For

Nexamp

4,950 kW_{AC} Photovoltaic Generator System

469 Wilson Hill Road

Hoosick Falls, NY 12090

Interconnection to National Grid

New York East

Capital Region

Troy District

Hoosick Substation

13.2 kV Feeder 31451

TABLE OF CONTENTS

1.0 INTRODUCTION

This report presents the analysis results of the Niagara Mohawk Power Corporation d/b/a National Grid ("National Grid" or the "Company") interconnection study based on the proposed interconnection and design submittal from the Interconnection Customer in accordance with the National Grid Electric System Bulletin No. 756, Appendix B 'Distributed Generation Connected To National Grid Distribution Facilities Per The New York State Standardized Interconnection Requirements'. The intent of this report is to assess this project's feasibility, determine its impact to the existing electric power system (EPS), determine interconnection scope and installation requirements, and determine costs associated with interconnecting the Interconnection Customer's generation to the Company's Electric Power System (EPS). This Coordinated Electric System Impact Review (CESIR) study; according to the NYSSIR Section I.C Step 6; identifies the scope, schedule, and costs specific to this Interconnection Customer's installation requirements.

2.0 EXECUTIVE SUMMARY

The total estimated planning grade cost of the work associated with the interconnection of the Interconnection Customer [redacted]

The interconnection was found to be feasible with modifications to the existing Company EPS and operating conditions, which are described in detail in the body of this Study.

The ability to generate is contingent on this facility being served by the interconnecting circuit during normal Utility operating conditions. Therefore, if the interconnecting circuit is out of service, or if abnormal Utility operating conditions of the area EPS are in effect National Grid reserves the right to disengage the facility.

No future increase in generation output beyond that which is specified herein for this interconnection has been studied. Any increase in system size and/or design change is subject to a new study and costs associated shall be borne by the Interconnection Customer. An increase in system size may also forfeit the Interconnection Customer's existing queue position.

3.0 COMPANY EPS PARAMETERS

Substation	**Hoosick**
Transformer Name	TB2
Transformer Peak Load (kW)	9,120
Contingency Condition Load, N-1 Criteria (as applicable) (kW)	N/A
Daytime Light Load (kW)	3,290
Generation: Total[1], Connected, Queued Ahead (kW)	22,756; 1,803; 16,003
Contingency Condition Generation: Total[1], Connected, Queued Ahead (kW)	N/A
Supply Voltage (kV)	115
Transformer Summer Normal Rating (kVA)	13,300
Distribution Bus Voltage Regulation	Yes
Transmission GFOV Status	Not Installed
Bus Tie	No
Number of Feeders Served from this Bus	2

Connecting Feeder/Line	**31451**
Peak Load on Feeder (kW)	5,276
Daytime Light Load (kW)	2,100
Feeder Primary Voltage at POI (kV)	13.2
Line Phasing at POI	3
Circuit Distance from POI to Substation	2.51 miles
Distance to Nearest 3-phase (if applicable)	0.00 miles
Line Regulation	No
Line/Source Grounding Configuration at POI	Effective
Other Generation: Total[1], Connected, Queued Ahead (kW)	10,839; 863; 5,026

System Fault Characteristics without Interconnection Customer DER at POI	
Interconnection Customer POI Location	Pole 15 Wilson Hill Road
I 3-phase (3LLL)	2,730 Amps
I Line to Ground (3I0)	1,905 Amps
Z1 (100 MVA Base)	0.444 + j1.5689 pu
Z0 (100 MVA Base)	1.2595 + j3.5349 pu

[1] The total value referenced here includes the subject generator, connected generation, and generation that is queued ahead.

4.0 INTERCONNECTION CUSTOMER SITE

The Interconnection Customer is proposing a new primary service connection with Account No. 00768-48023.

This location is presently served by National Grid at 13.2 kV, thereby only requiring a 3-phase extension to the point of common coupling (PCC) from National Grid's radial 13.2 kV distribution feeder 31451 from the Hoosick substation.

The proposed generating system consists of:

- A PV system (DC) consisting of 16,380 JA Solar JAM72D10-405/BP solar panels (405 W) for a total DC system size of 6,633.90 kW_{DC}.
- Thirty-three (33) Sunny Highpower PEAK3 150-US inverters (150 kW, 600 V_{AC}) for a total AC system size of 4,950 kW_{AC}.
- Three (3) 20 kVA, 0.12 Ohm, secondary-connected, two-winding grounding transformers.
- One (1) 3,150 kVA, 13.2 kV_{AC} / 600 V_{AC}, wye-grounded primary / wye-grounded secondary, step-up transformer with Z=5.75% and X/R=6.8.
- One (1) 1,200 kVA, 13.2 kV_{AC} / 600 V_{AC}, wye-grounded primary / wye-grounded secondary, step-up transformer with Z=5.75% and X/R=6.8.
- One (1) 600 kVA, 13.2 kV_{AC} / 600 V_{AC}, wye-grounded primary / wye-grounded secondary, step-up transformer with Z=5.75% and X/R=6.8.
- Customer-owned riser pole with surge arrestors.
- Customer-owned pole with Customer-owned primary meter, surge arrestors, and solid blade cutouts.
- Customer-owned pole with National Grid utility-owned primary meter and Customer-owned surge arrestors.
- Customer-owned pole with recloser with SEL-651R and surge arrestors.
- Customer-owned pole with gang-operated, lockable, main generator disconnect switch and surge arrestors.

