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|----------------------|--|------------------------------|
| National Grid | Coordinated Electric System Interconnect Review | Doc. #506455 Page 1 of 12 |
| | Distributed Energy Resources - NYSSIR | Version 1.0 – 12/22/2023 |

For
Interconnection Customer: 332 Ellisburg St
Applicant: Delaware River Solar
1,500 kW Solar Generator System
Reduced to 300kW due to thermal limits
332 Ellisburg St, Sandy Creek, NY 13145

Interconnection to National Grid
NY Central
Central Region
Pulaski District
Sandy Creek Substation
13.2 kV Feeder 6652

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| | | |
|----------------------|--|------------------------------|
| National Grid | Coordinated Electric System Interconnect Review | Doc. #506455 Page 2 of 12 |
| | Distributed Energy Resources - NYSSIR | Version 1.0 – 12/22/2023 |

TABLE OF CONTENTS

| <u>Section</u> | <u>Page</u> |
|---|-------------|
| 1.0 INTRODUCTION | 3 |
| 2.0 EXECUTIVE SUMMARY | 3 |
| 3.0 COMPANY EPS PARAMETERS | 4 |
| 4.0 INTERCONNECTION CUSTOMER SITE | 5 |
| 5.0 SYSTEM IMPACT ANALYSIS | 6 |
| 6.0 MITIGATIONS FOR SYSTEM IMPACT ANALYSIS FAILURES | 10 |
| 7.0 CONCEPTUAL COST ESTIMATE | 11 |

| | | |
|----------------------|--|--|
| National Grid | Coordinated Electric System Interconnect Review | Doc. # 506455 Page 3 of 12 |
| | Distributed Energy Resources - NYSSIR | Version 1.0 – 12/22/2023 |

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 Company ESB 750 series. 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 \$285,406.

The interconnection was found to NOT be feasible at the proposed size. The site must be downsized to **300 kW** along with modifications to the existing Company EPS and operating conditions, which are described in detail in the body of this Study. The point of common coupling (PCC) will be discussed during the initial construction field visit. The Customer is responsible for extending their facilities to meet the company at the PCC. The Company is currently proposing a tap off the existing 13.2 kV feeder and placement of a pole with a Company owned recloser. If the Company needs to provide a line extension, additional costs will be incurred by the Customer.

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.

| | | |
|----------------------|--|--|
| National Grid | Coordinated Electric System Interconnect Review | Doc. #506455 |
| | Distributed Energy Resources - NYSSIR | Page 4 of 12 Version 1.0 – 12/22/2023 |

3.0 COMPANY EPS PARAMETERS

| Substation | Sandy Creek |
|---|--------------------|
| Transformer Name | TB2 |
| Transformer Peak Load (kW) | 6,100 |
| Contingency Condition Load, N-1 Criteria (kW) (as applicable) | N/A |
| Daytime Light Load (kW) | 601 |
| Generation: Total ¹ , Connected, Queued Ahead (kW) | 7,817, 6,317, 0 |
| Contingency Condition Generation: Total ¹ , Connected, Queued Ahead (kW) | N/A |
| Supply Voltage (kV) | 34.5 |
| Transformer Maximum Nameplate Rating (kVA) | 6,600 |
| Distribution Bus Voltage Regulation | yes |
| Transmission GFOV Status | installed |
| Bus Tie | N/A |
| Number of Feeders Served from this Bus | 2 |

| Connecting Feeder/Line | 6651 |
|--|-----------------|
| Peak Load on feeder (kW) | 3,081 |
| Daytime Light Load on Feeder (kW) | 329 |
| Feeder Primary Voltage at POI (kV) | 13.2 |
| Line Phasing at POI | 3 |
| Circuit Distance from POI to Substation | 0.89 miles |
| Distance to nearest 3-phase, (if applicable) | n/a |
| Line Regulation | N |
| Line/Source Grounding Configuration at POI | effective |
| Generation: Total ¹ , Connected, Queued Ahead(kW) | 5,594, 4,094, 0 |

| System Fault Characteristics without Interconnection Customer DG at POI | |
|--|-----------------------|
| Interconnection Customer POI Location | Pole 17, Ellisburg St |
| I 3-phase (3LLL) | 1,180 Amps |
| I Line to Ground (3I0) | 1,273 Amps |
| Z1 (100 MVA base) | 0.9086 + j 4.2545 PU |
| Z0 (100 MVA base) | 0.4782 + j 2.5759 PU |

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

| | | |
|----------------------|--|------------------------------|
| National Grid | Coordinated Electric System Interconnect Review | Doc. #506455 Page 5 of 12 |
| | Distributed Energy Resources - NYSSIR | Version 1.0 – 12/22/2023 |

4.0 INTERCONNECTION CUSTOMER SITE

The Interconnection Customer is proposing a new solar photovoltaic primary service connection with Account No. 25456-06015.

