Generation Interconnection System Impact Study Report

For

PJM Generation Interconnection Request Queue Position AD2-192

“Glen Falls 138 kV”

20 MW Capacity / 45 MW Energy Uprate

June 2019

Introduction

This System Impact Study has been prepared in accordance with the PJM Open Access Transmission Tariff, 36.2, as well as the Feasibility Study Agreement between **ESC Harrison County Power, LLC,** the Interconnection Customer (IC), and PJM Interconnection, LLC (PJM), Transmission Provider (TP). The Interconnected Transmission Owner (ITO) is Allegheny Power Systems (APS).

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.

General

ESC Harrison County Power, LLC, the Interconnection Customer (IC), has proposed an increase in output of their planned future Glen Falls natural gas combustion turbine facility to be located in Harrison County, Clarksburg, West Virginia. The uprate will increase the maximum facility output (MFO) of the combined cycle facility by **45 MWE** for a total plant MFO of 625 MW. The uprate will also increase the Capacity value by **20 MW** for a total of 600 MW being recognized by PJM as Capacity. (See the summary table below.) The installed facilities will have a total capability of **625 MW** with **600 MW** of this output being recognized by PJM as Capacity. The proposed Commercial Operation Date for this project is **December 31, 2021**.

Uprate to AA2-119 and AC1-055 Glen Falls 138 kV Facility (no new equipment):

Queue No.	MFO (MW)	Capacity (MW)
AA2-119	550	550
AC1-055	30	30
AD2-192	+45	+20
Total	**625**	**600**

Point of Interconnection

AD2-192 "Glen Falls 138 kV" uprate project will be at increase to the planned future Glen Falls natural gas generation plant which will interconnect to the APS transmission system at the Glen Falls 138 kV substation bus.

Attachment 1 shows the one line diagram of the project and the point of interconnection with the Glen Falls 138 kV substation. Attachments 2a and 2b show the project location.

Cost Summary

The **AD2-192 "Glen Falls 138 kV"** project will be responsible for the following costs. These costs do not include CIAC Tax Gross-up:

Description	Total Cost
Attachment Facilities	$ 0
Direct Connection Network Upgrades	$ 0
Non Direct Connection Network Upgrades	$ 6,200
New System Upgrades	$ 0
Contribution to Previously Identified Upgrades	$ 0
Total Costs	**$ 6,200**

The transmission and substation 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, APS shall be reimbursed by the Interconnection Customer for such taxes. APS estimates the tax, if applicable, would be approximately **$6,200** ($900 for Non-Direct Connection Network Upgrades.)

The required Attachment Facilities, Direct Connection, and Non-Direct Connection work for the interconnection of the AD2-192 generation project to the APS 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. APS 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.

Transmission Owner Scope of Work

Attachment Facilities

There is no Attachment Facilities scope of work required for this project.

Direct Connection Cost Estimate

There is no Direct Connection scope of work required for this project.

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
Glen Falls 138 kV SS. Adjust Remote Relay and Metering Settings at the Glen Falls 138 kV substation (APS)	$ 6,200
Total Non-Direct Connection Facility Costs	**$ 6,200**

The total Non-Direct Connection cost estimate for the AD2-192 project is approximately **$6,200**. This work is to review the protection system settings at APS's Glen Falls Substation and to implement any necessary changes.

Schedule

Based on the extent of the APS Non-Direct Connection work required to support the AD2-192 generation project, it is expected to take a minimum of **8 months** from the date of a fully executed Interconnection Construction Service Agreement to complete the installation. Full payment of the estimated cost of the Non-Direct Connection work will be required upon execution of the Interconnection Service Agreement. True up of the actual cost versus estimated cost of the project will be performed by FE at the end of the project. A further assumption is that PJM will allow all transmission system outages when requested.

Revenue Metering and SCADA Requirements

PJM Requirements

Existing metering is adequate for this request.

APS Requirements

The IC will be require 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

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. In particular, the IC is responsible for the following:

1. The purchase and installation of a fully rated 138 kV circuit breaker to protect the AD2-192 generator lead line. A single circuit breaker must be used to protect this line; if the project has several GSU transformers, the individual GSU transformer breakers cannot be used to protect this line.

