Revised
Generation Interconnection
System Impact Study Report

For

PJM Generation Interconnection Request
Queue Position AD2-113/AD2-114

"South Bend 500 kV"

AD2-113: 60.6 MW Capacity / 70 MW Energy

AD2-114: 400 MW Capacity / 410 MW Energy

September 2019

Introduction

This System Impact Study has been prepared in accordance with the PJM Open Access Transmission Tariff, 36.2, as well as the System Impact Study Agreement between **Armstrong Power, LLC**, the Interconnection Customer (IC), and PJM Interconnection, LLC (PJM), Transmission Provider (TP). The Interconnected Transmission Owner (ITO) is West Penn Power Company (WPP).

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.

Revision from August 2019 System Impact Study Report

Customer revised the Commercial Operation date from May 31, 2022 to June 1, 2023.

General

The IC has proposed uprates to the existing natural gas generating facility, South Bend Generating Station, located at 2313 State Route 156, Shelocta, Pennsylvania 43443. The requested increases come under Queue Position Numbers AD2-113 and AD2-114 as shown in the table below. AD2-113 is for an increase to the MFO of 70 MW and an increase in Capacity of 60.6. AD2-114 is for an increase to the MFO of an additional 410 MW and an additional increase in Capacity of 400 MW. The total Maximum Facility Output (MFO) will be **1200 MW** and the new Capacity Interconnection Rights (CIR) will be **1170 MW**.

The following table shows all Queue Positions associated with the South Bend Generating Station and their MFO and CIR values. Please note that the CIR values may decrease over time based on the reported unit's summer and winter performance numbers to PJM.

Queue Position	MW Energy	MW Capacity	MFO	CIR
B12_W01	600	600	720[1]	709.4[2]
G30_W53	104	104		
Z1-055	10	10		
Z1-056	6	6		
AD1-099	0	70		
AD2-113	70	60.6	790	770
AD2-114	410	400	1200	1170
Total	**1200**	**(see CIR)**	**1200**	**1170**

The customer's expected Commercial Operation Date is **June 1, 2023**.

Point of Interconnection (POI)

The AD2-113/114 uprate project will interconnect with the ITO transmission system through the same existing POI as prior Queue position requests identified in the table above at the South Bend Substation.

Attachment 1 shows the one-line diagram for this project. **Attachment 2** provides the site plan.

[1] The above 720 MW MFO number is based on the latest Interconnection Service Agreement ("ISA") associated with Queue Position AD1-099, designated Second Revised ISA Service Agreement No. 1127 , and is posted on the PJM Website at this link:
https://www.pjm.com/pub/planning/project-queues/isa/ad1_099_isa.pdf

[2] The above 709.4 MW CIR number is based on the 2018 Summer Net Capability Test effective 9/1/2018 + 70 MW from AD1-099.

Cost Summary

The **AD2-13/114 "South Bend 138 kV"** project does not require any facility upgrades to interconnect. Therefore, there are no direct or non-direct connection facilities costs associated with these projects.

Description	Total Cost
Attachment Facilities	$ 0
Direct Connection Work	$ 0
Non-Direct Connection Work	$ 62,400
New System Upgrades[3]	$ 0
Previously Identified Upgrades	$ 0
Total Costs	$ 62,400

The upgrade costs given above exclude any applicable state or federal taxes. If at a future date Federal CIAC (contribution in aid of construction) taxes are deemed necessary by the IRS for this project, WPP shall be reimbursed by the Interconnection Customer for such taxes. WPP estimates the tax, if applicable, would be approximately **$10,000**.

The required Attachment Facilities, Direct Connection, and Non-Direct Connection work for the interconnection of the AD2-113/AD2-114 generation project to the WPP Transmission System is detailed in the following sections. The associated one-line with the generation project is shown in Attachment 1.

Note that all cost estimates contained in this document were produced without a detailed engineering review and are therefore subject to change. IC will be responsible for the actual cost of the work that is implemented. WPP herein reserves the right to return to any issues in this document and, upon appropriate justification, request additional monies to complete any reinforcements to the transmission or subtransmission systems.