This location is presently served via the Company's 13.2kV radial distribution feeder 6651 from Sandy Creek Substation.

The proposed generating system consists of:

- 3-phase PV inverts with a generation total of 1,500kW.
- One (1) 3,425VA wye-ground/delta step up transformer.
- One (1) Primary neutral grounding reactor.
- Gang operated disconnect switch
- Pole mounted Customer recloser
- Primary Utility Meter
- Gang operated disconnect switch

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|----------------------|--|------------------------------|
| National Grid | Coordinated Electric System Interconnect Review | Doc. #506455 Page 6 of 12 |
| | Distributed Energy Resources - NYSSIR | Version 1.0 – 12/22/2023 |

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 is 103.8% of nominal. | | | |
| Voltage | Undervoltage | > 95% (ANSI C84.1) | Pass |
| With the addition of the subject generator the minimum voltage as modeled on the line does not violate the limit. | | | |
| Voltage | Substation Regulation for Reverse Power | minimum load criteria | Fail |
| The total generation on Feeders 6651 and 6652 is 7.82 MW. The total minimum load on these Feeders is 0.60 MW. Therefore, the generation to load ratio is 1303%. | | | |
| Voltage | Feeder Regulation for Reverse Power | Minimum load to generation ratio | N/A |
| There are no voltage regulators between the site and the substation. | | | |
| Voltage | Fluctuation | <3% steady state from proposed generation on feeder, <5% steady state from aggregate DER on substation bus, Regulator tap movement exceeds 1 position. ² | Pass |
| The greatest voltage fluctuation on the feeder occurs at pole 89 NYS Route 3. The resulting fluctuation at the feeder location is 0.7% due to the proposed generation. | | | |
| Voltage | Flicker | Screen H Flicker | Pass |
| The Pst for the location with the greatest voltage fluctuation is 0.0608 and the emissions limit is 0.35. | | | |
| Equipment Ratings | Thermal (continuous current) | < 100% thermal limits | Fail |
| The subject generator's full output current is 66 A. The total full output current of all DER downstream of transformer is 342 A. The transformers thermal capabilities are 289A. | | | |

| | | |
|---------------|--|------------------------------|
| National Grid | Coordinated Electric System Interconnect Review | Doc. #506455 Page 7 of 12 |
| | Distributed Energy Resources - NYSSIR | Version 1.0 – 12/22/2023 |

To stay within the thermal limitations of the transformer, the maximum generator output shall be reduced to 0.3MW.

| 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 0.3 MW PV generation system. | | | | | | | | | | | | | | | | | | | | | |
| The proposed generation system exceeds the Company’s criteria for islanding a distributed resource, therefore unintentional islanding is a concern. <i>Therefore, the following system upgrades are required:</i> | | | | | | | | | | | | | | | | | | | | | |
| National Grid Protection and Control package (e.g. the PCC Recloser) | | | | | | | | | | | | | | | | | | | | | |
| Protection | Protective device coordination | Company Guidelines | Fail | | | | | | | | | | | | | | | | | | |
| <div>The DG Interconnection Customer has proposed a Utility Grade Recloser for use as Primary Service Protection (PSP). This protective device is shown in the proper location on the submitted line diagrams. Preliminary recloser device settings were provided in the initial submittals. Both ground and phase instantaneous and time curve overcurrent settings will need to be provided in this recloser, as well as ESB-756B Power Quality functions (27,59,81).</div> <div>The DG Interconnection Customer will need ensure that this recloser will coordinate, with 0.25 second margin, to the following device characteristics:</div> <table><tr><th>Device</th><th>Curve</th><th>Pickup</th><th>Time Dial/Multiplier</th><th>Time Delay/Adder</th><th>Instantaneous</th></tr><tr><td>50/51</td><td>U4</td><td>400</td><td>1</td><td>0.0 s</td><td>Not Used</td></tr><tr><td>50/51N</td><td>U4</td><td>300</td><td>1</td><td>0.0 s</td><td>Not Used</td></tr></table> <div>The customer shall submit formal relay settings for review and approval by National Grid to ensure proper coordination, correct function types, etc. if the project moves forward. These files will be required in their native format (SEL AcSELeRator, Cooper Proview, etc.) when submitted.</div> | | | | Device | Curve | Pickup | Time Dial/Multiplier | Time Delay/Adder | Instantaneous | 50/51 | U4 | 400 | 1 | 0.0 s | Not Used | 50/51N | U4 | 300 | 1 | 0.0 s | Not Used |
| Device | Curve | Pickup | Time Dial/Multiplier | Time Delay/Adder | Instantaneous | | | | | | | | | | | | | | | | |
| 50/51 | U4 | 400 | 1 | 0.0 s | Not Used | | | | | | | | | | | | | | | | |
| 50/51N | U4 | 300 | 1 | 0.0 s | Not Used | | | | | | | | | | | | | | | | |
| Protection | Fault Sensitivity | Rated capabilities of EPS equipment | Fail | | | | | | | | | | | | | | | | | | |
| Of the currently active protectives devices (line reclosers, Station breaker relays, line fusing) on this portion of the system, existing line recloser R41470. <i>Therefore, the following system upgrades are required:</i> | | | | | | | | | | | | | | | | | | | | | |
| R41470 Line Recloser Upgrade to SEL-651R w/ Deadline Sensing | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | |
| Protection | Ground Fault Detection | Reduction of reach > x% (by Utility) | Pass | | | | | | | | | | | | | | | | | | |

