APPENDIX C

PJM STUDIES

Generation Interconnection Feasibility Study Report

For

PJM Generation Interconnection Request Queue Position AD1-140

Greene-Clark 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.

The conduct of light load analysis as required under the PJM planning process is not performed during the Generation Interconnection Feasibility Study phase of the PJM study process. Additional reinforcement requirements for this Interconnection Request may be defined during the conduct of the light load analysis which shall be performed following execution of the System Impact Study agreement.

General

The Interconnection Customer (IC), has proposed a Solar generating facility located in Greene County, Ohio. The installed facilities will have a total capability of 200 MW with 102 MW of this output being recognized by PJM as capacity. The proposed in-service date for this project is May 29, 2020. **This study does not imply a ATSI commitment to this in-service date.**

Point of Interconnection

AD1-140 will interconnect with the ATSI transmission system at one of the following:

Primary POI:
Along the Clark-Greene 138kV line
10.9 Miles from Greene Substation (39.782, -83.830)

Secondary POI:
Cost Along the Clark-Greene 138kV line
15.8 Miles from Greene Substation (39.833, -83.781)

Summary

The AD1-140 project will be responsible for the following costs:

Description	Total Cost
Attachment Facilities	$ 0
Direct Connection Network Upgrades	$ 5,021,800
Non Direct Connection Network Upgrades	$ 5,548,700
Total Costs	**$ 10,570,500**

In addition, the AD1-140 project may be responsible for a contribution to the following costs:

Description	Total Cost
New System Upgrades	$ 0
Previously Identified Upgrades	$ 3,368,000
Total Costs	**$ 3,368,000**

Cost allocations for these upgrades will be provided in the System Impact Study Report.

Attachment Facilities

No Attachment Facilities are required to support this interconnection request.

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	Activity Cost	Tax (if applicable)	Total Cost
Install a new 138kV 3 breaker ring bus switchyard for 200MW of solar generation. The new switchyard will cut the Greene and Clark lines. @ AD1-140 Interconnect	$ 4,543,300	$ 620,500	$ 5,163,800
Install one (1) span from the AD1-140 Interconnection sub to customer owned wood monopole strain structure. @ AD1-140 Interconnection Sub Customer Span	$ 451,100	$ 59,400	$ 510,500
Modify substation and switchboard nameplates as well as drawings. @ AD1-140 Collector Substation	$ 27,400	$ 3,700	$ 31,100
Total Direct Connection Facility Costs	**$ 5,021,800**	**$ 683,600**	**$ 5,705,400**

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	Activity Cost	Tax (if applicable)	Total Cost
Loop the Clark-Greene 138kV circuit into the AD1-140 ring bus. The proposed location of the new ring bus is near structure #5604. @ Clark-Greene 138kV Loop to AD1-140 Ring Bus	$ 390,600	$ 51,500	$ 442,100
Install OPGW on the Clark-Greene 138kV line between Clark Substation and the AD1-140 Ring Bus Loop, 16.5 miles. The proposed location of the new ring bus is near structure #5604. @ Clark-Greene (DPL) 138kV OPGW Installation	$ 4,682,000	$ 609,900	$ 5,291,900
Adjust remote, relaying, and metering settings at Clark Substation.	$ 451,100	$ 59,400	$ 510,500

Description	Activity Cost	Tax (if applicable)	Total Cost
Adjust remote, relaying, and metering settings at Greene Substation.	$ 25,000	$ 3,292	$ 28,292
Total Non-Direct Connection Facility Costs	**$ 5,548,700**	**$ 724,092**	**$ 6,272,792**

Transmission Owner Scope of Work

The primary Point of Interconnection (POI) for the AD1-140 generation project is located one span outside of the proposed ATSI ring bus switch station which will be located on the Clark-Greene 138kV line. The direct connection of AD1-140 generation project will be accomplished by utilizing a three (3) breaker ring bus to connect to the Clark-Greene 138 kV Line. A conceptual one-line diagram of the proposed connection of AD1-140 generation project to the FE / ATSI transmission system is provided in the attachments. The Interconnection Customer will be responsible for constructing all the facilities on their side of the POI, including the 138 kV Line extension to its generation facilities. Interconnection Customer may not install above ground equipment within any FirstEnergy right-of-way unless permission to do so is expressly granted by FirstEnergy.

Based on the extent of the ATSI primary direct connection required to support the AD1-140 generation project, it is expected to take a minimum of twenty-three (23) months from the date of a fully executed Interconnection Construction Service Agreement to complete the installation. This includes the requirement for Interconnection Customer to make a preliminary payment to ATSI which funds the first three months of engineering design that is related to the construction of the direct connection facilities. It further assumes that Interconnection Customer will provide all rights-of-way, permits, easements, etc. that will be needed. A further assumption is that there will be no environmental issues with any of the new properties associated with this project, that there will be no delays in acquiring the necessary permits for implementing the defined direct connection and facility upgrades, and that all system outages will be allowed when requested.

Note that the FE findings were made from a conceptual review of this project. A more detailed review of the connection facilities and their cost will be identified in the System Impact Study. Further note that the cost estimate data contained in this document should be considered high level estimates since it was produced without a detailed engineering review. The applicant will be responsible for the actual cost of construction. FE 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 sub-transmission systems.

Interconnection Customer Requirements

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.

3. The Interconnection Customer seeking to interconnect a solar generation facility larger than 3MW shall maintain meteorological data facilities as well as provide that meteorological data which is required per PJM Manual 3 and the Interconnection Service Agreement.

4. The AD1-140 generation facility shall design its solar facility with the ability to maintain a power factor of at least 0.95 leading to 0.95 lagging power factor measured at the high-side of the facility substation transformers.

5. The purchase and installation of fully rated 138 kV circuit breakers on the high side of the AD1-140 step-up transformer.

6. The purchase and installation of the minimum required ATSI generation interconnection relaying and control facilities. This includes over/under voltage protection, over/under frequency protection, and zero sequence voltage protection relays.

7. 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.

8. The establishment of dedicated communication circuits for SCADA to the FE Transmission System Control Center.

9. A compliance with the FE and PJM generator power factor and voltage control requirements.

10. The execution of a back-up service agreement to serve the customer load supplied from the AD1-140 generation project metering point when the units are out-of-service. This assumes the intent of Interconnection Customer is to net the generation with the load.

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.

FE Requirements

The Interconnection Customer will be required to comply with all FE Revenue Metering Requirements for Generation Interconnection Customers. The Revenue Metering Requirements may be found within the "FirstEnergy Requirements for Transmission Connected Facilities" document located at the following links:

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

Compliance Issues

The proposed interconnection facilities must be designed in accordance with the FE "Requirements for Transmission Connected Facilities" located at:

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

Interconnection Customer will be responsible for following the requirements of the "FE Approved Vendors and Contractors" documents which is also located at the above link.

Interconnection Customer will also be required to meet all PJM, ReliabilityFirst and NERC reliability criteria and operating procedures for standards compliance. For example, Interconnection Customer 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 ATSI system.

Network Impacts

Option 1

The Queue Project AD1-140 was evaluated as a 200.0 MW (Capacity 102.0 MW) injection tapping Clark to Greene 138kV line in the Dayton area. Project AD1-140 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AD1-140 was studied with a commercial probability of 53%. Potential network impacts were as follows:

Summer Peak Analysis - 2021

Contingency Descriptions

The following contingencies resulted in overloads:

Contingency Name	Description
AEP_P1-2_#349	CONTINGENCY 'AEP_P1-2_#349' OPEN BRANCH FROM BUS 242528 TO BUS 248005 CKT 1 / 242528 05SPORN 345 248005 06KYGER 345 1 END
AEP_P7-1_#468	CONTINGENCY 'AEP_P7-1_#468' OPEN BRANCH FROM BUS 239133 TO BUS 243458 CKT 1 / 239133 02TANGY 345 243458 05HYATT 345 1 OPEN BRANCH FROM BUS 239133 TO BUS 242939 CKT 1 / 239133 02TANGY 345 242939 05MARYSV 345 1 END

Contingency Name	Description
ATSI-P7-1-OES-345-68T	CONTINGENCY 'ATSI-P7-1-OES-345-68T' /* TANGY-HYATT & TANGY-MARYSVILLE COMMON TOWER DISCONNECT BRANCH FROM BUS 239133 TO BUS 243458 CKT 1 /* 02TANGY 345 05HYATT 345 DISCONNECT BRANCH FROM BUS 239133 TO BUS 242939 CKT 1 /* 02TANGY 345 05MARYSV 345 DISCONNECT BRANCH FROM BUS 239133 TO BUS 239134 CKT 3 /* 02TANGY 345 02TANGY 138 DISCONNECT BRANCH FROM BUS 239133 TO BUS 239134 CKT 4 /* 02TANGY 345 02TANGY 138 DISCONNECT BRANCH FROM BUS 239133 TO BUS 239134 CKT 5 /* 02TANGY 345 02TANGY 138 DISCONNECT BUS 239133 /* 02TANGY 345 END

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)

#	Contingency Type	Contingency Name	Affected Area	Facility Description	Bus From	Bus To	Circuit	Power Flow	Loading % Initial	Loading % Final	Rating Type	Rating MVA	MW Contribution	Ref
1	DCTL	ATSI-P7-1-OES-345-68T	AEP - FE	AC1-078 TAP-02LONDON 138 kV line	926010	238908	1	DC	106.89	107.95	ER	242	4.83	1
2	DCTL	AEP_P7-1_#468	AEP - FE	AC1-078 TAP-02LONDON 138 kV line	926010	238908	1	DC	106.89	107.95	ER	242	4.83	

Note: Please see Attachment 3 for projects providing impacts to flowgate violations. The values in the Reference column correspond to the proper table in the Attachment.