[3] At Keystone 500 kV Substation, Cabot No. 14 and Cabot No. 15 circuit breakers will need to be replaced to address overdutied CBs identified in the AD2-114 analysis. These CBs will be replaced under RTEP Baseline Projects b2953 and b2954. No cost for AD2-114 IC but these baseline projects will need to be completed in order for the AD2-114 project to be placed in-service. Currently these breakers are expected to be replaced by 6/1/2020.

Transmission Owner Scope of Work

The **AD2-113/114 "South Bend 138 kV"** project does not require any facility upgrades to interconnect. Therefore, there are no direct or non-direct connection facilities costs associated with these projects.

Attachment Facilities

There is no Attachment Facility scope of work required.

Direct Connection Cost Estimate

There is no Direct Connection scope of work required.

Non-Direct Connection Cost Estimate[3]

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
Keystone Substation: Revise relay settings on South Bend Terminal. (PJM Network Upgrade Number n6107)	$ 31,200
Yukon Substation: Revise relay settings on the South Bend Terminal. (PJM Network Upgrade Number n6108)	$ 31,200
Total	**$ 62,400**

Keystone 500 kV Substation:

Replace Cabot No. 14 and Cabot No. 15 circuit breakers. This work is scheduled to be completed under PJM Regional Transmission Expansion Plan Baseline Projects b2953 and b2954, respectively. The Interconnection Customer will not have cost responsibility for these breaker replacements. **These baseline projects need to be completed prior to AD2-114 going into service.**

Schedule

Based on the extent of the ITO interconnection work required to support the AD2-113/AD2-114 generation project, it is expected to take a minimum of **9 months** from the date of a fully executed Interconnection Construction Service Agreement. This includes preliminary payment that compensates FE for the cost of the Non-Direction Connection work.

Note: Before AD2-114 can go into service, RTEP Baseline projects b2953 and b2954 for the replacement of the Cabot No. 14 and Cabot No. 15 500 kV breakers at Keystone Substation must be placed in service. Currently these breakers are expected to be replaced by 6/1/2020.

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 Attachment O, Appendix 2, Section 8.

ITO Requirements

The IC will be required to comply with all FE revenue metering requirements for generation interconnection customers which can be found in FE's "Requirements for Transmission Connected Facilities" document located at:

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

ITO Analysis and Connection Requirements:

Power Flow Analysis

PJM performed a power flow analysis of the transmission system using a 2021 summer peak load flow model and the results were verified by FE. Additionally, FE performed an analysis of its underlying transmission <100 kV system. The AD2-113/114 project did not contribute to any overloads on the FE transmission system.

Short Circuit Analysis

PJM performed a short circuit analysis and the results were verified by FE. The connection of AD2-113/114 project to the system does not result in any newly overdutied circuit breakers on the FE transmission system and does not have a significant fault current contribution to existing overdutied circuit breakers.

Stability Analysis

PJM will be responsible for completing a dynamic stability analysis, if necessary, as part of the Facilities Study. The results of this analysis will be reviewed by FE. Should stability concerns be identified in PJM's study, FE will develop appropriate system reinforcement(s) and include the estimated cost of any reinforcement(s) in FE's Facilities Study report.

System Protection

The IC must design it's Customer Facilities in accordance with all applicable standards, including the standards in FE's "Requirements for Transmission Connected Facilities" document located at: http://www.pjm.com/planning/design-engineering/to-tech-standards/private-firstenergy.aspx. Preliminary Protection requirements will be provided as part of the Facilities Study. Detailed Protection Requirements will be provided once the project enters the construction phase.

Compliance Issues and Interconnection Customer Requirements

The proposed Customer Facilities must be designed in accordance with FE's "Requirements for Transmission Connected Facilities" document located at: http://www.pjm.com/planning/design-engineering/to-tech-standards/private-firstenergy.aspx. If not already existing, the IC is responsible for the following:

1. 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.

2. 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.

3. Compliance with the FE and PJM generator power factor and voltage control requirements.

4. The execution of a back-up service agreement to serve the customer load supplied from the AD2-113/114 generation project metering point when the units are out-of-service. This assumes the intent of the IC is to net the generation with the load.

The IC will also be required to meet all PJM, ReliabilityFirst, and NERC reliability criteria and operating procedures for standards compliance. For example, the IC 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.