5.0 SYSTEM IMPACT ANALYSIS

Category	Criteria	Limit	Result
Voltage	Overvoltage	<105% (ANSI C84.1)	Pass
With the addition of the subject generator, the maximum voltage as modeled on the feeder will be 104.42% of nominal.			
Voltage	Undervoltage	>95% (ANSI C84.1)	Pass
With the addition of the subject generator, the minimum voltage as modeled on the feeder will be 95.13% of nominal.			
Voltage	Substation Regulation for Reverse Power	<100% Minimum Load Criteria	Fail
The total generation on feeders 31451 and 31452 will be 22.76 MW. The total minimum load on these feeders is 3.35 MW. The generation-to-load ratio will be 679%, thereby requiring a replacement of the substation LTC with a bi-directional, co-generation capable LTC controller, however, National Grid will be installing one; no further action required.			
Voltage	Feeder Regulation for Reverse Power	<100% Minimum Load to Generation Ratio	Pass
There are no feeder regulators between the POI and substation.			
Voltage	Fluctuation	<3% Steady State from Proposed Generation on the Feeder <5% Steady State from Aggregate DER on the Substation Bus	Pass
The greatest voltage fluctuation on the feeder occurs off Clay Hill Road in the vicinity of pole 18. The resulting fluctuation at said feeder location will be 2.32% due to the proposed generation and <1% on the substation bus due to the aggregate generation.			
Voltage	Screen H Flicker	<0.350 Emissions Limit	Pass
The Pst for the location with the greatest voltage fluctuation will be 0.061.			
Equipment Ratings	Thermal (Continuous Current)	<100% Thermal Limits	Pass
The subject generator's full output current will be 217 Amps. The subject generator's full output current will not exceed the thermal capability of any equipment nor conductor between the POI and substation.			
Equipment Ratings	Withstand (Fault Current)	<90% Withstand Limits	Pass
The additional fault current contribution from the generator does not contribute to interrupting ratings in excess of existing EPS equipment.			

Category	Criteria	Limit	Result
Protection	Unintentional Islanding	Unintentional Islanding Document & Company Guidelines	Fail

The subject generator is a 4.95 MW generation system. The subject generation exceeds the Company's criteria for islanding a distributed resource under light load conditions. Therefore, the project will require a National Grid protection and control package.

There is one (1) upstream recloser from the subject generator, a Cooper VWE recloser controlled by a Form 6 controller at pole 175-½ on Wilson Hill Road. This recloser lacks the functionality for reclose blocking. Due to the aggregate DER downstream of this recloser being greater than 50% of minimum load, the recloser will need to be replaced with a G&W Viper recloser with 6IVS and a SEL-651R controller with reclose blocking enabled. See ESB 756B 7.6.12.3 for further information in relation to reclose blocking.

Protection	Protective Device Coordination	Company Guidelines	Fail

There is one (1) protective device between the subject generator's POI and the substation; the G&W Viper recloser with SEL-651R controller on pole 175-½ on Wilson Hill Road (see the Unintentional Islanding screen above). The Interconnection Customer's currently proposed system protection for this project is a Tavrida recloser with SEL-651R controller; relay settings were provided for the device.

Due to the narrow time margin between the upstream recloser and the Customer-proposed protective device, the proposed settings fail to coordinate with the upstream recloser.

The Interconnection Customer shall revise the site's overcurrent protection to provide adequate coordination with the Company's upstream protective device, listed below, in accordance with IEEE 242 Table 15-3.

<u>Recloser on Pole 175-½ on Wilson Hill Road</u>:

- Overcurrent Phase Relay Settings:
  U4 Curve, PU = 400 Amps, Time Dial = 0.70, Instantaneous = N/A
- Overcurrent Ground Relay Settings:
  U4 Curve, PU = 275 Amps, Time Dial = 0.75, Instantaneous = N/A

If the Interconnection Customer installs an automatic sectionalizing device utilizing a utility-grade microprocessor relay, the 50, 51, 50N, and 51N functions must be enabled, as highlighted by ESB 756B, to provide appropriate coordination with the interconnected distribution system. Settings for these functions shall be submitted to the Company for acceptance review.

Protection	Fault Sensitivity	Rated Capabilities of EPS Equipment	Pass

Fault studies show that contribution from the subject generator for faults on the feeder will not have a significant increase in fault current seen by utility equipment. Aggregate source fault contribution with the addition of the subject generator is within the rated capabilities of EPS equipment.

