Generation Interconnection

System Impact Study Report

for

Queue Project AF2-078

REYNOLDS-OLIVE #1 345 KV

120 MW Capacity / 200 MW Energy

February 2021

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1 Introduction

This System Impact Study has been prepared in accordance with the PJM Open Access Transmission Tariff, 205, as well as the System Impact Study Agreement between the Interconnection Customer (IC), and PJM Interconnection, LLC (PJM), Transmission Provider (TP). The Interconnected Transmission Owner (ITO) is AEP.

2 Preface

The intent of the System Impact Study is to determine a plan, with approximate cost and construction time estimates, to connect the subject generation interconnection project to the PJM network at a location specified by the Interconnection Customer. As a requirement for interconnection, the Interconnection Customer may be responsible for the cost of constructing: Network Upgrades, which are facility additions, or upgrades to existing facilities, that are needed to maintain the reliability of the PJM system. All facilities required for interconnection of a generation interconnection project must be designed to meet the technical specifications (on PJM web site) for the appropriate transmission owner.

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 or merchant transmission upgrade, 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 System Impact Study is performed.

The System Impact 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.

The Interconnection Customer seeking to interconnect a wind or solar generation facility shall maintain meteorological data facilities as well as provide that meteorological data which is required per Schedule H to the Interconnection Service Agreement and Section 8 of Manual 14D.

An Interconnection Customer 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.

3 General

The Interconnection Customer (IC), has proposed a Solar; Storage generating facility located in White County, Indiana. The installed facilities will have a total capability of 200 MW with 120 MW of this output being recognized by PJM as Capacity.

The proposed in-service date for this project is October 31, 2022. This study does not imply a TO commitment to this in-service date.

Queue Number	AF2-078
Project Name	REYNOLDS-OLIVE #1 345 KV
State	Indiana
County	White
Transmission Owner	AEP
MFO	200
MWE	200
MWC	120
Fuel	Solar; Storage
Basecase Study Year	2023

Any new service customers who can feasibly be commercially operable prior to June 1st of the basecase study year are required to request interim deliverability analysis.

4 Point of Interconnection

AF2-078 will interconnect with the AEP transmission system via a direct connection to the AF1-207 proposed 345 kV station cut into Olive (AEP) – Reynolds (NIPSCO) 354kV circuit.

To accommodate the interconnection to the AF1-207 proposed 345 kV station, one (1) new 345 kV circuit breaker will be installed (Attachment 1). Installation of associated protection and control equipment, line risers, SCADA, jumpers, switches, and 345 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.

AEP will extend one span of 345 kV transmission line for the generation-leads going to the AF2-078 site. Unless this span extends directly from within the AEP station at the POI to the IC collector station structure, AEP will build and own the first transmission line structure outside of the AF1-207 proposed 345 kV station fence to which the AEP and AF2-078 transmission line conductors will attach.

5 Cost Summary

The AF2-078 project will be responsible for the following costs:

Description	Total Cost
Total Physical Interconnection Costs	$3,517,000
Allocation towards System Network Upgrade Costs*	$0
Total Costs	**$3,517,000**

*As your project progresses through the study process and other projects modify their request or withdraw, then your cost allocation could change.

The estimates provided in this report 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. In addition, Stability analysis will be completed during the Facilities Study stage. It is possible that a need for additional upgrades could be identified by these studies.

This cost excludes a Federal Income Tax Gross Up charges. This tax may or may not be charged based on whether this project meets the eligibility requirements of IRS Notice 2016-36, 2016-25 I.R.B. (6/20/2016). If at a future date it is determined that the Federal Income Tax Gross charge is required, the Transmission Owner shall be reimbursed by the Interconnection Customer for such taxes.

Note 1: PJM Open Access Transmission Tariff (OATT) section 217.3A outline cost allocation rules. The rules are further clarified in PJM Manual 14A Attachment B. The allocation of costs for a network upgrade will start with the first Queue project to cause the need for the upgrade. Later queue projects will receive cost

allocation contingent on their contribution to the violation and are allocated to the queues that have not closed less than 5 years following the execution of the first Interconnection Service Agreement which identifies the need for this upgrade.

Note 2: For customers with System Reinforcements listed: If your present cost allocation to a System Reinforcement indicates $0, then please be aware that as changes to the interconnection process occur, such as prior queued projects withdrawing from the queue, reducing in size, etc, the cost responsibilities can change and a cost allocation may be assigned to your project. In addition, although your present cost allocation to a System Reinforcement is presently $0, your project may need this system reinforcement completed to be deliverable to the PJM system. If your project comes into service prior to completion of the system reinforcement, an interim deliverability study for your project will be required.

