Generation Interconnection
Facility Study Report

For

PJM Generation Interconnection Request
Queue Position AC1-078/AD1-081

“Beatty-London 138 kV”

October 2021

Queue #AC1-078/AD1-081 Beatty-London 138 kV

Facilities Study Report

General

This Facilities Study has been prepared in accordance with the PJM Open Access Transmission Tariff, Section 205, as well as the Facilities Study Agreement between Big Plain Solar, LLC, the Interconnection Customer ("IC" or "Developer") and PJM Interconnection, LLC (PJM), Transmission Provider (TP). The Interconnected Transmission Owner ("ITO" or "TO") is American Transmission Systems, Incorporated (ATSI).

Preface

The intent of the Facility 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 Facility Study estimates attempt to identify the estimated 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.

1. Description of the Project[1]

Big Plain Solar, LLC has proposed a solar generating facility located in Madison County, Ohio. The installed facilities for AC1-078/AD1-081 will have a total capability of 196 MW with 79.2 MW of this output being recognized by PJM as capacity. AC1-078/AD1-081 consists of PE HEM 3350 inverters with a point of interconnection on the Beatty-London 138-kV line. AC1-078/AD1-081 will be connected to the POI via a 138/34.5 kV main collector transformer with a rating of 127/168/210 MVA connected to (61) 34.5/0.6 kV generator step-up transformers each with a rating of 3.465 MVA. The facilities are proposed to connect to the Beatty-London 138 kV line. The proposed Commercial Operation date for this project is February 28, 2023.

[1] The scope of work identified in this Facilities Study is the same as was identified in the AC1-078 report. AD1-081 is an uprate to AC1-078. PJM is adding AD1-081 to the Facilities Study as both projects will be constructed together. No additional scope of work is required to accommodate the additional output from AD1-081.

Queue #	MWC	MW Total
AC1-078	66	176
AD1-081	13.2	20
Total	**79.2**	**196**

The generation facility will interconnect with the TO at a point of interconnection along the Beatty-London 138-kV line, located to the north and west of the proposed generation facilities. The proposed substation location is north of the Beatty-London 138 kV line.

2. Cost Summary

The AC1-078/AD1-081 project will be responsible for the following costs:

Description	Total Cost
Attachment Facilities	$ 393,700
Direct Connection Network Upgrades	$ 5,083,400
Non Direct Connection Network Upgrades	$ 1,593,300
System Upgrades	$ 0
Total Costs	**$ 7,070,400**

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.

3. Interconnection Customer's Submitted Milestone Schedule

Developer's requested Commercial Operation Date (COD) for the generation facility is **February 28, 2023**. Transmission Owner's proposed schedule does not match the Developer's requested Milestone Schedule. A Project Kickoff meeting must occur by October 31, 2020 to meet Transmission Owner's Assumed Milestone Schedule listed below.

Transmission Owner's Assumed Milestone Schedule:

10/31/2022 Initial Back-feed through Project Substation Date
02/28/2023 Project Commercial Operation Date

Attachment Facilities Schedule:
In order to meet the Back-feed Date, a twenty-four (24) month schedule is estimated, from the date of a fully executed Interconnection Construction Service Agreement and Construction Kick-Off Meeting, to complete the engineering, construction and associated activities, as detailed in the "Attachment Facilities" section below.

Direct Connection Schedule:
In order to meet the Back-feed Date, a twenty-four (24) month schedule is estimated, from the date of a fully executed Interconnection Construction Service Agreement and Construction Kick-Off Meeting, to complete the engineering, construction and associated activities, as detailed in the "Direct Connection" section below.

This assumes that sufficient engineering details are available to evaluate the scope of work. It also assumes that there is limited or no transmission line work for the months of June, July and August due to potential lack of obtaining system outages during that timeframe.

24-month Schedule

Activity	Start Month	End Month
Preliminary Engineering	1	3
Siting, Permits & Real Estate	2	12
Detailed Engineering	2	12
Equipment Delivery	14	15
Below Grade Construction – Substation	15	18
Below Grade Construction – T-Lines	21	22
Above Grade Construction – Substation	18	23
Above Grade Construction – T-Lines	22	23
Testing & Commissioning	24	24

Non-Direct Connection Schedule: A proposed twenty-four (24) month schedule (assumed November 2020 start) is estimated to complete the engineering, construction and associated activities, as detailed in the "Non-Direct Connection" section below, assuming an Interconnection Construction Service Agreement has been fully-executed, and a Construction Kick-Off Meeting has occurred. It is assumed these system reinforcements are able to be engineered and constructed within the same time frame as the interconnection substation. The estimated time to complete these tasks is approximately eleven (11) months, but this work would be coordinated with the

engineering and construction associated with the Direct Connection work and therefore would take as long twenty-four (24) months as the Direct Connection schedule.

System Reinforcements Schedule: None.

4. Scope of Developer's Work

Direct Connection Facilities

IC will construct facilities, including the generation step-up (GSU) transformer, 138 kV (AC1-078/AD1-081) generator lead line and connect to the new 3 breaker ring bus interconnection substation.

Point of Interconnection (POI): The POI will be located within the new 138 kV ring bus interconnection where Developer-owned 138 kV attachment line conductor will terminate on the insulators on the dead-end takeoff structure and will be defined as the POI. (see Figure 1)

Developer is required to own, install, and maintain a fully-rated, fault-interrupting circuit breaker on the high-side of the GSU transformer with revenue metering equipment between the collector bus and the incoming generator lead line.

The attachment facilities include a new line terminal equipment on Transmission Owner's side of the point of interconnection. This typically includes operational metering, dead-end structure, and a three-phase, gang-operated disconnect switch. These facilities are considered radial equipment from the terminal to the point of interconnection.

Project Scope

The AC1-078/AD1-081 project will be interconnected via generator lead line to a new 3 breaker ring bus substation which will be built in close proximity to the Beatty-London 138-kV line. Developer is responsible for constructing all the facilities on its side of the POI, as shown in the attached single-line diagram (see Figure 1).

The Transmission Owner is responsible for the design, procurement, and construction of the new 3 breaker ring bus substation and loop feed from the Beatty-London 138 kV line.

5. Description of Facilities Work:

a. Attachment Facilities Work to be constructed by IC:

- Construct generator lead line approximately 0.25-mile interconnection to AC1-078/AD1-081 from the new terminal (POI) at the ring bus interconnection substation.

