Generation Interconnection Feasibility Study Report

For

PJM Generation Interconnection Request Queue Position AD1-106

North Waldo – Wildcreek 138 kV

April 2018

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

The Interconnection Customer (IC) proposes to install PJM Project #AD1-106, a 60.0 MW (22.8 MW Capacity) solar generating facility in Marion County, Ohio (see Figure 1). The Primary point of interconnection is to AEP's North Waldo – Wildcreek 138 kV section of the West Mount Vernon – South Kenton 138 kV circuit .The Secondary point of interconnection will be a direct connection to AEP's North Waldo 138 kV substation (see Figure 3).

The requested Backfeed date is March 12, 2019.

The requested in service date is June 12, 2019.

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 maintaining the reliability of the AEP transmission system. Stability analysis is not included as part of this study.

Attachment Facilities

Primary Point of Interconnection (North Waldo –Wildcreek 138 kV)

To accommodate the interconnection on the North Waldo – Wildcreek 138 kV section of the West Mount Vernon – South Kenton 138 kV circuit, a new three (3) circuit breaker 138 kV switching station physically configured in a breaker and half bus arrangement but operated as a ring-bus will be constructed (see Figure 1). Installation of associated protection and control equipment, 138 kV line risers, SCADA, and 138 kV revenue metering will also be required. AEP reserves the right to specify the final acceptable configuration considering design practices, future expansion, and compliance requirements.

<u>New Switching Station Work and Cost:</u>

- Construct a new three (3) circuit breaker 138 kV switching station physically configured in a breaker and half bus arrangement but operated as a ring-bus. Installation of associated protection and control equipment, 138 kV line risers, SCADA, and 138 kV revenue metering will also be required (see Figure 1).
    - **Estimated Station Cost: $5,000,000**

Direct Connection Cost Estimate

The total preliminary cost estimate for Direct Connection work is given in the following tables below.

For AEP building Direct Connection cost estimates:

Description	Total Cost
North Waldo – Wildcreek 138 kV T-Line Cut In	$1,000,000
Total	**$1,000,000**

Table 1

Non-Direct Connection Cost Estimate

The total preliminary cost estimate for Non-Direct Connection work is given in the following table below:

For AEP building Non-Direct Connection cost estimates:

Description	Estimated Cost
138 kV Revenue Metering	$250,000
Upgrade line protection and controls at the North Waldo 138 kV station.	$250,000
Upgrade line protection and controls at the Wildcreek 138 kV substation.	$250,000
Total	**$750,000**

Table 2

Secondary Point of Interconnection (North Waldo 138 kV Substation)

To accommodate the interconnection at the North Waldo 138 kV substation, the substation will have to be expanded requiring the installation of four (4) 138 kV circuit breakers, 138 kV switching station physically configured in a breaker and half bus arrangement but operated as a ring-bus (see Figure 3). Installation of associated protection and control equipment, 138 kV line risers, SCADA, and 138 kV revenue metering will also be required. AEP reserves the right to specify the final acceptable configuration considering design practices, future expansion, and compliance requirements.

Interconnection Customer Requirements

It is understood that the IC is responsible for all costs associated with this interconnection. The cost of the IC's generating plant and the costs for the line connecting the generating plant to the North Waldo 138 kV substation are not included in this report; these are assumed to be The IC Energy'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 to determine if a local service agreement is required.

Requirement from the PJM Open Access Transmission Tariff:

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.

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.

AEP Requirements

The Interconnection Customer will be required to comply with all AEP Revenue Metering Requirements for Generation Interconnection Customers. The Revenue Metering Requirements may be found within the "Requirements for Connection of New Facilities or Changes to Existing Facilities Connected to the AEP Transmission System" document located at the following link:

http://www.pjm.com/~/media/planning/plan-standards/private-aep/aep-interconnection-requirements.ashx

Option 1

Network Impacts

The Queue Project AD1-106 was evaluated as a 60.0 MW (Capacity 22.8 MW) injection tapping the North Waldo to Wildcreek 138 kV line section in the AEP area. Project AD1-106 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AD1-106 was studied with a commercial probability of 53%. Potential network impacts were as follows:

Base Case Used

Summer Peak Analysis – 2021 Case

Contingency Descriptions

The following contingencies resulted in overloads:

None

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)

None

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

None

Short Circuit

(Summary of impacted circuit breakers)

New circuit breakers found to be over-duty:

None

Affected System Analysis & Mitigation

LGEE Impacts:

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

MISO Impacts:

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

Duke, Progress & TVA Impacts:

Duke Carolina, Progress, & TVA Impacts to be determined during later study phases (as applicable).

OVEC Impacts:

OVEC 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.