6 Transmission Owner Scope of Work

The total physical interconnection costs is given in the table below:

6.1 Attachment Facilities

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

Description	Total Cost
345 kV Revenue Metering	$431,000
Generator lead first span exiting the POI station, including the first structure outside the fence	$651,000
Total Attachment Facility Costs	**$1,082,000**

6.2 Direct Connection Cost Estimate

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

Description	Total Cost
One (1) new 345 kV circuit breaker(s) will be installed at the AF1-207 proposed 345 kV station (Attachment 1). Installation of associated protection and control equipment, 345 kV line risers, and SCADA will also be required.	$2,390,000
Total Direct Connection Facility Costs	**$2,390,000**

6.3 Non-Direct Connection Cost Estimate

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

Description	Total Cost
Review line protection and control settings at the AF1-207 proposed 345 kV station	$45,000
Total Non-Direct Connection Facility Costs	**$45,000**

7 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 generally be between 24 to 36 months after Agreement execution.

8 Interconnection Customer Requirements

It is understood that the Interconnection Customer (IC) is responsible for all costs associated with this interconnection. The costs above are reimbursable to the Transmission Owner. The cost of the IC's generating plant and the costs for the line connecting the generating plant to the Point of Interconnection are not included in this report; these are assumed to be the IC's responsibility.

The Generation Interconnection Agreement does not in or by itself establish a requirement for the Transmission Owner 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.

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.

9 Revenue Metering and SCADA Requirements

9.1 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 Section 8 of Attachment O.

9.2 Meteorological Data Reporting Requirements

The solar generation facility shall provide the Transmission Provider with site-specific meteorological data including:

- Back Panel temperature (Fahrenheit) - (Required for plants with Maximum Facility Output of 3 MW or higher)
- Irradiance (Watts/meter2) - (Required for plants with Maximum Facility Output of 3 MW or higher)
- Ambient air temperature (Fahrenheit) - (Accepted, not required)
- Wind speed (meters/second) - (Accepted, not required)
- Wind direction (decimal degrees from true north) - (Accepted, not required)

9.3 Interconnected Transmission Owner Requirements

The IC will be required to comply with all Interconnected Transmission Owner's revenue metering requirements for generation interconnection customers located at the following link:

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

10 Summer Peak Analysis

The Queue Project AF2-078 was evaluated as a 200.0 MW (Capacity 120.0 MW) injection into the AF1-207 interconnection substation which is a tap of the Reynolds to Olive 345 kV line #1 (specifically a tap of the Reynolds – AC2-080 Tap line segment) in the AEP area. Project AF2-078 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AF2-078 was studied with a commercial probability of 100.0 %. Potential network impacts were as follows:

10.1 Generation Deliverability

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

None

10.2 Multiple Facility Contingency

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

ID	FROM BUS#	FROM BUS	kV	FROM BUS AREA	TO BUS#	TO BUS	kV	TO BUS AREA	CKT ID	CONT NAME	Type	Rating MVA	PRE PROJECT LOADING %	POST PROJECT LOADING %	AC|DC	MW IMPACT
95232387	243217	05DEQUIN	345.0	AEP	243878	05MEADOW	345.0	AEP	2	AEP_P4_#4704_05DEQUIN 345_B1	breaker	1959.0	99.91	100.13	AC	4.34

10.3 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

10.4 Steady-State Voltage Requirements

To be determined.

10.5 Potential Congestion due to Local Energy Deliverability

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.

Note: Only the most severely overloaded conditions are listed below. 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 shall study all overload conditions associated with the overloaded element(s) identified.

10.6 System Reinforcements

ID	Idx	Facility	Upgrade Description	Cost	Cost Allocated to AF2-078	Upgrade Number
95232387	2	**05DEQUIN 345.0 kV - 05MEADOW 345.0 kV Ckt 2**	PJM network upgrades N5817 and N5818 which added a 345 kV breaker at Dequine (breaker 'D') eliminate the Dequine stuck breaker contingency which cuases this overload. N5817 and N5818 are in-service.	$0	$0	N5817 N5818
			Total Cost	**$0**	**$0**	

Note : For customers with System Reinforcements listed: If your present cost allocation to a System Reinforcement indicates $0, then please be aware that as changes to the interconnection process occur, such as prior queued projects withdrawing from the queue, reducing in size, etc, the cost responsibilities can change and a cost allocation may be assigned to your project. In addition, although your present cost allocation to a System Reinforcement is presently $0, your project may need this system reinforcement completed to be deliverable to the PJM system. If your project comes into service prior to completion of the system reinforcement, an interim deliverability study for your project will be required.

