Generation Interconnection Feasibility Study Report

For

PJM Generation Interconnection Request Queue Position AA2-116

Cook-East Elkhart 345 kV

October 2015

Preface

The intent of the feasibility study is to determine a plan, with ballpark cost 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 a generator interconnection 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 Feasibility 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 (IC) proposes to interconnect a 994 MW (994 MW Capacity) natural gas fired Electric Power Plant to the American Electric Power (AEP) Transmission System at two (2) alternative points. The primary point of interconnection is located approximately 1 mile west of existing Kenzie Creek 345/138 kV substation as shown in Figures 1. This Point of interconnection will tie together the Cook – Kenzie Creek 345-kV circuit section and the Cook – East Elkhart 345-kV circuit section via a new switching station as shown in Figure 1. The secondary point of interconnection is obtained by rebuilding the primary side of Kenzie Creek 345/138 kV sub-station to a new switching station as shown in Figures 3. This secondary point of interconnection will tie together the Cook – Twin Branch 345-kV line and the Cook – East Elkhart 345-kV circuit section including the 138 kV Kenzie Creek secondary side. The proposed PJM Project #AA2-116 is located in Cass County, Michigan State.

The requested in-service date is 04/01/2020.

The objective of this Feasibility Study is to determine budgetary cost estimates and approximate construction timelines for identified transmission facilities required to connect the proposed generating facilities to the AEP Transmission System. These reinforcements include the Attachment Facilities, Local Upgrades, and Network Upgrades required to maintain the reliability of the AEP Transmission System. Stability analysis is not included as part of this study.

Attachment Facilities

Primary Point of Interconnection (West of Kenzie Creek Substation - Figure 1**):**

A new in-line 345 kV switching station will be constructed approximately 1 mile west from the existing Kenzie Creek 345/138 kV substation in Cass County, Michigan. This new station will tie together the Cook – Kenzie Creek 345-kV circuit section and the Cook – East Elkhart 345-kV circuit section as shown in Figure 1. The new switching station is to consist of six (6) 345 kV circuit breakers physically configured to provide for future expansion to a breaker and half bus arrangement, but initially operated as a ring-bus (Figure 1). The station will also include 345 kV metering, SCADA, and associated equipment. Protection relays in the surrounding area will need to be upgraded to accommodate the addition of the new generating station.

Interconnection Customer is expected to obtain, at its cost, a station site for the AEP facilities. Interconnection Customer shall obtain all necessary permits. Ownership of the new in-line switching facility and associated equipment shall be transferred from Interconnection Customer to AEP upon successful completion of the required work.

A 345 kV line extension is required to loop through the proposed station. The new AEP switching station is assumed to be located immediately adjacent to the existing transmission lines. A supplemental line easement for the tap poles will be required. It is expected that Interconnection Customer will obtain the supplemental easement when the station property is purchased.

The following work is required to connect Project AA2-116 to the Proposed Primary Point of Interconnection shown in Figure 1:

Description	Estimated Cost
Construct a new six (6) breaker 345 kV switching station laid out in a breaker and half arrangement including installation of associated disconnect switches, bus work, SCADA and 345 kV revenue metering.	$15,000,000
Line protection and controls will need to be installed at the new 345 kV switching station.	$1,000,000
Line protection and controls for Cook Circuit # 1 and #2 at Cook 345 kV substation will need to be upgraded to coordinate with the new 345 kV switching station due to the new generation added	$1,200,000
Line protection and controls at the Kenzie Creek 345/138 kV Substation will need to be upgraded to coordinate with the new 345 kV switching station due to the new generation added.	$600,000
Line protection and controls at the East Elkhart 345/138 kV Substation will need to be upgraded to coordinate with the new 345 kV switching station due to the new generation added.	$600,000
Total	**$18,400,000**

It is understood that Interconnection Customer is responsible for all these connection costs associated with interconnecting the PJM project AA2-116 to AEP transmission system. The costs above are reimbursable to AEP. The cost of IC's generating plant and the costs for the line connecting the generating plant to IC's switching station are not included in this report; these are assumed to be IC's responsibility.

The Generation Interconnection Agreement does not in or by itself establish a requirement for American Electric Power to provide power for consumption at the developer's facilities. A separate agreement may be reached with the local utility that provides service in the area to ensure that infrastructure is in place to meet this demand and proper metering equipment is installed. It is the responsibility of the developer to contact the local service provider utility to determine if a local service agreement is required.

