Generation Interconnection Feasibility Study Report Web Version

For

PJM Generation Interconnection Request Queue Position Y2-042

Oxbow 34.5kV Project

February, 2013

Feasibility Study Report

Oxbow 34.5 kV Generation Project

Introduction

The intent of the Feasibility/Impact study is to determine a plan, with estimated costs and construction time estimates, to connect the subject generation to the PJM network at a location specified by the Interconnection Customer. The Interconnection Customer may request the interconnection of generation as a capacity resource or as an energy-only resource. As a requirement for interconnection, the Interconnection Customer may be responsible for the cost of constructing: (1) Direct Connections, which are new facilities and/or facilities upgrades needed to connect the generator to the PJM network, and (2) Network Upgrades, which are facility additions, or upgrades to existing facilities, that are needed to maintain the reliability of the PJM system.

In some instances an Interconnection Customer may not be responsible for 100% of the identified network upgrade cost because other transmission network uses, e.g. another generation interconnection, may also contribute to the need for the same network reinforcement. The possibility of sharing the reinforcement costs with other projects may be identified in the feasibility study, but the actual allocation will be deferred until the impact study is performed.

The study estimates do not include the feasibility, cost, or time required to obtain property rights and permits for construction of the required facilities. The project developer is responsible for the right of way, real estate, and construction permit issues. For properties currently owned by Transmission Owners, the costs may be included in the study.

General

Interconnection Customer has proposed the installation of reciprocating engines totaling 19.9 MW and 19.9 MW (capacity). The proposed generating unit site is approximately 5.0 miles northwest of Factoryville, PA., off Henry Holod Road. This is in the PJM queue at Y2-042. The project is proposed to be in service by the 1st quarter of 2014.

This project is being studied for one point of interconnection (POI). The primary choice POI is a 34.5kV interconnection to the North Oxbow Substation bus. (See Figures 1 and 2)

PJM Interconnection Study Results

The following is the report describing the results of the analysis performed by PJM engineers with respect to the transmission system impacts.

Network Impacts

The Queue Project #Y2-042 was studied as a 19.9MW (Capacity 19.9MW) injection at the Oxbow 34.5 kV substation in the PENELEC area. Project #Y2-042 was evaluated for compliance with reliability criteria for summer peak conditions in 2016. Potential network impacts were as follows:

Generator Deliverability

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

None

Light Load Analysis

Light Load Studies to be conducted during later study phases (applicable to wind, coal, nuclear, and pumped storage projects).

Multiple Facility Contingency

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

None

Short Circuit

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

To be determined

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. The NO MESHO-TOWANDA 115 kV line (from bus 200677 to bus 200674 ckt 1) loads from 100.92% to 102.67% (**DC power flow**) of its emergency rating (158 MVA) for the single line contingency outage of CONTINGENCY DESCRIPTION ('B_PN230-SX-#11_A'). This project contributes approximately 2.78 MW to the thermal violation.

CONTINGENCY 'B_PN230-SX-#11_A' /* EAST TOWANDA - X1-109 TAP
DISCONNECT BRANCH FROM BUS 200675 TO BUS 907460 CKT 1F

DISCONNECT BRANCH FROM BUS 200924 TO BUS 200706 CKT 1F
DISCONNECT BRANCH FROM BUS 200706 TO BUS 200677 CKT 4
END

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

2. The NO MESHO-LENOX 115 kV line (from bus 200677 to bus 200678 ckt 1) loads from 105.31% to 106.68% (**DC power flow**) of its emergency rating (180 MVA) for the line fault with failed breaker contingency outage of CONTINGENCY DESCRIPTION ('C2_PN115-SB-46G_X2-023_X1-109'). This project contributes approximately 2.46 MW to the thermal violation.

CONTINGENCY 'C2_PN115-SB-46G_X2-023_X1-109' /* NORTH MESHOPPEN 115 KV STUCK CB20 - (N MESHOPPEN XFMR 4)
DISCONNECT BRANCH FROM BUS 909070 TO BUS 200698 CKT 2
DISCONNECT BRANCH FROM BUS 200677 TO BUS 200674 CKT 1
DISCONNECT BRANCH FROM BUS 200677 TO BUS 200687 CKT 2
DISCONNECT BRANCH FROM BUS 200706 TO BUS 200677 CKT 4
DISCONNECT BRANCH FROM BUS 200675 TO BUS 907460 CKT 1F
END

Please refer to PJM Analysis Appendix 2 for a table containing the generators having contribution to this flowgate.

3. The LENOX-TIFFANY 115 kV line (from bus 200678 to bus 200679 ckt 1) loads from 128.53% to 130.09% (**DC power flow**) of its emergency rating (151 MVA) for the line fault with failed breaker contingency outage of CONTINGENCY DESCRIPTION ('C2_PN115-SB-46G_X2-023_X1-109'). This project contributes approximately 2.35 MW to the thermal violation.

CONTINGENCY 'C2_PN115-SB-46G_X2-023_X1-109' /* NORTH MESHOPPEN 115 KV STUCK CB20 - (N MESHOPPEN XFMR 4)
DISCONNECT BRANCH FROM BUS 909070 TO BUS 200698 CKT 2
DISCONNECT BRANCH FROM BUS 200677 TO BUS 200674 CKT 1
DISCONNECT BRANCH FROM BUS 200677 TO BUS 200687 CKT 2
DISCONNECT BRANCH FROM BUS 200706 TO BUS 200677 CKT 4
DISCONNECT BRANCH FROM BUS 200675 TO BUS 907460 CKT 1F
END

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

4. The E.SAYRE-N.WAV115 115 kV line (from bus 200676 to bus 130836 ckt 1) loads from 144.42% to 145.65% (**DC power flow**) of its emergency rating (128 MVA) for the single line

contingency outage of CONTINGENCY DESCRIPTION ('B_PN230-SX-#8'). This project contributes approximately 1.56 MW to the thermal violation.

CONTINGENCY 'B_PN230-SX-#8' /* EAST TOWANDA - HILLSIDE (ETH) 230 KV
DISCONNECT BRANCH FROM BUS 200675 TO BUS 130763 CKT 1
END

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

5. The OXBOW-LACK 230 kV line (from bus 200708 to bus 208009 ckt 1) loads from 112.2% to 114.23% (**DC power flow**) of its emergency rating (617 MVA) for the single line contingency outage of CONTINGENCY DESCRIPTION ('KEYSTONE_JACKMTN1_1'). This project contributes approximately 12.49 MW to the thermal violation.

CONTINGENCY 'KEYSTONE_JACKMTN1_1' /* 500/500KV, AREA 225/225.
DISCONNECT BRANCH FROM BUS 200011 TO BUS 200071 CKT 1
END

Please refer to PJM Analysis Appendix 5 for a table containing the generators having contribution to this flowgate.

6. The LAUREL L-WESTOVER115 115 kV line (from bus 200680 to bus 130807 ckt 1) loads from 150.82% to 152.46% (**DC power flow**) of its emergency rating (150 MVA) for the line fault with failed breaker contingency outage of CONTINGENCY DESCRIPTION ('C2_PN115-SB-46G_X2-023_X1-109'). This project contributes approximately 2.46 MW to the thermal violation.

CONTINGENCY 'C2_PN115-SB-46G_X2-023_X1-109' /* NORTH MESHOPPEN 115 KV STUCK CB20 - (N MESHOPPEN XFMR 4)
DISCONNECT BRANCH FROM BUS 909070 TO BUS 200698 CKT 2
DISCONNECT BRANCH FROM BUS 200677 TO BUS 200674 CKT 1
DISCONNECT BRANCH FROM BUS 200677 TO BUS 200687 CKT 2
DISCONNECT BRANCH FROM BUS 200706 TO BUS 200677 CKT 4
DISCONNECT BRANCH FROM BUS 200675 TO BUS 907460 CKT 1F
END

Please refer to PJM Analysis Appendix 6 for a table containing the generators having contribution to this flowgate.

