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**Interconnection to National Grid  
 NY East  
 Northeast Region  
 Cobleskill District  
 Delanson Substation  
 13.2 kV Feeder 26951**

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### 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 \$153,177.

The interconnection with the Company EPS was found to not be feasible unless the following modifications to the Interconnecting Customers system are completed, which are described in further detail in the body of this Study.

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 proposed Energy Storage System (ESS) in combination with the generation component of this project shall at no time exceed the generation component of this project or 5,000 kW. The ESS is approved to release energy to the EPS 24 hours a day.

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

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Contingency Condition Load, N-1 Criteria (MW) (as applicable)	3.4
Daytime Light Load (MW)	2.1
Generation: Total, Connected, Queued (MW)	13.1, 3.1, 10.0
Contingency Condition Generation: Total, Connected, Queued (MW)	12.6, 2.6, 10.0
Supply Voltage (kV)	13.2
Transformer Maximum Nameplate Rating (MVA)	14
Distribution Bus Voltage Regulation	Yes
Transmission GFOV Status	installed
Bus Tie	None
Number of Feeders Served from this Bus	2

<b>Connecting Feeder/Line</b>	<b>26951</b>
Peak Load on feeder (MW)	5.2
[Daytime, 24 hour] 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 (MW)	12.6, 2.6, 10.0

<b>System Fault Characteristics without Interconnection Customer DG at POI</b>	
Interconnection Customer POI Location	P182-2 Duaneburg Rd.
I 3-phase (3LLL)	1,425 Amps
I Line to Ground (3I0)	1,116 Amps
Z1 (100 MVA base)	1.4877 + j2.7113 PU
Z0 (100 MVA base)	1.4289 + j5.5790 PU

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	Transformer Name	Transformer Peak Load (MW)
Delanson 269	T81	8.6

#### 4.0 INTERCONNECTION CUSTOMER SITE

The Interconnection Customer is proposing new solar photovoltaic primary service connection with Account No. 1638576030

This location is presently served by the Company's 13.2kV radial distribution 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 105.27% of nominal.			
Voltage	Undervoltage	> 95% (ANSI C84.1)	Pass
With the addition of the subject generator the minimum voltage as modeled on the Feeder is 98.7% of nominal.			
Voltage	Substation Regulation for Reverse Power	Reverse Power on LTC	Pass
The total generation on Feeders 26951 and 26952 is 13.1 MW. The total minimum load on these Feeders is 2.15 MW. Therefore, the generation to load ratio is 609% 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 3-333kVA voltage regulator on P.115 Duanesburg Rd is 10.08 MW. Due to downstream DG in queue, the subject voltage regulators will have bi-directional controls installed and will experience reverse power flow.

Voltage	Fluctuation	<3% steady state from proposed generation on feeder	Pass
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The greatest voltage fluctuation on the feeder occurs at P.23 Old HWY 30 Tax District 7225, Line #86. The resulting fluctuation at the feeder location is 2.1% due to the proposed generation and < 1% on the substation bus due to the aggregate generation.

Voltage	Flicker	Screen H Flicker	Pass
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The Pst for the location with the greatest voltage fluctuation is 0.178 and the emissions limit is 0.35.

Equipment Ratings	Thermal (continuous current)	< 100% thermal limits	Fail
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The subject generator's full output current is 219 A. The total full output current of all DER downstream of 3-333kVA regulators on P.115 Duanesburg Rd is 441 A. The 3-333kVA regulators thermal capabilities are 437 A.

Additionally, the Delanson substation getaway conductor consists of 4/0 Bare conductor which has a thermal capability of 440 A. Due to the proposed generation, approximately 200' of conductor must be replaced with 366.4 SAL.

Equipment Ratings	Withstand (fault current)	<90% withstand limits	Pass
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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
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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
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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. Setting changes to the R99541 recloser are required to maintain coordination with the R99543 recloser. However the replacement of R99543 and setting changes for R99541 are already planned under an in-process DER project higher in the queue.

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.