2. 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.

3. 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.

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

5. The execution of a back-up service agreement to serve the customer load supplied from the AD2-192 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[1]

The 580 MW portion of the Customer Facility (installed by December 31, 2020 under AA2-119 and AC1-055) shall maintain a power factor of at least 0.95 leading to 0.90 lagging measured at the generator's terminals.

The increase of 45 MW to the Customer Facility associated with this AD2-192 project (by June 1, 2021) shall be designed with the ability to maintain a power factor of at least 1.0 (unity) to 0.90 lagging (supplying vars) measured at the generator's terminals.

FE performed a reactive capability analysis of the proposed incremental increase. The following table(s) show the reactive power requirements and capabilities for both the existing and additional output.

Queue	Size	Leading PF	Lagging PF	Leading MVARs	Lagging MVARs
AA2-119	550	0.95	0.90	180.78	266.38
AC1-055	30	1.00	0.90	0	14.53
AD2-192	45	1.00	0.90	0	21.79
Total	**625**	**-**	**-**	**180.78**	**302.70**
Reactive Capability at 625 MW				**206.08**	**388.58**
MVAR Surplus				**25.30**	**85.88**

APS Analysis:

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. At the Primary POI, the AD2-192 project contributes to an overload on the FE transmission system as shown in the Network Impact section of this report. This overload is driven by a prior queue. Based on PJM criteria, project AD2-192 currently does not receive cost allocation for this upgrade.

Short Circuit Analysis

No short circuit analysis was required for this project since it is an uprate project and the original electrical characteristics of the machines and GSUs did not change.

[1] Customer indicated to PJM that the full output from all three interconnection queues (AA2-119, AC1-055 and AD2-192) will be commercial by December 31, 2021. There will be no 'phasing in' of MW by queue. Therefore, this customer will be required to meet the Tariff power factor requirement of at least 0.95 leading to 0.9 lagging measured at the generator's terminals for their full MFO considering the output of all three queues (625 MW). Given the electrical characteristics, this generator is capable of meeting this requirement.

Stability Analysis

A dynamic stability analysis was completed by PJM and the results were reviewed by FE. There were no stability concerns identified for the faults studied.

System Protection

The IC must design its 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. Detailed Protection Requirements will be provided once the project enters the construction phase.

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Network Impacts

The Queue Project AD2-192 was evaluated as a 20.0 MW (Capacity 20.0 MW) uprate to AA2-119 / AC1-055 which is an injection at Glen Falls 138kV substation in the APS area. Project AD2-192 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AD2-192 was studied with a commercial probability of 100%. Potential network impacts were as follows:

Contingency Descriptions

The following contingencies resulted in overloads:

Option 1	
Contingency Name	**Description**
AP-P1-2-MP-138-013A	CONTINGENCY 'AP-P1-2-MP-138-013A' /* 53 DISCONNECT BRANCH FROM BUS 235334 TO BUS 235375 CKT 1 /* 01GLENFL 138 01NATLCN 138 DISCONNECT BRANCH FROM BUS 235375 TO BUS 235415 CKT 1 /* 01NATLCN 138 01RIDER 138 END
AP-P1-2-MP-138-023	CONTINGENCY 'AP-P1-2-MP-138-023' /* 235417 01VARNER 138 235432 01WALDORN 138 1 DISCONNECT BRANCH FROM BUS 235334 TO BUS 235812 CKT 1 /* 01GLENFL 138 01CHIEFTON 138 DISCONNECT BRANCH FROM BUS 235417 TO BUS 235812 CKT 1 /* 01VARNER 138 01CHIEFTON 138 DISCONNECT BRANCH FROM BUS 235417 TO BUS 235432 CKT 1 /* 01VARNER 138 01WALDORN 138 END
AP-P2-2-MP-138-013	CONTINGENCY 'AP-P2-2-MP-138-013' /* GLEN-FALLS-138-EAST DISCONNECT BRANCH FROM BUS 235334 TO BUS 235375 CKT 1 /* 01GLENFL 138 01NATLCN 138 DISCONNECT BRANCH FROM BUS 235334 TO BUS 235349 CKT 1 /* 01GLENFL 138 01HARR T 138 DISCONNECT BRANCH FROM BUS 235334 TO BUS 235442 CKT 1 /* 01GLENFL 138 01MCALPN 138 END