7. The TIFFANY-LAUREL L 115 kV line (from bus 200679 to bus 200680 ckt 1) loads from 154.79% to 156.44% (**DC power flow**) of its emergency rating (149 MVA) for the line fault with failed breaker contingency outage of CONTINGENCY DESCRIPTION ('C2_PN115-SB-

46G_X2-023_X1-109'). This project contributes approximately 2.46 MW to the thermal violation.

```
CONTINGENCY 'C2_PN115-SB-46G_X2-023_X1-109'                    /* NORTH
MESHOPPEN 115 KV STUCK CB20 - (N MESHOPPEN XFMR 4)
  DISCONNECT BRANCH FROM BUS 909070 TO BUS 200698 CKT 2
  DISCONNECT BRANCH FROM BUS 200677 TO BUS 200674 CKT 1
  DISCONNECT BRANCH FROM BUS 200677 TO BUS 200687 CKT 2
  DISCONNECT BRANCH FROM BUS 200706 TO BUS 200677 CKT 4
  DISCONNECT BRANCH FROM BUS 200675 TO BUS 907460 CKT 1F
  END
```

Please refer to PJM Analysis Appendix 7 for a table containing the generators having contribution to this flowgate.

8. The TOWANDA-E.SAYRE 115 kV line (from bus 200674 to bus 200676 ckt 1) loads from 159.14% to 160.15% (**DC power flow**) of its emergency rating (155 MVA) for the single line contingency outage of CONTINGENCY DESCRIPTION ('B_PN230-SX-#8'). This project contributes approximately 1.56 MW to the thermal violation.

```
CONTINGENCY 'B_PN230-SX-#8'                                    /* EAST TOWANDA -
HILLSIDE (ETH) 230 KV
  DISCONNECT BRANCH FROM BUS 200675 TO BUS 130763 CKT 1
  END
```

Please refer to PJM Analysis Appendix 8 for a table containing the generators having contribution to this flowgate.

9. The E.SAYRE-N.WAV115 115 kV line (from bus 200676 to bus 130836 ckt 1) loads from 171.53% to 171.78% (**DC power flow**) of its emergency rating (128 MVA) for the bus fault outage of CONTINGENCY DESCRIPTION ('C1_PN230-BS-#5A'). This project contributes approximately 1.98 MW to the thermal violation.

```
CONTINGENCY 'C1_PN230-BS-#5A'                                  /* EAST TOWANDA #1 230
KV BUS FAULT
  DISCONNECT BRANCH FROM BUS 200701 TO BUS 200675 CKT 1
  DISCONNECT BRANCH FROM BUS 200675 TO BUS 130763 CKT 1
  DISCONNECT BRANCH FROM BUS 200674 TO BUS 200675 CKT 3
  END
```

Please refer to PJM Analysis Appendix 9 for a table containing the generators having contribution to this flowgate.

10. The E.SAYRE-N.WAV115 115 kV line (from bus 200676 to bus 130836 ckt 1) loads from 171.53% to 171.78% (**DC power flow**) of its emergency rating (128 MVA) for the line fault

with failed breaker contingency outage of CONTINGENCY DESCRIPTION ('C2_PN230-SB-#3F'). This project contributes approximately 1.98 MW to the thermal violation.

CONTINGENCY 'C2_PN230-SB-#3F' /* EAST TOWANDA 230 KV STUCK CB - (#3 XF)
DISCONNECT BRANCH FROM BUS 200675 TO BUS 130763 CKT 1
DISCONNECT BRANCH FROM BUS 200701 TO BUS 200675 CKT 1
DISCONNECT BRANCH FROM BUS 200674 TO BUS 200675 CKT 3
END

Please refer to PJM Analysis Appendix 10 for a table containing the generators having contribution to this flowgate.

11. The NO MESHO-TOWANDA 115 kV line (from bus 200677 to bus 200674 ckt 1) loads from 170.8% to 172.47% (**DC power flow**) of its emergency rating (158 MVA) for the bus fault outage of CONTINGENCY DESCRIPTION ('C1_PN230-BS-#5C_A'). This project contributes approximately 2.64 MW to the thermal violation.

CONTINGENCY 'C1_PN230-BS-#5C_A' /* EAST TOWANDA #2 230 KV BUS FAULT
DISCONNECT BRANCH FROM BUS 200674 TO BUS 200675 CKT 4
DISCONNECT BRANCH FROM BUS 200675 TO BUS 907460 CKT 1F
DISCONNECT BRANCH FROM BUS 200924 TO BUS 200706 CKT 1F
END

Please refer to PJM Analysis Appendix 11 for a table containing the generators having contribution to this flowgate.

12. The TOWANDA-E.SAYRE 115 kV line (from bus 200674 to bus 200676 ckt 1) loads from 175.01% to 175.21% (**DC power flow**) of its emergency rating (155 MVA) for the bus fault outage of CONTINGENCY DESCRIPTION ('C1_PN230-BS-#5A'). This project contributes approximately 1.98 MW to the thermal violation.

CONTINGENCY 'C1_PN230-BS-#5A' /* EAST TOWANDA #1 230 KV BUS FAULT
DISCONNECT BRANCH FROM BUS 200701 TO BUS 200675 CKT 1
DISCONNECT BRANCH FROM BUS 200675 TO BUS 130763 CKT 1
DISCONNECT BRANCH FROM BUS 200674 TO BUS 200675 CKT 3
END

Please refer to PJM Analysis Appendix 12 for a table containing the generators having contribution to this flowgate.

13. The TOWANDA-E.SAYRE 115 kV line (from bus 200674 to bus 200676 ckt 1) loads from 175.01% to 175.21% (**DC power flow**) of its emergency rating (155 MVA) for the line fault

with failed breaker contingency outage of CONTINGENCY DESCRIPTION ('C2_PN230-SB-#3F'). This project contributes approximately 1.98 MW to the thermal violation.

```
CONTINGENCY 'C2_PN230-SB-#3F'                    /* EAST TOWANDA 230 KV
STUCK CB - (#3 XF)
  DISCONNECT BRANCH FROM BUS 200675 TO BUS 130763 CKT 1
  DISCONNECT BRANCH FROM BUS 200701 TO BUS 200675 CKT 1
  DISCONNECT BRANCH FROM BUS 200674 TO BUS 200675 CKT 3
  END
```

Please refer to PJM Analysis Appendix 13 for a table containing the generators having contribution to this flowgate.

14. The TOWANDA-E.SAYRE 115 kV line (from bus 200674 to bus 200676 ckt 1) loads from 175.19% to 176.49% (**DC power flow**) of its emergency rating (155 MVA) for the line fault with failed breaker contingency outage of CONTINGENCY DESCRIPTION ('C2_PN230-SB-#3D'). This project contributes approximately 2.01 MW to the thermal violation.

```
CONTINGENCY 'C2_PN230-SB-#3D'                    /* EAST TOWANDA 230 KV
STUCK CB - (GROVER)
  DISCONNECT BRANCH FROM BUS 200675 TO BUS 130763 CKT 1
  DISCONNECT BRANCH FROM BUS 200857 TO BUS 200701 CKT 1
  DISCONNECT BRANCH FROM BUS 200701 TO BUS 200675 CKT 1
  DISCONNECT BRANCH FROM BUS 200701 TO BUS 200702 CKT 1
  DISCONNECT BUS 200701
  DISCONNECT BRANCH FROM BUS 200674 TO BUS 200675 CKT 3
  END
```

Please refer to PJM Analysis Appendix 14 for a table containing the generators having contribution to this flowgate.