Short Circuit

(Summary of impacted circuit breakers)

None.

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.

#	Contingency		Affected Area	Facility Description	Bus		Circuit	Power Flow	Loading %		Rating		MW Contribution	Ref
	Type	Name			From	To			Initial	Final	Type	MVA		
3	N-1	AEP_P1-2_#349	OVEC - AEP	06KYGER-05SPORN 345 kV line	248005	242528	2	DC	130.53	131.2	NR	971	14.38	

Steady-State Voltage Requirements

(Results of the steady-state voltage studies should be inserted here)

To be determined

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).

OVEC Impacts:

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

Light Load Analysis - 2021

Light Load Studies to be conducted during later study phases (as required by PJM Manual 14B).

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)

Violation #	Overloaded Facility	Upgrade Description	Network Upgrade Number	Upgrade Cost
#1, 2	AC1-078 TAP-02LONDON 138 kV line	AEP: Non-AEP element is limiting this line. ATSI: Reconductor approximately 8 miles of transmission line from the “London-Beatty 138 kV (AD1-081) Generation Project” point of interconnection to the London substation. Estimated Cost: $3,368,000. Estimated Schedule: minimum of twenty-three (23) months from the date of a fully executed Interconnection Construction Service Agreement to complete the installation		**$ 3,368,000**
			Total New Network Upgrades	**$ 3,368,000**

Option 2

The Queue Project AD1-140 was evaluated as a 200.0 MW (Capacity 102.0 MW) injection tapping Clark to Greene 138kV line in the Dayton area. Project AD1-140 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AD1-140 was studied with a commercial probability of 53%. Potential network impacts were as follows:

Summer Peak Analysis - 2021

Contingency Descriptions

The following contingencies resulted in overloads:

Contingency Name	Description
AEP_P1-2_#349	CONTINGENCY 'AEP_P1-2_#349' OPEN BRANCH FROM BUS 242528 TO BUS 248005 CKT 1 / 242528 05SPORN 345 248005 06KYGER 345 1 END
AEP_P7-1_#468	CONTINGENCY 'AEP_P7-1_#468' OPEN BRANCH FROM BUS 239133 TO BUS 243458 CKT 1 / 239133 02TANGY 345 243458 05HYATT 345 1 OPEN BRANCH FROM BUS 239133 TO BUS 242939 CKT 1 / 239133 02TANGY 345 242939 05MARYSV 345 1 END
ATSI-P7-1-OES-345-68T	CONTINGENCY 'ATSI-P7-1-OES-345-68T' /* TANGY-HYATT & TANGY-MARYSVILLE COMMON TOWER DISCONNECT BRANCH FROM BUS 239133 TO BUS 243458 CKT 1 /* 02TANGY 345 05HYATT 345 DISCONNECT BRANCH FROM BUS 239133 TO BUS 242939 CKT 1 /* 02TANGY 345 05MARYSV 345 DISCONNECT BRANCH FROM BUS 239133 TO BUS 239134 CKT 3 /* 02TANGY 345 02TANGY 138 DISCONNECT BRANCH FROM BUS 239133 TO BUS 239134 CKT 4 /* 02TANGY 345 02TANGY 138 DISCONNECT BRANCH FROM BUS 239133 TO BUS 239134 CKT 5 /* 02TANGY 345 02TANGY 138 DISCONNECT BUS 239133 /* 02TANGY 345 END

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)

	Contingency		Affected		Bus			Power	Loading %		Rating		MW	
#	Type	Name	Area	Facility Description	From	To	Circuit	Flow	Initial	Final	Type	MVA	Contribution	Ref
1	DCTL	ATSI-P7-1-OES-345-68T	AEP - FE	AC1-078 TAP-02LONDON 138 kV line	926010	238908	1	DC	106.89	109.48	ER	242	6.27	1
2	DCTL	AEP_P7-1_#468	AEP - FE	AC1-078 TAP-02LONDON 138 kV line	926010	238908	1	DC	106.89	109.48	ER	242	6.27	

Note: Please see Attachment 3 for projects providing impacts to flowgate violations. The values in the Reference column correspond to the proper table in the Attachment.

Short Circuit

(Summary of impacted circuit breakers)

None.

Steady-State Voltage Requirements

(Results of the steady-state voltage studies should be inserted here)

To be determined

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).

OVEC Impacts:

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

Light Load Analysis - 2021

Light Load Studies to be conducted during later study phases (as required by PJM Manual 14B).

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.

	Contingency		Affected		Bus			Power	Loading %		Rating		MW	
#	Type	Name	Area	Facility Description	From	To	Circuit	Flow	Initial	Final	Type	MVA	Contribution	Ref
3	N-1	AEP_P1-2_#349	OVEC - AEP	06KYGER-05SPORN 345 kV line	248005	242528	2	DC	130.54	131.16	NR	971	13.41	

Attachment 1. Flowgate Details – Option 1

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. 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 AC1-078 TAP-02LONDON 138 kV line (from bus 926010 to bus 238908 ckt 1) loads from 106.89% to 107.95% (**DC power flow**) of its emergency rating (242 MVA) for the tower line contingency outage of 'ATSI-P7-1-OES-345-68T'. This project contributes approximately 4.83 MW to the thermal violation.

Bus Number	Bus Name	Full Contribution
934561	AD1-081 C	4.87
934562	AD1-081 E	2.51
935043	AD1-140 BAT	4.83

Bus Number	Bus Name	Full Contribution
926011	AC1-078 C	24.35
926012	AC1-078 E	40.59

Attachment 2. Flowgate Details – Option 2

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. 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 AC1-078 TAP-02LONDON 138 kV line (from bus 926010 to bus 238908 ckt 1) loads from 106.89% to 109.48% (**DC power flow**) of its emergency rating (242 MVA) for the tower line contingency outage of 'ATSI-P7-1-OES-345-68T'. This project contributes approximately 6.27 MW to the thermal violation.

Bus Number	Bus Name	Full Contribution
934561	AD1-081 C	4.87
934562	AD1-081 E	2.51
935043	AD1-140 BAT	6.27
LTF	AMIL	0.04
LTF	BAYOU	0.06
LTF	BIG_CAJUN1	0.08
LTF	BIG_CAJUN2	0.17
LTF	BLUEG	0.34
LTF	CANNELTON	0.05
LTF	CBM-N	< 0.01
LTF	CBM-S2	0.15
LTF	CHOCTAW	0.05
LTF	CLIFTY	0.17
LTF	COTTONWOOD	0.25
LTF	CPLE	0.05
LTF	DEARBORN	0.49
LTF	EDWARDS	0.08
LTF	ELMERSMITH	0.13

Bus Number	Bus Name	Full Contribution
LTF	FARMERCITY	0.04
LTF	G-007A	0.15
LTF	GIBSON	0.11
LTF	MORGAN	0.07
LTF	NEWTON	0.2
LTF	NYISO	0.02
LTF	O-066A	0.07
LTF	PRAIRIE	0.33
LTF	SMITHLAND	0.02
LTF	TATANKA	0.09
LTF	TILTON	0.11
LTF	TRIMBLE	0.07
LTF	TVA	0.03
LTF	VFT	0.41
LTF	X1-078	0.12
926011	AC1-078 C	24.35
926012	AC1-078 E	40.59

Generation Interconnection System Impact Study Report

For

PJM Generation Interconnection Request Queue Position AD1-140

Greene-Clark 138 kV

December 2018

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

Lendlease Energy Development, LLC, the Interconnection Customer (IC), has proposed a Solar generating facility located in Greene County, Ohio. The installed facilities will have a total capability of 200 MW with 102 MW of this output being recognized by PJM as capacity. The proposed in-service date for this project is May 29, 2020. **This study does not imply a ATSI commitment to this in-service date.**

Point of Interconnection

AD1-140 will interconnect with the ATSI transmission system along the Clark-Greene 138kV line.

Cost Summary

The AD1-140 project will be responsible for the following costs:

Description	Cost
Attachment Facilities	$ 0
Direct Connection Network Upgrades	$ 6,975,600
Non Direct Connection Network Upgrades	$ 5,292,800
Allocation for New System Upgrades	$ 0
Contribution for Previously Identified Upgrades	$ 0
Total Costs	**$ 12,268,400**

General Information

Interconnection Customer ("IC"): Lendlease Energy Development, LLC   Queue Position: AD1-140

Interconnected Transmission Owner ("TO"): American Transmission Systems, Incorporated ("ATSI")

Affected TO(s) (if applicable): American Transmission Systems, Incorporated ("ATSI")

PJM Zone: American Transmission Systems, Incorporated ("ATSI")

FE Operating Company or Planning Region: Ohio Edison - Southern

Customer Connection Request

Requested Backfeed Date: (assumed 3 mo. prior to COD)   Requested Commercial Operation Date: 05/29/2020

This study does not imply a FirstEnergy commitment to these dates.

New Facilities		Existing Facilities	
Capacity:	95.8 MW	Capacity:	N/A
Energy:	175 MW	Energy:	N/A
MFO[1]:	175 MW	MFO:	N/A
Fuel:	Solar	Prior Queue Position(s):	N/A

Point of Interconnection

Primary Point of Interconnection: Clark (FE) – Greene (DPL) 138 kV

[1] Maximum Facility Output

Attachment Facilities

There are no Attachment Facilities are required to support this interconnection.