Secondary Point of Interconnection (Kenzie Creek Substation - Figure 3**):**

Convert existing 345 kV primary bus of Kenzie Creek to 345 kV Switching station as shown in Figure 3. This new 345 kV switching station will tie together the Cook – Twin Branch 345-kV circuit and the Cook – East Elkhart 345-kV circuit section including the 138 kV section of Kenzie Creek substation. The new switching station is to initially operate as a ring-bus (Figure 3), but with a

breaker and half bus arrangement expansion potential in the future. The station will also include 345 kV metering, SCADA, and associated equipment. Protection relays in the surrounding area will need to be reset to accommodate the addition of the new station.

Interconnection Customer is expected to obtain, at its cost, any land required to expand the existing Kenzie Creek station site for the Interconnection facilities. Interconnection Customer shall obtain all necessary permits. Ownership of the new switching facility and associated equipment shall be transferred from Interconnection Customer to AEP upon successful completion of the required work.

The following work is required to connect Project AA2-116 to Proposed Secondary Point of Interconnection shown in Figure 3:

Station:

- Convert the 345 kV side of existing Kenzie Creek 345/138 kV Substation to a new six (6) breaker 345 kV switching station laid out in a breaker and half arrangement including installation of associated disconnect switches, bus work, SCADA and 345 kV revenue metering.

Protection and Relaying:

- Line protection and controls will need to be installed at the new 345 kV switching station.
- Lines protection and controls for Cook Circuit # 1 and #2 at the Cook 345 kV Substation will need to be upgraded to coordinate with the new 345 kV switching station due to the new generation added.
- Line protection and controls at the Twin Branch 345 kV Substation will need to be upgraded to coordinate with the new 345 kV switching station.

- Line protection and controls at the East Elkhart 345/138 kV Substation will need to be upgraded to coordinate with the new 345 kV switching station.

- Line protection and controls at the Kenzie Creek 138 kV side will need to be upgraded to coordinate with the new 345 kV switching station.

Local and Network Impacts

The impact of the proposed natural gas fired generating facility on the AEP System was assessed for adherence with applicable reliability criteria. AEP planning criteria require that the transmission system meet performance parameters prescribed in the AEP FERC Form 715[1] and Connection Requirements for AEP Transmission System[2]. Therefore, these criteria were used to assess the

1 https://www.aep.com/about/codeofconduct/oasis/transmissionstudies/GuideLines/2015%20AEP%20PJM%20FERC%20715_Final_Part%204.pdf

2 https://www.aep.com/about/codeofconduct/OASIS/TransmissionStudies/Requirements/AEP_Interconnection_Requirements_rev1.pdf

impact of the proposed facility on the AEP System. PJM project AA2-116 was studied as a 994 MW (994 MW capacity) injection to AEP system consistent with the interconnection application. The proposed Project AA2-116 was evaluated for compliance with reliability criteria for summer peak conditions in 2019.

Primary Point of Interconnection Potential network impacts were as follows:

Normal System (2019 Summer Conditions Capacity Output)

- No problems identified

Single Contingency (2019 Summer Conditions Capacity Output)

- No problems identified

Multiple Contingency (2019 Summer Conditions Capacity Output)

- No problems identified

Contribution to Previously Identified Overloads (2019 Summer Conditions Capacity Output)

- No problems identified

Normal System (2019 Summer Conditions Full Output)

- No problems identified

Single Contingency (2019 Summer Conditions Full Output)

- No problems identified

Multiple Contingency (2019 Summer Conditions Full Output)

Table 1 (Primary POI) – Multiple Contingency (2019 Summer Conditions Full Output)						
#	**Contingency Name**	**Contingency Description**	**Facility Description**	**Limiting element**	**Mitigation**	**Cost ($) and Schedule**
1	'7444_C2_05DUMONT 765-A2'	OPEN BRANCH FROM BUS 243206 TO BUS 246999 CKT 1 / 243206 05DUMONT 765 246999 05SORENS 765 1 OPEN BRANCH FROM BUS 243206 TO BUS 243219 CKT 2 / 243206 05DUMONT 765 243219 05DUMONT 345 2 OPEN BRANCH FROM BUS 243219 TO BUS 909144 CKT 2 / 243219 05DUMONT 345 909144 X2-052 TAP 345 2 END	(MISO NIPS - AEP) The 17HIPLE-05COLNGW 345 kV line (from bus 255105 to bus 243214 ckt 1) loads from 93.78% to 100.98% (DC power flow) of its emergency rating (1409 MVA) for the line fault with failed breaker contingency outage of '7444_C2_05DUMONT 765-A2'. This project contributes approximately 108.28 MW to the thermal violation.	ACSR ~ 954 ~45/7 ~ RAIL conductor section 1. **(Sag De-rated)**	A sag check will be required for the entire 33.46 mile of ACSR ~ 954 ~45/7 ~ RAIL conductor section 1 to determine if the line can be operated above its emergency rating of 1409 MVA. After mitigation, new AEP rating: S/N = 1412 & S/E = 1779 MVA. PJM will need to coordinate the upgrade of this AEP-NIPSCO tie line with NIPSCO and MISO to make sure NIPSCO equipment will not set a lower limit than specified here.	Depending on the sag study results, cost for this upgrade is expected to be between **$133,840** (no remediation required, just for the sag study itself) and $67 Million (complete line rebuild required).