15. The E.SAYRE-N.WAV115 115 kV line (from bus 200676 to bus 130836 ckt 1) loads from 174.05% to 175.62% (**DC power flow**) of its emergency rating (128 MVA) for the line fault with failed breaker contingency outage of CONTINGENCY DESCRIPTION ('C2_PN230-SB-#3D'). This project contributes approximately 2.01 MW to the thermal violation.

```
CONTINGENCY 'C2_PN230-SB-#3D'                    /* EAST TOWANDA 230 KV
STUCK CB - (GROVER)
  DISCONNECT BRANCH FROM BUS 200675 TO BUS 130763 CKT 1
  DISCONNECT BRANCH FROM BUS 200857 TO BUS 200701 CKT 1
  DISCONNECT BRANCH FROM BUS 200701 TO BUS 200675 CKT 1
  DISCONNECT BRANCH FROM BUS 200701 TO BUS 200702 CKT 1
  DISCONNECT BUS 200701
  DISCONNECT BRANCH FROM BUS 200674 TO BUS 200675 CKT 3
  END
```

Please refer to PJM Analysis Appendix 15 for a table containing the generators having contribution to this flowgate.

16. The OXBOW-LACK 230 kV line (from bus 200708 to bus 208009 ckt 1) loads from 132.27% to 134.85% (**DC power flow**) of its normal rating (488 MVA) for non-contingency condition. This project contributes approximately 12.55 MW to the thermal violation.

Please refer to PJM Analysis Appendix 16 for a table containing the generators having contribution to this flowgate.

17. The OXBOW-LACK 230 kV line (from bus 200708 to bus 208009 ckt 1) loads from 151.0% to 153.05% (**DC power flow**) of its emergency rating (617 MVA) for the bus fault outage of CONTINGENCY DESCRIPTION ('C1_PN230-BS-22B_A'). This project contributes approximately 12.65 MW to the thermal violation.

```
CONTINGENCY 'C1_PN230-BS-22B_A'                    /* LEWISTOWN 2 230 KV
BUS FAULT
  DISCONNECT BRANCH FROM BUS 200513 TO BUS 200512 TO BUS 200548 CKT 2
  DISCONNECT BRANCH FROM BUS 200513 TO BUS 200512 CKT 3
  DISCONNECT BRANCH FROM BUS 200513 TO BUS 914350 CKT 1
  DISCONNECT BRANCH FROM BUS 200513 TO BUS 235248 CKT 1
  DISCONNECT BRANCH FROM BUS 200513 TO BUS 200531 CKT 2
  END
```

Please refer to PJM Analysis Appendix 17 for a table containing the generators having contribution to this flowgate.

Steady-State Voltage Requirements
(Results of the steady-state voltage studies should be inserted here)

To be determined

Stability and Reactive Power Requirement
(Results of the dynamic studies should be inserted here)

To be determined

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

None

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.

Not Applicable

PJM Analysis Appendix 1

Bus Number	Bus Name	Full Contribution
200851	MEHOOP3	.53
203125	OAKLAND	.22
294572	P-028 C	.27
218360	SEWAREN1	1.48
218361	SEWAREN2	1.67
218362	SEWAREN3	1.51
218363	SEWAREN4	1.75
218364	SEWAREN6	1.56
293093	U2-077	9.04
894731	V3-042 C	1.4
LTF	V4-050	1.66
902251	W2-023	8.89
LTF	W2-033	.98
905091	W4-009 OP1	9.9
905181	W4-021	9.89
907461	X1-109 C	77.6
909021	X2-012 C	14.59
909071	X2-023 C	2.51
909171	X2-050	9.85
912291	X4-048 OP1	33.84
913171	Y1-025 C OP1	9.9
913311	Y1-047 OP1	5.83
914021	Y2-013 OP1	11.47
914061	Y2-042	2.78

PJM Analysis Appendix 2

Bus Number	Bus Name	Full Contribution
200851	MEHOOP3	.45
294572	P-028 C	.23
294573	P-028 E	39.01
LTF	V4-050	1.57
LTF	W2-033	1.2
907461	X1-109 C	61.47
909021	X2-012 C	12.64
909071	X2-023 C	2.16
909072	X2-023 E	14.42
910522	X3-003 E	6.5
912291	X4-048 OP1	28.54
913171	Y1-025 C OP1	8.74
913172	Y1-025 E OP1	.72
913311	Y1-047 OP1	5.01
914021	Y2-013 OP1	10.09
914061	Y2-042	2.46

PJM Analysis Appendix 3

Bus Number	Bus Name	Full Contribution
200851	MEHOOP3	.43
294572	P-028 C	.22
294573	P-028 E	37.31
293093	U2-077	7.6
LTF	V4-050	1.51
LTF	W2-033	1.15
905091	W4-009 OP1	8.36
905181	W4-021	8.36
907461	X1-109 C	58.79
909021	X2-012 C	12.09
909071	X2-023 C	2.06
909072	X2-023 E	13.8
909171	X2-050	8.26
910522	X3-003 E	6.22
912291	X4-048 OP1	27.3
913171	Y1-025 C OP1	8.36
913172	Y1-025 E OP1	.69
913311	Y1-047 OP1	4.79
914021	Y2-013 OP1	9.65
914061	Y2-042	2.35

PJM Analysis Appendix 4

Bus Number	Bus Name	Full Contribution
238554	02AVONG7	-.83
238555	02AVONG9	-5.62
251934	08BCKJD2	-.59
251935	08BCKJD3	-.8
251936	08BCKJD4	-.94
251937	08BCKJD5	-1.49
251938	08BCKJD6	-2.58
203283	MANOR	.01
200851	MEHOOP3	.13
294572	P-028 C	.06
218360	SEWAREN1	1.48
218361	SEWAREN2	1.68
218362	SEWAREN3	1.52
218363	SEWAREN4	1.76
218364	SEWAREN6	1.57
293093	U2-077	9.05
900111	V4-020	7.16
LTF	V4-050	1.94
902251	W2-023	8.92
LTF	W2-033	1.92
905091	W4-009 OP1	10.
905181	W4-021	10.03
907091	X1-013 OP1	9.34
907461	X1-109 C	97.45
909021	X2-012 C	13.96
909071	X2-023 C	.61
909171	X2-050	9.79
912141	X4-020	7.14
912291	X4-048 OP1	29.92
913171	Y1-025 C OP1	10.01
913311	Y1-047 OP1	1.41
913401	Y1-065 C	7.39
914021	Y2-013 OP1	11.49
914061	Y2-042	1.56

PJM Analysis Appendix 5

Bus Number	Bus Name	Full Contribution
200887	ARMNA MT P47	.13
235567	ARMSTRONG 1	8.84
235569	ARMSTRONG 2	8.79
217006	BERGN26A	-1.33
203261	BLOSSBCT	.12
228000	CEDR#1CT	-2.4
228001	CEDR#2CT	-1.15
200805	COLVER13	.13
217078	ESSEX 12	-11.65
99210	G07_NEW	6.14
206331	GG A1&2	-2.5
206332	GG A3&4	-2.5
206333	GG B5&6	-2.5
206334	GG B7&8	-2.5
200828	HNSMLK 1	.08
200829	HNSMLK 2	.08
200830	HNSMLK 3	.08
200831	HNSMLK 4	.08
200832	HNSMLK 5	.08
200837	HOMER C1	.74
200838	HOMER C2	.98
200839	HOMER C3	1.04
200849	LAKVU GN	.01
209027	LOR2_Q27 E	-6.1
203283	MANOR	.01
200851	MEHOOP3	.68
293270	N-036 C	1.84
293942	O-052 C	1.68
94130	O66_NONFIRM	22.34
203125	OAKLAND	.56
294271	P-001 C	.9
294572	P-028 C	.35
200649	PENNTECH	.1
200608	PINEY #1	.04
200657	PINEY CK	.04
204652	PORT1GEN	-10.6
204653	PORT2GEN	-16.72
290085	Q-036 C	.02
295247	Q-046	.02
200882	Q-053 C	.01
290113	Q-063 C	.04
296914	R-092 C	1.36

