is 06/01/2020.

8) Install new 230 / 138 kV transformer at Catoctin substation. Convert Ringgold-Catoctin 138 kV Line to 230 kV operation. (PJM Upgrade Ids: b2970.4). The scheduled in-service date is 06/01/2020.

2. (AP - AP) The 01WOLFSVILLE-01CATOCT 138 kV line (from bus 237323 to bus 235452 ckt 1) loads from 95.33% to 103.26% (**DC power flow**) of its emergency rating (192 MVA) for the tower line contingency outage of 'AP-P7-1-PE-230-004'. This project contributes approximately 15.23 MW to the thermal violation.

Same as Multiple Facility Contingency #1

3. (PENELEC - PENELEC) The 26ROXBURY 138/115 kV transformer (from bus 200532 to bus 200520 ckt 2) loads from 86.52% to 100.26% (**DC power flow**) of its emergency rating (150 MVA) for the line fault with failed breaker contingency outage of 'ME_P4-500-002H'. This project contributes approximately 20.61 MW to the thermal violation.

PENELEC:
Replace the existing Roxbury 100 MVA 138/115 kV transformer with a 224 MVA unit. Convert Roxbury 115 kV substation into a four (4) breaker ring bus. (Upgrade Id: s1643) The scheduled in-service date is 12/31/2019.

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

Light Load 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)

None

Appendix 3

Flowgate Contingency - 01RINGLD - 01WOLFSVILLE 138 kV line
PJM Queue Position: AD2-028

This appendix contains additional information about the flowgate presented in the body of the report. The intent of this 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.

(AP - AP) The 01RINGLD-01WOLFSVILLE 138 kV line (from line bus 235505 to line bus 237323 ckt 1) loads from 97.73% to 105.66% (**DC power flow**) of its emergency rating (192 MVA) for the tower line contingency outage of 'AP-P7-1-PE-230-004'. This project contributes approximately 15.23 MW to the thermal violation.

```
CONTINGENCY 'AP-P7-1-PE-230-004'                    /* 120
  DISCONNECT BRANCH FROM BUS 235459 TO BUS 235543 CKT 1        /* 01DOUBS
230 01FROSTN 230
  DISCONNECT BRANCH FROM BUS 235506 TO BUS 235543 CKT 1        /* 01RINGLD
230 01FROSTN 230
  DISCONNECT BRANCH FROM BUS 235543 TO BUS 235544 CKT 1        /* 01FROSTN
230 01BOONES 230
  DISCONNECT BRANCH FROM BUS 235488 TO BUS 235494 CKT 1        /*
01MONOCY 230 01OLDFRM 230
  DISCONNECT BRANCH FROM BUS 235494 TO BUS 235506 CKT 1        /*
01OLDFRM 230 01RINGLD 230

END
```

Appendix 3 – Continued from previous page

Flowgate Contingency - 01RINGLD - 01WOLFSVILLE 138 kV line
PJM Queue Position: AD2-028

Bus Number	Gen. Bus Name	Full Contribution
LTF	VFT	4.39
LTF	UNIONPOWER	0.32
LTF	TVA	0.24
LTF	TRIMBLE	0.06
LTF	TILTON	0.11
LTF	TATANKA	0.13
LTF	SMITHLAND	0.05
LTF	SANTEETLA	0.05
LTF	ROWAN	0.36
LTF	PRAIRIE	0.57
LTF	O-066A	0.76
LTF	NYISO	2.43
LTF	NEWTON	0.26
LTF	MORGAN	0.56
LTF	HAMLET	0.66
LTF	GIBSON	0.11
LTF	G-007A	1.63
LTF	FARMERCITY	0.07
LTF	ELMERSMITH	0.18
LTF	EDWARDS	0.09
LTF	DEARBORN	0.05
LTF	COTTONWOOD	1.25
LTF	CLIFTY	1.22
LTF	CHOCTAW	0.34
LTF	CHILHOWEE	0.06
LTF	CHEOAH	0.18
LTF	CELEVELAND	0.5
LTF	CBM-N	0.16
LTF	CATAWBA	0.17
LTF	CANNELTON	0.06
LTF	CALDERWOOD	0.19
LTF	BLUEG	0.32
LTF	BIG_CAJUN2	1.01
LTF	BIG_CAJUN1	0.5
LTF	BAYOU	0.32
LTF	AMIL	0.06
936871	AD2-110	1.34
936472	AD2-062 E O1	2.3
936471	AD2-062 C O1	4.6
936311	AD2-040	0.34