Assumptions / Notes:

- Developer will coordinate design and alignment of proposed AC1-078/AD1-081, 138 kV generator lead line with the Transmission Owner for review of any clearance, right-of-way or right-of-way encroachment issues with TO owned facilities.
- Developer will coordinate design and construction of proposed AC1-078/AD1-081 138 kV Lead Line. For these areas, the Developer shall provide TO with proposed transmission plan & profile drawings prior to construction and as-built drawings, confirmed by as-built survey data post-construction.
- Transmission Owner's preference would be to limit interference and avoid transmission line crossings with new 138 kV terminal positions. As a minimum, Developer facilities should not encroach within 100 feet of TO centerline at blowout conditions. If Developer's line design does not comply with this requirement TO would need to review this area as a special exception.
- Given the proposed location of the developer's substation (north of the transmission line), the Developer should also take into consideration how they plan to cross the transmission corridor. It will require permission of FirstEnergy for design, clearances and route of the generator tie line that will need to cross the Transmission line right-of-way.
- If the Developer plans to cross the transmission line right of way with facilities or access roads, please refer to the Transmission Rights-of-Way Restrictions information located at:
    - https://www.firstenergycorp.com/help/safety/real-estate-power-lines/transmission-right-of-way.html#ROWform
- Additional costs will be incurred by the Developer, if final alignment of AC1-078/AD1-081 138 kV generator lead line causes encroachments, changes, or modifications to any existing or relocated TO facilities.

b. Facilities Work to be constructed by Transmission Owner:

Attachment Facilities

Transmission Owner will design, furnish and construct the new 138 kV line terminal and take off structure. This work will include, but not be limited to, installation of a 138 kV line exit take-off structure, foundations, disconnect switch and associated equipment to accommodate the termination of the 138 kV generator lead line.

Direct Connection

Interconnection Substation (138 kV 3 breaker ring bus)
[PJM Network Upgrade N5925]

Transmission Owner will design, furnish and construct the new 138 kV line terminal for the Developer as part of the new 3-breaker ring bus interconnection substation, including the following:

- Three (3) 138 kV, 3000 ampere, 40 kA interrupting power circuit breakers
- Six (6) 138 kV, 2000 ampere, three-pole, manually-operated, group disconnect switches
- One (1) 138 kV, 1200 ampere, three-pole, motor-operated, disconnect switch
- Two (2) 138 kV, 2000 ampere, three-pole, motor-operated disconnect switches
- Six (6) surge arresters for application on a 138 kV system
- Nine (9) 138 kV capacitor voltage transformers for relaying
- Station Service – Transmission Owner requires a primary and a backup station power supply with automatic transfer. This consists of the following sources:
    - Primary: One (1) 138 kV power voltage transformer
    - Backup: Feed from a local distribution feeder
        - Station service will require the execution of a back-up service agreement to serve the customer load supplied when the units are out-of-service.
- Three (3) 138 kV transmission line termination structures
- 138 kV bus (with damper wire) and conductor with associated structures
- Prefabricated building with battery and charger
- For Beatty (AEP) terminal: include 138kV interconnection metering from the three line CVT's and a set of metering accuracy CT's in each breaker.
- Install two (2) 138kV line traps, line tuners, and coax for the London and Beatty line exits
- Transmission Owner relaying and controls per the Protection Requirements (provided as Attachment "A").
- SCADA RTU/Communications circuit – Contact Transmission Owner for specifics
- Foundations for the equipment listed above.
- Substation fencing, cable trench & conduit system, ground grid and stoning.
- Compliance with Transmission Owner security standards. Developer to contact Transmission Owner for design / equipment details

Assumptions / Notes:

- A rough-graded, level site and access road is to be provided by Developer.
- In order to meet the requested Backfeed Date of **10/31/2022**, the exact interconnection switchyard site, pull-off structure location, and structure details (for connection to the transmission line loop) are required from Developer no later than **4/30/2021** (i.e. minimum **eighteen** (18) months lead-time from Backfeed Date). Delays in provision of interconnection switchyard site details will affect the schedule.
- Developer will acquire adequate land size to accommodate the Transmission Owner interconnection substation. Transmission Owner did not perform an evaluation to determine if Developer has secured an adequate amount of land for the interconnection substation. The proposed land for the interconnection substation has not yet been finalized. Schedule may be affected based upon size of the property and the terrain. The property should be large enough to contain the fenced area, graded slopes, and any storm water management for the Transmission Owner interconnection substation. Transmission Owner would need to review Developer's substation layout to determine if the land size is adequate.

SCADA Work
[PJM Network Upgrade N5925]

MPLS router at new interconnect substation to provide SCADA transport for new RTU. Estimated in-sub fiber run for connection from new interconnect substation to fiber backbone. These two costs are captured in the 3 breaker ring bus estimate. The SCADA work not captured in the substation estimate also includes, SCADA work at new interconnect substation to support new RTU and SCADA work at London substation to support line relay replacements.

Non-Direct Connection

Beatty-London 138 kV Line Loop
[PJM Network Upgrade N5926]

Transmission Owner will sectionalize the existing 138 kV transmission line at the new Transmission Owner interconnection substation, at a site selected by Developer with agreement from Transmission Owner. The proposed station is to be located at the following GPS coordinates:

39.86384°, -83.34957°

This study assumes that the interconnection new substation will be located adjacent to the Transmission Owner 138 kV line right-of-way (See "Figure 2") and the dead-end structures will each be within one (1) span of the line (approximately 300 feet). The estimated costs shown in this study are typical for this type of design. The actual costs will be determined by the final substation and line loop locations.

Transmission Owner will install a loop, approximately 300 feet in length, from the Beatty-London 138-kV line to the proposed 3-breaker ring bus substation.

The schedule is based on assuming project kick-off occurs no later than **10/31/2020** (i.e. minimum **twenty-four** (24) months prior to Backfeed Date) and that engineering for both the Direct and Non-Direct work will occur simultaneously even though the line loop requires a shorter duration for engineering and construction than the ring bus. Work between the two portions needs to be closely coordinated with one another. It also assumes the Ohio PUC will grant a waiver to a full application. The 'exact' substation location and details are required from Developer prior to the start of engineering (i.e. no later than **11/01/2020**). Delays in provision of substation site details will affect the schedule.