200846	RINGGOLD	.81
884780	S-058 C	17.6
884781	S-058 E	58.02
291011	S-103	.14
200662	SCRUB GR	.12
200642	SENECA#1	.5
200643	SENECA#2	.46
200644	SENECA#3	.07
218360	SEWAREN1	-6.29
218361	SEWAREN2	-7.11
218362	SEWAREN3	-6.45
218363	SEWAREN4	-7.45
218364	SEWAREN6	-6.67
200715	SHAWVL 1	12.17
200722	SHAWVL 2	12.4
200665	SHAWVL 3	18.46
200666	SHAWVL 4	18.29
200809	SITHE	.04
886091	T-121 C	2.52
889061	U2-055 C	1.17
292078	V1-034	.19
LTF	V3-012	16.31
894651	V3-030 C	.
894731	V3-042 C	3.97
209019	VIKI IPP	-1.24
902211	W2-019 C	-.12
LTF	W3-083	3.79
903641	W3-099 C OP1	1.21
905211	W4-025 C	-.14
905291	W4-038 OP1	-1.52
203102	WEST TAN	.16
907241	X1-068	-.58
907991	X1-078	29.82
907381	X1-094 C	-.42
907461	X1-109 C	334.94
909051	X2-021 C OP1	1.97
909071	X2-023 C	3.25
LTF	X2-042	18.52
910531	X3-004	-2.22
LTF	X3-020	5.14
LTF	X3-021	29.48
900404	X3-028 C	81.76
910661	X3-039	6.33
LTF	X3-050	28.44
910931	X3-085 C	-.2

LTF	X3-096	12.37
LTF	X3-097	17.54
LTF	X3-098	16.63
912091	X4-012 C OP1	-.15
912101	X4-015 C	-.1
LTF	X4-029D	4.72
LTF	X4-041	16.43
LTF	Y1-002	17.92
LTF	Y1-004	19.17
LTF	Y1-007	13.31
913081	Y1-012	.03
913231	Y1-032 C	2.17
LTF	Y1-041	4.72
913311	Y1-047 OP1	7.55
913471	Y1-071	.36
LTF	Y2-004	8.35
LTF	Y2-005	8.35
LTF	Y2-006	8.41
LTF	Y2-007	16.7
LTF	Y2-008	16.81
LTF	Y2-030	4.51
LTF	Y2-031	4.51
LTF	Y2-032	4.51
LTF	Y2-033	9.15
LTF	Y2-034	7.23
LTF	Y2-035	3.88
LTF	Y2-036	3.88
LTF	Y2-040	29.48
914061	Y2-042	12.49

PJM Analysis Appendix 6

Bus Number	Bus Name	Full Contribution
200851	MEHOOP3	.45
203125	OAKLAND	.97
294572	P-028 C	.23
294573	P-028 E	39.01
293093	U2-077	7.95
894731	V3-042 C	7.28
894732	V3-042 E	48.8
LTF	V4-050	1.57
902251	W2-023	7.83
LTF	W2-033	1.2
905091	W4-009 OP1	8.74
905181	W4-021	8.74
907461	X1-109 C	61.47
909021	X2-012 C	12.64
909071	X2-023 C	2.16
909072	X2-023 E	14.42
909171	X2-050	8.64
910522	X3-003 E	6.5
912291	X4-048 OP1	28.54
913171	Y1-025 C OP1	8.74
913172	Y1-025 E OP1	.72
913311	Y1-047 OP1	5.01
914021	Y2-013 OP1	10.09
914061	Y2-042	2.46

PJM Analysis Appendix 7

Bus Number	Bus Name	Full Contribution
200851	MEHOOP3	.45
203125	OAKLAND	.97
294572	P-028 C	.23
294573	P-028 E	39.01
293093	U2-077	7.95
894731	V3-042 C	7.28
894732	V3-042 E	48.8
LTF	V4-050	1.57
902251	W2-023	7.83
LTF	W2-033	1.2
905091	W4-009 OP1	8.74
905181	W4-021	8.74
907461	X1-109 C	61.47
909021	X2-012 C	12.64
909071	X2-023 C	2.16
909072	X2-023 E	14.42
909171	X2-050	8.64
910522	X3-003 E	6.5
912291	X4-048 OP1	28.54
913171	Y1-025 C OP1	8.74
913172	Y1-025 E OP1	.72
913311	Y1-047 OP1	5.01
914021	Y2-013 OP1	10.09
914061	Y2-042	2.46

PJM Analysis Appendix 8

Bus Number	Bus Name	Full Contribution
203283	MANOR	.01
200851	MEHOOP3	.13
294572	P-028 C	.06
218360	SEWAREN1	1.48
218361	SEWAREN2	1.68
218362	SEWAREN3	1.52
218363	SEWAREN4	1.76
218364	SEWAREN6	1.57
293093	U2-077	9.05
LTF	V4-050	1.94
902251	W2-023	8.92
LTF	W2-033	1.92
905091	W4-009 OP1	10.
905181	W4-021	10.03
907091	X1-013 OP1	9.34
907461	X1-109 C	97.45
909021	X2-012 C	13.96
909071	X2-023 C	.61
909171	X2-050	9.79
912291	X4-048 OP1	29.92
913171	Y1-025 C OP1	10.01
913311	Y1-047 OP1	1.41
914021	Y2-013 OP1	11.49
914061	Y2-042	1.56

PJM Analysis Appendix 9

Bus Number	Bus Name	Full Contribution
238554	02AVONG7	-.88
238555	02AVONG9	-5.93
251934	08BCKJD2	-.62
251935	08BCKJD3	-.85
251936	08BCKJD4	-.99
251937	08BCKJD5	-1.58
251938	08BCKJD6	-2.72
203283	MANOR	.01
200851	MEHOOP3	.17
294572	P-028 C	.09
294573	P-028 E	14.98
295952	R-011	6.67
291017	S-107 1CT	1.65
291019	S-107 1ST	3.29
291018	S-107 2CT	1.65
293093	U2-077	10.03
LTF	U4-022	.76
LTF	U4-023	.76
900111	V4-020	7.51
LTF	V4-050	2.02
902251	W2-023	9.87
LTF	W2-033	1.75
905091	W4-009 OP1	11.05
905181	W4-021	11.05
907091	X1-013 OP1	9.43
907461	X1-109 C	114.03
909021	X2-012 C	15.77
909071	X2-023 C	.83
909072	X2-023 E	5.54
909171	X2-050	10.88
910522	X3-003 E	2.5
912141	X4-020	7.48
912291	X4-048 OP1	35.
913171	Y1-025 C OP1	11.05
913172	Y1-025 E OP1	.91
913311	Y1-047 OP1	1.92
913401	Y1-065 C	7.83
913402	Y1-065 E	.46
914021	Y2-013 OP1	12.73
914031	Y2-015 OP1	6.86
914061	Y2-042	1.98

PJM Analysis Appendix 10

Bus Number	Bus Name	Full Contribution
238554	02AVONG7	-.88
238555	02AVONG9	-5.93
251934	08BCKJD2	-.62
251935	08BCKJD3	-.85
251936	08BCKJD4	-.99
251937	08BCKJD5	-1.58
251938	08BCKJD6	-2.72
203283	MANOR	.01
200851	MEHOOP3	.17
294572	P-028 C	.09
294573	P-028 E	14.98
295952	R-011	6.67
291017	S-107 1CT	1.65
291019	S-107 1ST	3.29
291018	S-107 2CT	1.65
293093	U2-077	10.03
LTF	U4-022	.76
LTF	U4-023	.76
900111	V4-020	7.51
LTF	V4-050	2.02
902251	W2-023	9.87
LTF	W2-033	1.75
905091	W4-009 OP1	11.05
905181	W4-021	11.05
907091	X1-013 OP1	9.43
907461	X1-109 C	114.03
909021	X2-012 C	15.77
909071	X2-023 C	.83
909072	X2-023 E	5.54
909171	X2-050	10.88
910522	X3-003 E	2.5
912141	X4-020	7.48
912291	X4-048 OP1	35.
913171	Y1-025 C OP1	11.05
913172	Y1-025 E OP1	.91
913311	Y1-047 OP1	1.92
913401	Y1-065 C	7.83
913402	Y1-065 E	.46
914021	Y2-013 OP1	12.73
914031	Y2-015 OP1	6.86
914061	Y2-042	1.98