| | | |
|---------------|--|--------------------------|
| National Grid | Coordinated Electric System Interconnect Review | Doc. #506455 |
| | Distributed Energy Resources - NYSSIR | Page 8 of 12 |
| | | Version 1.0 – 12/22/2023 |

The DG Interconnection Customer has proposed one (1) 3,425 kVA Yg/Δ GSU with a **5.6 Ω** neutral grounding reactor (NGR).

These devices satisfy the requirements for effective grounding and provide current limiting in order to satisfactorily comply with National Grid standards.

With these devices in service, the Interconnection Customer will contribute approximately **92 A** of 3I0 current to remote bolted line to ground faults and **252 A** to faults at the PCC.

| | | | |
|------------|---|----------------------|------|
| Protection | Overvoltage - Transmission System Fault | Company 3V0 criteria | Fail |
|------------|---|----------------------|------|

The interconnection of distributed generation facilities to National Grid distribution substations can result in conditions whereby line-to-ground faults on the transmission system could go undetected. This scenario was analyzed for the proposed interconnection to determine if the addition of the subject generator meets the Company's criteria for requiring transmission system line-to-ground fault protection.

The existing station protection schemes were reviewed, and analysis performed, and it has been determined that the addition of this DG Interconnection triggers the requirement of transmission system ground fault protection. *Therefore, the following system upgrades are required:*

A 3V₀ protection scheme is required to mitigate the transmission system line-to-ground fault condition at the Sandy Creek Distribution Substation.

| | | | |
|------------|---|----------------------|------|
| Protection | Overvoltage - Distribution System Fault | < 125 % voltage rise | Pass |
|------------|---|----------------------|------|

With subject generator interconnected the maximum modeled voltage rise on the unfaulted phases of the system is **113.6%**.

| | | | |
|------------|---------------------|-------------------------------------|------|
| Protection | Effective Grounding | [individual utility specifications] | Pass |
|------------|---------------------|-------------------------------------|------|

With subject generator interconnected the maximum modeled **R0/X1** is **0.3861 PU** and the maximum modelled **X0/X1** is **1.1835 PU**.

| | | | |
|-------|--|-----------------------------------|------|
| SCADA | Required EMS Visibility for Generation Sources | Monitoring & Control Requirements | Fail |
|-------|--|-----------------------------------|------|

The **0.3 MW** subject generator triggers the requirement for SCADA reporting to the Utility. *This requirement is covered by the following:*

National Grid Protection and Control package (e.g. the PCC Recloser)

| | | | |
|-------|---------------|--|--|
| Other | Environmental | | |
|-------|---------------|--|--|

If the facilities are proposed on an existing site with preexisting environmental conditions and/or environmental regulatory obligations, the Customer should be made aware of the following:

- The Customer is responsible, at its sole cost and expense, for providing an uncontaminated corridor for National Grid's facilities such that intrusive work performed during installation and long-term maintenance would not result in potential contact with any site contamination and would not interfere with institutional or engineering controls, if applicable. The aerial extent, depth, and location of the uncontaminated corridor required for National Grid's facilities will be determined with the Customer.