Note: An outage on the source line is unlikely to be granted from May 1 to October 1. Therefore, the engineering and construction for the project must be substantially completed by 05/01/2022 in order to meet the requested Backfeed Date. The schedule is based on no issues with siting/permitting, right-of-way acquisition, or outage requirements.

Assumptions:

Engineering Assumptions:

1. Install two guyed wood 3-pole deadend structures for the loop. Install an additional guyed wood monopole deadend on each leg of the loop to route the loop into the substation bays.
2. Install a hold-back structure on the Beatty-London 138 kV circuit.

3. Substation is adjacent to the existing line with the substation being approx. 300' in length (2 span lengths) off the transmission corridor.
4. Assume that the loop will tie into existing circuit near tower #5856.
5. Existing conductor is 477 ACSR and shield wire is 101.8 ACSR. Shield wire will be replaced with OPGW. Loop conductor will match existing 477 ACSR.
6. Access will be provided through the substation area and substation access roads.
7. No forestry work is anticipated.
8. It is assumed that one existing structure will need to be removed.
9. This location - given proximity to a stream (Glade Run) that would potentially need to be crossed, depending upon final substation location and orientation – may pose some environmental and siting issues.

Siting Assumptions:

1. An application to the Ohio Power Siting Board will be required. One of the issues required for approval is in determining what will be needed as far as property acquisition. It is expected that Developer will acquire all of the necessary property and transfer it to Transmission Owner.
2. The estimate assumes a Letter of Notification (LON) is required for OPSB approval. If a full siting application is required, significant external legal involvement and environmental studies will be required which would greatly increase costs and schedule (not included herein).
3. It is expected that the Erosion & Sedimentation Control Plan will be combined with the substation work and be the responsibility of the Transmission Owner.

Right-of-Way Assumptions:

1. Right-of-way is required from Developer only. The project is entirely on Developer's property and the property will be transferred to Transmission Owner at no cost.
2. Right-of-way acquisition must occur prior to Ohio Power Siting Board review of the submittal.
3. Title completed by Developer and provided to Transmission Owner upon request.

Beatty Substation

[PJM Network Upgrade N5928]

Upgrade line relaying for Beatty 138 kV line exit and rename for new AC1-078/AD1-081 PJM station.

London Substation

[PJM Network Upgrade N5927]

Remove 138 kV metering for tie line to AEP. Remove metering, CTs and VTs. Upgrade line relaying for London 138 kV line exit and rename for new AC1-078/AD1-081 PJM station. @ London SS. Replace line tuner, wave trap and coax.

6. Schedule:

A proposed **twenty-four** (24) month **Direct Connection** and **Non-Direct Connection** schedule is estimated to complete the engineering, construction and the associated activities, from the date of a fully executed Interconnection Construction Service Agreement and Construction Kick-Off Meeting. This schedule assumes that all issues covered by the "General Assumptions and Engineering, Siting, Right-of-Way, Environmental, Real Estate, Forestry, Vegetation Management and Permitting Issues" section of this document are resolved, and outages will occur as planned.

Assumptions / Notes:

Construction cannot begin until after all applicable permits and/or easements have been obtained.

Engineering Assumptions

- Existing structures are sufficient for the intended purpose. An engineering analysis and structure condition assessment of existing structures will be required to identify if any structures require repair or replacement due to condition.

Siting and Right-of-Way Assumptions

- In OH, assume that project will receive local municipal approval with no public or municipal opposition.
- In OH, assume that project line work will require a Letter of Notification (LON).
- Assumes all work occurs within an existing transmission line right-of-way with little or minor modifications to existing structures; however, additional clearing rights from property owners may be required where additional vegetation clearing is needed. These additional costs re NOT included as part of the estimate.
- Assumes all work will occur within existing FE right-of-way. Some off-ROW access will likely be required from adjacent property owners. These additional costs are NOT included as part of the estimate.
- Temporary land rental may be required for contractor material with material/equipment staging areas, depending upon size of property provided for interconnection substation.
- Temporary land use and rental for pull points and staging areas for the OPGW installation may be required.
- Schedule assumes no property owner, governmental, or municipal opposition to the overall AC1-078/AD1-081 project.

Environmental Assumptions

- Environmental permits from OH will be required.
- Environmental studies will be required to develop E&S Control Plans and required measures. Costs include development and submittal of E&S Plan, periodic monitoring of E&S measures including post construction removal and rehabilitation.

Forestry/Vegetation Management Assumptions

- Additional vegetation clearing may be required for access road installation and within existing right-of-way where additional conductor clearance is required.

- No special conditions for vegetation clearing. Vegetation removal may be constrained due to seasonal restrictions due to T&E's (10/1 - 3/31) for native bat habitat. This should be included and verified as part of project environmental studies.

7. Total Estimated Costs of TO Facilities for Direct and Non-Direct Connection:

The following table summarizes the total estimated costs according to FERC criteria. The estimated costs are in 2019 dollars. The taxes are a CIAC (Contribution in Aid of Construction) Federal Income Tax Gross Up charge. This tax may or may not be charged based on whether this project meets the eligibility requirements of IRS Notice 88-129.

Description	Total Cost (w/o Tax)	Tax (if applicable)	Total Cost (w/Tax)
Installation of a 138 kV line exit take-off structure, foundations, disconnect switch and associated equipment to accommodate the termination of the 138 kV generator lead line.	$ 393,700	$ 51,200	$ 444,900
Total Attachment Facilities (AF) Costs	**$ 393,700**	**$ 51,200**	**$ 444,900**
AC1-078/AD1-081 Interconnection Switchyard: Install 138 kV three breaker ring bus interconnection station for new customer generation addition. PJM Upgrade #N5925	$ 5,083,400	$ 659,900	$ 5,743,300
Project Management, Construction Management, Commissioning, Meter, and SCADA. PJM Upgrade #N5925	$ 735,900	$ 95,800	$ 831,700
Total Direct Connect (DC) Costs	**$ 5,819,300**	**$ 755,700**	**$ 6,575,000**
Beatty-London 138kV Loop: Loop the Beatty-London 138 kV circuit into the proposed 3-breaker ring bus near tower #5856. PJM Upgrade #N5926	$ 581,700	$ 75,600	$ 657,300
Beatty Substation (AEP) - Upgrade line relaying for Beatty 138 kV line exit and rename for new AC1-078/AD1-081 PJM station. PJM Upgrade #N5928	$300,000	$39,000	$339,000
London Substation - Remove 138 kV AEP interconnection metering, CT's & VT's. Upgrade line relaying for London 138 kV line exit and rename for new AC1-078/AD1-081 PJM station. PJM Upgrade #N5927	$ 275,700	$ 35,800	$ 311,500
Total Non Direct Connect (NDC) Costs	**$ 1,157,400**	**$ 150,400**	**$ 1,307,800**
Total AF +DC + NDC Costs	**$ 7,370,400**	**$ 957,300**	**$ 8,327,700**