PJM Analysis Appendix 11

Bus Number	Bus Name	Full Contribution
200851	MEHOOP3	.43
203125	OAKLAND	.15
294572	P-028 C	.22
294573	P-028 E	36.62
293093	U2-077	11.2
894731	V3-042 C	.94
894732	V3-042 E	6.34
LTF	V4-050	2.05
902251	W2-023	11.01
LTF	W2-033	1.27
905091	W4-009 OP1	12.27
905181	W4-021	12.26
907091	X1-013 OP1	9.44
907461	X1-109 C	95.18
909021	X2-012 C	18.
909071	X2-023 C	2.02
909072	X2-023 E	13.54
909171	X2-050	12.18
910522	X3-003 E	6.1
912291	X4-048 OP1	41.53
913171	Y1-025 C OP1	12.27
913172	Y1-025 E OP1	1.02
913311	Y1-047 OP1	4.7
913401	Y1-065 C	8.24
913402	Y1-065 E	.48
914021	Y2-013 OP1	14.2
914061	Y2-042	2.64

PJM Analysis Appendix 12

Bus Number	Bus Name	Full Contribution
203283	MANOR	.01
200851	MEHOOP3	.17
294572	P-028 C	.09
294573	P-028 E	14.98
293093	U2-077	10.03
LTF	V4-050	2.02
902251	W2-023	9.87
LTF	W2-033	1.75
905091	W4-009 OP1	11.05
905181	W4-021	11.05
907091	X1-013 OP1	9.43
907461	X1-109 C	114.03
909021	X2-012 C	15.77
909071	X2-023 C	.83
909072	X2-023 E	5.54
909171	X2-050	10.88
910522	X3-003 E	2.5
912291	X4-048 OP1	35.
913171	Y1-025 C OP1	11.05
913172	Y1-025 E OP1	.91
913311	Y1-047 OP1	1.92
913401	Y1-065 C	7.83
913402	Y1-065 E	.46
914021	Y2-013 OP1	12.73
914061	Y2-042	1.98

PJM Analysis Appendix 13

Bus Number	Bus Name	Full Contribution
203283	MANOR	.01
200851	MEHOOP3	.17
294572	P-028 C	.09
294573	P-028 E	14.98
293093	U2-077	10.03
LTF	V4-050	2.02
902251	W2-023	9.87
LTF	W2-033	1.75
905091	W4-009 OP1	11.05
905181	W4-021	11.05
907091	X1-013 OP1	9.43
907461	X1-109 C	114.03
909021	X2-012 C	15.77
909071	X2-023 C	.83
909072	X2-023 E	5.54
909171	X2-050	10.88
910522	X3-003 E	2.5
912291	X4-048 OP1	35.
913171	Y1-025 C OP1	11.05
913172	Y1-025 E OP1	.91
913311	Y1-047 OP1	1.92
913401	Y1-065 C	7.83
913402	Y1-065 E	.46
914021	Y2-013 OP1	12.73
914061	Y2-042	1.98

PJM Analysis Appendix 14

Bus Number	Bus Name	Full Contribution
203283	MANOR	.01
200851	MEHOOP3	.18
294572	P-028 C	.09
294573	P-028 E	15.24
293093	U2-077	10.1
LTF	V4-050	2.03
902251	W2-023	9.94
LTF	W2-033	1.73
905091	W4-009 OP1	11.11
905181	W4-021	11.13
907091	X1-013 OP1	9.41
907461	X1-109 C	115.73
909021	X2-012 C	15.91
909071	X2-023 C	.84
909072	X2-023 E	5.64
909171	X2-050	10.96
910522	X3-003 E	2.54
912291	X4-048 OP1	35.42
913171	Y1-025 C OP1	11.11
913172	Y1-025 E OP1	.92
913311	Y1-047 OP1	1.96
913401	Y1-065 C	7.85
913402	Y1-065 E	.46
914021	Y2-013 OP1	12.82
914061	Y2-042	2.01

PJM Analysis Appendix 15

Bus Number	Bus Name	Full Contribution
238554	02AVONG7	-.88
238555	02AVONG9	-5.95
251934	08BCKJD2	-.62
251935	08BCKJD3	-.85
251936	08BCKJD4	-.99
251937	08BCKJD5	-1.58
251938	08BCKJD6	-2.73
203283	MANOR	.01
200851	MEHOOP3	.18
294572	P-028 C	.09
294573	P-028 E	15.24
295952	R-011	6.71
291017	S-107 1CT	1.65
291019	S-107 1ST	3.31
291018	S-107 2CT	1.65
293093	U2-077	10.1
LTF	U4-022	.77
LTF	U4-023	.77
900111	V4-020	7.51
LTF	V4-050	2.03
902251	W2-023	9.94
LTF	W2-033	1.73
905091	W4-009 OP1	11.11
905181	W4-021	11.13
907091	X1-013 OP1	9.41
907461	X1-109 C	115.73
909021	X2-012 C	15.91
909071	X2-023 C	.84
909072	X2-023 E	5.64
909081	X2-025	6.42
909171	X2-050	10.96
910522	X3-003 E	2.54
912141	X4-020	7.49
912291	X4-048 OP1	35.42
913171	Y1-025 C OP1	11.11
913172	Y1-025 E OP1	.92
913311	Y1-047 OP1	1.96
913401	Y1-065 C	7.85
913402	Y1-065 E	.46
914021	Y2-013 OP1	12.82
914031	Y2-015 OP1	6.91
914061	Y2-042	2.01

PJM Analysis Appendix 16

Bus Number	Bus Name	Full Contribution
247528	05COVRT1	5.82
247529	05COVRT2	5.82
247530	05COVRT3	5.82
247531	05COVRT4	3.49
247532	05COVRT5	3.49
247533	05COVRT6	3.49
200887	ARMNA MT P47	.13
217006	BERGN26A	-1.24
203261	BLOSSBCT	.12
217078	ESSEX 12	-10.83
99210	G07_NEW	5.68
206331	GG A1&2	-2.33
206332	GG A3&4	-2.33
206333	GG B5&6	-2.33
206334	GG B7&8	-2.33
200828	HNSMLK 1	.08
200829	HNSMLK 2	.08
200830	HNSMLK 3	.08
200831	HNSMLK 4	.08
200832	HNSMLK 5	.08
200838	HOMER C2	.95
200839	HOMER C3	1.01
200849	LAKVU GN	.01
209027	LOR2_Q27 E	-5.7
203283	MANOR	.01
200851	MEHOOP3	.69
293270	N-036 C	1.84
293942	O-052 C	1.68
94130	O66_NONFIRM	20.78
203125	OAKLAND	.56
294271	P-001 C	.89
294572	P-028 C	.35
200649	PENNTECH	.1
200608	PINEY #1	.03
200657	PINEY CK	.04
204652	PORT1GEN	-9.89
204653	PORT2GEN	-15.62
290085	Q-036 C	.02
295247	Q-046	.02
200882	Q-053 C	.01
290113	Q-063 C	.04
296914	R-092 C	1.36

