Second Revised

Generation Interconnection

System Impact Study Report

for

Queue Project AD1-068

Albright-Garrett 138 kV

11.76 MW Capacity / 80 MW Energy

May 2020

Second Revision

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1 Introduction

This System Impact Study (SIS) has been prepared in accordance with the PJM Open Access Transmission Tariff, 205, as well as the System Impact Study Agreement between EverPower Wind Development, LLC, the Interconnection Customer (IC), and PJM Interconnection, LLC (PJM), Transmission Provider (TP). The Interconnected Transmission Owner (ITO) is Monongahela Power (MonPower).

2 Revisions since January 2020 System Impact Study Report

The report has been updated to reflect that the AD1-068 project causes an overload of the Rockwood-Somerset 115 kV line. This overload was missed in PJM's analysis provided in January 2020. The revised report also identifies the need for a system reinforcement to reconductor the Rockwood-Somerset 115 kV line as the least cost solution at an estimate of approximately $15.6 million. See the Network Impacts section of this report.

3 Revisions since October 2019 System Impact Study Report

The network impacts section of this report has been revised to reflect the retooled System Impact Study results for AD1-068. The re-tooled analysis considers various changes for prior queued projects, mainly, the MW reduction of AA1-062 from 224 MW to 150 MW, and various withdrawn projects such as AA1-046, AC1-186, AC2-004 and AC2-122. Due to these changes, the Dans Mountain-Ridgeley, William-Parsons, and Parsons-Loughlin 138 kV lines are no longer overloaded with the AD1-068 project. The recommended upgrade to resolve all of these overloads was to reconfigure the Albright Substation (PJM Network Upgrade Number n4655). Therefore, this upgrade has been removed from the System Reinforcements section of this report.

4 Preface

The intent of the System Impact Study is to determine a plan, with approximate cost and construction time estimates, to connect the subject generation interconnection project to the PJM network at a location specified by the Interconnection Customer. As a requirement for interconnection, the Interconnection Customer may be responsible for the cost of constructing: Network Upgrades, which are facility additions, or upgrades to existing facilities, that are needed to maintain the reliability of the PJM system. All facilities required for interconnection of a generation interconnection project must be designed to meet the technical specifications (on PJM web site) for the appropriate transmission owner.

In some instances an Interconnection Customer may not be responsible for 100% of the identified network upgrade cost because other transmission network uses, e.g. another generation interconnection or merchant transmission upgrade, may also contribute to the need for the same network reinforcement. The possibility of sharing the reinforcement costs with other projects may be identified in the Feasibility Study, but the actual allocation will be deferred until the System Impact Study is performed.

The System Impact Study estimates do not include the feasibility, cost, or time required to obtain property rights and permits for construction of the required facilities. The project developer is responsible for the right of way, real estate, and construction permit issues. For properties currently owned by Transmission Owners, the costs may be included in the study.

The Interconnection Customer seeking to interconnect a wind or solar generation facility shall maintain meteorological data facilities as well as provide that meteorological data which is required per Schedule H to the Interconnection Service Agreement and Section 8 of Manual 14D.

5 General

Interconnection Customer has proposed a new wind generating facility located in Preston County, West Virginia. The installed facilities will have a total capability of 80 MW with 11.76 MW of this output being recognized by PJM as Capacity. The proposed in-service date for this project is September 30, 2020. **This study does not imply a MonPower (Transmission Owner) commitment to this in-service date.**

Queue Number	**AD1-068**
Project Name	Albright-Garrett 138 kV
Interconnection Customer	EverPower Wind Development, LLC
State	West Virginia
County	Preston
Transmission Owner	APS - MonPower
MFO	80
MWE	80
MWC	11.76
Fuel	Wind
Basecase Study Year	2021

5.1 Point of Interconnection

This project will interconnect with the Potomac Edison transmission system by constructing a new 138 kV three (3) breaker ring bus and looping the Albright - Garrett 138 kV line into the new station. The new substation will be located approximately 6.4 miles from Albright substation. 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 Albright and Garrett substations.

Attachment 1 shows a one-line diagram of the proposed Direct Connection facilities for the AD1-068 generation project to connect to the FirstEnergy ("FE") transmission system. Attachment 2 provides the proposed location. The IC will be responsible for constructing all of the facilities on its side of the POI.