AP-P2-3-MP-138-023	CONTINGENCY 'AP-P2-3-MP-138-023' /* GLEN FALLS-MCALPIN STK BKR AT GLEN FALLS DISCONNECT BRANCH FROM BUS 235334 TO BUS 235349 CKT 1 /* 01GLENFL 138 01HARR T 138 DISCONNECT BRANCH FROM BUS 235334 TO BUS 235375 CKT 1 /* 01GLENFL 138 01NATLCN 138 DISCONNECT BRANCH FROM BUS 235334 TO BUS 235442 CKT 1 /* 01GLENFL 138 01MCALPN 138 END
AP-P2-3-MP-138-024	CONTINGENCY 'AP-P2-3-MP-138-024' /* GLEN FALLS-HARRISON TAP STK BKR AT GLEN FALLS DISCONNECT BRANCH FROM BUS 235334 TO BUS 235349 CKT 1 /* 01GLENFL 138 01HARR T 138 DISCONNECT BRANCH FROM BUS 235347 TO BUS 235349 CKT 1 /* 01HARSNR 138 01HARR T 138 DISCONNECT BRANCH FROM BUS 235349 TO BUS 235367 CKT 1 /* 01HARR T 138 01MARGAR 138 DISCONNECT BRANCH FROM BUS 235347 TO BUS 235396 CKT 1 /* 01HARSNR 138 01ROBERT 138 DISCONNECT BRANCH FROM BUS 235334 TO BUS 235442 CKT 1 /* 01GLENFL 138 01MCALPN 138 DISCONNECT BRANCH FROM BUS 235334 TO BUS 235375 CKT 1 /* 01GLENFL 138 01NATLCN 138 END
AP-P7-1-MP-138-015	CONTINGENCY 'AP-P7-1-MP-138-015' /* GLF-WUN-GLF-MRG DISCONNECT BRANCH FROM BUS 235334 TO BUS 235349 CKT 1 /* 01GLENFL 138 01HARR T 138 DISCONNECT BRANCH FROM BUS 235347 TO BUS 235349 CKT 1 /* 01HARSNR 138 01HARR T 138 DISCONNECT BRANCH FROM BUS 235349 TO BUS 235367 CKT 1 /* 01HARR T 138 01MARGAR 138 DISCONNECT BRANCH FROM BUS 235417 TO BUS 235432 CKT 1 /* 01VARNER 138 01WALDORN 138 DISCONNECT BRANCH FROM BUS 235417 TO BUS 235812 CKT 1 /* 01VARNER 138 01CHIEFTON 138 DISCONNECT BRANCH FROM BUS 235347 TO BUS 235396 CKT 1 /* 01HARSNR 138 01ROBERT 138

	DISCONNECT BRANCH FROM BUS 235334 TO BUS 235812 CKT 1 /* 01GLENFL 138 01CHIEFTON 138 END

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)

Overload Number	Type	Contingency Name	Affected Area	Facility Description	Bus From	Bus To	Circuit	Power Flow	Loading % Initial	Loading % Final	Rating Type	Rating MVA	MW Contribution	Flowgate Appendix
1	LFFB	AP-P2-3-MP-138-024	AP - AP	01GLENFL-01OAKMND 138 kV line	235334	235380	1	AC	140.44	144.91	ER	192	8.62	1
2	BUS	AP-P2-2-MP-138-013	AP - AP	01GLENFL-01OAKMND 138 kV line	235334	235380	1	AC	140.42	144.89	ER	192	8.62	
3	LFFB	AP-P2-3-MP-138-023	AP - AP	01GLENFL-01OAKMND 138 kV line	235334	235380	1	AC	140.42	144.89	ER	192	8.62	
4	DCTL	AP-P7-1-MP-138-015	AP - AP	01GLENFL-01OAKMND 138 kV line	235334	235380	1	AC	129.7	132.64	ER	192	5.6	
5	N-1	AP-P1-2-MP-138-023	AP - AP	01GLENFL-01OAKMND 138 kV line	235334	235380	1	AC	115.03	117.61	ER	192	4.89	
6	N-1	AP-P1-2-MP-138-013A	AP - AP	01GLENFL-01OAKMND 138 kV line	235334	235380	1	AC	100.9	103.62	ER	192	5.21	