200846	RINGGOLD	.78
884780	S-058 C	16.35
884781	S-058 E	53.91
291011	S-103	.14
200662	SCRUB GR	.12
200642	SENECA#1	.49
200643	SENECA#2	.46
200644	SENECA#3	.07
218360	SEWAREN1	-5.83
218361	SEWAREN2	-6.6
218362	SEWAREN3	-5.98
218363	SEWAREN4	-6.91
218364	SEWAREN6	-6.18
200715	SHAWVL 1	12.17
200722	SHAWVL 2	12.39
200665	SHAWVL 3	18.49
200666	SHAWVL 4	18.31
886091	T-121 C	2.51
889061	U2-055 C	1.18
292078	V1-034	.18
LTF	V3-012	15.04
894731	V3-042 C	3.97
209019	VIKI IPP	-1.15
LTF	W3-083	3.52
903641	W3-099 C OP1	1.19
905291	W4-038 OP1	-1.41
203102	WEST TAN	.15
907241	X1-068	-.54
907991	X1-078	27.55
907381	X1-094 C	-.39
907461	X1-109 C	336.04
909051	X2-021 C OP1	1.94
909071	X2-023 C	3.26
LTF	X2-042	17.13
910531	X3-004	-2.06
LTF	X3-020	4.76
LTF	X3-021	28.01
900404	X3-028 C	75.63
910661	X3-039	6.15
LTF	X3-050	28.39
910931	X3-085 C	-.18
LTF	X3-096	11.45
LTF	X3-097	16.24
LTF	X3-098	15.4
912091	X4-012 C OP1	-.14

LTF	X4-029D	4.38
LTF	X4-041	15.21
LTF	Y1-002	16.65
LTF	Y1-004	17.66
LTF	Y1-007	12.27
913081	Y1-012	.03
913231	Y1-032 C	2.16
LTF	Y1-041	4.38
913311	Y1-047 OP1	7.58
913441	Y1-069 OP1	25.08
913471	Y1-071	.34
LTF	Y2-004	7.73
LTF	Y2-005	7.73
LTF	Y2-006	7.78
LTF	Y2-007	15.46
LTF	Y2-008	15.55
LTF	Y2-030	4.16
LTF	Y2-031	4.16
LTF	Y2-032	4.16
LTF	Y2-033	8.42
LTF	Y2-034	6.62
LTF	Y2-035	3.55
LTF	Y2-036	3.55
LTF	Y2-040	28.01
914061	Y2-042	12.55

PJM Analysis Appendix 17

Bus Number	Bus Name	Full Contribution
200887	ARMNA MT P47	.14
235567	ARMSTRONG 1	10.03
235569	ARMSTRONG 2	9.98
217006	BERGN26A	-1.31
203261	BLOSSBCT	.13
228000	CEDR#1CT	-2.37
228001	CEDR#2CT	-1.14
217078	ESSEX 12	-11.49
206617	EXXON	-.43
99210	G07_NEW	6.06
206331	GG A1&2	-2.47
206332	GG A3&4	-2.47
206333	GG B5&6	-2.47
206334	GG B7&8	-2.47
200857	LAURHILL	18.8
209027	LOR2_Q27 E	-5.97
206679	M&M S721	-.68
210888	MACRTR10	-.33
203283	MANOR	.02
200851	MEHOOP3	.7
293270	N-036 C	1.98
293271	N-036 E	7.9
293603	O-018 E	2.67
293942	O-052 C	1.82
293943	O-052 E	7.29
94130	O66_NONFIRM	22.04
203125	OAKLAND	.57
294271	P-001 C	1.18
294272	P-001 E	4.72
294572	P-028 C	.35
294573	P-028 E	60.09
200888	P-047 E	23.19
206638	PEAPACK	-.25
200649	PENNTECH	.14
204652	PORT1GEN	-10.46
204653	PORT2GEN	-16.48
290086	Q-036 E	3.88
290092	Q-041 E	-1.92
295247	Q-046	.02
200883	Q-053 E	1.9
290113	Q-063 C	.05
296332	R-032 E	3.08

296914	R-092 C	1.85
296915	R-092 E	7.39
200846	RINGGOLD	.95
884780	S-058 C	17.65
884781	S-058 E	58.21
291011	S-103	.16
200642	SENECA#1	.59
200643	SENECA#2	.55
200644	SENECA#3	.08
218360	SEWAREN1	-6.21
218361	SEWAREN2	-7.02
218362	SEWAREN3	-6.37
218363	SEWAREN4	-7.36
218364	SEWAREN6	-6.58
200715	SHAWVL 1	17.25
200722	SHAWVL 2	17.61
200665	SHAWVL 3	26.51
200666	SHAWVL 4	26.38
886091	T-121 C	2.74
886092	T-121 E	10.94
889061	U2-055 C	1.82
889062	U2-055 E	12.28
292078	V1-034	.19
297050	V2-019 E	.
LTF	V3-012	16.2
894652	V3-030 E	1.63
894731	V3-042 C	4.08
894732	V3-042 E	27.36
209019	VIKI IPP	-1.21
901602	W1-111 E	1.69
902211	W2-019 C	-.12
LTF	W3-083	3.8
903641	W3-099 C OP1	1.32
903642	W3-099 E OP1	8.85
905211	W4-025 C	-.14
905291	W4-038 OP1	-1.5
203102	WEST TAN	.17
907021	X1-020 C	4.87
907022	X1-020 E	32.56
907241	X1-068	-.58
907991	X1-078	29.47
907381	X1-094 C	-.41
907461	X1-109 C	344.82
909051	X2-021 C OP1	2.14
909052	X2-021 E OP1	14.34

909071	X2-023 C	3.32
909072	X2-023 E	22.22
909111	X2-031 C	.33
909112	X2-031 E	2.24
LTF	X2-042	18.52
910522	X3-003 E	10.01
910531	X3-004	-2.19
LTF	X3-020	5.14
LTF	X3-021	30.15
900404	X3-028 C	81.65
910612	X3-029 E	-.72
910661	X3-039	6.98
LTF	X3-050	29.66
910762	X3-052 E	-.19
910931	X3-085 C	-.19
LTF	X3-096	12.36
LTF	X3-097	17.52
LTF	X3-098	16.61
912091	X4-012 C OP1	-.15
912101	X4-015 C	-.1
LTF	X4-029D	4.73
LTF	X4-041	16.41
LTF	Y1-002	17.98
LTF	Y1-004	19.02
LTF	Y1-007	13.21
913081	Y1-012	.03
913231	Y1-032 C	2.35
913232	Y1-032 E	15.7
LTF	Y1-041	4.73
913311	Y1-047 OP1	7.71
913471	Y1-071	.42
LTF	Y2-004	8.34
LTF	Y2-005	8.34
LTF	Y2-006	8.4
LTF	Y2-007	16.68
LTF	Y2-008	16.79
LTF	Y2-030	4.49
LTF	Y2-031	4.49
LTF	Y2-032	4.49
LTF	Y2-033	9.05
LTF	Y2-034	7.05
LTF	Y2-035	3.78
LTF	Y2-036	3.78
LTF	Y2-040	30.15
914061	Y2-042	12.65

Interconnected Transmission Owner's Analysis Results

The following was generated by FirstEnergy (Pennsylvania Electric Company or "Penelec") the Interconnected Transmission Owner, based upon its analysis, as well as that of PJM, for mitigation of the project's impacts on the transmission and lower voltage system as applicable. It includes the costs and schedules for any system upgrades.
Costs for affected Transmission owners other than FirstEnergy are included and reported in the "New System Reinforcements" and "Contribution to Previously Identified System Reinforcements" sections of the "PJM Interconnection Study Results" above.

Direct Connection

It was proposed that the project be studied as an interconnection into the First Energy distribution system at Oxbow Substation 34.5kV bus via a new breaker position.

Interconnection Customer is responsible for constructing all of the facilities on its side of the point of interconnection, on the line to the generating plant. Interconnection Customer will also be responsible for the modifications at Oxbow substation that are required due to connecting the facility.

