Third Revised
Generation Interconnection
System Impact Study Report
for
Queue Project AD1-118
“Lemoyne 345 kV”
60 MW Capacity / 60 MW Energy

May 2022
Revision 3

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1 Introduction

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

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.

3 Revisions since June 2021 System Impact Study Report

The AD1-118 System Impact Study results were revised based on a retooled analysis considering the AD1-118 customer's request to reduce their output from 70 MW to 60 MW (MFO, Energy and Capacity). Retooled load flow results indicate that there are no impacted flowgates.

There was no change to the stability analysis results.

See the **Network Impacts** section of this report for the revised results.

4 General

Interconnection Customer has proposed an uprate to a natural gas fired combustion turbine facility located in Wood County, Ohio. This project requests an increase to the installed capability of **60 MW** with 60 MW of this output being recognized by PJM as Capacity. Note that this project is an increase to the Interconnection Customer's W1-072A_AT5 project, which will share the same property and connection point. The installed facilities will have a total capability of **700 MW** with 700 MW of this output being recognized by PJM as Capacity. The originally proposed in-service date for this project is September 1, 2018. The interconnection customer will provide an updated in-service date at the facilities study phase.

Queue Project	MFO (MW)	Capacity (MW)
W1-072A_AT5	640	640
AD1-118	60	60
Total	**700**	**700**

Queue Number	**AD1-118**
Project Name	Lemoyne 345 kV
Interconnection Customer	Troy Energy, LLC
State	Ohio
County	Wood
Transmission Owner	ATSI
MFO	700
MWE	60
MWC	60
Fuel	Natural Gas
Basecase Study Year	2021

5 Point of Interconnection

This project will interconnect with the ATSI transmission system by direct injection into Lemoyne 345 kV substation. AD1-118 is an increase to an existing facility, no new interconnection facilities are required to accommodate the increased output.

5.1 Cost Summary

The AD1-118 project will be responsible for the following costs:

Description	Total Cost
Attachment Facilities	$0
Direct Connection Network Upgrade	$0
Non Direct Connection Network Upgrades	$0
New System Upgrades	$0
Contribution to Previously Identified Upgrades	$0
Total Costs	$0

The costs provided above exclude the Contribution in Aid of Construction ("CIAC") Federal Income Tax Gross Up charge. If, at a future date, it is determined that the CIAC Federal Income Tax Gross charge is required, the Transmission Owner shall be reimbursed by the Interconnection Customer for such taxes.

The required Attachment Facilities and Direct and Non-Direct Connection work for the interconnection of the AD1-118 generation project to the FE Transmission System is detailed in the following sections. The associated one-line with the generation project Attachment Facilities and the Direct Connection facilities are shown in Attachment 1.

6 Transmission Owner Scope of Work

The AD1-118 generation project will be accommodated by a direct connection into the Lemoyne 345 kV Substation. AD1-118 is an increase to an existing facility, no new interconnection facilities are required to accommodate the increased output.

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.

None.

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.

None.

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.

None.

7 Schedule

The estimate elapsed time to complete any required reinforcements is identified in the "System Reinforcements" section of the report.

8 Transmission Owner Analysis

8.1 Power Flow Analysis

PJM performed a power flow analysis of the transmission system using a 2021 summer load flow model and a 2021 winter 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 AD1-118 project contributes to overloads on the FE transmission system as shown in Attachment 3a. The estimated cost of system reinforcements necessary to mitigate these overloads are provided in Attachment 3b.

8.2 Short Circuit Analysis

The Developer has indicated that no changes to the electrical characteristics of the generation facility will be made for this project. This includes no changes to:

- Power equipment at the delivery voltage or interconnecting substation one-line
- Any protective relay application, relay scheme design or relay settings.
- Short circuit characteristics of the facility and short circuit contribution to the transmission system.

FirstEnergy will therefore require no changes to its transmission protection schemes and a short circuit / breaker duty study is not required.

9 Interconnection Customer Requirements

9.1 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. 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.

9.2 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 345 kV circuit breaker to protect the AD1-118 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 AD1-118 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.