Power Factor Requirements

The existing 704 MW portion of the Customer Facility shall retain its existing ability to maintain a power factor of at least 0.95 leading to 0.90 lagging measured at the generator's terminals.

The existing 16 MW portion of the Customer Facility (10 MW increase under PJM Queue Position #Z1-055 and 6 MW increase under PJM Queue Position #Z1-056) shall retain its existing ability to maintain a power factor of at least 1.0 (unity) to 0.90 lagging measured at the generator's terminals.

The increase of 70 MW to the Customer Facility associated with PJM Queue Position #AD2-113 shall be designed with the ability to maintain a power factor of at least 1.0 (unity) to 0.90 lagging measured at the generator's terminals.

The increase of 410 MW to the Customer Facility associated with PJM Queue Position #AD2-114 shall be designed with the ability to maintain a power factor of at least 1.0 (unity) to 0.90 lagging measured at the generator's terminals.

Based on data provided by the IC the facility should be able to meet this requirement.

Network Impacts

The queues were studied separately. You will first see the AD2-113 summer peak analysis results followed by the results for AD2-114.

Network Impacts- AD2-113

The Queue Project AD2-113 was evaluated as a 70.0 MW (Capacity 60.6 MW) injection into the South Bend 500 kV substation in the APS area. Project AD2-113 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AD2-113 was studied with a commercial probability of 100%. Potential network impacts were as follows:

Summer Peak Analysis - 2021

Generator Deliverability

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

None

Multiple Facility Contingency

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

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

Delivery of Energy Portion of Interconnection Request

PJM also studied the delivery of the energy portion of this interconnection request. Any problems identified below are likely to result in operational restrictions to the project under study. The developer can proceed with network upgrades to eliminate the operational restriction at their discretion by submitting a Merchant Transmission Interconnection request.

Only the most severely overloaded conditions are listed. There is no guarantee of full delivery of energy for this project by fixing only the conditions listed in this section. With a Transmission Interconnection Request, a subsequent analysis will be performed, which will study all overload conditions associated with the overloaded element(s) identified.

None

Short Circuit

(Summary of impacted circuit breakers)

None

Stability and Reactive Power Requirement for Low Voltage Ride Through

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

No mitigations required.

Affected System Analysis & Mitigation

None

Light Load Analysis - 2021

Not required for this customer.

System Reinforcements

Summer Peak Load Flow Analysis Reinforcements

New System Reinforcements
(Upgrades required to mitigate reliability criteria violations, i.e. Network Impacts, initially caused by the addition of this project generation)

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

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

None

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

None

Network Impacts- AD2-114

The Queue Project AD2-114 was evaluated as a 410.0 MW (Capacity 400.0 MW) injection into the South Bend 500 kV substation in the APS area. Project AD2-114 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AD2-114 was studied with a commercial probability of 100%. Potential network impacts were as follows:

Summer Peak Analysis - 2021

Generator Deliverability

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

None

Multiple Facility Contingency

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

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

Delivery of Energy Portion of Interconnection Request

PJM also studied the delivery of the energy portion of this interconnection request. Any problems identified below are likely to result in operational restrictions to the project under study. The developer can proceed with network upgrades to eliminate the operational restriction at their discretion by submitting a Merchant Transmission Interconnection request.

Only the most severely overloaded conditions are listed. There is no guarantee of full delivery of energy for this project by fixing only the conditions listed in this section. With a Transmission Interconnection Request, a subsequent analysis will be performed, which will study all overload conditions associated with the overloaded element(s) identified.

None

Short Circuit

(Summary of impacted circuit breakers)

Bus Number	Bus Name	BREAKER	Rating Type	Breaker Capacity (Amps)	Duty Percent withAD2-114_BKRRating_APS_OSF_Area=225.csv	Duty Percent withoutAD2-114_without_BKRRating_APS_OSF_Area=225.csv	Duty Percent Difference	Duty Amps withAD2-114_BKRRating_APS_OSF_Area=225.csv	Duty Amps withoutAD2-114_without_BKRRating_APS_OSF_Area=225.csv	Notes
11	KEYSTONE 500.kV	NO.14 CABOT	S	40000	110.56%	103.27%	7.29%	44222.3	41306	Over 100%, >=3% contribution
11	KEYSTONE 500.kV	NO.16 CABOT	S	40000	110.56%	103.27%	7.29%	44222.3	41306	Over 100%, >=3% contribution

Stability and Reactive Power Requirement for Low Voltage Ride Through

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

None

Affected System Analysis & Mitigation

None

Light Load Analysis - 2021

Not required for this customer.