The proposed interconnection facilities must be designed in accordance with the FirstEnergy "Requirements for Transmission Connected Facilities" document and "Technical Requirements for the Interconnection of Customer-Owned generation to the FirstEnergy Distribution System" document.

The 34.5kV interconnection point will require the installation of a Penelec installed/owned main line breaker in the Oxbow 34.5kV bus (which will act as the disconnect point between First Energy and the generator interconnection) and a new disconnect switch situated just outside of the Oxbow substation fence line (POI).

Interconnection metering is also required for this generation connection. The 34.5 kV revenue quality metering equipment shall be designed, furnished and installed by FirstEnergy. The Interconnection Customer will be responsible for designing, furnishing and installing a SCADA RTU in their generation substation and obtaining the telecommunication circuits from the RTU to the Penelec Data Center. The connection to the Penelec Data Center will be to provide MW, MVAR and 34.5kV voltage at Interconnection Customer generation substation. Please reference the FirstEnergy Metering Requirements for Interconnection Customers, for more details on the metering requirements for FirstEnergy. This document can be found on the FE website at:

https://www.firstenergycorp.com/feconnect/penelec/wholesale.html

Below are conceptual estimates for the engineering/construction associated with Direct Connection requirements.

Item	Description	Conceptual Cost Estimate
1	Oxbow sub. new 34.5kV breaker position, breaker, relaying and associated equipment	$402,800
2	RTU programming for connection to the First Energy SCADA and relay support for the generation installation.	$10,000
3	Revenue metering	$48,800
4	Express 0.1 mile 34.5kV line from Oxbow Sub interconnection disconnect switch to Y2-042, plus Y2-042 line breaker located at PV generator site	Customer Owned

Conceptual Estimate: $461,600
Estimated Lead Time: 1.0 year from signed IA/CA

Notes:

- Detailed Engineering & Construction Estimates TBD via Facility Study
- The above estimates do not include 1) tax gross-up, 2) property costs and site development up to rough grade which is to be provided by the developer, 3) generation SCADA to be provided by the developer, and 4) engineering and field activities for design review and commissioning of the developer's facilities.

The attached Figure 2 provides a conceptual one-line of the direct connection facilities needed.

Network Impacts

The Y2-042 project was studied as total injection of 19.9 MW (19.9 MW of capacity) into the Oxbow 34.5 kV bus. Project Y2-042 was evaluated for compliance with reliability criteria for summer peak conditions in 2014. Potential network impacts were as follows:

Generator Deliverability
None

Multiple Facility Contingency

None

Contribution to Previously Identified Overloads

The LAUREL L-WESTOVER115 115 kV line (from bus 200680 to bus 130807 ckt 1) loads from 107.55% to 109.19% (**DC power flow**) of its emergency rating (150 MVA) for the line fault with failed breaker contingency outage of CONTINGENCY DESCRIPTION ('C2_PN115-SB-46G'). This project contributes approximately 2.46 MW to the thermal violation.

CONTINGENCY 'C2_PN115-SB-46G' /* NORTH MESHOPPEN 115 KV STUCK CB20 - (N MESHOPPEN XFMR 4)
DISCONNECT BRANCH FROM BUS 200677 TO BUS 200698 CKT 2
DISCONNECT BRANCH FROM BUS 200677 TO BUS 200674 CKT 1
DISCONNECT BRANCH FROM BUS 200677 TO BUS 200687 CKT 2
DISCONNECT BRANCH FROM BUS 200706 TO BUS 200677 CKT 4
~~DISCONNECT BRANCH FROM BUS 200675 TO BUS 200924 CKT 1F~~
~~DISCONNECT BRANCH FROM BUS 200706 TO BUS 200924 CKT 1F~~
END

Upgrade: Replace the North Meshoppen #4 transformer 230kV circuit switcher with a breaker. The contingency should be updated as shown with this change.

Estimated Cost: $1,463,200 including $333,800 in tax.

The TIFFANY-LAUREL L 115 kV line (from bus 200679 to bus 200680 ckt 1) loads from 111.27% to 112.92% (**DC power flow**) of its emergency rating (149 MVA) for the line fault with failed breaker contingency outage of CONTINGENCY DESCRIPTION ('C2_PN115-SB-46G'). This project contributes approximately 2.46 MW to the thermal violation.

CONTINGENCY 'C2_PN115-SB-46G' /* NORTH MESHOPPEN 115 KV STUCK CB20 - (N MESHOPPEN XFMR 4)
DISCONNECT BRANCH FROM BUS 200677 TO BUS 200698 CKT 2
DISCONNECT BRANCH FROM BUS 200677 TO BUS 200674 CKT 1
DISCONNECT BRANCH FROM BUS 200677 TO BUS 200687 CKT 2
DISCONNECT BRANCH FROM BUS 200706 TO BUS 200677 CKT 4
DISCONNECT BRANCH FROM BUS 200675 TO BUS 200924 CKT 1F
DISCONNECT BRANCH FROM BUS 200706 TO BUS 200924 CKT 1F
END

Upgrade: Replace the North Meshoppen #4 transformer 230kV circuit switcher with a breaker. The contingency should be updated as shown with this change.

Estimated Cost: $1,463,200 including $333,800 in tax.

The E.SAYRE-N.WAV115 115 kV line (from bus 200676 to bus 130836 ckt 1) loads from 155.5% to 156.72% (**DC power flow**) of its emergency rating (128 MVA) for the single line contingency outage of CONTINGENCY DESCRIPTION ('B_PN230-SX-#8'). This project contributes approximately 1.56 MW to the thermal violation.

```
CONTINGENCY 'B_PN230-SX-#8'                    /* EAST TOWANDA -
HILLSIDE (ETH) 230 KV
  DISCONNECT BRANCH FROM BUS 200675 TO BUS 130763 CKT 1
  END
```

FE Comments: Open line per operating procedure in PJM manual 3.

The OXBOW-LACK 230 kV line (from bus 200708 to bus 208009 ckt 1) loads from 119.27% to 121.29% (**DC power flow**) of its emergency rating (617 MVA) for the single line contingency outage of CONTINGENCY DESCRIPTION ('KEYSTONE_JACKMTN1_1'). This project contributes approximately 12.49 MW to the thermal violation.

```
CONTINGENCY 'KEYSTONE_JACKMTN1_1'              /* 500/500KV, AREA
225/225.
  DISCONNECT BRANCH FROM BUS 200011 TO BUS 200071 CKT 1
  END
```

Reinforcement: Rebuild line using 1622 ACSS. Upgrade terminal equipment at Oxbow. PPL will also need to upgrade equipment at Lackawanna.

Estimated Cost: $23,701,200 including $5,406,300 in tax.

The TOWANDA-E.SAYRE 115 kV line (from bus 200674 to bus 200676 ckt 1) loads from 161.29% to 162.3% (**DC power flow**) of its emergency rating (155 MVA) for the single line contingency outage of CONTINGENCY DESCRIPTION ('B_PN230-SX-#8'). This project contributes approximately 1.56 MW to the thermal violation.

```
CONTINGENCY 'B_PN230-SX-#8'                    /* EAST TOWANDA -
HILLSIDE (ETH) 230 KV
  DISCONNECT BRANCH FROM BUS 200675 TO BUS 130763 CKT 1
  END
```

FE Comments: Open the East Sayre – North Waverly line per the operating procedure in PJM manual 3.

The TOWANDA-E.SAYRE 115 kV line (from bus 200674 to bus 200676 ckt 1) loads from 178.57% to 178.78% (**DC power flow**) of its emergency rating (155 MVA) for the bus fault

outage of CONTINGENCY DESCRIPTION ('C1_PN230-BS-#5A'). This project contributes approximately 1.98 MW to the thermal violation.