Schedule:

A proposed **twenty-four (24) month Direct Connection** schedule is estimated to complete the engineering, construction and the associated activities, from the date of a fully executed Interconnection Construction Service Agreement and Construction Kick-Off Meeting. This schedule assumes that all issues covered by the "Environmental, Real Estate and Permitting Issues" section of this document are resolved, and outages will occur as planned. Construction cannot begin until after all applicable permits and/or easements have been obtained.

24-month Schedule (assume November 2020 start)

Activity	Start Month	End Month
[redacted]		
Preliminary Engineering	1	3
Siting, Permits & Real Estate	2	12
Detailed Engineering	2	12
Equipment Delivery	14	15
Below Grade Construction – Substation	15	18
Below Grade Construction – T-Lines	21	22
Above Grade Construction – Substation	18	23
Above Grade Construction – T-Lines	22	23
Testing & Commissioning	24	24

8. New System Reinforcements and Network Upgrades

For AC1-078/AD1-081

- None

9. Total Estimated Costs of Transmission Owner Facilities:

Description	Total (w/o Tax)	Tax (if applicable)	Total Cost (w/Tax)
Attachment Facilities:	**$ 393,700**	**$ 51,200**	**$ 444,900**
Total Direct Connection (DC) Costs:	**$ 5,819,300**	**$ 755,700**	**$ 6,575,000**
Total Non-Direct Connection (NDC) Upgrade Costs:	**$ 1,157,400**	**$ 150,400**	**$ 1,307,800**
New System Upgrades	**$ 0**	**$ 0**	**$ 0**
TOTAL Costs (ALL Categories)	**$ 7,370,400**	**$ 957,300**	**$ 8,327,700**

10. Information Required for Interconnection Service Agreement

Work Description	Direct		Indirect		Total Cost
	Labor	Material	Labor	Material	
Installation of a 138 kV line exit take-off structure, foundations, disconnect switch and associated equipment to accommodate the termination of the 138 kV generator lead line.	$ 173,228	$ 125,984	$ 43,307	$ 51,181	$ 393,700
Total Attachment Facilities Cost	**$ 173,228**	**$ 125,984**	**$ 43,307**	**$ 51,181**	**$393,700**
AC1-078/AD1-081 Interconnection Switchyard: Install 138 kV three breaker ring bus interconnection station for new customer generation addition. PJM Upgrade #N5925	$ 2,560,492	$ 1,862,176	$ 640,123	$ 756,509	$ 5,819,300
Project Management, Construction Management, Commissioning, Meter, and SCADA. PJM Upgrade #N5925					
Total Direct Connection Cost	**$ 2,560,492**	**$ 1,862,176**	**$ 640,123**	**$ 756,509**	**$ 5,819,300**
Beatty-London 138kV Loop: Loop the Beatty-London 138 kV circuit into the proposed 3-breaker ring bus near tower #5856. PJM Upgrade #N5926	$ 255,948	$ 186,144	$ 63,987	$ 75,621	$ 581,700
Beatty Substation (AEP) - Upgrade line relaying for Beatty 138 kV line exit and rename for new AC1-078/AD1-081 PJM station. PJM Upgrade #N5928	$ 132,000	$ 96,000	$ 33,000	$ 39,000	$ 300,000
London Substation - Remove 138 kV AEP interconnection metering, CT's & VT's. Upgrade line relaying for London 138 kV line exit and rename for new AC1-078/AD1-081 PJM station. PJM Upgrade #N5927	$ 121,308	$ 88,224	$ 30,327	$ 35,841	$ 275,700
Total Non-Direct Connection Network Upgrades	**$ 509,256**	**$ 370,368**	**$ 127,314**	**$ 150,462**	**$ 1,157,400**
Total Project Costs	**$ 3,242,976**	**$ 2,358,528**	**$ 810,744**	**$ 958,152**	**$ 7,370,400**

11.Generation Connection Requirements

The proposed interconnection facilities must be designed in accordance with the Transmission Owner's *Requirements for Transmission Connected Facilities* documents located at either of the following links:

www.firstenergycorp.com/feconnect

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

The following is an excerpt taken from Transmission Owner's *Requirements for Transmission Connected Facilities* document:

> *For all generation facilities, other than wind-powered and other non-synchronous generating facilities, the minimum requirement shall be the provision of a reactive power capability sufficient to maintain a composite power delivery at continuous rated power output at a power factor as defined in the table below. This requirement will be measured at either the POI or generator terminals as specified in the table below. These reactive requirements apply to both the initial installation as well as to any incremental change in unit MW capability. FE will coordinate with the Connecting Party to identify the optimal generator step-up transformer tap to make such a capability available when demanded.*
>
> *For all wind-powered or other non-synchronous generating facilities the minimum requirement shall be the provision of a reactive power capability sufficient to maintain a composite power delivery at a power factor as defined in the table. This requirement will be measured at either the POI or generator's terminals as specified in the table below. These reactive requirements apply to both the initial installation as well as to any incremental change in unit MW capability. FE will coordinate with the Connecting Party to identify the optimal generator step-up transformer tap to make such a capability available when needed.*

For projects that entered PJM's New Service Queue on or after May 1, 2015, and before November 1, 2016, the power factor requirement will be as follows:

Generation Type	New / Increase	Size	Power Factor Requirement	Measurement Location
Synchronous	New	> 20 MW	0.95 leading to 0.90 lagging	Generator's Terminals
Synchronous	New	<= 20 MW	0.95 leading to 0.90 lagging	Point of Interconnection
Wind or Non-Synchronous	New	All	0.95 leading to 0.95 lagging	Generator's Terminals
Synchronous	Increase	> 20 MW	1.0 (unity) to 0.90 lagging	Generator's Terminals
Synchronous	Increase	<= 20 MW	1.0 (unity) to 0.90 lagging	Point of Interconnection
Wind or Non-Synchronous	Increase	All	0.95 leading to 0.95 lagging	Generator's Terminals

The above table is applicable to AC1-078/AD1-081.