9.3 Power Factor Requirements[1]

The existing 600 MW portion of the Customer Facility shall retain its existing ability to maintain a power factor of at least 0.95 leading (absorbing VARs) to 0.90 lagging (supplying VARs) measured at the generator's terminals. The increase of 40 MW to the Customer Facilities associated with the previous W1-072A_AT5 project shall be maintain its existing Power Factor of at least 1.0 (unity) to 0.90 lagging (supplying VARs) measured at the generator's terminals. The increase of 70 MW to the Customer Facilities associated with the AD1-118 project 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.

The reactive power capability is pending PJM providing the D-Curve specifications for the generation plant. The following table(s) show the reactive power requirements for both the existing and additional output.

Queue	Size (MW)	Leading PF	Lagging PF	Leading MVARs	Lagging MVARs
N/A	600	0.95	0.90	197	291
W1-072A_AT5	40	1.00	0.90	0	19
AD1-118	70	1.00	0.90	0	34
Total	**-**	**-**		**197**	**344**
Reactive Capability at <710> MW				**336**	**548**
MVAR Surplus				**139**	**204**

[1] Note that the power factor assessment was not restudied by FirstEnergy for the reduction from 70 MW to 60 MW. The analysis with 70 MW increase showed a surplus of MVAR.

10 Revenue Metering and SCADA Requirements

10.1 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 Attachment O, Appendix 2, Section 8.

10.2 FE 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

11 Network Impacts

The Queue Project AD1-118 was evaluated as a 60.0 MW (Capacity 60.0 MW) injection into the Lemoyne 345 kV substation in the ATSI area. Project AD1-118 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AD1-118 was studied with a commercial probability of 100%. Potential network impacts were as follows:

Summer Peak Load Flow

12 Generation Deliverability

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

None

13 Multiple Facility Contingency

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

None

14 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

15 Steady State Voltage Requirements

None.

16 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.

17 System Reinforcements

None

18 Flow Gate Details

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.

None

Affected Systems

19 Affected Systems

19.1 MISO Impacts:

No MISO impacts were found during the final MISO Affected System Study for the AD1 queue cycle. Report: R073-21 (Dated 6/21/2021)

20 Contingency Descriptions

None

Short Circuit

21 Short Circuit[2]

The following Breakers are overduty:

None

[2] Note that it is assumed with the reduction in output from 70 MW to 60 MW (MFO, Energy and Capacity) that there will still be no short circuit issues.

Stability

22 Stability Analysis and Reactive Power Assessment

22.1 Executive Summary[3]

Generator interconnection request AD1-118 is for a 60 MW uprate to the Lemoyne natural gas plant, which increases the Maximum Facility Output (MFO) from 640 MW to 700 MW. AD1-118 consists of 4 x 176 MW GE 7FH2 Simple Cycle Generators with the Point of Interconnection (POI) at the Lemoyne 345 kV substation in Wood County, Ohio in the First Energy (FE) transmission system. This report describes a dynamic simulation analysis of AD1-118 as part of the overall system impact study.

The power flow scenario for the analysis was based on the RTEP 2021 light load case, modified to include applicable queue projects. AD1-118 has been dispatched online at maximum facility output, with approximately unity power factor at the high-side of the station transformer.

AD1-118 was tested for compliance with NERC, PJM, Transmission Owner and other applicable criteria. For this study, 174 contingencies were simulated, each with a 20 second simulation time period. Studied faults included:

- Steady-state operation (20 second simulation)
- Three-phase faults with normal clearing time
- Single-phase faults with a stuck breaker
- Single-phase faults with delayed clearing at remote end
- Single-phase faults with loss of multiple-circuit towers

The 174 fault contingencies tested on the 2021 light load case met the recovery criteria:

- The AD1-118 generators were able to ride through the faults except for faults where protective actions trip one or more generator(s).
- All generators maintained synchronism and any post-contingency oscillations are positively damped with a damping margin of at least 3%.
- All bus voltages recover to 0.7 p.u. within 2.5 seconds and the final voltage is within the range of 0.92 p.u. to 1.05 p.u. for buses less than 500 kV and 765 kV buses. The final voltages for 500 kV buses should be within 1.02 p.u. to 1.08 p.u.
- No transmission element trips, other than those either directly connected or designated to trip as a consequence of the fault.

The AD1-118 queue project met both the 0.90 lagging and 1.00 unity power factor requirements.