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	Activity Cost	Tax (if applicable)	Total Cost
Install a new 138 kV 3 breaker ring bus switchyard for 175 MW of solar generation. The new switchyard will cut the Greene and Clark lines. @ AC1-140 Interconnect SS	$ 5,721,100	$ 734,100	$ 6,455,200
Loop the Clark-Greene 138 kV circuit into the AD1-140 ring bus. The proposed location of the new ring bus is near structure #5604. @ Clark-Greene 138 kV Loop to AD1-140 Ring Bus	$ 413,000	$ 53,000	$ 466,000
Project Management, Commissioning, Environmental, Forestry and SCADA.	$ 841,500	$ 108,000	$ 949,500
Total Direct Connection Facility Costs	**$ 6,975,600**	**$ 895,100**	**$ 7,870,700**

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	Activity Cost	Tax (if applicable)	Total Cost
Install OPGW on the Clark-Greene 138 kV line between Clark Substation and the AD1-140 Ring Bus Loop, 16.5 miles. The proposed location of the new ring bus is near structure #5604. @ Clark-Greene (DPL) 138 kV OPGW Installation	$ 4,577,400	$ 587,300	$ 5,164,700
Upgrade line terminal to new AD1-140 Interconnect Switchyard. @ Clark SS	$ 473,500	$ 60,800	$ 534,300
Adjust remote, relaying, and metering settings at Greene Substation.	$ 25,000	$ 3,292	$ 28,292
Modify substation and switchboard nameplates as well as drawings. @ AD1-140 Collector Substation	$ 28,300	$ 3,700	$ 32,000
Customer-owned 138 kV revenue metering at AD1-140 Kingwood Solar/BESS facility	$ 2,400	$ 400	$ 2,800

Description	Activity Cost	Tax (if applicable)	Total Cost
Estimated MPLS router at AD1-140 Interconnect substation to provide SCADA transport for new RTU. Estimated next MPLS hop to be at Clark substation.	$ 186,200	$ 23,900	$ 210,100
Total Non-Direct Connection Facility Costs	**$ 5,292,800**	**$ 679,392**	**$ 5,972,192**

Transmission Owner Scope of Work

The interconnection of the project at the Primary POI will be accomplished by constructing a new 138 kV three (3) breaker ring bus and looping the Clark (FE) – Greene (DPL) 138 kV line into the new station. The new substation will be located approximately 16.5 miles from Clark substation and will be owned and operated by FE upon completion. The IC will be responsible for acquiring all easements, properties, and permits that may be required to construct both the new interconnection switching station and the associated attachment facilities. The IC will also be responsible for the rough grade of the property and an access road to the proposed three breaker ring bus site. The project will also require non-direct connection upgrades at Clark and Greene substations.

A summary of the connection facilities that will be required for the Primary POI and their estimated costs are shown on the previous page. Based on this scope of work, it is expected to take a minimum of 23 months after the signing of an Interconnection Construction Service Agreement. This includes preliminary payment that compensates FE for the first three months of the engineering design work that is related to the construction of the AD1-140 interconnection substation. This assumes that there will be no environmental issues with any of the new properties associated with this project, that there will be no delays in acquiring the necessary permits for implementing the defined direct connection and network upgrades, and that PJM will allow all transmission system outages when requested.

Interconnection Customer Requirements

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.

3. The Interconnection Customer seeking to interconnect a wind generation facility shall maintain meteorological data facilities as well as provide that meteorological data which is required per item 5.iv. of Schedule H to the Interconnection Service Agreement.

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.

ATSI Requirements

The Interconnection Customer will be required to comply with all FE Revenue Metering Requirements for Generation Interconnection Customers. The Revenue Metering Requirements may be found within the "FirstEnergy Requirements for Transmission Connected Facilities" document located at the following links:

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

Short Circuit Analysis

Short Circuit Values

The 138 kV fault values for the AD1-140 interconnection location with all new generation out of service are:

Three Phase = 10.3 kA
Single Line to Ground = 8.3 kA
Z1= (0.77+ j 4.02) %
Z0= (2.19 + j 6.67) %

Impedances are given on 100 MVA and 138 kV base. The faults provided are bolted, symmetrical values for normal system conditions. Future increases in fault currents are possible and it is the customer's responsibility to upgrade their equipment and/or protective equipment coordination when necessary.

General Connection Requirements

The AD1-140 delivery point substation (DPS) is a 138 kV three-breaker ring bus on the Clark-Greene 138 kV line. See Attachment 2.

The existing line relays at Clark and Greene substations require replacement.

Line protection between Clark substation and the AD1-140 DPS and between Greene substation and the AD1-140 DPS shall consist of two independent SEL-411L line schemes with pilot communication over fiber for each 138 kV line, at each terminal.

At the AD1-140 DPS, each 138 kV breaker shall have breaker failure-to-trip protection. SEL-501 relays are acceptable for this application.

Protection of the 138 kV Generator Lead Line of approximately 4.6 miles shall consist of two SEL-411L line current differential schemes with pilot communication over fiber optic cable, at each terminal.

Protection Requirements

AD1-140 138 kV Interconnecting Substation

138 kV Transmission Line Protection

- Clark line exit
- Primary relay: SEL-411L relay with line current differential protection over Fiber with DTT
- Backup relay: SEL-411L relay with line current differential protection over Fiber with DTT

- Greene line exit
- Primary relay: SEL-411L relay with POTT over Fiber with DTT
- Backup relay: SEL-411L relay with line current differential protection over Fiber with DTT

- AD1-140 generating facility
- Primary relay: SEL-411L relay with line current differential protection over fiber with DTT
- Backup relay: SEL-411L relay with line current differential protection over fiber with DTT

138 kV AD1-140 Interconnecting Station Communications

- AD1-140 Interconnecting Station to Clark and Greene Fiber for use with primary and backup SEL-411Ls for Current Differential and DTT
- AD1-140 Interconnecting Station to AD1-140 generating facility
- Dual, independent fiber-optic cable paths with dedicated fibers for use with the SEL-411L primary and backup relaying
- Minimum of 12 fibers, separate primary and backup fiber cables

138 kV Breaker Failure to Trip Protection

- 138 kV Breaker Failure to Trip Relaying – SEL501 relay per breaker

AD1-140 Generating Station 138 kV

138 kV Transmission Line Protection @ AD1-140 generating station

- AD1-140 Interconnecting Station line exit
- Primary relay: SEL-411L relay with line current differential protection over fiber with DTT
- Backup relay: SEL-411L relay with line current differential protection over fiber with DTT
- Synch check for manual/SCADA close on the interconnecting line to be done at AD1-140 Generating Station

138 kV Breaker Failure to Trip Protection

- 138 kV Breaker Failure to Trip Relaying
- SEL-352-2 breaker failure to trip relaying on AD1-140 138 kV Generating Station breaker. The breaker failure to trip relaying on the AD1-140 Interconnecting Station line exit breaker shall initiate direct transfer trip via the SEL-411L primary and backup line relays (fiber).

138 kV Bus & GSU Transformer Protection @ AD1-140 generating station (minimum protection to meet FE requirements)

- Dual, independent transformer differential protection schemes (Transformer and Overall)
- Transformer neutral time overcurrent relay

The Connecting Party shall provide utility-grade relays for protection of the FE Transmission System. FE shall approve all relays specified for the protection of the FE Transmission System, including time delay and auxiliary relays. Relay operation for any of the listed functions that are required shall initiate immediate separation of the parallel generation from the FE Transmission System:

Relay	Function
Frequency	To detect underfrequency and overfrequency operation.
Overvoltage	To detect overvoltage operation.
Undervoltage	To detect undervoltage operation.
Ground Fault Detector	To detect a circuit ground on the FE Transmission System.
Phase Fault Detector	To detect phase to phase faults on the FE Transmission System.
Transfer Trip Receiver	To provide tripping logic to the generation owner for isolation of the generation upon opening of the FE supply circuits.
Directional Power	To detect, under all system conditions, a loss of FE primary source. The relay shall be sensitive enough to detect transformer magnetizing current supplied by the generation.

The Interconnection Customer will be required to comply with all FE Generation Protection Requirements for Generation Interconnection Customers. The Generation Protection Requirements may be found within the "FirstEnergy Requirements for Transmission Connected Facilities" document located at the following links:

www.firstenergycorp.com/feconnect

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

FE System Modifications

Clark Substation

138 kV Transmission Line Protection
- AD1-140 Interconnecting Station line exit Relaying
- Primary relay: SEL-411L relay over Fiber
- Backup relay: SEL-411L relay over Fiber

Settings Changes
- Settings changes are possible at remote substations.

Metering

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 [PRI POI VOLTAGE] kV circuit breaker to protect the AD1-140 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 AD1-140 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 IC shall design its non-synchronous Customer Facility with the ability to maintain a power factor of at least 0.95 leading (absorbing VARs) to 0.95 lagging (supplying VARs) measured at the high-side of the facility substation transformer(s) connected to the FE transmission system.

Network Impacts

Summer Peak Analysis - 2021

The Queue Project AD1-140 was evaluated as a 200.0 MW (Capacity 102.0 MW) injection into a tap of the Greene – Clark 138 kV line in the ATSI area. Project AD1-140 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AD1-140 was studied with a commercial probability of 100%. Potential network impacts were as follows:

Generator Deliverability

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

None.

Light Load Analysis

Light Load Studies to be conducted during later study phases (applicable to wind, coal, nuclear, and pumped storage projects).

None.

Multiple Facility Contingency

(Double Circuit Tower Line contingencies were studied for the full energy output. The contingencies of Line with Failed Breaker and Bus Fault will be performed for the Impact Study.)

None.

Short Circuit

(Summary of impacted circuit breakers)

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

(Summary of the VAR requirements based upon the results of the steady-state voltage studies)

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. See Attachment 3 for analysis

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)

None.

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.

None.