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)

None

Affected System Analysis & Mitigation

None

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)

1. To relieve the 01GLENFL-01OAKMND 138 kV line overload

   Reinforcement:
   Reconductor 2.5 miles of the Glen Falls – Oak Mound 138 kV line
   New Expected Ratings: 316 MVA (SE)
   PJM Network Upgrade Number: N4855
   Cost Estimate: $2.665M
   Estimated time to complete: 18 months

   This overload is driven by a prior queue. Based on PJM criteria, project AD2-192 currently does not receive cost allocation for this upgrade.

   Note: Although Queue Project AD2-192 may not have cost responsibility for this upgrade, Queue Project AD2-192 may need this upgrade in-service to be deliverable to the PJM system. If Queue Project AD2-192 comes into service prior to completion of the upgrade, Queue Project AD2-192 will need an interim study.

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)

No mitigations required.

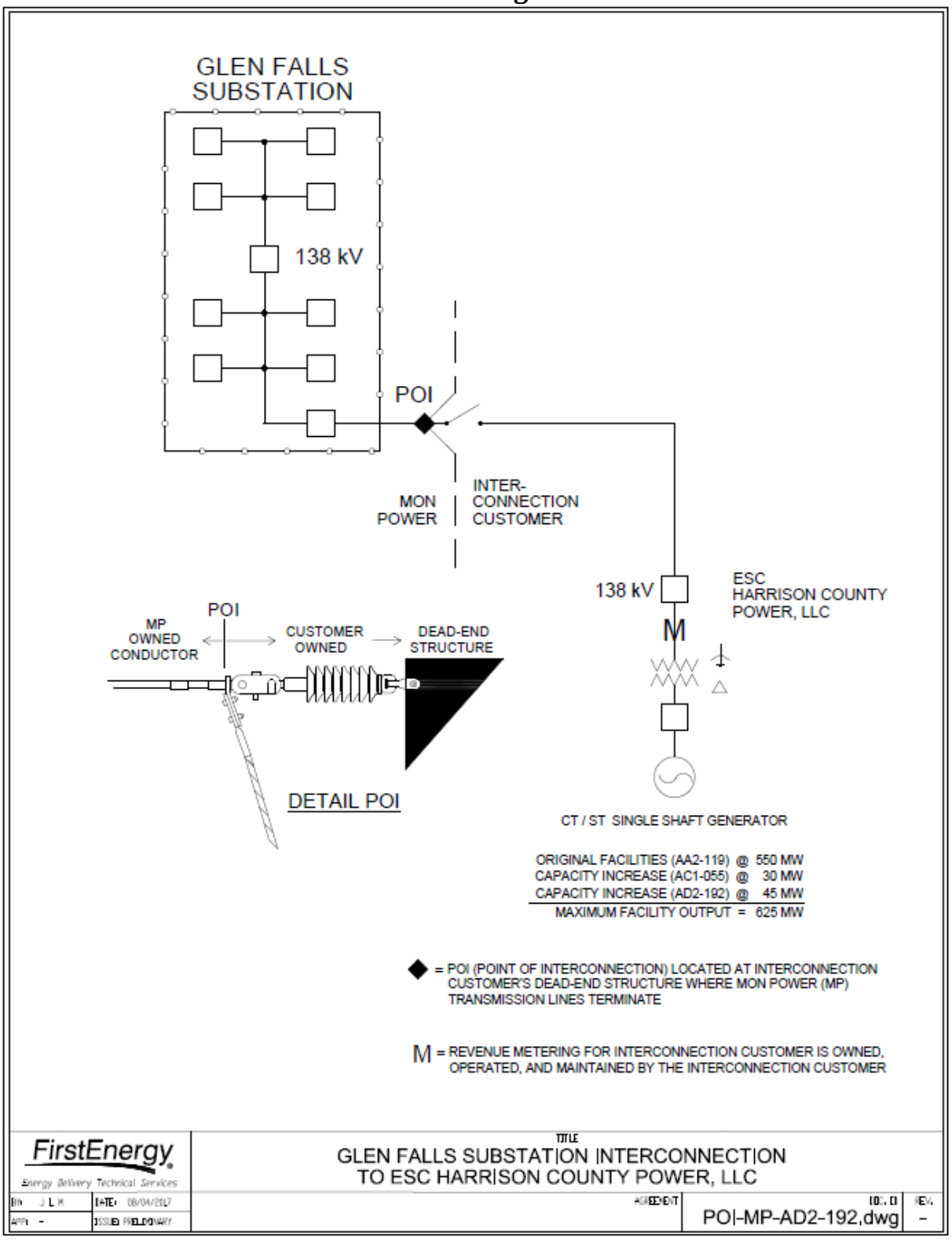
Light Load Analysis - 2021

Not required for APS zone.

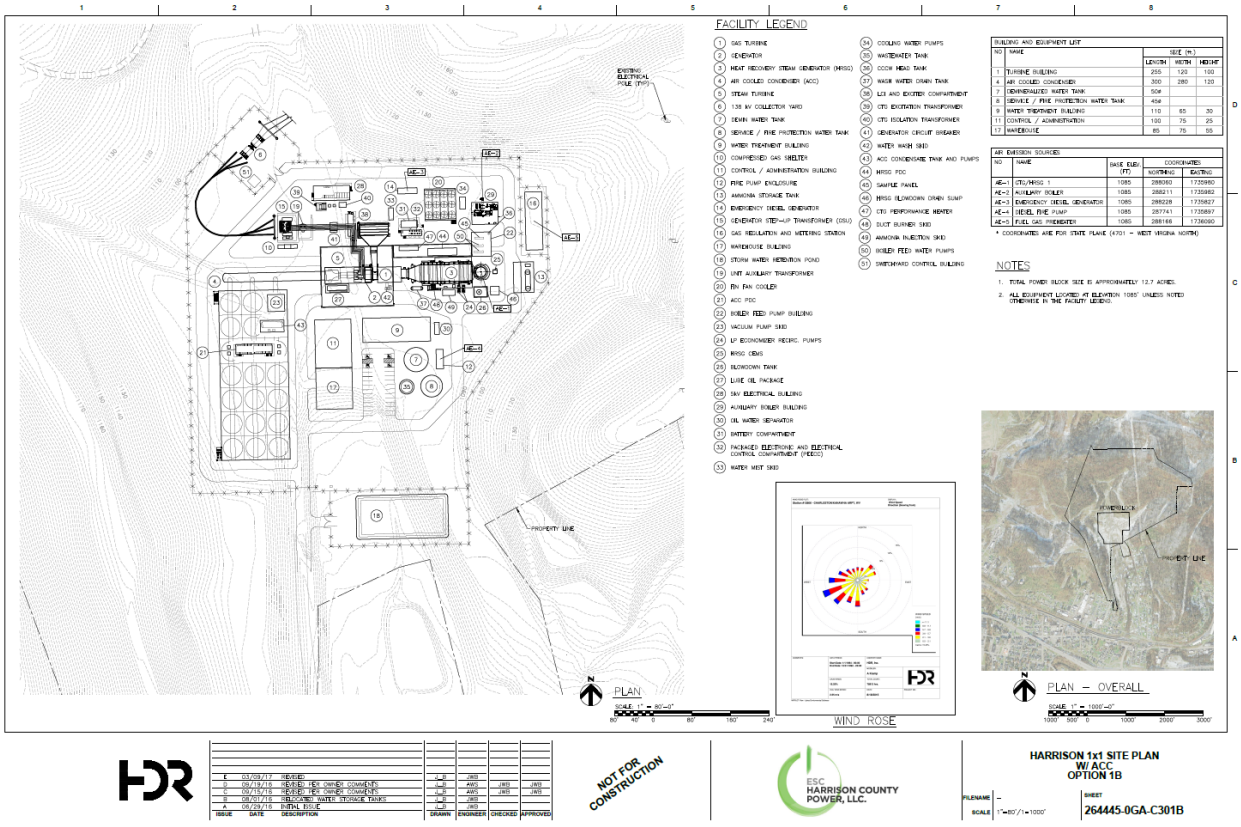
Incremental Capacity Transfer Rights (ICTRs)

This customer does not currently have cost responsibility for any network upgrades. Therefore, no study is required for an increase in CETL in the 2021/2022 BRA case.