10.7 Flow Gate Details

The following indices contain additional information about each facility presented in the body of the report. For each index, a description of the flowgate and its contingency was included for convenience. The intent of the indices is to provide more details on which projects/generators have contributions to the flowgate in question. All New Service Queue Requests, through the end of the Queue under study, that are contributors to a flowgate will be listed in the indices. Please note that there may be contributors that are subsequently queued after the queue under study that are not listed in the indices. Although this information is not used "as is" for cost allocation purposes, it can be used to gage the impact of other projects/generators. It should be noted the project/generator MW contributions presented in the body of the report are Full MW Impact contributions which are also noted in the indices column named "Full MW Impact", whereas the loading percentages reported in the body of the report, take into consideration the PJM Generator Deliverability Test rules such as commercial probability of each project as well as the ramping impact of "Adder" contributions. The MW Impact found and used in the analysis is shown in the indices column named "Gendeliv MW Impact".

10.7.1 Index 1

None

10.7.2 Index 2

ID	FROM BUS#	FROM BUS	FROM BUS AREA	TO BUS#	TO BUS	TO BUS AREA	CKT ID	CONT NAME	Type	Rating MVA	PRE PROJECT LOADING %	POST PROJECT LOADING %	AC|DC	MW IMPACT
95232387	243217	05DEQUIN	AEP	243878	05MEADOW	AEP	2	AEP_P4_#4704_05DEQUIN 345_B1	breaker	1959.0	99.91	100.13	AC	4.34

Bus #	Bus	Gendeliv MW Impact	Type	Full MW Impact
243859	05FR-11G C	1.7945	50/50	1.7945
243862	05FR-12G C	1.7670	50/50	1.7670
243864	05FR-21G C	1.8860	50/50	1.8860
243866	05FR-22G C	1.8036	50/50	1.8036
243870	05FR-3G C	3.6530	50/50	3.6530
243873	05FR-4G C	2.8290	50/50	2.8290
247900	05FR-11G E	42.6610	50/50	42.6610
247901	05FR-12G E	41.9527	50/50	41.9527
247902	05FR-21G E	44.8403	50/50	44.8403
247903	05FR-22G E	42.9334	50/50	42.9334
247904	05FR-3G E	86.9565	50/50	86.9565
247905	05FR-4G E	68.1050	50/50	68.1050
930461	AB1-087	73.2380	50/50	73.2380
930471	AB1-088	73.2380	50/50	73.2380
933441	AC2-157 C	10.1202	50/50	10.1202
933442	AC2-157 E	16.5118	50/50	16.5118
942601	AE2-276	6.6580	50/50	6.6580
944201	AF1-088 FTIR	133.1600	50/50	133.1600
945391	AF1-204 C O1	12.9291	50/50	12.9291
945392	AF1-204 E O1	38.7874	50/50	38.7874
953761	J829	25.0350	PJM External (MISO)	25.0350
954681	J949 C	16.1041	PJM External (MISO)	16.1041
954761	J468 C	3.1848	PJM External (MISO)	3.1848
954762	J468 E	18.0474	PJM External (MISO)	18.0474
954772	J515 E	66.1920	PJM External (MISO)	66.1920
956451	J1139	15.9795	PJM External (MISO)	15.9795
957141	AF2-008 FTIR	66.5800	50/50	66.5800
957142	AF2-008 NFTI	66.5800	50/50	66.5800
957843	AF2-078 BAT	4.3430	50/50	4.3430
LGEE	LGEE	2.0133	Confirmed LTF	2.0133
CPLE	CPLE	0.8189	Confirmed LTF	0.8189
G-007A	G-007A	0.2110	Confirmed LTF	0.2110
VFT	VFT	0.5483	Confirmed LTF	0.5483
CBM-W2	CBM-W2	41.3349	Confirmed LTF	41.3349
TVA	TVA	4.6256	Confirmed LTF	4.6256
CBM-S2	CBM-S2	8.9243	Confirmed LTF	8.9243
CBM-S1	CBM-S1	28.5079	Confirmed LTF	28.5079
MADISON	MADISON	1.3527	Confirmed LTF	1.3527
MEC	MEC	2.9285	Confirmed LTF	2.9285

10.8 Queue Dependencies

The Queue Projects below are listed in one or more indices for the overloads identified in your report. These projects contribute to the loading of the overloaded facilities identified in your report. The percent overload of a facility and cost allocation you may have towards a particular reinforcement could vary depending on the action of these earlier projects. The status of each project at the time of the analysis is presented in the table. This list may change as earlier projects withdraw or modify their requests.