5.2 Cost Summary

The AD1-068 project will be responsible for the following costs:

Description	Total Cost
Attachment Facilities	$2,300
Direct Connection Network Upgrade	$6,674,300
Non Direct Connection Network Upgrades	$619,900
New System Upgrades	$15,600,000
Contribution to Previously Identified Upgrades	$0
Total Costs	$ 22,896,500

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

The required Attachment Facilities and Direct and Non-Direct Connection work for the interconnection of the AD1-068 generation project to the FE Transmission System is detailed in the following sections. The associated one-line is shown in Attachment 1.

6 Transmission Owner Scope of Work

The AD1-068 generation project will be accommodated by constructing a new 138 kV three (3) breaker ring bus and looping the Albright - Garrett 138 kV line into the new station. The new substation will be located approximately 6.4 miles from Albright substation. 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 Albright and Garrett substations.

Attachment 1 shows a one-line diagram of the proposed interconnection of the AD1-068 generation project to connect to the FirstEnergy ("FE") transmission system. Attachment 2 provides the proposed location. The IC will be responsible for constructing all of the facilities on its side of the POI.

6.1 Attachment Facilities

The total preliminary cost estimate for the Attachment work is given in the table below. These costs do not include CIAC Tax Gross-up.

Description	Total Cost
Revenue metering - Customer-owned 138 kV revenue metering at AD1-068 Albright Garret Wind Farm	$2,300
Total Attachment Facility Costs	$2,300

6.2 Direct Connection Cost Estimate

The total preliminary cost estimate for the Direct Connection work is given in the table below. These costs do not include CIAC Tax Gross-up.

Description	Total Cost
AD1-068 Interconnection Switchyard- Construct new 138kV three breaker ring bus.	$5,225,700
Project Management, Commissioning, and SCADA.	$ 751,200
Modify nameplates and drawings for inclusion of AD1-068 switchyard onto the system.	$ 18,600
Fiber Installation: Estimated 5.4 miles of ADSS fiber from AD1-068 interconnection substation to the FE Fiber Backbone.	$ 678,800
Total Direct Connection Costs	$6,674,300

6.3 Non-Direct Connection Cost Estimate

The total preliminary cost estimate for the Non-Direct Connection work is given in the table below. These costs do not include CIAC Tax Gross-up.

Description	Total Cost
Loop the Albright-Garrett 138kV line into the proposed AD1-068 interconnect ring bus. @ Albright-Garrett 138kV Loop to AD1-068 Interconnect Sub	$453,700
Replace Garrett line tuner. Add DTT for anti-islanding. @ Albright SS	$ 83,100
Replace Albright line tuner. Add DTT for anti-islanding. @ Garrett SS	$ 83,100
Total Non-Direct Connection Facility Costs	$ 619,900

7 Schedule

Based on the scope of work for the Attachment Facilities and the Direct and Non-Direct Connection facilities, it is expected to take a minimum of **13 months** after the signing of an Interconnection Construction Service Agreement to complete the installation. This includes the requirement for the IC to make a preliminary payment that compensates FE for the first three months of the engineering design work that is related to the Attachment Facilities and Direct Connection work. Full initial deposit will be required for the Non-Direct Connection work. 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 all transmission system outages will be allowed when requested.

The schedule for the required System Reinforcements identified in the "Network Impacts" section of this report will be more clearly defined in the Facilities Study Phase.

8 Transmission Owner Analysis

8.1 Power Flow Analysis

PJM performed a power flow analysis of the transmission system using a 2021 summer peak load flow model and the results were verified by FE. Additionally, FE performed an analysis of its underlying transmission <100 kV system. The AD1-068 project does not cause any overloads on the FE transmission system.

8.2 Short Circuit Analysis

PJM performed a short circuit analysis and the results were verified by FE. The connection of AD1-068 project to the system does not result in any newly overdutied circuit breakers on the FE transmission system and does not have a significant fault current contribution to existing overdutied circuit breakers.

8.3 Stability Analysis

A dynamic stability analysis was completed by PJM and the results were reviewed by FE. The results of the stability analysis are provided in the Network Impacts section of this report.