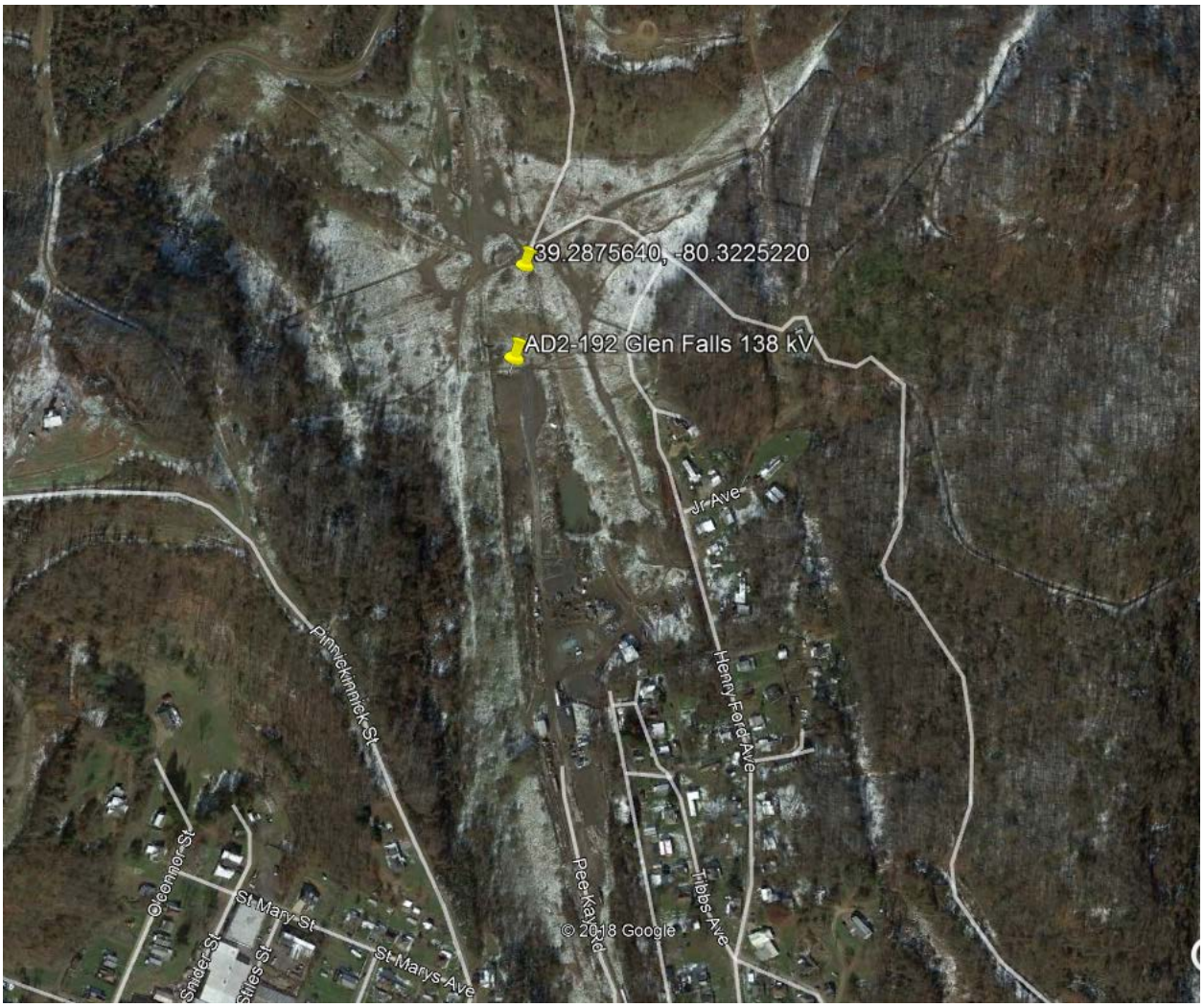
Attachment 1. AD2-192 "Glen Falls 138 kV" One Line Diagram



Attachment 2a. AD2-192 'Glen Falls 138 kV'
Project Location



Attachment 2b. AD2-192 'Glen Falls 138 kV'
Project Location



Attachment 3.