1. (AEP - FE) The 05HOWARD-02BRKSID 138 kV line (from bus 243024 to bus 238586 ckt 1) loads from 121.48% to 122.38% (**DC power flow**) of its normal rating (167 MVA) for non-contingency condition. This project contributes approximately 3.33 MW to the thermal violation.

System Reinforcements

None

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.

Note: The time provided between anticipated normal completion of System Impact, Facilities Studies, subsequent execution of ISA and ICSA documents, and the proposed Backfeed Date is shorter than usual and may be difficult to achieve.

Conclusion

Based upon the results of this Feasibility Study, the construction of the 60.0 MW (22.8 MW Capacity) solar generating facility of The IC Energy (PJM Project #AD1-106) will require the following additional interconnection charges. This plan of service will interconnect the proposed solar generating facility in a manner that will provide operational reliability and flexibility to both the AEP system and the IC's generating facility.

Cost Breakdown for the Primary Point of Interconnection (North Waldo – Wildcreek 138 kV)		
Attachment Cost	New 138 kV Switching Station	$5,000,000
Non-Direct Connection Cost Estimate	North Waldo – Wildcreek 138 kV T-Line Cut In	$1,000,000
	138 kV Revenue Metering	$250,000
	Upgrade line protection and controls at the Mount Vernon 138 kV substation.	$250,000
	Upgrade line protection and controls at the South Kenton 138 kV substation.	$250,000
	Total Estimated Cost for Project AD1-106	**$6,750,000**

Table 3

The estimates are preliminary in nature, as they were determined without the benefit of detailed engineering studies. Final estimates will require an on-site review and coordination to determine final construction requirements.

Option 2

Network Impacts

The Queue Project AD1-106 was evaluated as a 60.0 MW (Capacity 22.8 MW) injection at the North Waldo 138kV substation in the AEP area. Project AD1-106 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AD1-106 was studied with a commercial probability of 53%. Potential network impacts were as follows:

Base Case Used

Summer Peak Analysis – 2021 Case

Contingency Descriptions

The following contingencies resulted in overloads:

Option 2	
Contingency Name	**Description**
'AEP_P7-1_#7731-A'	CONTINGENCY 'AEP_P7-1_#7731-A' OPEN BRANCH FROM BUS 243006 TO BUS 934460 CKT 1 / 243006 05FOSTOR 138 934460 AD1-070 TAP 138 1 OPEN BRANCH FROM BUS 243039 TO BUS 243110 CKT 1 / 243039 05MELMOR 138 243110 05STIFFI 138 1 END

Table 4

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)

AD1-106 Delivery of Energy Portion of Interconnection Request														
	Contingency				Bus				Loading		Rating			
#	Type	Name	Affected Area	Facility Description	From	To	Cir.	PF	Initial	Final	Type	MVA	MW Con.	FG App.
1	DCTL	'AEP_P7-1_#7731-A'	AEP-FE	05HOWARD-02BRKSID	243024	238586	1	DC	99.45	100.19	ER	245	3.99	

Table 5

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

None

Short Circuit

(Summary of impacted circuit breakers)

New circuit breakers found to be over-duty:

None

Affected System Analysis & Mitigation

LGEE Impacts:

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

MISO Impacts:

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

Duke, Progress & TVA Impacts:

Duke Carolina, Progress, & TVA Impacts to be determined during later study phases (as applicable).

OVEC Impacts:

OVEC 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.

1. (AEP - FE) The 05HOWARD-02BRKSID 138 kV line (from bus 243024 to bus 238586 ckt 1) loads from 108.44% to 109.45% (**DC power flow**) of its normal rating (167 MVA) for non-contingency condition. This project contributes approximately 3.75 MW to the thermal violation.

Figure 1: Primary Point of Interconnection (North Waldo – Wildcreek 138 kV)