9 Interconnection Customer Requirements

9.1 System Protection

The IC must design its Customer Facilities in accordance with all applicable standards, including the standards in FE's "Requirements for Transmission Connected Facilities" document located at: http://www.pjm.com/planning/design-engineering/to-tech-standards/private-firstenergy.aspx.

Preliminary Protection requirements will be provided as part of the Facilities Study. Detailed Protection Requirements will be provided once the project enters the construction phase.

9.2 Compliance Issues and Interconnection Customer Requirements

The proposed Customer Facilities must be designed in accordance with FE's "Requirements for Transmission Connected Facilities" document located at: http://www.pjm.com/planning/design-engineering/to-tech-standards/private-firstenergy.aspx. In particular, the IC is responsible for the following:

1. The purchase and installation of a fully rated 138 kV circuit breaker to protect the AD1-068 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 retail service agreement with the electric distribution company to serve the customer load supplied from the AD1-068 generation project interconnection point when the units are out of service. This assumes the intent of the IC is to net the generation with the load.

6. The Developer shall install, own, operate, test and maintain the necessary revenue metering for projects connecting to a voltage of 46 kV and greater.

The IC will also be required to meet all PJM, ReliabilityFirst, and NERC reliability criteria and operating procedures for standards compliance. For example, the IC will need to properly locate and report the over and under voltage and over and under frequency system protection elements for its units as well as the submission of the generator model and protection data required to satisfy the PJM and ReliabilityFirst audits. Failure to comply with these requirements may result in a disconnection of service if the violation is found to compromise the reliability of the FE system.

9.3 Power Factor Requirements

The IC shall design its wind-powered 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.

10 Revenue Metering and SCADA Requirements

10.1 PJM Requirements

The Interconnection Customer will be required to install equipment necessary to provide Revenue Metering (KWH, KVARH) and real time data (KW, KVAR) for IC's generating Resource. See PJM Manuals M-01 and M-14D, and PJM Tariff Attachment O, Appendix 2, Section 8.

10.2 FE Requirements

The IC will be required to comply with all FE revenue metering requirements for generation interconnection customers which can be found in FE's "Requirements for Transmission Connected Facilities" document located at: http://www.pjm.com/planning/design-engineering/to-tech-standards/private-firstenergy.aspx

11 Network Impacts

The Queue Project AD1-068 was evaluated as a 80.0 MW (Capacity 11.8 MW) injection into tap of the Albright – Garrett 138 kV line in the APS (MonPower) area. Project AD1-068 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AD1-068 was studied with a commercial probability of 100%. Potential network impacts were as follows:

Summer Peak Load Flow

12 Generation Deliverability

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

None

13 Multiple Facility Contingency

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

1. (PN - PN) The 26ROCKWOOD - 26SOMERST 115 kV line (from bus 200746 to bus 200744 ckt 1) loads from 88.54% to 106.94% (AC power flow) of its emergency rating (179 MVA) for the fault with stuck breaker contingency outage of 'AP-P2-3-MP-138-153'. This project contributes approximately 33.08 MW to the thermal violation.

```
CONTINGENCY 'AP-P2-3-MP-138-153'                    /* OAK PARK-KELSO GAP STK BKR AT ALBRIGHT
  DISCONNECT BRANCH FROM BUS 235120 TO BUS 235485 CKT 1      /* 01ALBRIG 138 01METTIK 138
  DISCONNECT BRANCH FROM BUS 235120 TO BUS 235492 CKT 1      /* 01ALBRIG 138 01MTZION 138
  DISCONNECT BRANCH FROM BUS 235120 TO BUS 235305 CKT 1      /* 01ALBRIG 138 01 106 J 138
  DISCONNECT BRANCH FROM BUS 235120 TO BUS 235320 CKT 1      /* 01ALBRIG 138 01DENVER 138
  DISCONNECT BRANCH FROM BUS 235120 TO BUS 934440 CKT 1      /* 01ALBRIG 138 AD1-068 TAP 138
  DISCONNECT BRANCH FROM BUS 235120 TO BUS 235402 CKT 1      /* 01ALBRIG 138 01SNOW T 138
  DISCONNECT BRANCH FROM BUS 235402 TO BUS 235403 CKT 1      /* 01SNOW T 138 01SNWYCK 138
  DISCONNECT BRANCH FROM BUS 235402 TO BUS 235497 CKT 1      /* 01SNOW T 138 01OAKPRK 138
  DISCONNECT BRANCH FROM BUS 235403 TO BUS 237273 CKT 1      /* 01SNWYCK 138 01SNOW C 66
  DISCONNECT BRANCH FROM BUS 235497 TO BUS 237313 CKT 1      /* 01OAKPRK 138 01KELSOG 138
  END
```