Network Impacts

Winter Peak Analysis – 2021

The Queue Project AD1-140 was evaluated as a 175.0 MW (Capacity 95.8 MW) injection into a tap of the Greene – Clark 138 kV line in the ATSI area. Project AD1-140 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AD1-140 was studied with a commercial probability of 100%. Potential network impacts were as follows:

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

(Results of the steady-state voltage studies should be inserted here)

None

Winter 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)

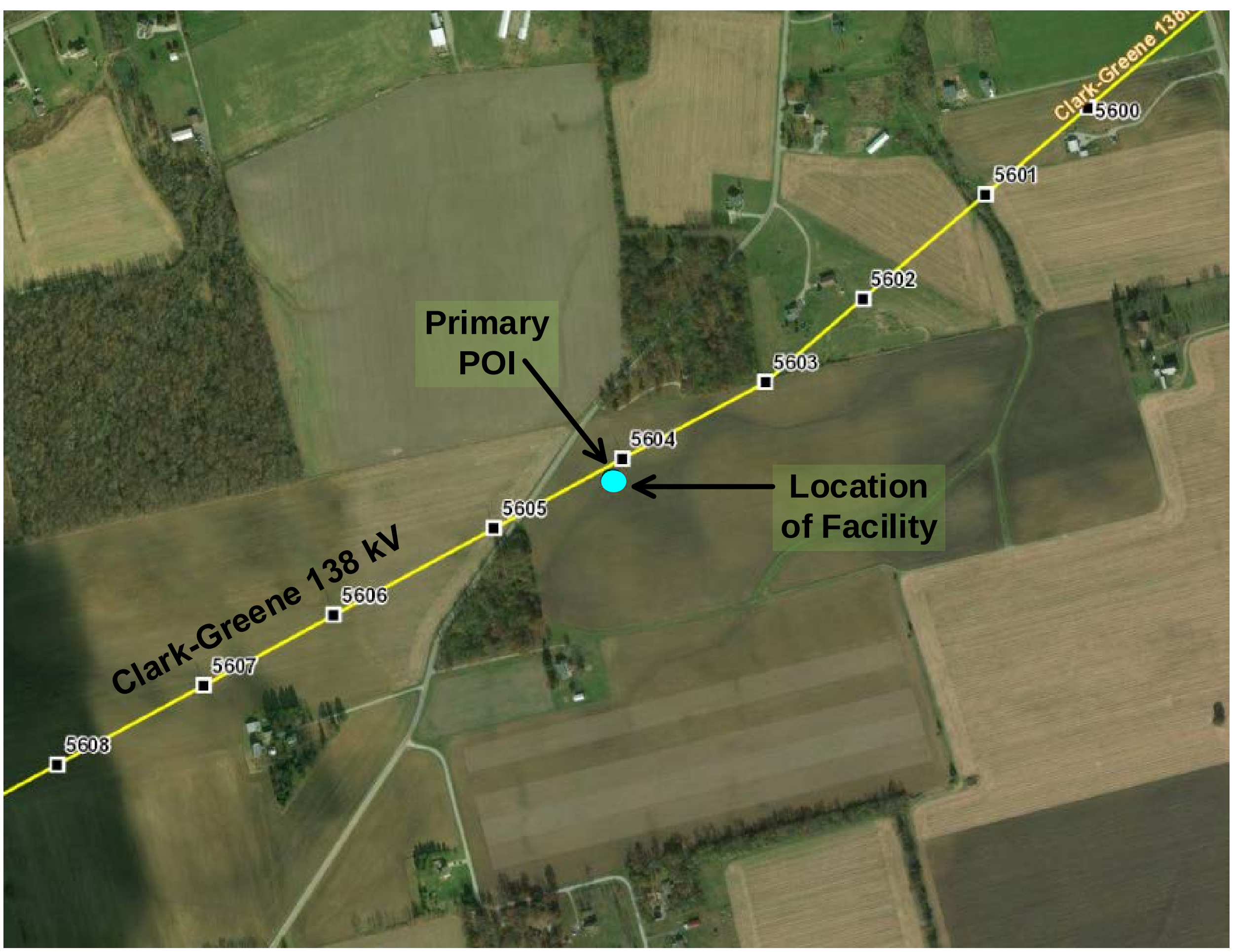
None

Contribution to Previously Identified System Reinforcements

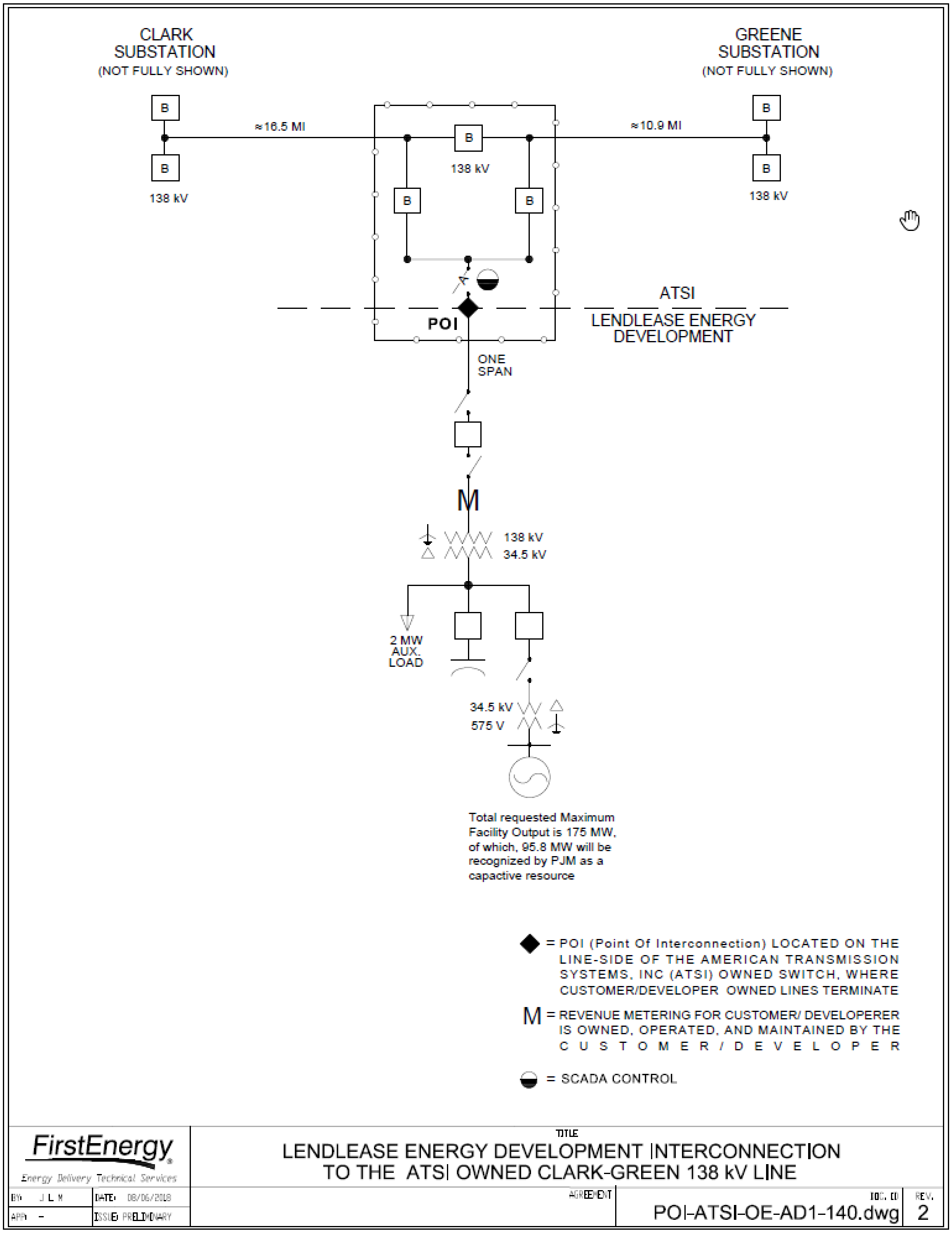
(Overloads initially caused by prior Queue positions with additional contribution to overloading by this project. This project may have a % allocation cost responsibility which will be calculated and reported for the Impact Study)

None

Attachment 1. Project Location



Attachment 2. Single Line Diagram



Attachment 3. Dynamic Simulation Analysis

Executive Summary

Generator interconnection request AD1-140 is for a 175 MW Maximum Facility Output (MFO) Photovoltaic Plant. AD1-140 consists of 96 x 1.83 MW Schneider SC2000 solar inverters with a Point of Interconnection (POI) on the Clark to Greene 138 kV transmission line in Greene County, Ohio in the First Energy (FE) transmission system. This report describes a dynamic simulation analysis of AD1-140 as part of the overall system impact study.

The power flow scenario for the analysis was based on the RTEP 2021 summer peak load case, modified to include applicable queue projects. AD1-140 has been dispatched online at maximum facility output, with approximately unity power factor at the high-side of the station transformer. The queue project, AD1-140, does not meet the 0.95 lead/lag power factor requirement, and therefore, shunt capacitors will be required to maintain the 0.95 power factor requirement.

AD1-140 was tested for compliance with NERC, PJM, Transmission Owner and other applicable criteria. For this study, 77 contingencies were simulated, each with a 10 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 remining 77 fault contingencies tested on the 2021 summer peak load case met the recovery criteria:

- The AD1-140 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.

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Attachment 3. Plots from Dynamic Simulations 27

1. Introduction

Generator interconnection request AD1-140 is for a 175 MW Maximum Facility Output (MFO) Photovoltaic Plant. AD1-140 consists of 96 x 1.83 MW Schneider SC2000 solar inverters with a Point of Interconnection (POI) on the Clark to Greene 138 kV transmission line in Greene County, Ohio in the First Energy (FE) transmission system.

This analysis is effectively a screening study to determine whether the addition of AD1-140 will meet the dynamic requirements of the NERC, PJM and Transmission Owner reliability standards.