Single-Line Diagram

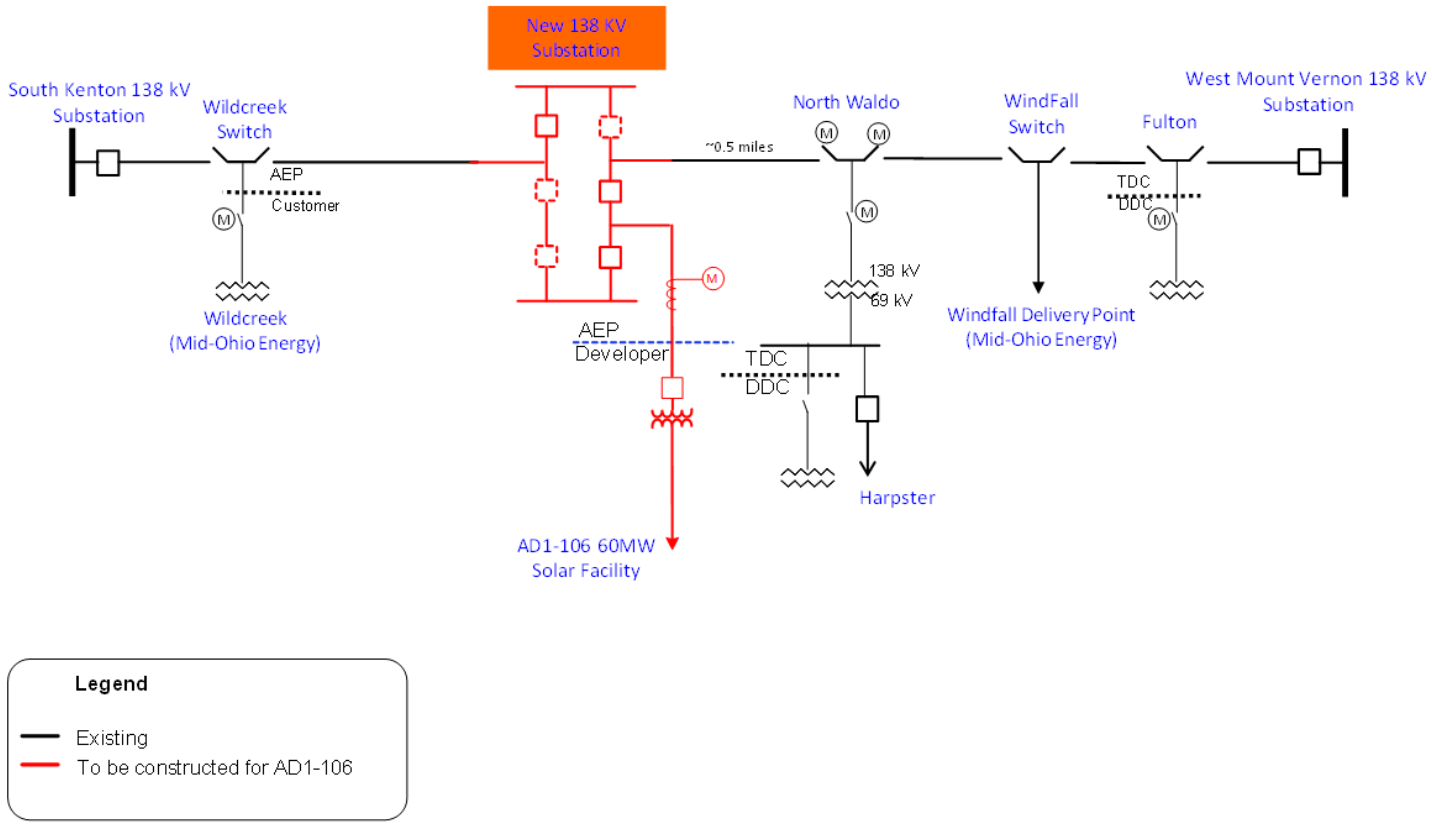
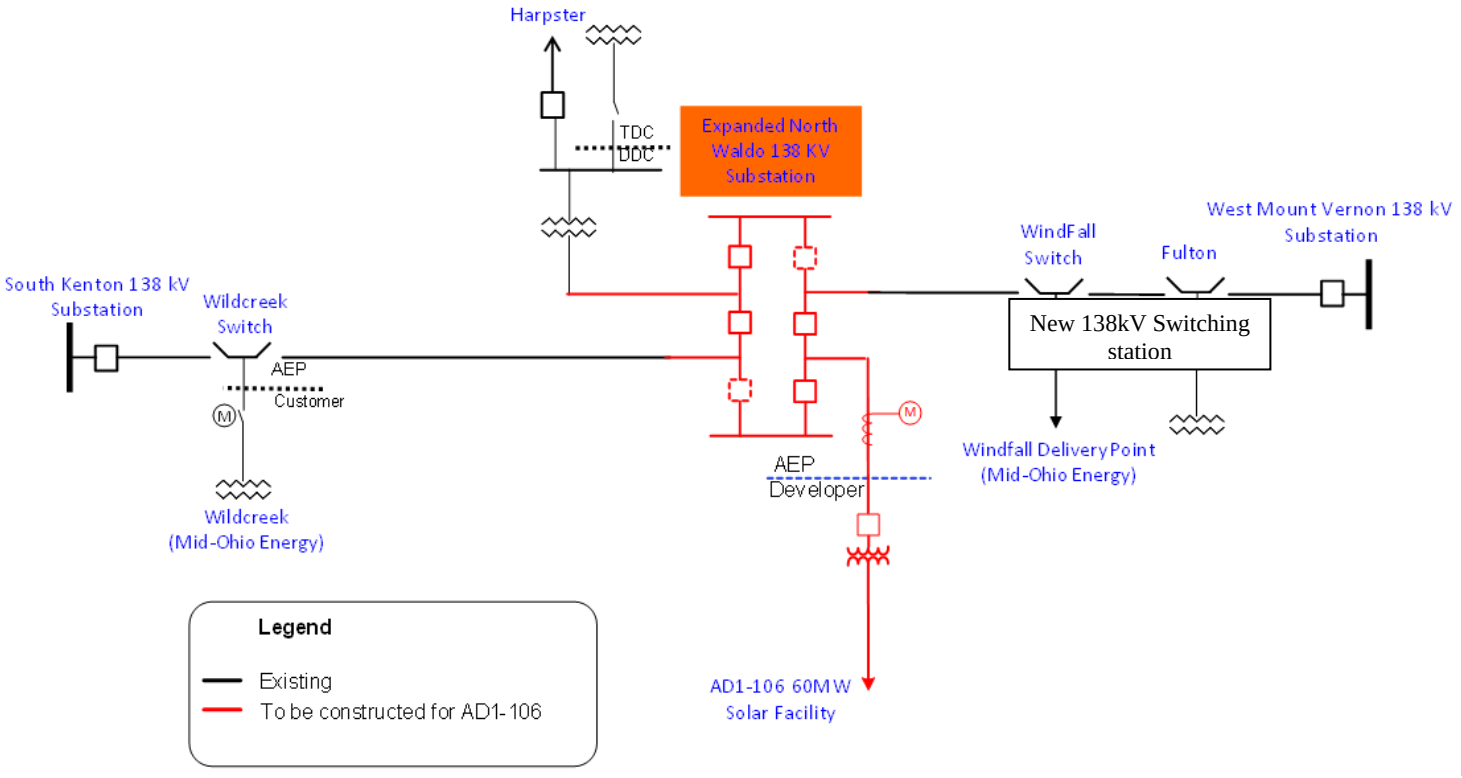