Bus Number	Gen. Bus Name	Full Contribution
936224	AD2-028 E2	4.23
936223	AD2-028 C2	0.85
936222	AD2-028 E1	3.25
936221	AD2-028 C1	6.9
936062	AD2-009 E	2.06
936061	AD2-009 C	4.52
934372	AD1-061 E	1.19
934371	AD1-061 C	0.74
934362	AD1-060 E	0.93
934361	AD1-060 C	0.57
933252	AC2-136 E	1.09
933251	AC2-136 C	0.95
930832	AB1-128 E	1.25
930831	AB1-128 C	0.77
930822	AB1-127 E	1.25
930821	AB1-127 C	0.77
930782	AB1-123 E	0.62
930781	AB1-123 C	0.59
924482	AB2-097 E	1.15
923872	AB2-027 E	0.49
923871	AB2-027 C	0.29
920562	AA2-159 E	0.51
920561	AA2-159 C	0.61
920012	AA2-085 E	0.43
920011	AA2-085 C	0.27
918772	AA1-096 E	0.09
918771	AA1-096 C	0.17
918762	AA1-095 E	0.24
918761	AA1-095 C	0.48
918742	AA1-093 E	0.08
918741	AA1-093 C	0.16
918732	AA1-092 E	0.37
918731	AA1-092 C	0.73
918662	AA1-080 E	0.09
918661	AA1-080 C	0.17
905554	W4-102 E	1.08
901242	W1-045E OP1	0.77
901241	W1-045C OP1	0.47
237329	01CHBRG_I12	0.67
235724	01GUILF2	0.97
235723	01GUILF1	0.97

Appendix 4

Flowgate Contingency - 01WOLFSVILLE-01CATOCT 138 kV line
PJM Queue Position: AD2-028

This appendix contains additional information about the flowgate presented in the body of the report. The intent of this 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.

(AP - AP) The 01WOLFSVILLE-01CATOCT 138 kV line (from bus 237323 to bus 235452 ckt 1) loads from 95.33% to 103.26% (**DC power flow**) of its emergency rating (192 MVA) for the tower line contingency outage of 'AP-P7-1-PE-230-004'. This project contributes approximately 15.23 MW to the thermal violation.

```
CONTINGENCY 'AP-P7-1-PE-230-004'                    /* 120
  DISCONNECT BRANCH FROM BUS 235459 TO BUS 235543 CKT 1        /* 01DOUBS
230 01FROSTN 230
  DISCONNECT BRANCH FROM BUS 235506 TO BUS 235543 CKT 1        /* 01RINGLD
230 01FROSTN 230
  DISCONNECT BRANCH FROM BUS 235543 TO BUS 235544 CKT 1        /* 01FROSTN
230 01BOONES 230
  DISCONNECT BRANCH FROM BUS 235488 TO BUS 235494 CKT 1        /*
01MONOCY 230 01OLDFRM 230
  DISCONNECT BRANCH FROM BUS 235494 TO BUS 235506 CKT 1        /*
01OLDFRM 230 01RINGLD 230
  END
```

Appendix 4 – Continued from previous page

Flowgate Contingency - 01WOLFSVILLE-01CATOCT 138 kV line
PJM Queue Position: AD2-028

Bus Number	Gen. Bus Name	Full Contribution
LTF	AMIL	0.06
LTF	BAYOU	0.32
LTF	BIG_CAJUN1	0.5
LTF	BIG_CAJUN2	1.01
LTF	BLUEG	0.32
LTF	CALDERWOOD	0.19
LTF	CANNELTON	0.06
LTF	CATAWBA	0.17
LTF	CBM-N	0.16
LTF	CELEVELAND	0.5
LTF	CHEOAH	0.18
LTF	CHILHOWEE	0.06
LTF	CHOCTAW	0.34
LTF	CLIFTY	1.22
LTF	COTTONWOOD	1.25
LTF	DEARBORN	0.05
LTF	EDWARDS	0.09
LTF	ELMERSMITH	0.18
LTF	FARMERCITY	0.07
LTF	G-007A	1.63
LTF	GIBSON	0.11
LTF	HAMLET	0.66
LTF	MORGAN	0.56
LTF	NEWTON	0.26
LTF	NYISO	2.43
LTF	O-066A	0.76
LTF	PRAIRIE	0.57
LTF	ROWAN	0.36
LTF	SANTEETLA	0.05
LTF	SMITHLAND	0.05
LTF	TATANKA	0.13
LTF	TILTON	0.11
LTF	TRIMBLE	0.06
LTF	TVA	0.24
LTF	UNIONPOWER	0.32
LTF	VFT	4.39
936871	AD2-110	1.34
936472	AD2-062 E O1	2.3
936471	AD2-062 C O1	4.6
936311	AD2-040	0.34