14 Contribution to Previously Identified Overloads

(This project contributes to the following contingency overloads, i.e. "Network Impacts", identified for earlier generation or transmission interconnection projects in the PJM Queue)

None

15 Steady State Voltage Requirements

None

16 Potential Congestion due to Local Energy Deliverability

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

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

None

17 System Reinforcements

New System Reinforcements

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

1. To resolve the Rockwood – Somerset 115 kV line overload:

   Re-conductor the Rockwood-Somerset 115kV line, approximately 8.1 miles.
   Expected Summer Emergency rating after the completion of the network upgrade: 213 MVA
   PJM Network Upgrade Number N6170
   Estimated Cost: $15.6 M
   Estimated Time of Completion: 22 Months

Affected Systems

18 Affected Systems

18.1 NYISO Impacts:

None

Short Circuit

19 Short Circuit

The following Breakers are overduty:

None

Stability

20 Stability Analysis and Reactive Power Assessment

20.1 Executive Summary

This system impact study was performed for generation interconnection request AD1-068.

Generator Interconnection Request AD1-068 is for an 80 MW Maximum Facility Output (MFO) wind generating facility. AD1-068 consists of 23 x 3.6 MW Nordex N131/3600 wind turbines with a Point of Interconnection (POI) at a tap off of the Albright to Garrett 138 kV line in Preston County, West Virginia in the First Energy (FE) Transmission System.

The power flow scenario for the analysis was based on the RTEP 2021 summer peak load case, modified to include applicable queue projects. AD1-068 has been dispatched online at its maximum facility output (MFO), with approximately unity power factor at the high-side of the station transformer.

AD1-068 was tested for compliance with NERC, PJM, Transmission Owner and other applicable criteria. For this study, 102 contingencies were simulated, each with a 20 second simulation time period. Studied faults included:

- Steady-state operation (20 second simulation)
- Three-phase faults with normal clearing time
- Single-phase bus faults
- Single-phase faults with a stuck breaker
- Single-phase faults placed at 80% of the line with delayed (Zone 2) clearing at remote line end because of primary communications/relaying failure
- Single-phase faults with loss of multiple-circuit tower

The 102 fault contingencies tested on the 2021 summer peak load case met the recovery criteria:

- The AD1-068 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. excluding 500 kV buses. The final voltages for 500 kV buses should be within 1.02 p.u. to 1.08 p.u.
- No transmission element trips, other than those either directly connected or designated to trip as a consequence of the fault.

The AD1-068 project met both the 0.95 lagging and 0.95 leading power factor requirement.

20.2 Power Factor Assessment

A power factor assessment was performed for the AD1-068 project evaluating if the plant meets PJM's power factor requirement for a non-synchronous generator. PJM requires a non-synchronous generator to provide 0.95 lagging power factor and 0.95 leading power factor measured at the high side of the station transformer. The reactive capability of the unit was calculated after Nordex indicated the unit was capable of 0.90 leading/lagging power factor. The table below summarizes the results for the power factor assessment for the AD1-068 queue project.

The AD1-068 project met both the 0.95 lagging and 0.95 leading power factor requirement.