Appendices

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. All New Service Queue Requests, through the end of the Queue under study, that are contributors to a flowgate will be listed in the Appendices. Please note that there may be contributors that are subsequently queued after the queue under study that are not listed in the Appendices. 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 and appendices sections are full contributions, whereas the loading percentages reported in the body of the report, take into consideration the commercial probability of each project as well as the ramping impact of "Adder" contributions.

Appendix 1

(AP - AP) The 01GLENFL-01OAKMND 138 kV line (from bus 235334 to bus 235380 ckt 1) loads from 140.44% to 144.91% (AC power flow) of its emergency rating (192 MVA) for the line fault with failed breaker contingency outage of 'AP-P2-3-MP-138-024'. This project contributes approximately 8.62 MW to the thermal violation.

CONTINGENCY 'AP-P2-3-MP-138-024' /* GLEN FALLS-HARRISON TAP STK BKR AT GLEN FALLS
DISCONNECT BRANCH FROM BUS 235334 TO BUS 235349 CKT 1 /* 01GLENFL 138 01HARR T 138
DISCONNECT BRANCH FROM BUS 235347 TO BUS 235349 CKT 1 /* 01HARSNR 138 01HARR T 138
DISCONNECT BRANCH FROM BUS 235349 TO BUS 235367 CKT 1 /* 01HARR T 138 01MARGAR 138
DISCONNECT BRANCH FROM BUS 235347 TO BUS 235396 CKT 1 /* 01HARSNR 138 01ROBERT 138
DISCONNECT BRANCH FROM BUS 235334 TO BUS 235442 CKT 1 /* 01GLENFL 138 01MCALPN 138
DISCONNECT BRANCH FROM BUS 235334 TO BUS 235375 CKT 1 /* 01GLENFL 138 01NATLCN 138
END

Bus Number	*Bus Name*	*Full Contribution*
937391	*AD2-192*	*8.62*
LTF	*AMIL*	*0.09*
LTF	*BAYOU*	*0.31*
LTF	*BIG_CAJUN1*	*0.48*
LTF	*BIG_CAJUN2*	*0.97*
LTF	*BLUEG*	*0.56*
LTF	*CALDERWOOD*	*0.16*
LTF	*CANNELTON*	*0.1*
LTF	*CARR*	*0.01*
LTF	*CATAWBA*	*0.09*
LTF	*CHEOAH*	*0.15*
LTF	*CHILHOWEE*	*0.05*

LTF	*CHOCTAW*	*0.32*
LTF	*CLIFTY*	*2.47*
LTF	*COTTONWOOD*	*1.25*
LTF	*DEARBORN*	*0.22*
LTF	*EDWARDS*	*0.16*
LTF	*ELMERSMITH*	*0.28*
LTF	*FARMERCITY*	*0.11*
LTF	*G-007*	*< 0.01*
LTF	*GIBSON*	*0.19*
LTF	*HAMLET*	*0.27*
LTF	*MORGAN*	*0.53*
LTF	*NEWTON*	*0.41*
LTF	*O-066*	*< 0.01*
LTF	*PRAIRIE*	*0.79*
LTF	*RENSSELAER*	*< 0.01*
LTF	*SANTEETLA*	*0.04*
LTF	*SMITHLAND*	*0.06*
LTF	*TATANKA*	*0.19*
LTF	*TILTON*	*0.19*
LTF	*TRIMBLE*	*0.11*
LTF	*TVA*	*0.24*
LTF	*UNIONPOWER*	*0.22*
920231	*AA2-119*	*48.45*
925791	*AC1-055*	*2.64*