Contribution to Previously Identified Overloads (2019 Summer Conditions Energy Output)

- No problems identified

Short Circuit Analysis

Bus Name	BREAKER	Rating Type	Breaker Capacity (Amps)	Duty Percent With AA2-116_Op1_AEP	Duty Percent Without AA2-116_Op1_AEP	Duty Percent Difference	Duty Amps With AA2-116_Op1_AEP	Duty Amps Without AA2-116_Op1_AEP	Notes	Estimated Cost
05TWINB1 138.kV	A2 (Rehab)	T	49204.4	101.77%	99.61%	2.17%	50077.1	49010.1	New Over-duty	$500,000
05ROB PK 138.kV	A1	T	48000.1	100.30%	99.65%	0.65%	48145.3	47834	New Over-duty	$500,000
05ROB PK 138.kV	A2	T	48000.1	100.30%	99.65%	0.65%	48145.3	47834	New Over-duty	$500,000
05ROB PK 138.kV	B1	T	48000.1	100.30%	99.65%	0.65%	48145.3	47834	New Over-duty	$500,000
05ROB PK 138.kV	B2	T	48000.1	100.30%	99.65%	0.65%	48145.3	47834	New Over-duty	$500,000
05ROB PK 138.kV	C1	T	48000.1	100.30%	99.65%	0.65%	48145.3	47834	New Over-duty	$500,000
05ROB PK 138.kV	C2	T	48000.1	100.30%	99.65%	0.65%	48145.3	47834	New Over-duty	$500,000
05ROB PK 138.kV	D1	T	48000.1	100.30%	99.65%	0.65%	48145.3	47834	New Over-duty	$500,000
05ROB PK 138.kV	D2	T	48000.1	100.30%	99.65%	0.65%	48145.3	47834	New Over-duty	$500,000
05ROB PK 138.kV	E1	T	48000.1	100.30%	99.65%	0.65%	48145.3	47834	New Over-duty	$500,000
05ROB PK 138.kV	E2	T	48000.1	100.30%	99.65%	0.65%	48145.3	47834	New Over-duty	$500,000
05ROB PK 138.kV	F1	T	48000.1	100.30%	99.65%	0.65%	48145.3	47834	New Over-duty	$500,000

- A1, A2, B1, B2, C1, C2, D1, D2, E1, E2 and F1 138 kV Circuit Breakers at Robison Park 138 kV substation have been identified to be over-duty. The A2 138 kV Circuit breaker at Twin Branch has also been identified as overdutied. A baseline project is under development to replace some, or all, of these breakers. The scope and schedule of the circuit breaker replacements will be determined during the system impact study phase of this project, as well as any cost allocations to AA2-116 for the breaker replacements.

Estimated cost to replace twelve (12) 138 kV Breakers: **$6,000,000**

Stability Analysis

- Stability Analysis will be performed during the System Impact Study.

Voltage Variations

- No problems identified.

Additional Limitations of Concern

- No problems identified

Local/Network Upgrades

- A sag check will be required for the AEP owned section of the Collingwood – Hiple 345 kV line to determine if the line section can be operated above its emergency rating of 1409 MVA. The result could prove that no additional upgrades are necessary, that some upgrades on the circuit are necessary, or that the entire 33.46 mile section of line would need to be rebuilt.

    - **Estimated Cost for the Sag Study Only: $133,840.**
    - **Estimated Cost to reconductor AEP portion of the line if needed: $67 Million.**
        - **Sag study analysis will determine if the line has to be reconductored.**

- This is an AEP-NIPSCO tie line therefore; PJM is going to have to coordinate this upgrade with NIPSCO as well to make sure that their equipment will not set a limit lower than what is specified here.