| | | |
|----------------------|--|------------------------------|
| National Grid | Coordinated Electric System Interconnect Review | Doc. #506455 Page 9 of 12 |
| | Distributed Energy Resources - NYSSIR | Version 1.0 – 12/22/2023 |

- The Customer is responsible for providing any and all information regarding site conditions, the nature and extent of any site contamination, and design information for any engineering controls (including plans and drawings), if applicable, immediately upon acceptance of this proposal.
- The Customer is responsible for all obligations imposed by governmental authorities, including but not limited to notifications regarding modifications to institutional or engineering controls (if applicable), any required monitoring and/or reporting obligations, disposal of any wastes generated at the site, and the resolution of any violations caused by the work.”

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|----------------------|--|-------------------------------|
| National Grid | Coordinated Electric System Interconnect Review | Doc. #506455 Page 10 of 12 |
| | Distributed Energy Resources - NYSSIR | Version 1.0 – 12/22/2023 |

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 – [name] | Option 2+ [name] (if applicable) | Failures Addressed |
|---|----------------------|----------------------------------|--|
| 3V0 cost sharing | \$26,502 | Cost, or n/a | Overvoltage - Transmission System Fault |
| LTC Bi-directional control co-generation capability | Included in 3V0 Cost | n/a | Substation Regulation for Reverse Power |
| Scada Integration | Included in PCC Cost | n/a | Required EMS Visibility for Generation Sources |
| National Grid Protection and Control Package | \$103,814 | n/a | Unintentional Islanding |
| Existing National Grid Recloser Upgrade | \$69,631 | n/a | Fault Sensitivity |

*-No cost to developer as this is an in-progress National Grid Project

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:

- 3V0 protection is required on transformer bank TB2.
- LTC Bi-directional control co-generation capability.

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

- National Grid Protection and Control Package (13.2 kV Recloser, Switches, Poles, and associated hardware). Reference ESB-756B Figure 5.
- SCADA Integration (Equipment integrated into PCC Recloser)
- Upgrade Recloser R41470 on pole 173 US 11

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|----------------------|--|-------------------------------|
| National Grid | Coordinated Electric System Interconnect Review | Doc. #506455 Page 11 of 12 |
| | Distributed Energy Resources - NYSSIR | Version 1.0 – 12/22/2023 |

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

Case#: 506455

| CESIR Estimate to Developer | | | | | | | | |
|--|--|-----------|-----------|------------------|---|----------------------------------|---------------------|--|
| 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 | Total \$ | |
| Distribution System Modifications | | | | | | 13.91% | | |
| National Grid Protection and Control Package (Recloser, Switches, and Poles) | \$ 37,478 | \$ 16,566 | \$ 37,415 | \$ 91,459 | \$ 88,816 | \$ 12,354 | \$ 103,814 | |
| Upgrade recloser | \$ 30,117 | \$ 8,816 | \$ 23,254 | \$ 62,187 | \$ 53,513 | \$ 7,444 | \$ 69,631 | |
| Non-System Costs | | | | | | 13.91% | | |
| Customer Documentation Review, Field Verification and Witness Testing | \$ - | \$ 12,000 | \$ 6,000 | \$ 18,000 | \$ - | \$ - | \$ 18,000 | |
| CEI Project Mgt | | \$ 3,500 | \$ 1,500 | | | | | |
| Substation Modifications | | | | | | 13.91% | | |
| | | | | \$ - | \$ - | \$ - | \$ - | |
| 3VO cost sharing on TB2 | | | | \$ - | | \$ - | \$ 26,502 | |
| Distribution Summary | \$ 101,169 | \$ 47,704 | \$ 77,820 | \$ 226,693 | \$ 195,621 | \$ 12,354 | \$ 253,904 | |
| Station Summary | \$ - | \$ - | \$ - | \$ - | \$ - | \$ - | \$ 26,502 | |
| Total | \$ 101,169 | \$ 47,704 | \$ 77,820 | \$ 226,693 | \$ 195,621 | \$ 12,354 | \$ 280,406 | |

Notes:

- 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.
- 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.
- 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.

| | | |
|----------------------|--|---------------------------------------|
| National Grid | Coordinated Electric System Interconnect Review | Doc. # 506455 Page 12 of 12 |
| | Distributed Energy Resources - NYSSIR | Version 1.0 – 12/22/2023 |

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.