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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)	<b>Fail</b>
The Interconnection Customer has proposed a 13.2kV connected 500kVA grounding bank with an impedance of 5%. To be within Company guidelines the grounding bank shall have an impedance of 33.686 for a voltage base of 13.2kV. With this grounding bank in place the Interconnection Customer will contribute approximately 60A of 3I0 current to remote bolted line to ground faults and 308A to faults at the PCC.			
Protection	Overvoltage - Transmission System Fault	Company 3V0 criteria	<b>Fail</b>
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, 3V0 is already incorporated at Delanson Station.			
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 124%.			
Protection	Effective Grounding	$R0/X1 < 1$ and $X0/X1 < 3$	Pass
With subject generator interconnected the modeled $R0/X1$ is 0.3874 PU and the $X0/X1$ is 1.9712 PU			
SCADA	Required EMS Visibility for Generation Sources	Monitoring & Control Requirements	<b>Fail</b>
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
Reconductor ~ 200ft of primary overhead 4/0 CU conductor	\$25,812	Thermal Limits
SCADA Integration	\$6,848	Required EMS Visibility for Generation Sources

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

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)
- Reconductor ~ 200ft of primary overhead 4/0 CU conductor from the Delanson Substation to P.11. Replace 4/0 CU with 336.4 SAL.

Other
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## 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
	Material	Labor	Overheads	Pre-Tax Total	Capital Costs	Rate	Total
<b>Description of Scope</b>							
<b>Distribution System Modifications</b>						14.14%	
National Grid Protection and Control Package <i>(Recloser, Switches, and Poles)</i>	\$ 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
Reconductor ~200' of primary overhead	\$ 2,832	\$ 10,168	\$ 10,605	\$ 23,605	\$ 15,605	\$ 2,207	\$ 25,812
<b>Substation Modifications</b>						14.14%	
<b>Non-System Costs</b>						0%	
Customer Documentation Review, Field Verification and Witness Testing		\$ 12,000	\$ 6,000	\$ 18,000	\$ -	\$ -	\$ 18,000
<b>Total Project Costs:</b>	<b>\$ 47,121</b>	<b>\$ 42,741</b>	<b>\$ 47,949</b>	<b>\$ 137,810</b>	<b>\$ 108,680</b>	<b>\$ 15,368</b>	<b>\$ 153,177</b>
<b>Dline Summary</b>	<b>\$ 47,121</b>	<b>\$ 42,741</b>	<b>\$ 47,949</b>	<b>\$ 137,810</b>	<b>\$ 108,680</b>	<b>\$ 15,367</b>	<b>\$ 153,177</b>
<b>Station Summary</b>	<b>\$ -</b>	<b>\$ -</b>	<b>\$ -</b>	<b>\$ -</b>	<b>\$ -</b>	<b>\$ -</b>	<b>\$ -</b>
<b>Total</b>	<b>\$ 47,121</b>	<b>\$ 42,741</b>	<b>\$ 47,949</b>	<b>\$ 137,810</b>	<b>\$ 108,680</b>	<b>\$ 15,367</b>	<b>\$ 153,177</b>

#### 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.

Table 7-1: Estimate

Description of Scope	Planning Grade Estimate			Customer Cost		
	Estimate	Labor	Overhead	Total	Capital Costs	Fixed Assets
National Grid Protection and Control Packages	\$ 10,372	\$ 28,344	\$ 90,208	\$ 128,924	\$ 57,072	\$ 18,112
SCADA Integration (equipment, installation, PCC, field)	\$ 4,000	\$ -	\$ 2,000	\$ 6,000	\$ 2,000	\$ 848
Reconnector "SIR" of primary overhead	\$ 2,822	\$ 20,188	\$ 23,482	\$ 26,304	\$ 12,402	\$ 1,307
Installation Modifiers	\$ 12,148	\$ -	\$ -	\$ 12,148	\$ -	\$ -
Workstation Costs	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
Customer Documentation Review, Field Verification and Witness Testing	\$ 21,000	\$ 8,000	\$ 18,000	\$ 47,000	\$ -	\$ 18,000
Total Project Costs	\$ 47,222	\$ 46,742	\$ 137,890	\$ 231,854	\$ 71,474	\$ 19,967
Other Summary	\$ 47,222	\$ 46,742	\$ 137,890	\$ 231,854	\$ 71,474	\$ 19,967
Station Summary	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -

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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.
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  3. This estimate does not include the following:
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    - 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