For projects that entered PJM's New Service Queue after November 1, 2016, the power factor requirement will be as follows:

Generation Type	New / Increase	Size	Power Factor Requirement	Measurement Location

Synchronous	New	> 20 MW	0.95 leading to 0.90 lagging	Generator's Terminals
Synchronous	New	<= 20 MW	0.95 leading to 0.90 lagging	Point of Interconnection
Wind or Non-Synchronous	New	All	0.95 leading to 0.95 lagging	High Side of the Facility Substation Transformers
Synchronous	Increase	> 20 MW	1.0 (unity) to 0.90 lagging	Generator's Terminals
Synchronous	Increase	<= 20 MW	1.0 (unity) to 0.90 lagging	Point of Interconnection
Wind or Non-Synchronous	Increase	All	0.95 leading to 0.95 lagging	High Side of the Facility Substation Transformers

The above table is applicable to AD1-081.

Any different reactive power requirements that FE and/or PJM determines to be appropriate for wind-powered or other non-synchronous generation facilities will be stated in the applicable interconnection agreement(s).

Induction generators and other generators with no inherent VAR (reactive power) control capability, or those that have a restricted VAR capability less than the defined requirements, must provide dynamic supplementary reactive support located at the generation facility with electrical characteristics equivalent to that provided by a similar-sized synchronous generator.

Design Requirements

Developer is responsible for specifying appropriate equipment and facilities such that the parallel generation is compatible with Transmission Owner's Transmission System. Developer is also responsible for meeting any applicable federal, state, and local codes.

Design Criteria

Facilities owned and operated by Transmission Owner shall comply with the applicable Transmission Owner technical requirements and standards posted on the PJM website per the PJM Tariff, and the following criteria. Where there are different requirements for the same criterion, the more restrictive shall apply. Developer must abide by any PJM, RFC or NERC criteria imposed that is more restrictive than those of Transmission Owner.

General Design Requirements

- System phasing (counter clockwise): X-Y-Z
- System frequency: 60 hertz
- Elevation, AMSL: Less than 1000 meters
- Isokeraunic level: 40
- Maximum ambient temperature: 40 degrees C
- Minimum ambient temperature: -40 degrees C
- Maximum conductor operating temperature: Contact Transmission Owner
- Wind Loading (round shapes): Per ASCE 7-98, per Fig. 6-1 depending on location
- Ice loading – Substations (no wind): 25 mm
- Seismic zone: Per ASCE 7-98, per Fig. 9.4.1.1(a) and (b). Equipment qualification per IEEE 693-97

Voltage and Current Ratings

- Nominal phase-to-phase: 138 kV
- Maximum phase-to-phase: 145 kV
- Basic impulse level (BIL): 650 kV
- Maximum continuous current carrying capacity: 2000 A
- Design fault current: 40 kA
- Single Contingency (breaker failure) clearing time: 60 cycles

Clearances and Spacing

- Recommended rigid bus center-to-center phase spacing: 96”
- Minimum phase-to-phase, metal-to-metal distance: 63”
- Recommended phase-to-ground: 52.5”
- Minimum phase-to-ground: 50”
- Low bus height above top of foundations (match existing): 16’-0”
- High bus height above top of foundations (match existing): 24’-0”
- Minimum vertical clearance from live parts to grade: 12’-2”
- Minimum horizontal clearance from live parts: 6’-8”
- Minimum conductor clearance above roads in switchyard: 25’-0”
- Minimum bottom of insulator to top of foundation: 8’-6”

Metering, SCADA and Communications

Developer shall install, own, operate, test and maintain the necessary revenue metering equipment. Developer shall provide Transmission Owner with dial-up communication to the revenue meter.

Transmission Owner’s Revenue Metering Requirements may be found in the *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

These requirements are in addition to any metering required by PJM.

Transmission Owner will provide the telecommunication circuits for the SCADA RTU and the telephone in the Transmission Owner interconnection substation.

Transmission Owner will obtain real-time, site-specific, generation data from PJM, via the required communication link from Developer to PJM. Transmission Owner will work with PJM and Developer to ensure the generation data provided to PJM meets Transmission Owner's requirements.

Communications for transmission line protection between the new **interconnection** substation, and Developer’s **generation** (collector) substation, will be via fiber optics (see “Fiber Optic Communication Channels” section below).

Fiber Optic Communication Channels

Developer will design, provide, install, own and maintain a fiber-optic communications cable between the new **interconnection** substation, and Developer's **generation** (collector) substation. Two (2) fiber-optic channels are required for each generator protection scheme to obtain high-speed tripping capability for any fault within the zone of protection. Dual, redundant fiber cables in separate paths are required for system stability reasons. Should subsequent/additional PJM studies indicate that stability issues exist, the primary and backup relay fiber-optic communication channels must be in separately-routed cable paths and additional fiber-optic connection costs would apply (not included herein).
The Developer will make the fiber-optic cable termination connections for its cable(s) at the interconnection substation control house.

Transmission Owner will make the fiber termination connections for its cable(s) at the interconnection substation control house. Developer is responsible for obtaining and maintaining all associated Rights-of-Way (ROW), Easements, and Permits for its fiber cable.

Environmental, Real Estate and Permitting Issues

The following are possible environmental, real estate and permitting issues:

- Environmental permitting, Real Estate acquisition, and Public Utilities Commission of Ohio (PUCO) notifications vary, some up to twelve (12) months after preliminary engineering is completed to secure the required approvals.
- Prior to agreement by Developer to purchase the property, a Phase 1 Environmental Assessment should be conducted for the entire site to avoid assumption of environmental liabilities by Developer or Transmission Owner.
- The Transmission Owner interconnection substation may involve environmental surveys, permits, approvals and plans with federal, state, and/or local agencies.
- Assumed Developer is to provide all access rights, easements, ROW and permits necessary to complete the Project to the satisfaction of Transmission Owner. Environmental permitting shall encompass all federal, state and local requirements, consultations and agency coordination. Confirmation of meeting all permitting requirements shall be provided to Transmission Owner, prior to start of construction. Following construction and energization, confirmation of permit closeout shall be provided to the satisfaction of Transmission Owner, prior to transfer of ownership. If any of these elements are not included in the final agreement between Transmission Owner and Developer, twelve (12)-to-eighteen (18)- months should be added to the Project Schedule to secure necessary permits, and additional costs would apply.
- Developer will provide copies of all of the relative environmental permits and other necessary approvals to Transmission Owner before Transmission Owner accepts the interconnection facilities.
- Developer is required to install an access road from the new interconnection substation to the nearest public road (must be approved by Transmission Owner), and obtain access rights for Transmission Owner. Developer is responsible to maintain access road and ensure unimpeded access for Transmission Owner at all times.
- Developer is responsible for all property acquisition (including easements/rights-of-way (ROW)) for transmission, distribution and communication facilities needed for the generator interconnection.