Figure 3: Secondary Point of Interconnection (North Waldo 138 kV)



Appendices for Option 2

The following appendices contain additional information about each flowgate presented in the body of the report. For each appendix, a description of the flowgate and its contingency was included for convenience. However, the intent of the appendix section is to provide more information on which projects/generators have contributions to the flowgate in question. 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.

Appendix 1

(AEP - FE) The 05HOWARD-02BRKSID 138 kV line (from bus 243024 to bus 238586 ckt 1) loads from 99.45% to 100.19% (**DC power flow**) of its emergency rating (245 MVA) for the tower line contingency outage of 'AEP_P7-1_#7731-A'. This project contributes approximately 3.99 MW to the thermal violation.

CONTINGENCY 'AEP_P7-1_#7731-A'
OPEN BRANCH FROM BUS 243006 TO BUS 934460 CKT 1 / 243006 05FOSTOR 138 934460 AD1-070 TAP 138 1
OPEN BRANCH FROM BUS 243039 TO BUS 243110 CKT 1 / 243039 05MELMOR 138 243110 05STIFFI 138 1
END

Bus Number	*Bus Name*	*Full Contribution*
932051	*AC2-015 C*	*14.23*
932052	*AC2-015 E*	*16.6*
934461	*AD1-070 C O2*	*6.74*
934462	*AD1-070 E O2*	*31.63*
934791	*AD1-106 C O2*	*1.51*
934792	*AD1-106 E O2*	*2.47*
LTF	*CARR*	*0.14*
LTF	*CBM-S1*	*0.97*
LTF	*CBM-S2*	*0.39*
LTF	*CBM-W1*	*6.38*
LTF	*CBM-W2*	*6.61*
LTF	*CIN*	*1.08*
LTF	*CPLE*	*0.07*
LTF	*G-007*	*0.28*
LTF	*IPL*	*0.7*
LTF	*LGEE*	*0.21*
LTF	*MEC*	*2.02*
LTF	*MECS*	*2.85*
LTF	*O-066*	*0.93*
LTF	*RENSSELAER*	*0.11*
LTF	*ROSETON*	*0.82*
247926	*U1-059 E*	*2.36*
247542	*U4-001 C*	*8.26*
247934	*U4-001 E*	*55.28*
247551	*U4-028 C*	*2.43*
247940	*U4-028 E*	*16.28*
247552	*U4-029 C*	*2.43*
247941	*U4-029 E*	*16.28*
247548	*V4-010 C*	*3.93*
247947	*V4-010 E*	*26.28*
247942	*W1-056 E*	*0.87*
LTF	*WEC*	*0.32*

925751	*AC1-051 C*	*2.*
925752	*AC1-051 E*	*13.38*