CONTINGENCY 'C1_PN230-BS-#5A' /* EAST TOWANDA #1 230 KV BUS FAULT
DISCONNECT BRANCH FROM BUS 200701 TO BUS 200675 CKT 1
DISCONNECT BRANCH FROM BUS 200675 TO BUS 130763 CKT 1
DISCONNECT BRANCH FROM BUS 200674 TO BUS 200675 CKT 3
END

FE Comments: Open the East Sayre – North Waverly line per the operating procedure in PJM manual 3.

The E.SAYRE-N.WAV115 115 kV line (from bus 200676 to bus 130836 ckt 1) loads from 184.79% to 185.04% (**DC power flow**) of its emergency rating (128 MVA) for the bus fault outage of CONTINGENCY DESCRIPTION ('C1_PN230-BS-#5A'). This project contributes approximately 1.98 MW to the thermal violation.

CONTINGENCY 'C1_PN230-BS-#5A' /* EAST TOWANDA #1 230 KV BUS FAULT
DISCONNECT BRANCH FROM BUS 200701 TO BUS 200675 CKT 1
DISCONNECT BRANCH FROM BUS 200675 TO BUS 130763 CKT 1
DISCONNECT BRANCH FROM BUS 200674 TO BUS 200675 CKT 3
END

FE Comments: Open the East Sayre – North Waverly line per the operating procedure in PJM manual 3.

The E.SAYRE-N.WAV115 115 kV line (from bus 200676 to bus 130836 ckt 1) loads from 184.79% to 185.04% (**DC power flow**) of its emergency rating (128 MVA) for the line fault with failed breaker contingency outage of CONTINGENCY DESCRIPTION ('C2_PN230-SB-#3F'). This project contributes approximately 1.98 MW to the thermal violation.

CONTINGENCY 'C2_PN230-SB-#3F' /* EAST TOWANDA 230 KV STUCK CB - (#3 XF)
DISCONNECT BRANCH FROM BUS 200675 TO BUS 130763 CKT 1
DISCONNECT BRANCH FROM BUS 200701 TO BUS 200675 CKT 1
DISCONNECT BRANCH FROM BUS 200674 TO BUS 200675 CKT 3
END

FE Comments: Open the East Sayre – North Waverly line per the operating procedure in PJM manual 3.

The OXBOW-LACK 230 kV line (from bus 200708 to bus 208009 ckt 1) loads from 139.76% to 142.33% (**DC power flow**) of its normal rating (488 MVA) for non-contingency condition. This project contributes approximately 12.55 MW to the thermal violation.

Reinforcement: Rebuild line using 1622 ACSS. Upgrade terminal equipment at Oxbow. PPL will also need to upgrade equipment at Lackawanna.

Estimated Cost: $23,701,200 including $5,406,300 in tax.

The OXBOW-LACK 230 kV line (from bus 200708 to bus 208009 ckt 1) loads from 151.99% to 154.04% (**DC power flow**) of its emergency rating (617 MVA) for the bus fault outage of CONTINGENCY DESCRIPTION ('C1_PN230-BS-22B_A'). This project contributes approximately 12.65 MW to the thermal violation.

CONTINGENCY 'C1_PN230-BS-22B_A' /* LEWISTOWN 2 230 KV BUS FAULT
DISCONNECT BRANCH FROM BUS 200513 TO BUS 200512 TO BUS 200548 CKT 2
DISCONNECT BRANCH FROM BUS 200513 TO BUS 200512 CKT 3
DISCONNECT BRANCH FROM BUS 200513 TO BUS 914350 CKT 1
DISCONNECT BRANCH FROM BUS 200513 TO BUS 235248 CKT 1
DISCONNECT BRANCH FROM BUS 200513 TO BUS 200531 CKT 2
END

Reinforcement: Rebuild line using 1622 ACSS. Upgrade terminal equipment at Oxbow. PPL will also need to upgrade equipment at Lackawanna.

Estimated Cost: $23,701,200 including $5,406,300 in tax.

New System Reinforcements

None

Contribution to Previously Identified System Reinforcements

None

Short Circuit

A short circuit analysis will be performed in the System Impact Study stage

Cost Allocation

The Y2-042 project will be responsible for 100% of the direct connection costs estimated at $0.462 million. Total costs are estimated to be $0.462 million to accommodate interconnection of the project.

The project will require $25,164,400 in transmission upgrades. This cost includes a CIAC (Contribution in Aid of Construction) Federal Income Tax Gross Up charge of $5,740,100. This tax may or may not be charged based on whether or not this project meets the eligibility requirements of IRS Notice 88-129. PJM is responsible for determining the cost allocation for these upgrades.

Compliance Issues

Interconnection Customer will be responsible for meeting all FE criteria as defined in the FE Requirements for Distribution Connected Facilities document:

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

Interconnection Customer must also meet all PJM, ReliabilityFirst and NERC reliability criteria and operating procedures required for standards compliance. For example, the Interconnection Customer will need to properly locate and report the over and under-voltage and over and under-frequency system protection elements for its units as well as the submission of the generator model and protection data required to satisfy the PJM and ReliabilityFirst audits. Failure to comply with these requirements may result in a disconnection of service if the violation is found to compromise the reliability of the FE system.

Interconnection Customer Requirements

In addition to the FE facilities, 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 a fully rated circuit breaker on the high side of the Y2-042 step-up transformer.

2. The purchase and installation of a lockable load-break switch at the point of interconnection. This switch must be accessible by FE.

3. 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.

4. The purchase and installation of a 34.5kV interconnection metering instrument transformer. FE will provide the ratio and accuracy specifications based on the customer load and generation levels.

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

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 Interconnection Customer . The RTU must communicate with the FirstEnergy EMS via DNP 3.0 protocol.

7. The following status, control, and metering points will be required:
    a. Interconnection breaker position status.

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.

8. The establishment of dedicated communication circuits for SCADA report to the FE Transmission System Control Center.

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

10. The execution of a back-up service agreement to serve the customer load supplied from the Y2-042 34.5kV interconnection substation when the units are out-of-service. This assumes the intent of Interconnection Customer is to net the generation with the load.

11. Compliance with the PJM manuals and Operating instructions to have a plant operator on call 24/7 to respond within a minute to reduce the output of the project when network constraints occur.

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

Note that an assumption of this study is that the Oxbow 34.5 kV (Y2-042) Project generation will automatically be disconnected whenever the local area network is islanded. If this assumption is not correct, a direct transfer trip scheme will need to be implemented for such situations at Interconnection Customer ’s cost.

Summary

Conceptual estimates are provided for the assumption that the point of interconnection would be on the 34.5kV bus at Oxbow substation and that the customer interconnection substation would be at a site approximately 5.0 miles north of Factoryville, PA.

The Y2-042 project will be responsible for 100% of the direct connection costs estimated at $0.462 million. Total costs are estimated to be $0.462 million to accommodate interconnection of the project. This project may or may not be charged CIAC (Contribution in Aid of Construction) Federal Income Tax Gross Up based on whether or not this project meets the eligibility requirements of IRS Notice 88-129. The Project does not have any required network upgrades.

Additionally, the project will require $25,164,400 in transmission upgrades. This cost includes a CIAC (Contribution in Aid of Construction) Federal Income Tax Gross Up charge of $5,740,100. This tax may or may not be charged based on whether or not this project meets the eligibility requirements of IRS Notice 88-129. PJM is responsible for determining the cost allocation for these upgrades.

Based on the scope of the direct connection, it is expected to take approximately one (1) year from the signing of an Interconnection Service Agreement/Construction Service Agreement to complete the installation required for the Project. Full payment of the estimated direct connection costs of the project will be required upon execution of the Interconnection and Construction Service Agreements. A true up of the actual cost versus estimated cost of the project will be performed by FE at the end of the project. It further assumes 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 all 34.5kV transmission system outages can be scheduled when needed.