[3] **Reduction Revision:** The AD1-118 queue project reduced its MFO by 10 MW, from 710 MW to 700 MW, after this analysis was completed. To meet the reduced MFO, the gross output of each combustion turbine was decreased from 178.50 MW to 177 MW and the auxiliary loads associated with these units were turned on. After reviewing the latest data submitted and finding no other changes to the plant or its dynamic model, it was determined that a restudy was not necessary.

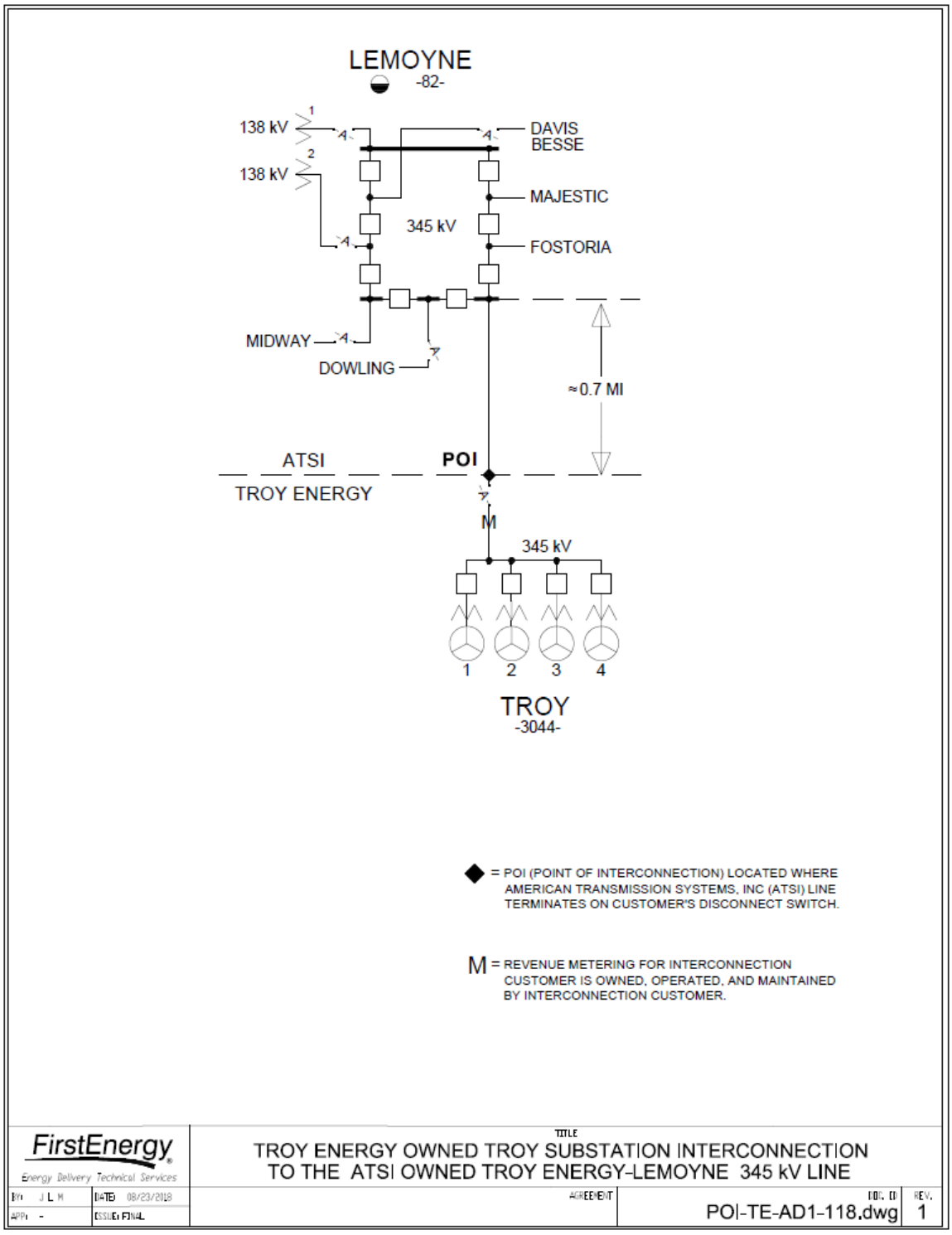
No mitigations are required.

Light Load

23 Light Load Analysis

No impacts.

24 Attachment 1 – One Line



25 Attachment 2 – Project Location