- If Developer owns the project property, in fee title, Transmission Owner will require a fee property transfer for the interconnection substation site which may require subdivision approval, together with permanent access rights to and from the substation, as well as a perpetual easement for any transmission lines to the substation. Developer is responsible for all costs, including but not limited to subdivision, associated with the property transfer.
- If Developer leases the project property, the Developer will be required to obtain fee property from the underlying fee property owner, on behalf of Transmission Owner, for the interconnection substation site, together with permanent access rights to and from the substation, as well as a perpetual easement for any transmission lines to the substation.
- All property rights must be surveyed and metes and bounds descriptions prepared for incorporation into Transmission Owner's document forms, for transfer of title.
- The Transmission Owner interconnection substation and transmission line loop will involve Public Utilities Commission of Ohio (PUCO) and Ohio Power Siting Board (OPSB) notification/approval.

General Assumptions/Qualifiers

The accomplishment of the work on the Transmission Owner system to support the estimated costs and proposed schedule is dependent on the following:

- Obtaining the necessary line outages. Transmission line outages are typically not granted from June to September and are discouraged during extreme winter conditions.
- No equipment delivery, environmental, permitting, regulatory or real estate delays.
- No extreme weather.
- No force majeure.
- Estimates assume no significant rock encountered during construction, and suitable soil conditions exist to accommodate a standard ground-grid and foundation installation.
- It is assumed that the new interconnection substation will be located on the northern side of the transmission corridor (see "Figure 2").
- All work occurs within an existing transmission line right-of-way or on Developer's property with access to all existing structures possible via that property and the right-of-way following established access routes that do not cross wetlands or streams.
- Right-of-way is required from Developer only. The project is entirely on Developer's property.
- Developer will develop, and secure regulatory approval for, all necessary Erosion and Sediment Control (E&SC) plans and National Pollutant Discharge Elimination System (NPDES) permits.
- Developer will obtain all necessary permits.
- Developer will develop all necessary access roads for project sites.
- Developer will conduct all necessary wetlands and waterways studies and permits.
- Developer will conduct all necessary historical and archaeological studies.
- Assumed the interconnection substation and generation (collector) substation are not adjacent (i.e. share a common fence). The 138 kV connection between the substations will be via a 138 kV transmission line.
- In order to meet the requested Backfeed Date of **10/31/2022**, the exact substation site, pull-off structure location, and structure details (for connection to the transmission line loop) are required from Developer **no later than 4/30/2021** (i.e. minimum **eighteen** (**18**)

months lead-time from Backfeed Date). Delays in provision of substation site details will affect the schedule.

- Developer is responsible to make all arrangements for electric distribution service (if required) for its generation station. No costs or schedule included herein.
- Developer's generation step-up (GSU) transformer winding configuration shall have a wye-grounded winding on the high-side (transmission system) and have a delta connected winding on the low side.
- If the Developer were to choose the "Option to Build" for the interconnection substation, it must utilize an approved Transmission Owner A/E & Construction Contractor. A listing of Transmission Owner Approved Vendors and Contractors is located at the following PJM site:
  www.pjm.com/planning/design-engineering/to-tech-standards.aspx
- Developer shall maintain adequate clearances for its 138 kV generation attachment line from Transmission Owner's electric lines and structures. Developer shall submit final engineering design of its generation attachment line to Transmission Owner for approval prior to proceeding with the construction of the attachment line.
- Given the proposed location of the developer's substation (north of the transmission line), the Developer should also take into consideration how they plan to cross the transmission corridor. It will require permission of FirstEnergy for design, clearances and route of the generator tie line that will need to cross the Transmission line right-of-way.
- If the Developer plans to cross the transmission line right of way with facilities or access roads, please refer to the Transmission Rights-of-Way Restrictions information located at:
  - https://www.firstenergycorp.com/help/safety/real-estate-power-lines/transmission-right-of-way.html#ROWform

ATTACHMENTS
&
FIGURES

ATTACHMENT A
Queue # AC1-078/AD1-081

Detailed Protection Requirements

Short Circuit Analysis

Short Circuit Values

The 138kV fault values for the AC1-078/AD1-081 interconnection location with all new generation out of service are:

Three phase = 10.4kA
Single line to ground = 8.7kA
Z1= (0.92+ j 3.91) %
Z0= (2.23 + j 5.96) %

Impedances are given on 100 MVA and 138kV bases. 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 AC1-078/AD1-081 delivery point substation (DPS) is a 138kV three-breaker ring bus on the London-Beatty 138kV line. See Attachment 2.

The existing line relays at London and Beatty require replacement.

Line protection between London and AC1-078/AD1-081 and between Beatty and AC1-078/AD1-081 shall consist of two independent SEL-421 line schemes with pilot communication over PLC for each 138kV line, at each terminal.

At the AC1-078/AD1-081 DPS, each 138kV breaker shall have breaker failure-to-trip protection. SEL-501 relays are acceptable for this application.

Protection of the 138kV Generator Lead Line of approximately 0.25 miles shall consist of two SEL-411L line current differential schemes with pilot communication over fiber optic cable, at each terminal.