This report describes the following:

- A description of the AD1-140 project and how it is proposed to be connected to the grid
- A description of how the project is modeled in this study
- A description of the fault cases analyzed in this study
- A discussion of the results

2. Description of Project

AD1-140 consists of 96 x 1.83 MW Schneider Electric SC2000 Solar Inverters. Each inverter is connected to a 34.5/0.575 kV two winding transformer, each with a 2.0 MVA rating. A 0.1 mile line connects the 138/34.5/13.8 kV collector step-up transformer to the POI through a 138 kV generation tie line and taps the Clark to Greene 138 kV transmission line. Refer to Figure 1 for a one-line diagram of the generation.

Table 1 lists the parameters given in the impact study data and the corresponding parameters of the AD1-140 loadflow model. The dynamic model for the AD1-140 plant is based on user written models for PSS/E with the parameters supplied by the developer.

Additional project details are provided in Attachments 1 and 2, as well as, Appendices A and B:

- Appendix A: PSS/E Slider Diagram for AD1-140.
- Appendix B: PSS/E power flow and dynamic model for AD1-140
- Attachment 1: System Impact Study Data for AD1-140
- Attachment 2: Tranmission one-line diagrams of the FE and Dayton network in the vicinity of AD1-140.

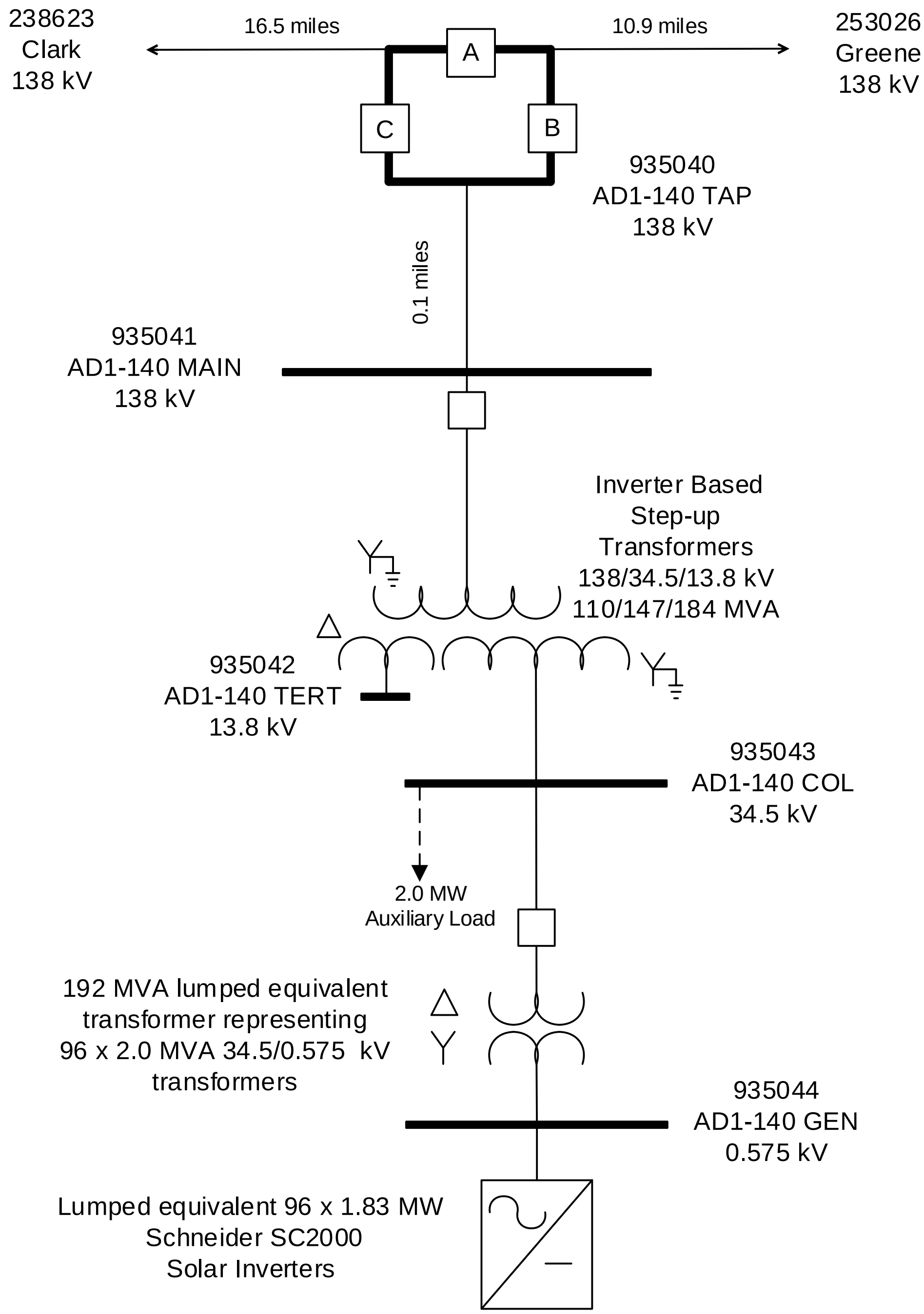

Figure 1: AD1-140 Plant Model.

Table 1: AD1-140 Plant Model

<table>
<tr><th></th><th>Impact Study Data</th><th>Model</th></tr>
<tr><td>Solar Inverters</td><td>96 x 1.83 MW Schneider Electric SC2000 Solar Inverters

MVA base = 2.0 MVA

Vt = 0.575 kV

Stator resistance = 0 p.u.

Saturated sub-transient reactance = 999 p.u.</td><td>1 x Lumped equivalent representing 96 x 1.83 MW Schneider Electric SC2000 Solar Inverters

Pgen 175.0 MW
Pmax 175.68 MW
Pmin 0 MW
Qmax 58.3 MVAr
Qmin -58.3 MVAr
Mbase 192.0 MVA
R 0 p.u.
X 999 p.u.</td></tr>
<tr><td>Solar Inverter Based Step-Up Transformer</td><td>96 x 34.5/0.575 kV two winding transformers

Rating = 2.0 MVA

Transformer MVA base = 2.0 MVA

Impedance = 0.007 + j0.07 p.u.

Number of taps = N/A
Tap step size = N/A</td><td>1 x Lumped equivalent representing 96 x 34.5/0.575 kV two winding transformers

Rating = 192 MVA

Transformer base = 192 MVA

Impedance = 0.007+ j0.07 p.u

Number of taps = N/A
Tap step size = N/A</td></tr>
<tr><td>Inverter Based Main Transformer</td><td>1 x 138/34.5/13.8 kV

Rating = 110/147/184 MVA

Transformer MVA base = 110 MVA

Impedance:
High to Low = 0.0018 + j0.079920 p.u.
High to Tert = 0.00350 + j0.123876 p.u.
Low to Tert = 0.00250 + j0.027972 p.u.
Number of taps = N/A
Tap step size = N/A</td><td>1 x 138/34.5/13.8 kV

Rating = 110/147/184 MVA

Transformer MVA base = 110 MVA

Impedance:
High to Low = 0.0018 + j0.079920 p.u.
High to Tert = 0.00350 + j0.123876 p.u.
Low to Tert = 0.00250 + j0.027972 p.u.
Number of taps = N/A
Tap step size = N/A</td></tr>
<tr><td></td><td>Impact Study Data</td><td>Model</td></tr>
<tr><td>Auxiliary Load</td><td>2 MW + 0.10 MVAr at low side of the GSU</td><td>2 MW + 0.10 MVAr at low side of the GSU</td></tr>
</table>

Collector System	No Data Provided	Not Modelled
Attachment Line	0.1 mile 138 kV line Impedance = 0.000050 + j0.000360 p.u Charging susceptance = j0.000080 p.u (Impedance on 100 MVA Base)	0.1 mile 138 kV line Impedance = 0.000050 + j0.000360 p.u Charging susceptance = j0.000080 p.u (Impedance on 100 MVA Base)

3. Power Flow and Dynamics Case Setup

The dynamic simulation analysis was performed using PSS/E Version 33.10.0.

The power flow scenario and fault cases for this study are based on PJM's Regional Transmission Planning Process[2].

The selected power flow scenario is the RTEP 2021 summer peak load case with the following modifications:

- Addition of all applicable queue projects prior to AD1-140.
- Addition of the AD1-140 queue project.
- Dispatch of units within 5 buses of the POI of the AD1-140 queue project.
    - Generators set to their maximum power output.
    - The reactive power output of each unit set near unity power factor at the high side of the station transformer.

The AD1-140 initial conditions are listed in Table 2, indicating maximum power output, with approximately unity power factor at the high-side of the station transformer.

Table 2: AD1-140 Machine Initial Conditions

Bus	Name	Unit	PGEN (MW)	QGEN (Mvar)	ETERM (p.u.)	POI Voltage (p.u.)
934064	AD1-140 GEN	1	175.0	38.15	1.026	1.026

Generation within the vicinity of AD1-140 (5 bus radius) has been dispatched online at maximum output (PMAX). The dispatch of generation in the vicinity of AD1-140 is given in Attachment 5.

[2] Manual 14B: PJM Region Transmission Planning Process, Rev 33, May 5 2016, Attachment G : PJM Stability, Short Circuit, and Special RTEP Practices and Procedures.

4. Fault Cases

Tables 3 through 7 list the contingencies that were studied, with representative worst case total clearing times provided by PJM. Each contingency was studied over a 10 second simulation time interval.