Power Factor Assessment for the AD1-068 Queue Project

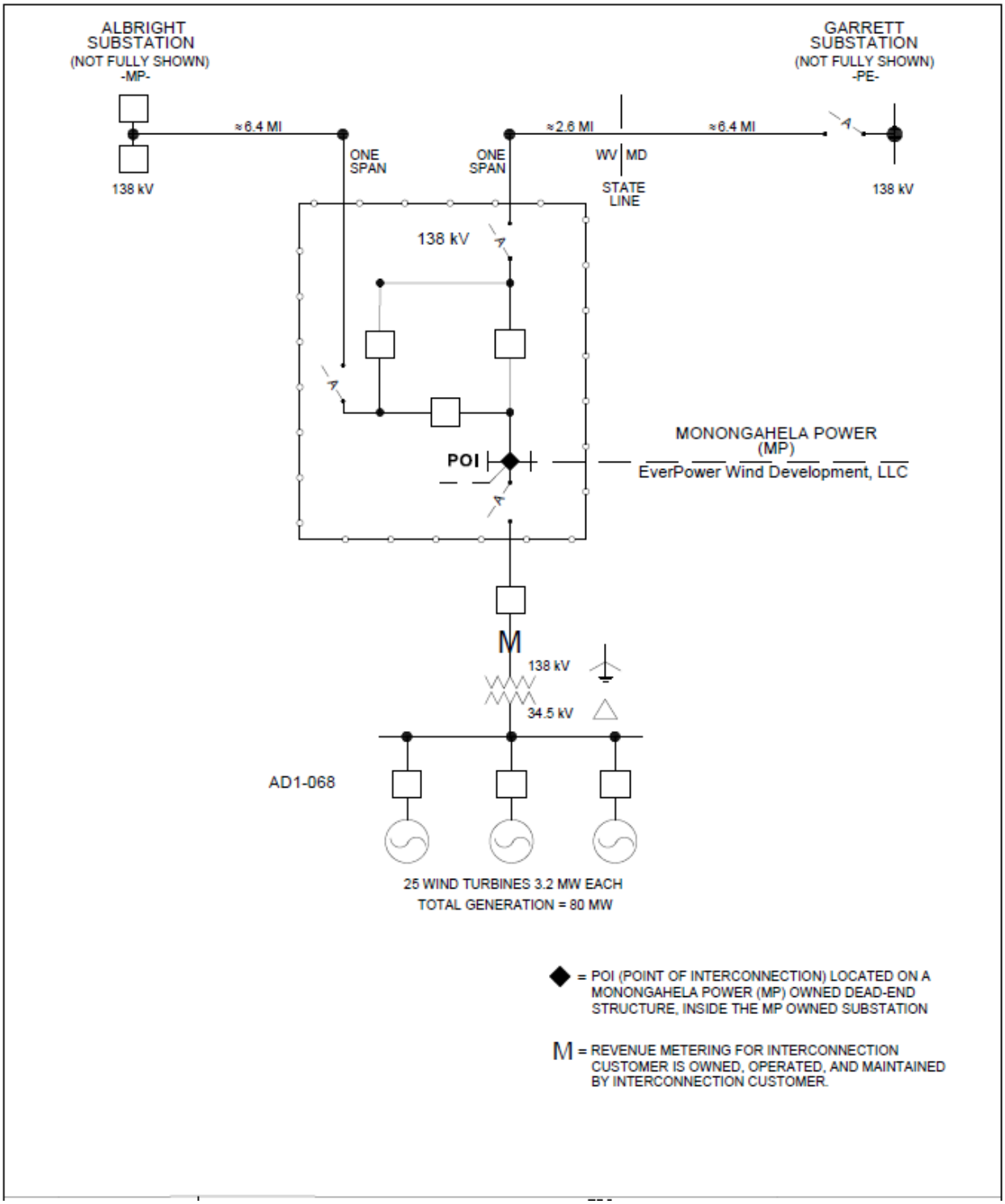
Generator	**MFO (MW)**	**Required Power Factor Range**		**Maximum Lagging (Mvar)**	**Minimum Leading (Mvar)**
		Lagging	**Leading**		
AD1-068	80.00	0.95	0.95		
Total Reactive Power Required				26.29	-26.29
Reactive Power from Generator				**Qmax**	**Qmin**
				41.40	-41.40
Customer Planned Compensation				0	0
Reactive Power Losses				-12.33	-12.33
Total Available Reactive Power at High Side of Main Transformer				29.07	-53.73
Deficiency in Reactive Power				Meet	Meet

Light Load

21 Light Load Analysis

No impacts.

22 Attachment 1 – One Line



23 Attachment 2 – Project Location