Queue Number	Project Name	Status
AB1-006	Meadow Lake 345kV	In Service
AB1-080	Dumont-Olive 345kV	In Service
AB1-087	Sullivan 345kV #1	Active
AB1-088	Sullivan 345kV #2	Active
AC2-080	Olive-Reynolds 345kV	Active
AC2-140	DC Cook Unit 2	In Service
AC2-157	Sullivan 345 kV	Active
AD2-138	Olive-Reynolds 345kV	Active
AE1-194	Crete 345 kV	Active
AE1-195	Crete 345 kV	Active
AE1-198	Crete 345 kV	Active
AE2-045	Olive-Reynolds 345 kV	Active
AE2-130	Rockport 765 kV	Active
AE2-154	Meadow Lake 345 kV (MLV VIII)	Active
AE2-276	Sullivan 345kV	Active
AF1-088	Sullivan 345 kV	Active
AF1-204	Eugene 345 kV	Active
AF1-207	Reynolds–Olive #1 345 kV	Active
AF1-215	Reynolds-Olive 345 kV	Active
AF1-322	Meadow Lake 345 kV	Active
AF2-008	Sullivan 345 kV	Active
AF2-033	Miami Fort GT 138 kV	Active
AF2-078	Reynolds-Olive #1 345 kV	Active
AF2-132	Reynolds-Olive #1 345 kV	Active
AF2-133	Reynolds-Olive #2 345 kV	Active
AF2-134	Reynolds-Olive #2 345 kV	Active
AF2-188	Reynolds-Meadow Lake #1 345 kV	Active
AF2-189	Greentown 138 kV	Active
AF2-205	Olive-Reynolds #2 345 kV	Active
AF2-359	Olive-University Park 345 kV	Active
Y1-054	Rochelle 138kV	In Service
Y3-099	Beckjord 2 MW-1	In Service
Y3-100	Beckjord 2 MW-2	In Service
Z1-065	Wiley 34.5kV	In Service
J1139	MISO	MISO
J468	MISO	MISO
J515	MISO	MISO
J829	MISO	MISO
J949	MISO	MISO

10.9 Contingency Descriptions

Contingency Name	Contingency Definition
AEP_P1-2_#709	CONTINGENCY 'AEP_P1-2_#709' OPEN BRANCH FROM BUS 242924 TO BUS 243208 CKT 1 / 242924 05HANG R 765 243208 05JEFRSO 765 1 END
AEP_P4_#4704_05DEQUIN 345_B1	CONTINGENCY 'AEP_P4_#4704_05DEQUIN 345_B1' OPEN BRANCH FROM BUS 243217 TO BUS 243878 CKT 1 / 243217 05DEQUIN 345 243878 05MEADOW 345 1 OPEN BRANCH FROM BUS 243217 TO BUS 249525 CKT 1 / 243217 05DEQUIN 345 249525 08WESTWD 345 1 REMOVE SWSHUNT FROM BUS 243217 / 243217 05DEQUIN 345 END
AEP_P4_#6189_05HANG R 765_D1	CONTINGENCY 'AEP_P4_#6189_05HANG R 765_D1' OPEN BRANCH FROM BUS 242921 TO BUS 242924 CKT 1 / 242921 05CORNU 765 242924 05HANG R 765 1 OPEN BRANCH FROM BUS 242924 TO BUS 243208 CKT 1 / 242924 05HANG R 765 243208 05JEFRSO 765 1 OPEN BRANCH FROM BUS 242921 TO BUS 242934 CKT 1 / 242921 05CORNU 765 242934 05CORNU 345 1 REMOVE UNIT 1A FROM BUS 247245 / 247245 05HRKG1A 18.0 REMOVE UNIT 1B FROM BUS 247246 / 247246 05HRKG1B 18.0 REMOVE UNIT 1S FROM BUS 247247 / 247247 05HRKG1S 18.0 REMOVE UNIT 2A FROM BUS 247248 / 247248 05HRKG2A 18.0 REMOVE UNIT 2B FROM BUS 247249 / 247249 05HRKG2B 18.0 REMOVE UNIT 2S FROM BUS 247250 / 247250 05HRKG2S 18.0 END

11 Light Load Analysis

The Queue Project AF2-078 was evaluated as a 20.0 MW injection tapping the Reynolds to Olive 345 kV line in the AEP area. Project AF2-078 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AF2-078 was studied with a commercial probability of 100.0 %. Potential network impacts were as follows:

11.1 Light Load Deliverability

(Single or N-1 contingencies)

None.

11.2 Multiple Facility Contingency

(Double Circuit Tower Line, Fault with a Stuck Breaker, and Bus Fault contingencies)

None.

11.3 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.

11.4 Potential Congestion due to Local Energy Deliverability

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.

Note: Only the most severely overloaded conditions are listed below. 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 shall study all overload conditions associated with the overloaded element(s) identified.

None.

11.5 System Reinforcements

None.

12 Short Circuit Analysis

The following Breakers are overdutied:

None.

13 Stability and Reactive Power

(Summary of the VAR requirements based upon the results of the dynamic studies)

To be determined in the Facilities Study Phase.

14 Affected Systems

None

15 Attachment 1: One Line Diagram and Project Site Location