The studied contingencies include:

- 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

Contingencies were created for the following buses:

- Clark 138 kV
- Clark 69 kV
- East Springfield 138 kV
- Urbana 138 kV
- Airways 138 kV
- Knollwood 138 kV
- Monument 138kV
- Alpha 138 kV
- Greene 345 kV
- Greene 138 kV
- Trebein 138 kV

Clearing times were modeled based on PJM's "2017 Revised Clearing times for each PJM company" spreadsheet revision 20.

Attachment 2 contains one-line diagrams of the FE and Dayton networks in the vicinity of AD1-140, showing where faults were applied.

The positive sequence fault impedances for single-phase faults were modeled using a zero sequence to positive sequence impedance ratios of 0.4 for buses in the FE area and 0.3 for buses in the Dayton area derived from a separate short-circuit case. The ratio was applied to the posive sequence value in PSS/E and the single-phase fault impedance was calculated.

5. Evaluation Criteria

This study is focused on AD1-140, along with the rest of the PJM system, maintaining synchronism and having all states return to an acceptable new condition following the disturbance. The recovery criteria applicable to this study are as per PJM's Regional Transmission Planning Process and Transmission Owner criteria:

- The AD1-140 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.

6. Summary of Results

Plots from the dynamic simulations are provided in Attachment 6 with results summarized in Tables 3 through 7.

The remining 77 fault contingencies tested on the 2021 summer peak load case met the recovery criteria:

- The AD1-140 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 queue project, AD1-140, does not meet the 0.95 lead/lag power factor requirement and therefore, shunt capacitors will be required to maintain the 0.95 power factor requirement.

No mitigation or system upgrades were identified to interconnect the AD1-140 generation. No additional costs associated with the addition of the AD1-140 were identified in the System Impact Study.

Table 3: Steady-State Operation

Fault ID	Fault Description	AD1-140
SS.01	Steady State 20 sec (No Fault)	Stable

Table 3: Three-Phase Faults with Normal Clearing Time

Fault ID	Fault Description	Clearing Time (cycles)	AD1-140
P1.01	Fault at Clark 138 kV on East Springfield circuit 1.	12	Stable
P1.02	Fault at Clark 138 kV on Urbana circuit 13828.	12	Stable
P1.03	Fault at Clark 138 kV on 138/69 kV Transformer 1 and trips 1 x 26.4 Mvar capacitor bank.	12	Stable
P1.04	Fault at Clark 138 kV on 138/69 kV Transformer 2 and trips 1 x 26.4 Mvar capacitor bank.	12	Stable
P1.05	Fault at Clark 138 kV on AD1-140 circuit 13809.	12	Stable
P1.06	Fault at Clark 69 kV on Waterworks circuit 1.	60	Stable
P1.07	Fault at Clark 69 kV on Navistar circuit 1.	60	Stable
P1.08	Fault at Clark 69 kV on 138/69 kV Transformer 1 and trips 1 x 26.4 Mvar capacitor bank.	60	Stable
P1.09	Fault at Clark 69 kV on 138/69 kV Transformer 2 and trips 1 x 26.4 Mvar capacitor bank	60	Stable
P1.10	Fault at Clark 69 kV on two 25.2 Mvar capacitor banks	60	Stable
P1.11	Fault at Clark 69 kV on Rockaway circuit 1.	60	Stable
P1.12	Fault at Clark 69 kV on Rona circuit 1.	60	Stable
P1.13	Fault at Clark 69 kV on East Springfield circuit 1.	60	Stable
P1.14	Fault at Clark 69 kV on Medway circuit 1.	60	Stable
P1.15	Fault at Clark 69 kV on Mad River circuit 1.	60	Stable
P1.16	Fault at East Springfield 138 kV on Tangy circuit 1.	12	Stable
P1.17	Fault at East Springfield 138 kV on London circuit 1.	12	Stable
P1.18	Fault at East Springfield 138 kV on London circuit 2.	12	Stable
P1.19	Fault at East Springfield 138 kV on 138/69 kV Transformer 4.	12	Stable
P1.20	Fault at East Springfield 138 kV on 138/69 kV Transformer 5.	12	Stable
P1.21	Fault at East Springfield 138 kV on 138/69 kV Transformer 6.	12	Stable
P1.22	Fault at East Springfield 138 kV on 28.8 Mvar capacitor bank.	12	Stable
P1.23	Fault at Urbana 138 kV on Bath circuit 13849.	9	Stable
P1.24	Fault at Urbana 138 kV on Darby circuit 13811.	9	Stable
P1.25	Fault at Urbana 138 kV on 138/69 kV Transformer 7.	9	Stable
P1.26	Fault at Greene 138 kV on Knollwood circuit 13847.	9	Stable
P1.27	Fault at Greene 138 kV on Monument circuit 13815.	9	Stable
P1.28	Fault at Greene 138 kV on Alpha circuit 13821.	9	Stable
P1.29	Fault at Greene 138 kV on Airway circuit 13814.	9	Stable

Fault ID	Fault Description	Clearing Time (Cycles)	AD1-140
P1.30	Fault at Greene 138 kV on Trebein circuit 13813.	9	Stable
P1.31	Fault at Greene 138 kV on 138/345 kV Transformer N.	9	Stable
P1.32	Fault at Greene 138 kV on 138/345 kV Transformer S.	9	Stable
P1.33	Fault at Greene 138 kV on AD1-140 circuit 13809.	12	Stable
P1.34	Fault at Greene 345 kV on Bath circuit 34526.	7	Stable
P1.35	Fault at Greene 345 kV on Beatty circuit 34506.	7	Stable
P1.36	Fault at Greene 345 kV on Clinton circuit 34522.	7	Stable
P1.37	Fault at Greene 345 kV on Sugar Creek circuit 34503.	7	Stable
P1.38	Fault at Trebein 138 kV on Bath circuit 13810.	9	Stable
P1.39	Fault at Trebein 138 kV on 138/69 kV Transformer 7.	9	Stable
P1.40	Fault at Airway 138 kV on Greene circuit 13814 and the Airway 138/69 kV Transformer 7.	9	Stable
P1.41	Fault at Knollwood 138 kV on Monument circuit 13843, Overlook 138/69 kV Transformer 1 and Monument 138/12.5 kV Transformer 1.	9	Stable
P1.42	Fault on Monument 138 kV on Webster circuit 13848.	9	Stable
P1.43	Fault on Monument 138 kV on Wyandot circuit 13818.	9	Stable
P1.44	Fault on Monument 138 kV on Webster circuit 13919 and Monument 138/12.5 kV Transformer 3.	9	Stable
P1.45	Fault on Monument 138 kV on Wyandot circuit 13851.	9	Stable
P1.46	Fault at Alpha 138 kV on Bellbrook circuit 13833 and Bellbrook 138 kV Transformer 2.	9	Stable
P1.47	Fault at Alpha 138 kV on 138/69 kV Transformer 7.	9	Stable

Table 4: Single-Phase Faults with Stuck Breakers

Fault ID	Fault Description	Clearing Time Normal/Delayed (Cycles)	AD1-140
P4.01	Fault on Clark 138 kV at East Springfield. Breaker 6 stuck. Fault it cleared with loss of 2 x 26.4 Mvar capacitor banks and the Clark 138/69 kV Transformer 2.	12/20	Stable
P4.02	Fault on Clark 138 kV at East Springfield. Breaker 72 is stuck. Fault is cleared with loss of Clark 138/69 kV Transformer 1 and 1 x 26.4 Mvar capacitor bank.	12/20	Stable
P4.03	Fault on Clark 138 kV at Urbana. Breaker 124 is stuck. Fault is cleared with no additional loss.	12/20	Stable
P4.04	Fault on Clark 138 kV on 138/69 kV Transformer 1. Breaker 106 is stuck. Fault is cleared with loss of Clark to Urbana 138 kV circuit and 1 x 26.4 Mvar capacitor bank.	12/20	Stable
P4.05	Fault on Clark 138 kV on 138/69 kV Transformer 1. Breaker 72 is stuck. Fault is cleared with loss of Clark to East Springfield 138 kV circuit and 1 x 26.4 Mvar capacitor bank.	12/20	Stable
P4.06	Fault at Clark 138 kV on 138/69 kV Transformer 2. Breaker 65 is stuck. Fault is cleared with loss of Clark to AD1-140 138 kV circuit, and 1 x 26.4 Mvar capacitor bank.	12/20	Stable
P4.07	Fault at Clark 138 kV on 138/69 kV Transformer 2. Breaker 6 is stuck. Fault is cleared with loss of Clark to East Springfield 138 kV circuit and 1 x 26.4 Mvar capacitor bank.	12/20	Stable
P4.08	Fault at Clark 138 kV on AD1-140 circuit. Breaker 5 is tuck. Fault is cleared with no additional loss.	12/20	Stable
P4.09	Fault at Clark 138 kV on AD1-140 circuit. Breaker 65 is stuck. Fault is cleared with loss of Clark to 138/69 kV Transformer 2 and 1 x 26.4 Mvar capacitor bank.	12/20	Stable
P4.10	Fault at Greene 138 kV on AD1-140 circuit 13809. Breaker I is stuck. Fault is cleared with loss of Greene 138/345 kV Transformer N.	12/20	Stable
P4.11	Fault at Greene 138 kV on AD1-140 circuit 13809. Breaker H is stuck. Fault is cleared with loss of Greene to Trebein 138 kV circuit 13813.	12/20	Stable
P4.12	Fault on Greene 138 kV on Trebein circuit 13809. Breaker H is stuck. Fault is cleared with loss of Greene to AD1-140 TAP 138 kV circuit 13809.	9/21	Stable
P4.13	Fault at Greene 138 kV on Trebein circuit 13813. Breaker G is stuck. Fault is cleared with loss of Greene 138/345 kV Transformer S and 1 x 91.8 Mvar capacitor bank.	9/21	Stable
P4.14	Fault at Greene 138 kV on Alpha circuit 13821. Breaker D is stuck. Fault is cleared with loss of Greene 138/345 kV Transformer S and 1 x 91.8 Mvar capacitor bank.	9/21	Stable
P4.15	Fault at Greene 138 kV on Alpha circuit 13821. Breaker E is stuck. Fault is cleared with loss of Greene to Knollwood 138 kV circuit 13847.	9/21	Stable