Category	Criteria	Limit	Result
Protection	Ground Fault Detection	Reduction of Reach >0%	Pass/Fail
The interconnection Customer has proposed: • Three (3) 20 kVA, 0.12 Ohm, secondary-connected, two-winding grounding transformers. • One (1) 3,150 kVA, 13.2 kVAC / 600 VAC, wye-grounded primary / wye-grounded secondary, step-up transformer with Z=5.75% and X/R=6.8. • One (1) 1,200 kVA, 13.2 kVAC / 600 VAC, wye-grounded primary / wye-grounded secondary, step-up transformer with Z=5.75% and X/R=6.8. • One (1) 600 kVA, 13.2 kVAC / 600 VAC, wye-grounded primary / wye-grounded secondary, step-up transformer with Z=5.75% and X/R=6.8. To be within Company guidelines, the grounding transformers shall have an impedance of 0.10 Ohms on a 600 V base. With this grounding transformer in service, the interconnection Customer will contribute approximately 228 Amps of 3I0 current to remote, bolted line-to-ground faults (154 Amps with one transformer out of service) and 582 Amps to faults at the PCC (380 Amps with one transformer out of service).			
Protection	Overvoltage - Transmission System Fault	Company 3V0 Criteria	Fail
The generation-to-load ratio on the serving distribution system has failed the Company's planning threshold in which transmission ground fault overvoltage will become an electrical hazard due to the distribution source contribution. An evaluation of the existing EPS has been performed and it has been determined that ground fault overvoltage protection will be required, however, National Grid will be installing this protection; no further action required.			
Protection	Overvoltage - Distribution System Fault	<125% Voltage Rise	Pass
With the addition of the subject generator, the modeled voltage rise on the unfaulted phases of the system is 124.5%.			
Protection	Effective Grounding	R0/X1<1; X0/X1<3	Pass
With the addition of the subject generator, the modeled R0/X1 ratio is 0.924 and the X0/X1 ratio is 2.589.			
SCADA	Required EMS Visibility for Generation Sources	Monitoring & Control Requirements	Fail
The 4.95 MW subject generator triggers the requirement for SCADA reporting to the Utility.			
Other			
National Grid is performing work at the Hoosick substation. Current timelines estimate a completion date in 2025. As such, this generator cannot interconnect until the work being performed at Hoosick substation is complete.			

6.0 MITIGATIONS FOR SYSTEM IMPACT ANALYSIS FAILURES

Detail below is intended to provide sufficient information and clarity to give the Interconnection Customer an understanding to the relationship of costs and scope associated with the DER interconnection and the system modifications due to the DER impact. Where scope items are identified, associated labor, equipment rentals and indirect project support functions (such as engineering and project management) are intended and implied.

Upgrade Required	Cost	Failure(s) Addressed
National Grid Protection and Control Package	$103,804	Unintentional Islanding
Midline Recloser Replacement	$69,625	Protective Device Coordination

Additional details on the scope of each option can be found below:

The substation upgrades required to facilitate the proposed installation include the following:

- None.

The distribution upgrades required to facilitate the proposed installation include the following:

- National Grid protection and control package (recloser, switches, poles, and SCADA integration).
- Replacement of the recloser on pole 175-½ on Wilson Hill Road.

7.0 CONCEPTUAL COST ESTIMATE

The following items are a good faith estimate for the scope and work required to interconnect the project estimated under rates and schedules in effect at the time of this study in accordance with the most recent version of the New York State Standardized Interconnection Requirements (SIR).

Planning Grade Estimate

National Grid Work Segment	Planning Grade Cost Estimate not Including Tax Liability				Capital Portion for Calculating Tax Liability	Tax Liability Applied to Capital	Customer Cost Total
Distribution Modifications	Material	Labor	Overheads	Pre-Tax Total	Capital Costs	Rate 13.90%	Total
Distribution System Modifications							
National Grid Protection and Control Package	$	[redacted]					
Midline Recloser Replacement	$						
Non-System Costs							
Customer Documentation Review, Field Verification, and Witness Testing	$						
Substation Modifications							
	$						
Totals							
Distribution Summary:	$						
Substation Summary:	$						
Total:	$						

Notes:

1. These estimated costs are based upon the results of this study and are subject to change. All costs anticipated to be incurred by the Company are listed.
2. The Company will reconcile actual charges upon project completion and the Interconnection Customer will be responsible for all final charges, which may be higher or lower than estimated according to the SIR I.C step 11.
3. This estimate does not include the following:
   - additional interconnection study costs, or study rework
   - additional application fees,
   - applicable surcharges,
   - property taxes,
   - overall project sales tax,
   - future operation and maintenance costs,
   - adverse field conditions such as weather and Interconnection Customer equipment obstructions,
   - extended construction hours to minimize outage time or Company's public duty to serve,
   - the cost of any temporary construction service, or
   - any required permits.
4. Cost adders estimated for overtime would be based on 1.5 and 2 times labor rates if required for work beyond normal business hours. Per Diems are also extra costs potentially incurred for overtime labor.