For

Interconnection Customer: Oakhill Solar 1 LLC

Applicant: New PowerCo Inc.

5,000 kW Photovoltaic Generator System

13590 Duanesburg Delanson, NY 12053

Interconnection to National Grid

NY Eastern Division

Northeast Region

Cobleskill District

Delanson #269 Substation

13.2 kV Feeder 26951

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. 75, 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 is $283,066.

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 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	Delanson 269
Transformer Name	TB1
Transformer Peak Load (MW)	8.6
Contingency Condition Load, N-1 Criteria (MW) (as applicable)	3.4
Daytime Light Load (MW)	2.1
Generation: Total, Connected, Queued (MW)	8.1, 3.1, 5.1
Contingency Condition Generation: Total, Connected, Queued (MW)	7.6, 2.6, 5.0
Supply Voltage (kV)	13.2

Transformer Maximum Nameplate Rating (kVA)	14
Distribution Bus Voltage Regulation	Yes
Transmission GFOV Status	Installed
Bus Tie	None
Number of Feeders Served from this Bus	2

Connecting Feeder/Line	26951
Peak Load on feeder (kW)	5.2
Daytime Light Load on Feeder (MW)	1.3
Feeder Primary Voltage at POI (kV)	13.2
Line Phasing at POI	3
Distance to nearest 3-phase, (if applicable)	n/a
Line/Source Grounding Configuration at POI	effective
Other Generation: Total, Connected, Queued (kW)	7.6, 2.6, 5.0

System Fault Characteristics without Interconnection Customer DG at POI	
Interconnection Customer POI Location	P182-1 (Duanesburg Rd.)
I 3-phase (3LLL)	1,303 Amps
I Line to Ground (3I0)	894 Amps
Z1 (100 MVA base)	1.0860 + j3.1946 PU
Z0 (100 MVA base)	2.7636 + j7.5176 PU

4.0 INTERCONNECTION CUSTOMER SITE

The Interconnection Customer is proposing a new solar photovoltaic primary service connection with Account No. 2858968039.

This location is presently served via National Grid 13.2kV feeder 26951 from Delanson Substation.

The proposed generating system consists of:

- One hundred-eleven HUAWEI SUN2000-45KTL-US, 45kW, 600VAC, 3-Phase Inverters connected to
- Nine 800A, 3-Phase Powerboards, having a 800A main circuit breaker, through a 70A circuit breaker (1 per inverter x 11 per powerboard),
- Two 600A, 3-phase Powerboards, having a 450A main circuit breaker, through a 70A circuit breaker (1 per inverter x 6 per powerboard.)
- Two 2500kVA 2 Winding Design 600V - 13.2kV step-up transformers
- The outputs of both transformers are then connected to a customer-owned riser pole. This then continues on to
- A customer-owned primary service that consists of a customer-owned gang operated air break switch.

- A 75kVA, 3-Phase grounding transformer with Z= 5% and X/R = 6 configured wye-ground/delta is connected on the primary side of the step-up transformers utilizing a 51G ground overcurrent relay through a customer owner recloser

5.0 SYSTEM IMPACT ANALYSIS

Category	Criteria	Limit	Result
Voltage	Overvoltage	< 105% (ANSI C84.1)	**Fail**
With the addition of the subject generator the maximum voltage as modeled on the Feeder is 106% of nominal. To alleviate the overvoltage with the addition of the subject generator, the bank of 3-76.2kVA regulators on P.170 Duanesburg Rd would need to be replaced with 3-333kVA 7.62kV regulators with bi-directional controls and relocated to on or near Pole 115 Duanesburg Rd.			
Voltage	Undervoltage	> 95% (ANSI C84.1)	Pass
With the addition of the subject generator the minimum voltage as modeled on the Feeder is 95% of nominal.			
Voltage	Substation Regulation for Reverse Power	Reverse Power on LTC	Pass
The total generation on Feeders 26951 and 26952, is 8.1 MW. The total minimum load on these Feeders is 2.15 MW. Therefore, the generation to load ratio is 376% and reverse power can flow through TB2 onto the transmission system. TB2 already has a LTC with bi-directional controls and no further action is required.			
Voltage	Feeder Regulation for Reverse Power	Minimum load to generation ratio	**Fail**
The total generation downstream of voltage regulator P.170 is 5.08 MW. The minimum load downstream of the voltage regulator is 0.217 MW. Therefore, the generation to load ratio is 2341%. Bi-directional controls will be needed on the distribution voltage regulator.			
Voltage	Fluctuation	<3% steady state from proposed generation on feeder	Pass
The greatest voltage fluctuation on the feeder occurs at P.170 Duanesburg Rd The resulting fluctuation at the feeder location is 3% due to the proposed generation.			
Voltage	Flicker	Screen H Flicker	Pass
The Pst for the location with the greatest voltage fluctuation is 0.256 and the emissions limit is 0.35.			
Equipment Ratings	Thermal (continuous current)	thermal limits	**Fail**
The subject generator's full output current is 219 A. The total full output current of all DER downstream of the regulators at P.170 is 222A. The 3-76.2kVA regulators on P.170 thermal capabilities are 100A. Regulators on P.170 would need to be increased in size to accommodate the full output current of all DER downstream.			