Fault ID	Fault Description	Clearing Time Normal/Delayed (Cycles)	AD1-140
P4.16	Fault at Greene 138 kV on Monument circuit 13815. Breaker A is stuck. Fault is cleared with loss of Greene to 138/345 kV Transformer 2 and 1 x 91.8 Mvar capacitor bank.	9/21	Stable
P4.17	Fault at Greene 138 kV on Monument circuit 13815. Breaker B is stuck. Fault is cleared with loss of Greene to Airway 138 kV circuit 13814.	9/21	Stable
P4.18	Fault at Greene 138 kV on Knollwood circuit 13847. Breaker E is stuck. Fault is cleared with loss of Greene to Alpha 138 kV circuit 13821.	9/21	Stable
P4.19	Fault at Greene 138 kV on Knollwood circuit 13847. Breaker F is stuck. Fault is cleared with loss of Greene 138/345 kV Transformer N.	9/21	Stable
P4.20	Fault at Green 138 kV on Airway circuit 13814. Breaker C is stuck. Fault is cleared with loss of Green 138/69 kV Transformer N.	9/21	Stable
P4.21	Fault at AD1-140 TAP 138 kV on Clark circuit 13809. Breaker A is stuck. Fault is cleared with loss of AD1-140 Tap to Green 138 kV circuit 13809.	12/20	Stable
P4.22	Fault at AD1-140 TAP 138 kV on Clark circuit 13809. Breaker C is stuck. Fault is cleared with loss of AD1-140. (Trips AD1-140)	12/20	Stable
P4.23	Fault at AD1-140 TAP 138 kV on Greene circuit 13809. Breaker B is stuck. Fault is cleared with loss of AD1-140. (Trips AD1-140)	12/20	Stable
P4.24	Fault at AD1-140 TAP 138 kV on Greene circuit 13809. Breaker B is stuck. Fault is cleared with loss of AD1-140 TAP to Clark 138 kV circuit. (Trips AD1-140)	12/20	Stable

Table 5: Single-Phase Faults with Delayed Clearing at Remote End

Fault ID	Fault Description	Clearing Time Near & Remote (Cycles)	AD1-140
P5.01	Fault at 80% of 138 kV line from AD1-140 TAP to Clark circuit 13809. Delayed clearing at AD1-140 TAP.	12/45	Stable
P5.02	Fault at 80% of 138 kV line from Clark to AD1-140 TAP circuit 13809. Delayed clearing at Clark.	12/45	Stable
P5.03	Fault at 80% of 138 kV line form AD1-140 TAP to Greene circuit 13809. Delayed clearing at AD1-140 TAP.	12/45	Stable
P5.04	Fault at 80% of 138 kV line from Greene to AD1-140 TAP circuit 13809. Delayed clearing at Greene.	12/45	Stable

Table 6: Single-Phase Faults with Loss of Multiple-Circuit Towers

Fault ID	Fault Description	Clearing Time (Cycles)	AD1-140
P7.01	Fault on AD1-140 138 kV on the Clark circuit resulting in a tower failure. Fault cleared with loss of: - AD1-140 to Greene 138 kV circuit. - East Springfield to Airpark 138 kV circuit - Airpark to Clark 138 kV circuit. (CONTINGENCY 'ATSI-P7-1-OES-138-065T-A')	12	Stable

APPENDIX A:
PSS/E ONE- LINE DIAGRAM

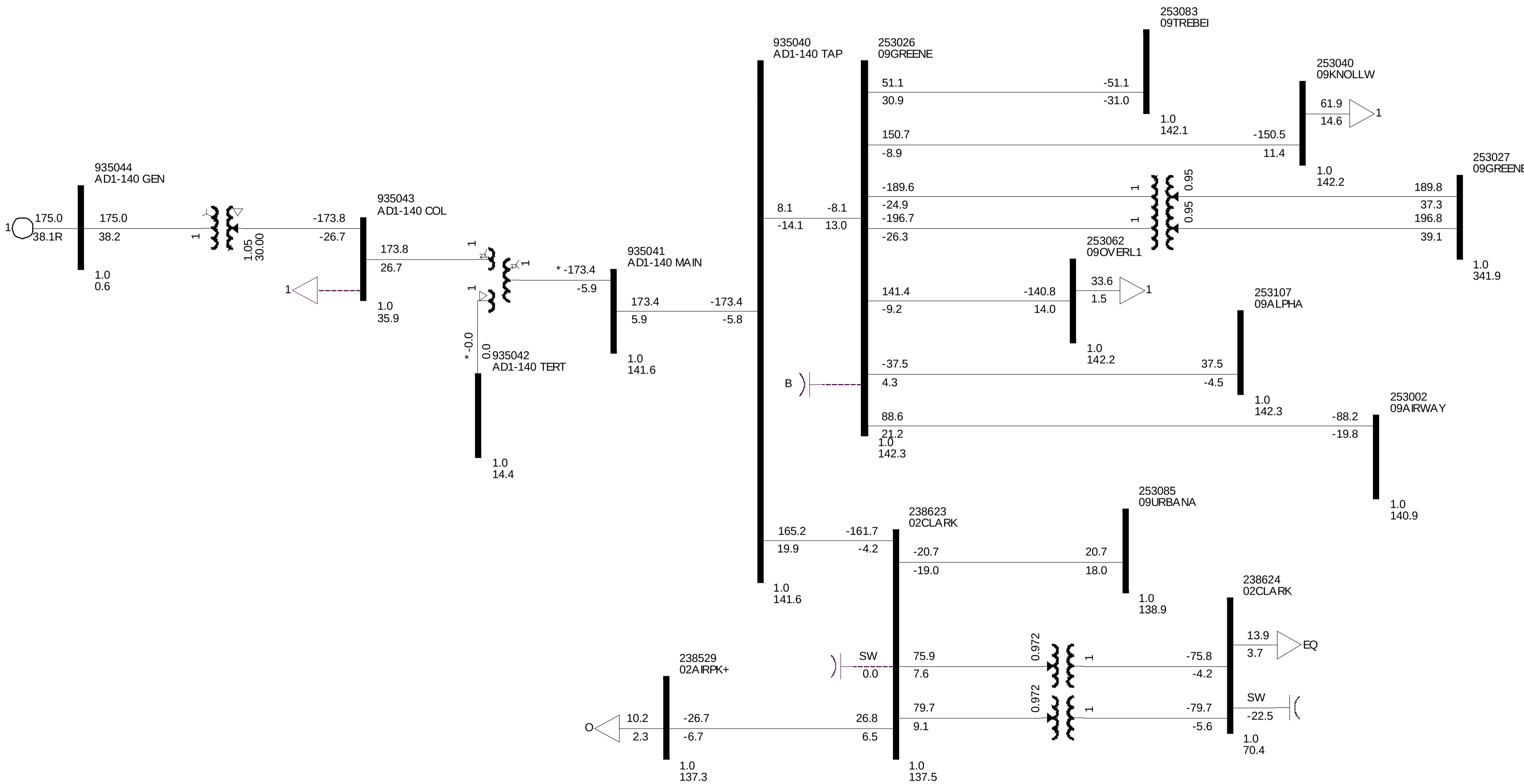

Figure A-2: PSS/E Slider Diagram for AD1-140.

APPENDIX B:
PSS/E DYNAMIC MODEL AND IDEV FILE

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/***Addition of AD1-140 Queue Project***/

BAT_PURGBRN,238623,253026,'1'
RDCH
1
935040,'AD1-140 TAP ', 138.0000,1, 202,1243, 202,1.03000,  -9.0672,1.10000,0.90000,1.10000,0.90000
935041,'AD1-140 MAIN', 138.0000,1, 202,1243, 202,1.02997,  -9.0326,1.10000,0.90000,1.10000,0.90000
935042,'AD1-140 TERT',  13.8000,1, 202,1243, 202,1.01678,  -1.4045,1.10000,0.90000,1.10000,0.90000
935043,'AD1-140 COL ',  34.5000,1, 202,1243, 202,1.01805,  -2.1019,1.10000,0.90000,1.10000,0.90000
935044,'AD1-140 GEN ',   0.5750,2, 202,1243, 202,1.02258, -28.5898,1.10000,0.90000,1.10000,0.90000
0 / END OF BUS DATA, BEGIN LOAD DATA
935043,'1 ',0,   1,   1,     2.000,     0.000,     0.000,     0.000,     0.000,     0.000,   1,1,0
0 / END OF LOAD DATA, BEGIN FIXED SHUNT DATA
0 / END OF FIXED SHUNT DATA, BEGIN GENERATOR DATA
935044,'1 ',   175.000,     0.586,    58.300,   -58.300,1.03000,935040,   192.000, 0.00000E+0, 9.99000E+2, 0.00000E+0,
0.00000E+0,1.00000,1,  192.0,   175.680,     0.000,   1,1.0000
0 / END OF GENERATOR DATA, BEGIN BRANCH DATA
238623,935040,'1 ', 1.35000E-2, 6.66000E-2,   0.01770,  233.00,  282.00,    0.00,  0.00000,  0.00000,  0.00000,  0.00000,1,2,   0.00,
209,1.0000
253026,935040,'1 ', 9.00000E-3, 4.44000E-2,   0.01180,  233.00,  282.00,    0.00,  0.00000,  0.00000,  0.00000,  0.00000,1,1,   0.00,
209,1.0000
935040,935041,'1 ', 5.00000E-5, 3.60000E-4,   0.00008,    0.00,    0.00,    0.00,  0.00000,  0.00000,  0.00000,  0.00000,1,2,   0.00,
1,1.0000
0 / END OF BRANCH DATA, BEGIN TRANSFORMER DATA
935041,935043,935042,'1 ',1,2,1, 0.00000E+0, 0.00000E+0,2,'            ',1,   1,1.0000,   0,1.0000,   0,1.0000,   0,1.0000,'YN0yn0d1    '
 1.80000E-3, 7.99200E-2,   110.00, 2.50000E-3, 2.79720E-2,   110.00, 3.50000E-3, 1.23876E-1,   110.00,1.01678,  -1.4045
1.00000,   0.000,   0.000,   110.00,   147.00,   184.00, 0,      0, 1.10000, 0.90000, 1.10000, 0.90000,  33, 0, 0.00000, 0.00000,  0.000
1.00000,   0.000,   0.000,   110.00,   147.00,   184.00, 0,      0, 1.10000, 0.90000, 1.10000, 0.90000,  33, 0, 0.00000, 0.00000,  0.000
1.00000,   0.000,   0.000,   110.00,   147.00,   184.00, 0,      0, 1.10000, 0.90000, 1.10000, 0.90000,  33, 0, 0.00000, 0.00000,  0.000
```