System Reinforcements

Summer Peak Load Flow Analysis Reinforcements

New System Reinforcements
(Upgrades required to mitigate reliability criteria violations, i.e. Network Impacts, initially caused by the addition of this project generation)

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

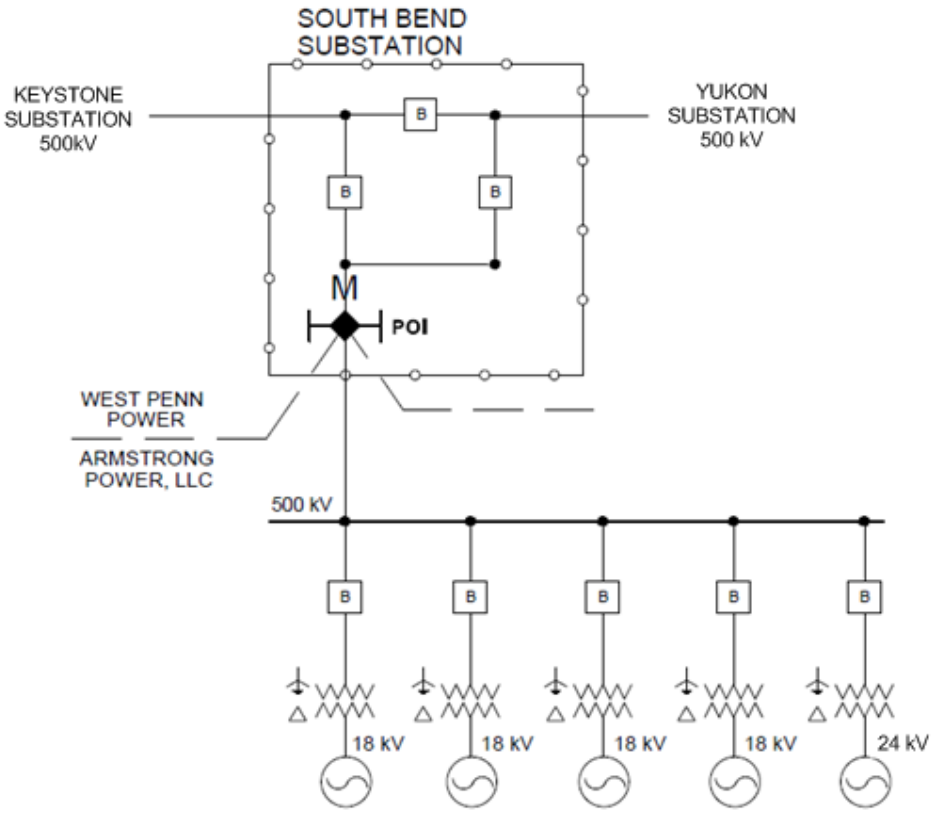
Short Circuit
(Summary form of Cost allocation for breakers will be inserted here if any)

At Keystone 500 kV Substation, replace Cabot No. 14 and Cabot No. 15 circuit breakers. This work will be done under RTEP Baseline Projects b2953 and b2954. No cost for AD2-113 and AD2-114 IC but these baseline projects will need to be completed in order for the AD2-114 project to be placed in-service.

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

None

Attachment 1. AD2-113/114 "South Bend 138 kV"
One Line Diagram



ARMSTRONG POWER, LLC
5 x 1 COMBINE CYCLE NATURAL GAS GENERATION
MFO - 1200 MW
CAPACITY - 1170 MW

◆ = POI (POINT OF INTERCONNECTION) LOCATED AT WEST PENN POWER SUBSTATION DEAD-END STRUCTURE, WHERE ARMSTRONG POWER, LLC TRANSMISSION LINE TERMINATES

M = REVENUE METERING

Attachment 2. AD2-113/114 “South Bend 138 kV”
Project Location