Protection Requirements

AC1-078/AD1-081 138kV Interconnecting Substation

138kV Transmission Line Protection

- London line exit
- Primary relay: SEL-421 relay with pilot protection over PLC with BF DTT and AI DTT
- Backup relay: SEL-421 relay with pilot protection over PLC with BF DTT and AI DTT

- Beatty line exit
- Primary relay: SEL-421 relay with pilot protection over PLC with BF DTT and AI DTT
- Backup relay: SEL-421 relay with pilot protection over PLC with BF DTT and AI DTT

- AC1-078/AD1-081 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

138kV AC1-078/AD1-081 Interconnecting Station Communications

- AC1-078/AD1-081 Interconnecting Station to London and Beatty
- Fiber for use with PRI SEL-411L for Current Differential and DTT
- AC1-078/AD1-081 Interconnecting Station to AC1-078/AD1-081 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

138kV Breaker Failure to Trip Protection

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

AC1-078/AD1-081 Generating Station 138kV

138kV Transmission Line Protection @ AC1-078/AD1-081 generating station

- AC1-078/AD1-081 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 AC1-078/AD1-081 Generating Station

138kV Breaker Failure to Trip Protection

- 138kV Breaker Failure to Trip Relaying

- SEL-352-2 breaker failure to trip relaying on AC1-078/AD1-081 138kV Generating Station breaker. The breaker failure to trip relaying on the AC1-078/AD1-081 Interconnecting Station line exit breaker shall initiate direct transfer trip via the SEL-411L primary and backup line relays (fiber).

138kV Bus & GSU Transformer Protection @ AC1-078/AD1-081 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

London Substation

138kV Transmission Line Protection

- AC1-078/AD1-081 Interconnecting Station line exit Relaying
- Primary relay: SEL-421 relay with pilot protection over PLC with BF DTT and AI DTT
- Backup relay: SEL-421 relay with pilot protection over PLC with BF DTT and AI DTT

Settings Changes

- Settings changes are possible at remote substations.

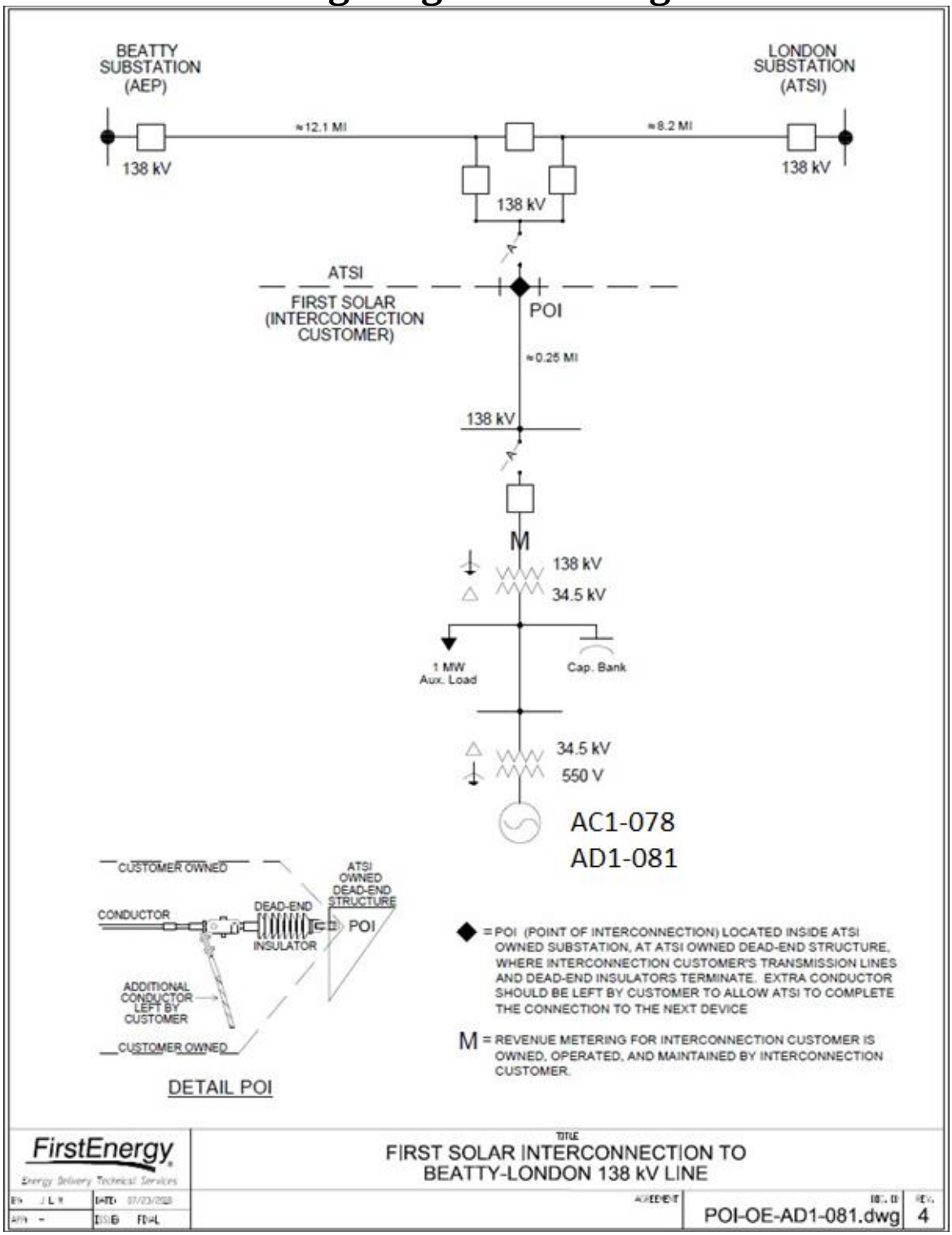
Revenue Metering and SCADA Requirements

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:

www.firstenergycorp.com/feconnect

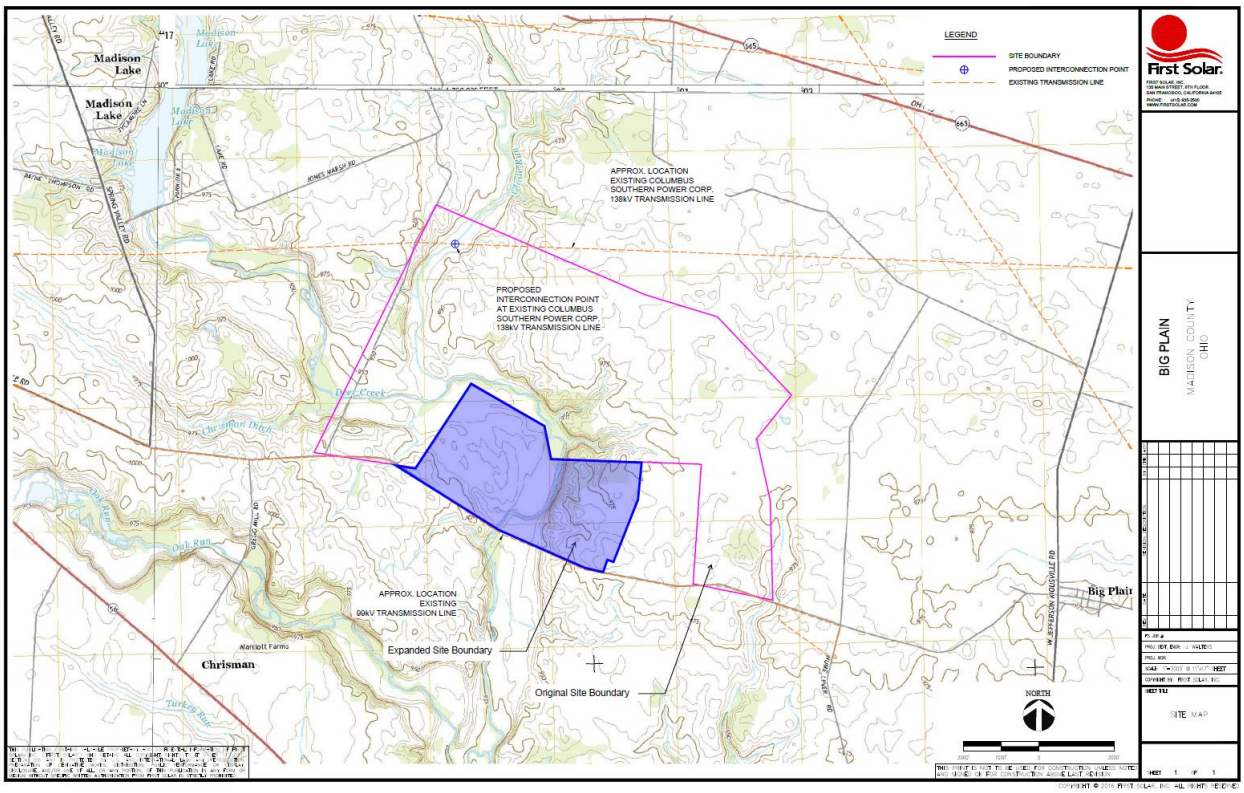
www.pjm.com/planning/design-engineering/to-tech-standards.aspx

FIGURE 1
Queue #AC1-078/AD1-081
Planning Single-Line Diagram*



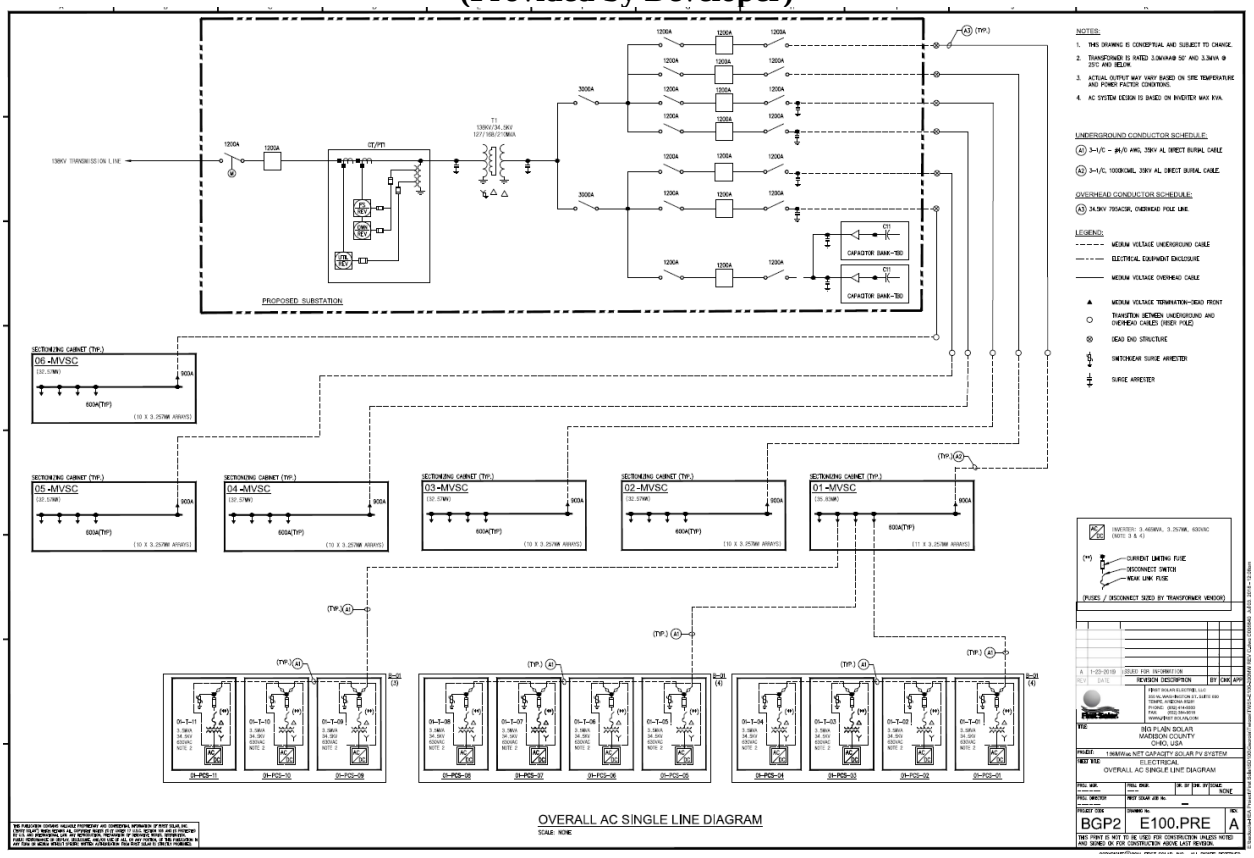
* Note: Diagram does not represent a physical layout. Not to be used for construction.

FIGURE 2
Queue #AC1-078/AD1-081
Proposed Project Location
(Provided by Developer)



Conceptual Layout of Interconnection Substation
(Provided by FirstEnergy)

Single Line Diagram
(Provided by Developer)



* Note: Diagram does not represent a physical layout. Not to be used for construction.

Model Diagram
(Provided by Developer)