```
935043,935044,     0,'1 ',1,2,1, 0.00000E+0, 0.00000E+0,2,'            ',1,   1,1.0000,   0,1.0000,   0,1.0000,   0,1.0000,'Dy1         '
 7.00000E-3, 7.00000E-2,   192.00
1.00000,   0.000,  30.000,   192.00,   192.00,   192.00, 0,      0, 1.10000, 0.90000, 1.10000, 0.90000,  33, 0, 0.00000, 0.00000,  0.000
1.00000,   0.000
0 / END OF TRANSFORMER DATA, BEGIN AREA DATA
   1,     0,     0.000,    10.000,'AREA1       '
 202,238967, -1541.000,     5.000,'FE          '
0 / END OF AREA DATA, BEGIN TWO-TERMINAL DC DATA
0 / END OF TWO-TERMINAL DC DATA, BEGIN VSC DC LINE DATA
0 / END OF VSC DC LINE DATA, BEGIN IMPEDANCE CORRECTION DATA
0 / END OF IMPEDANCE CORRECTION DATA, BEGIN MULTI-TERMINAL DC DATA
0 / END OF MULTI-TERMINAL DC DATA, BEGIN MULTI-SECTION LINE DATA
0 / END OF MULTI-SECTION LINE DATA, BEGIN ZONE DATA
   1,'CHICAGO     '
1243,'FE-SP       '
0 / END OF ZONE DATA, BEGIN INTER-AREA TRANSFER DATA
0 / END OF INTER-AREA TRANSFER DATA, BEGIN OWNER DATA
   1,'CENT HUD    '
 202,'PEF-SOUTH   '
 209,'OWNER_209   '
0 / END OF OWNER DATA, BEGIN FACTS DEVICE DATA
0 / END OF FACTS DEVICE DATA, BEGIN SWITCHED SHUNT DATA
0 / END OF SWITCHED SHUNT DATA, BEGIN GNE DATA
0 / END OF GNE DATA, BEGIN INDUCTION MACHINE DATA
0 / END OF INDUCTION MACHINE DATA
Q
```

```
/**********************************************************************
/*** Project:      AD1-140
/**********************************************************************
/**********************************************************************
/**********************************************************************
/*****************************************************
/*** Project: AD1-140  - MFO  175 MW
/*** POI: Clark - Greene 138 kV line
/*** Fuel Type: Solar
/*** Turbine: Schneider Electric SC200 Solar Inverter
/*** DLL: SE1INVT_A6_v33.dll
/*** Size: 96 x 1.83 MW wind turbines (175 MW)
/*** PSSE Version 33
/*****************************************************

     935044 'USRMDL' 1 'SE1INVT' 1 1 0 42 6 31
          0 1 1 1.00 0.05 2.0 0.015 0.85 1.15 8.0
          60.0 0.3 1.0 1.2 0.5 1.15 1.5 0.5 0.5 0.8
          3.5 62.0 1.0 61.0 200 59.0 300 57.5 1 10.0
          10.0 999.0 0.98 1.02 59.5 60.5 0 -0.4 60.2 60.05
          59.8 59.95/

/**********************************************************************
/*** Project:      AD1-140 ends
/**********************************************************************
```

APPENDIX C:

FINAL GENERATION DISPATCH TABLE

Table C-1: Final Generation Dispatch

Ref. No.	Bus Number	Bus Name	Voltage (kV)	Id	Area Num	Area Name	In Service	Pgen (MW)	Pmax (MW)	Pmin (MW)	Qgen (Mvar)	Qmax (Mvar)	Qmin (Mvar)
1	253038	09KILLEN	345	2	209	DAY	1	612	612	230	199	199	-63
2	253038	09KILLEN	345	3	209	DAY	1	18	18	15.66	10.37	18	-10.2
3	253077	09STUART	345	1	209	DAY	1	580.6	580.6	300	3.09	280	-17
4	253077	09STUART	345	2	209	DAY	1	580	580	300	3.09	280	-30
5	253077	09STUART	345	3	209	DAY	1	580.4	580.4	300	8	280	8
6	253077	09STUART	345	4	209	DAY	1	577	577	300	3.07	280	-30
7	253077	09STUART	345	5	209	DAY	1	9.2	9.2	0	0.05	8.8	-5.2
8	253097	09YANKEE	69	1	209	DAY	1	16	16	13.92	-2.12	10	-3
9	253097	09YANKEE	69	2	209	DAY	1	16.5	16.5	13.5	-2.19	10	-3
10	253097	09YANKEE	69	3	209	DAY	1	16	16	13.92	-2.12	10	-3
11	253097	09YANKEE	69	4	209	DAY	1	13	13	9.57	-1.73	11	-5
12	253097	09YANKEE	69	5	209	DAY	1	13	13	0	-1.73	11	-6
13	253097	09YANKEE	69	6	209	DAY	1	13	13	10.27	-1.73	11	-6
14	253097	09YANKEE	69	7	209	DAY	1	13	13	9.57	-1.73	11	-6
15	253110	09ADKINS	345	1	209	DAY	1	94	94	38	6.81	32	-15
16	253110	09ADKINS	345	2	209	DAY	1	94	94	38	6.81	30	-16
17	253110	09ADKINS	345	3	209	DAY	1	94	94	38	6.81	23	-13
18	253110	09ADKINS	345	4	209	DAY	1	94	94	38	6.81	26	-14
19	253110	09ADKINS	345	5	209	DAY	1	94	94	38	6.81	27	-13
20	253110	09ADKINS	345	6	209	DAY	1	94	94	38	6.81	24	-14
21	253222	09TAIT E	69	1	209	DAY	1	87	87	41	-16.4	50.7	-16.4
22	253222	09TAIT E	69	2	209	DAY	1	89	89	41	-16.8	42.8	-16.8
23	253222	09TAIT E	69	4	209	DAY	1	79	79	41	-18.8	50.6	-18.8

Ref. No.	Bus Number	Bus Name	Voltage (kV)	Id	Area Num	Area Name	In Service	Pgen (MW)	Pmax (MW)	Pmin (MW)	Qgen (Mvar)	Qmax (Mvar)	Qmin (Mvar)
24	253222	09TAIT E	69	6	209	DAY	1	80	80	41	-18	50	-18
25	253223	09TAIT W	69	3	209	DAY	1	80	80	41	-14	42	-14
26	253223	09TAIT W	69	5	209	DAY	1	80	80	41	-18	50	-18
27	253223	09TAIT W	69	7	209	DAY	1	81	81	41	-16.8	48.4	-16.8
28	253261	09MON D	4.2	1	209	DAY	1	12	12	0	-4.97	8.8	-5.2
29	904721	V4-073C	69	1	209	DAY	1	0.9	0.9	0	0	0	0
30	904722	V4-073E	69	1	209	DAY	1	1.5	1.5	0	0	0	0
31	914372	Y2-111 E	69	1	209	DAY	1	12	12	0	5.76	5.76	-3.96
32	915582	Y3-080 E	69	1	209	DAY	1	8	8	0	3.84	3.84	-2.64
33	916332	Z1-079 CT	21	CT	212	DEO&K	1	301.4	301.4	143.4	47.67	195	-145
34	916333	Z1-079 ST	18	ST	212	DEO&K	1	224.2	224.2	100.4	47.67	145	-73
35	926014	AD1-081 GEN	0.6	1	202	FE	1	200.2	200.2	0	40.76	65.81	-65.81
36	926063	AC1-085 GENA	0.6	1	209	DAY	1	200	200	0	28.81	81.4	-81.4
37	926065	AC1-085 GENB	0.6	1	209	DAY	1	200	200	0	28.81	81.4	-81.4
38	931183	AB1-169 CT1	25	1	209	DAY	1	341	341	0	69.19	165.63	-112.41
39	931184	AB1-169 ST1	25	1	209	DAY	1	243.6	243.6	0	69.19	300	-177
40	931185	AB1-169 CT2	25	1	209	DAY	1	341	341	0	69.19	165.63	-112.41
41	931186	AB1-169 ST2	25	1	209	DAY	1	243.6	243.6	0	69.19	300	-177
42	935044	AD1-140 GEN	0.6	1	212	FE	1	175	175.68	0	38.15	58.3	-58.3

Attachment 1. Impact Study Data

Attachment 2. FE and DAYTON One Line Diagram

Attachment 3. Plots from Dynamic Simulations