Secondary Point of Interconnection Potential network impacts were as follows:

Normal System (2019 Summer Conditions Capacity Output)

- No problems identified

Single Contingency (2019 Summer Conditions Capacity Output)

- No problems identified

Multiple Contingency (2019 Summer Conditions Capacity Output)

- No problems identified

Contribution to Previously Identified Overloads (2019 Summer Conditions Capacity Output)

- No problems identified

Normal System (2019 Summer Conditions Full Output)

- No problems identified

Single Contingency (2019 Summer Conditions Full Output)

- No problems identified

Multiple Contingency (2019 Summer Conditions Full Output)

Table 2 (Secondary POI) – Multiple Contingency (2019 Summer Conditions Full Output)					
#	**Contingency Name**	**Contingency Description**	**Overloaded Facility Description**	**Limiting element**	**Mitigation**
1	'8032'	OPEN BRANCH FROM BUS 243215 TO BUS 243220 CKT 1 / 243215 05COOK 345 243220 05EELKHA 345 1 OPEN BRANCH FROM BUS 243224 TO BUS 243234 CKT 1 / 243224 05KENZIE 345 243234 05TWIN B 345 1 END	AEP - AEP) The 05KENZIE 345/138 kV transformer (from bus 243224 to bus 243322 ckt 1) loads from 61.53% to 102.28% (DC power flow) of its emergency rating (571 MVA) for the tower line contingency outage of '8032'. This project contributes approximately 232.73 MW to the thermal violation.	Kenzie Creek #1 345/138 kV transformer.	Replace Kenzie Creek #1 345/138 kV transformer **Estimated Cost: $3,500,000**

Contribution to Previously Identified Overloads (2018 Summer Conditions Energy Output)

- No problems identified

Short Circuit Analysis

Bus Name	BREAKER	Rating Type	Breaker Capacity (Amps)	Duty Percent With AA2-116_Op2_AEP	Duty Percent Without AA2-116_Op2_AEP	Duty Percent Difference	Duty Amps With AA2-116_Op2_AEP	Duty Amps Without AA2-116_Op2_AEP	Notes
05TWINB1 138.kV	A (Rehab)	T	49204.4	112.54%	107.68%	4.86%	55376.6	52984.9	Over 100%, >3% contribution
05TWIN B 345.kV	J1	T	48000	104.79%	94.42%	10.36%	50298.5	45323.6	New Over-duty
05TWIN B 345.kV	JM	T	48000	104.79%	94.42%	10.36%	50298.5	45323.6	New Over-duty
05TWIN B 345.kV	J2	T	48000	104.37%	93.59%	10.78%	50098.8	44923.3	New Over-duty
05TWINB1 138.kV	A2 (Rehab)	T	49204.4	103.45%	99.61%	3.84%	50900.7	49010.1	New Over-duty
05TWIN B 345.kV	K2	T	48000	102.13%	91.44%	10.69%	49020	43890.7	New Over-duty

- A1 and A2 138 kV Circuit Breakers at the Twin Branch 138 kV substation have been identified to be over-duty and have been replaced so should not be an issue.
- J1 and K2 345 kV Circuit Breakers at the Twin Branch 345 kV substation have been identified to be over-duty. These circuit breakers are modeled incorrectly and should not be an issue.

- J2 and JM 345 kV Circuit Breakers at the Twin Branch 138 kV substation have been identified to be over-duty. The developer will be required to replace these circuit breakers.

Stability Analysis

- Stability studies were not performed as part of this Feasibility Study. The stability assessments will be performed during the System Impact Study.

Voltage Variations

- No problems identified.

Additional Limitations of Concern

- No known additional limitations of concern.

Local/Network Upgrades

- Estimates are not required to be provided for the Secondary POI analysis.

Schedule

It is anticipated that the time between receipt of executed agreements and Commercial Operation may range from 12 to 18 months if no line work is required. If line work is required, construction time would be between 24 to 36 months after signing an interconnection agreement.

Conclusion

Based upon the results of this Feasibility Study, the interconnection of the PJM #AA2-116 project to AEP transmission system will require the following construction costs.

Estimated Station Cost: $15,000,000
Estimated Protection and Relaying Cost: $3,400,000
Estimated Breaker Replacement Costs: $6,000,000
Estimated Network upgrade cost (Sag Study Only): $133,840

Total Estimated Cost for Project AA2-116: $24,533,840

The estimates are preliminary in nature, as they were determined without the benefit of detailed engineering studies. The cost of remediation for the sag study and line reconductoring is not included in this estimate. Final estimates will require, sag study results, determination of exact breaker replacement costs, an on-site review and coordination to determine final construction requirements.