Bus Number	Gen. Bus Name	Full Contribution
936224	AD2-028 E2	4.23
936223	AD2-028 C2	0.85
936222	AD2-028 E1	3.25
936221	AD2-028 C1	6.9
936062	AD2-009 E	2.06
936061	AD2-009 C	4.52
934372	AD1-061 E	1.19
934371	AD1-061 C	0.74
934362	AD1-060 E	0.93
934361	AD1-060 C	0.57
933252	AC2-136 E	1.09
933251	AC2-136 C	0.95
930832	AB1-128 E	1.25
930831	AB1-128 C	0.77
930822	AB1-127 E	1.25
930821	AB1-127 C	0.77
930782	AB1-123 E	0.62
930781	AB1-123 C	0.59
924482	AB2-097 E	1.15
923872	AB2-027 E	0.49
923871	AB2-027 C	0.29
920562	AA2-159 E	0.51
920561	AA2-159 C	0.61
920012	AA2-085 E	0.43
920011	AA2-085 C	0.27
918772	AA1-096 E	0.09
918771	AA1-096 C	0.17
918762	AA1-095 E	0.24
918761	AA1-095 C	0.48
918742	AA1-093 E	0.08
918741	AA1-093 C	0.16
918732	AA1-092 E	0.37
918731	AA1-092 C	0.73
918662	AA1-080 E	0.09
918661	AA1-080 C	0.17
905554	W4-102 E	1.08
901242	W1-045E OP1	0.77
901241	W1-045C OP1	0.47
237329	01CHBRG_I12	0.67
235724	01GUILF2	0.97
235723	01GUILF1	0.97

Appendix 5

Flowgate Contingency - 26ROXBURY 138/115 kV transformer
PJM Queue Position: AD2-028

This appendix contains additional information about the flowgate presented in the body of the report. The intent of this 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.

(PENELEC - PENELEC) The 26ROXBURY 138/115 kV transformer (from bus 200532 to bus 200520 ckt 2) loads from 86.52% to 100.26% (**DC power flow**) of its emergency rating (150 MVA) for the line fault with failed breaker contingency outage of 'ME_P4-500-002H'. This project contributes approximately 20.61 MW to the thermal violation.

CONTINGENCY 'ME_P4-500-002H' /* HUNTERSTOWN 500 KV STUCK CB - CBB11392
DISCONNECT BRANCH FROM BUS 200026 TO BUS 200004 CKT 1 /* HUNTERTN 500 CNASTONE 500
DISCONNECT BRANCH FROM BUS 200026 TO BUS 204501 CKT 1 /* HUNTERTN 500 27HUNTRSTN 230
END

Bus Number	*Gen. Bus Name*	*Full Contribution*
LTF	*CARR*	*0.4*
LTF	*CBM-S1*	*1.56*
LTF	*CBM-S2*	*1.68*
LTF	*CBM-W1*	*5.01*
LTF	*CBM-W2*	*9.01*
LTF	*CIN*	*1.14*
LTF	*CPLE*	*0.44*
LTF	*G-007*	*1.24*
LTF	*IPL*	*0.74*
LTF	*LGEE*	*0.24*
LTF	*MEC*	*2.2*
LTF	*MECS*	*1.37*
LTF	*O-066*	*4.25*
LTF	*RENSSELAER*	*0.32*
LTF	*ROSETON*	*2.32*
LTF	*WEC*	*0.31*
936871	*AD2-110*	*1.89*
936472	*AD2-062 E O1*	*10.48*
936471	*AD2-062 C O1*	*20.92*
936311	*AD2-040*	*0.23*
936224	*AD2-028 E2*	*5.73*
936223	*AD2-028 C2*	*1.14*
936222	*AD2-028 E1*	*4.4*
936221	*AD2-028 C1*	*9.34*
936062	*AD2-009 E*	*2.69*
936061	*AD2-009 C*	*5.92*

Bus Number	*Gen. Bus Name*	*Full Contribution*
934372	*AD1-061 E*	*1.41*
934371	*AD1-061 C*	*0.87*
934362	*AD1-060 E*	*0.88*
934361	*AD1-060 C*	*0.54*
933974	*AD1-020 BAT*	*1.24*
933252	*AC2-136 E*	*0.39*
933251	*AC2-136 C*	*0.34*
930832	*AB1-128 E*	*1.7*
930831	*AB1-128 C*	*1.04*
930822	*AB1-127 E*	*1.7*
930821	*AB1-127 C*	*1.04*
930782	*AB1-123 E*	*0.43*
930781	*AB1-123 C*	*0.41*
924482	*AB2-097 E*	*0.64*
923872	*AB2-027 E*	*0.3*
923871	*AB2-027 C*	*0.18*
918772	*AA1-096 E*	*0.06*
918771	*AA1-096 C*	*0.12*
918762	*AA1-095 E*	*0.17*
918761	*AA1-095 C*	*0.33*
918732	*AA1-092 E*	*0.28*
918731	*AA1-092 C*	*0.55*
918662	*AA1-080 E*	*0.06*
918661	*AA1-080 C*	*0.12*
905554	*W4-102 E*	*0.67*
237329	*01CHBRG_I12*	*1.26*
235724	*01GUILF2*	*1.36*