Equipment Ratings	Withstand (fault current)	<90% withstand limits	Pass
The additional fault current contribution from the generation does not contribute to interrupting ratings in excess of existing EPS equipment.			
Protection	Unintentional Islanding	Unintentional Islanding Document & Company Guidelines	**Fail**
The subject generator is a 5 MW PV generation system. The subject generation exceeds the Company's criteria for islanding a distributed resource under light load conditions and will require a National Grid protection and control package.			
Protection	Protective device coordination	Company Guidelines	**Fail**
There are two reclosers between the subject generator POI and the substation. Recloser R99541 on Alexander Road and recloser R99543 on Duanesburg Road. The subject generator exceeds the Company's criteria for islanding a distributed resource, necessitating the replacement of the R99543 recloser to enable voltage supervised reclose on the DER side of the recloser. The R99541 recloser is already equipped with this functionality and does not need to be replaced, however setting changes are required to maintain coordination with the R99543 recloser. The proposed customer owned recloser for site overcurrent protection will provide adequate coordinate with upstream devices on the Company's EPS. Settings for the 51 and 51G protection 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.			
Protection	Ground Fault Detection	Reduction of reach > x% (by Utility)	**Fail**
The Interconnection Customer has proposed a 13.2kV connected 75kVA grounding bank with an impedance of 5% and X/R ratio of 6. To be within Company guidelines the grounding bank shall have an impedance of 33.686 ohms for a voltage base of 13.2kV. With this grounding bank in place the Interconnection Customer will contribute approximately 76A of 3I0 current to remote bolted line to ground faults and 328A to faults at the PCC.			
Protection	Overvoltage - Transmission System Fault	Company 3V0 criteria	Pass
The generation to load ratio on the serving distribution system has failed the Company's planning threshold in which transmission ground fault overvoltage 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 protection mitigation methods are required. However, a 3V0 protection scheme has already been installed and no further action is required			
Protection	Overvoltage - Distribution System Fault	< 125 % voltage rise	Pass
With subject generator interconnected the modeled voltage rise on the unfaulted phases of the system is 121%.			

Protection	Effective Grounding	R0/X1 < 1 and X0/X1 < 3	Pass
With subject generator interconnected the modeled R0/X1 is 0.527 PU and the X0/X1 is 2.0577 PU			
SCADA	Required EMS Visibility for Generation Sources	Monitoring & Control Requirements	**Fail**
The 5 MW subject generator triggers the requirement for SCADA reporting to the Utility.			
Other			

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	Option 1	Failures Addressed
3VO Substation cost sharing mechanism	$0	Overvoltage - Transmission System Fault
National Grid protection and control package	$102,518	Unintentional Islanding
Recloser R95543 on P95 Duanesburg Rd– Full Replacement	$70,183	Lack of voltage supervised reclosing
Removal of existing 3-phase regulator bank and installation of 3-phase regulator bank on P115 Duanseburg Rd	$85,518	Overvoltage - Distribution
SCADA Integration	$6,848	Required EMS Visibility for Generation Sources

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

Option 1:

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

- LTC bi-directional control capability is already incorporated in TB 1 at Delanson
- A 3V0 protection scheme is already incorporated at Delanson station

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

- National Grid Protection and Control Package
- SCADA Integration (equipment integrated into the PCC recloser)
- The R95543 recloser on pole 95 Duanesburg Road will be replaced in its entirety to enable voltage supervised reclosing on the DER side of the recloser.
- Replacing 3-76.2kVA regulators P.170 Duanesburg Rd with 3-333kVA 7.62kV regulators cluster mounted on or near P.115 Duanesburg Rd

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

Table 7-1: 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 Totals
Description of Scope	Material	Labor	Overheads	Pre-Tax Total	Capital Costs	Rate	Total
Distribution System Modifications						14.14%	
National Grid Protection and Control Package *(Recloser, Switches, and Poles)*	$ 40,289	$ 20,573	$ 29,344	$ 90,205	*$ 87,075*	$ 12,312	$ 102,517
SCADA Integration (equipment integrated into PCC Recloser)	$ 4,000	$ -	$ 2,000	$ 6,000	*$ 6,000*	$ 848	$ 6,848
New Mid-Line Recloser in the vicinity of P149 Riverview Road	$ 41,083	$ 11,985	$ 8,485	$ 61,553	*$ 61,033*	$ 8,630	$ 70,183
Removal of existing 3-phase regulator bank and installation of 3-phase regulator bank on P115 Duanseburg Rd	$ 36,675	$ 9,595	$ 30,844	$ 77,114	*$ 59,431*	$ 8,404	$ 85,518
Substation Modifications						14.14%	
Non-System Costs						0%	
Customer Documentation Review, Field Verification and Witness Testing		$ 12,000	$ 6,000	$ 18,000	$ -	$ -	$ 18,000
Total Project Costs:	$ 122,047	$ 54,153	$ 76,673	$ 252,872	*$ 213,539*	*$ 30,195*	$ 283,066
Dline Summary	$ 122,047	$ 54,153	$ 76,673	$ 252,872	$ 213,539	$ 30,194	$ 283,066
Station Summary	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Total	$ 122,047	$ 54,153	$ 76,673	$ 252,872	$ 213,539	$ 30,194	$ 283,066

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.