Interconnection Customer: Moore Hill Road Farm
Applicant: Delaware River Solar
3,900 kW Photovoltaic (PV) Generator System
Moore Hill Road, Neversink, NY, 12765
Interconnection to Central Hudson Gas and Electric Corp.
NY
Kingston District
Neversink Substation
13.2 kV Feeder 3091

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1.0 INTRODUCTION

This report presents the analysis results of the Central Hudson Gas and Electric Corp. ("CHGE" or the "Company") interconnection study based on the proposed interconnection and design submittal from the Interconnection Customer in accordance with the Company Interconnection Requirements for Distributed Energy Resources Connected in Parallel with the CHGE Electrical Delivery System, IEEE Standard 1547-2018 ("IEEE Standard for Interconnecting Distributed Resources with Electric Power Systems"), and "New York State Standardized Interconnection Requirements and Application Process for New Distributed Generators 5 MW or Less Connected in Parallel with Utility Distribution Systems" (NYSSIR). 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 $118,386.00.

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.

3.0 COMPANY EPS PARAMETERS

Substation	**Neversink**
Transformer Name (list multiple where normally tied to common bus)	Transformer #3
Transformer Peak Load (kW)	3,842
Contingency Condition Load, N-1 Criteria (kW) (as applicable)	n/a
Daytime Light Load (kW)	3,199
Generation: Total, Connected, Queued Ahead (kW)	4,999; 1,083; 16
Contingency Condition Generation: Total, Connected, Queued Ahead (kW)	n/a
Supply Voltage (kV)	13.8
Transformer Base Nameplate Rating (kVA)	4,500
Distribution Bus Voltage Regulation	Yes
Transmission GFOV Status	Installed
Bus Tie	Open
Number of Feeders Served from this Bus	2

Connecting Feeder/Line	3091
Peak Load on feeder (kW)	3,564
Daytime Light Load on Feeder (kW)	3,058
Feeder Primary Voltage at POI (kV)	13.2
Line Phasing at POI	3
Circuit distance from POI to substation	0.51 mi
Distance from POI to nearest 3-phase (if applicable)	N/A
Line Regulation	Yes
Line/Source Grounding Configuration at POI	Effective
Other Generation: Total, Connected, Queued Ahead (kW)	4,992; 1,076; 16

System Fault Characteristics without Interconnection Customer DG at POI with System Upgrades Described in Section 6	
Interconnection Customer POI Location	Pole K72807, Moore Hill Road
I 3-phase (3LLL)	1,045 Amps
I Line to Ground (3I0)	1,424 Amps
Z1 (100 MVA base)	1.19+j8.13 Ohms
Z0 (100 MVA base)	1.42+j8.56 Ohms

4.0 INTERCONNECTION CUSTOMER SITE

The Interconnection Customer is proposing a new primary service connection with Project No. CH-17574.

The proposed project POI is on Feeder 3091 supplied from Neversink Substation Transformer #3. The POI is located approximately 0.51 miles from the substation. The POI is on three-phase 13.2 kV. The interconnection includes 178.14 feet of 250 kcmil ACSR OH conductor, 1,514.71 feet of 250 kcmil 15 kV AL UG cable and 50 feet of 250 kcmil 15 kV AL UG cable. The PV units are interconnected to the low side (600 V delta) of the two customer-owned 3,425 kVA interconnection transformers.

The proposed generating system consists of:

- A total of 8,320 Longi LR5-72HBD 545M 545 W PV modules
- Two Sungrow SG3425UD-MV 3,425 kW solar inverters (de-rated to 1,950 kW), totaling 3,900 kW at 600 Vac output
- Two, three-phase 3,425 kVA, 600 V delta – 13.2 kV wye grounded, step-up transformers with 5.84% impedance and 11.41 X/R ratio

5.0 SYSTEM IMPACT ANALYSIS

The analysis was run at the rated project size in normal system configuration connected to the Feeder 3091. The following table shows the impact study results of the proposed 3,900 kW system at unity power factor and with Volt-Var functions implemented interconnecting to Central Hudson's distribution system.

Category	Criteria	Limit	Result
Voltage	Overvoltage - Primary	<105% (ANSI C84.1)	Fail
With the addition of the subject generator, the maximum voltage as modeled on the feeder is 105.89% of nominal. However, this is a pre-existing condition.			
Voltage	Overvoltage - Project Inverters	<105% (ANSI C84.1)	Pass
With the addition of the subject generator, the maximum voltage as modeled on the project inverters is 104.51% of nominal.			
Voltage	Undervoltage	>95% (ANSI C84.1)	Fail
With the addition of the subject generator, the minimum voltage as modeled on the feeder is 85.33% of nominal. The undervoltage will be mitigated by applying the mitigation mentioned in Section 6.0.			
Voltage	Substation Regulation for Reverse Power	<100% minimum load criteria	Fail
The total generation on Transformer #3, including this project and any projects ahead in queue, is 3.99 MW. The total gross minimum load on this Transformer is 3.20 MW. Therefore, the generation to load ratio is 125%. Reverse flow is expected through Neversink Substation Transformer #3 due to the interconnection of the proposed project. Neversink Substation Transformer #3 LTC control needs to be upgraded by the interconnecting customer to handle reverse power flow.			
Voltage	Feeder Regulation for Reverse Power	<100% minimum load to generation ratio	Fail
The total generation on Feeder 3091, including this project and any projects ahead in queue, is 3.99 MW. The total minimum load on this Feeder is 3.06 MW. Therefore, the generation to load ratio is 130%. Reverse flow is expected through Feeder 3091 due to the interconnection of the proposed project. However, there are no line regulator installed between the substation breaker and POI.			
Voltage	Fluctuation	<3% steady state from proposed generation on feeder	Pass
The maximum resulting voltage fluctuation at the POI location is 2.50% due to the proposed generation output stepping from 100% to 0%.			
Voltage	Fluctuation	<5% steady state from aggregate DER on substation bus	Pass
The maximum resulting voltage fluctuation at the feeder location is 4.45% due to all generation output stepping from 100% to 0%.			

Category	Criteria	Limit	Result
Voltage	Fluctuation	Regulator tap movement exceeds 1 position, generation change of 75% of nameplate rating does not result in voltage change >½ the bandwidth of any feeder voltage regulating device.	Fail
The steady state load flow results show that the Neversink Substation Transformer #3 LTC and the distribution line regulators K11556/K11557/K11560 will have excessive tap movement with the proposed generation online. There is a voltage change at the Neversink Substation Transformer #3 LTC and line regulators K11556/K11557/K11560 >½ the bandwidth of the voltage regulating device. The tap movement and voltage change issues will be mitigated by applying the mitigation mentioned in Section 6.0.			
Voltage	Flicker	Screen H Flicker	Fail
E_{Pst} = 0.350. Pst at POI = 1.271 is greater than E_{Pst} limit from the proposed generation output stepping from 100%-0%. The voltage flicker will be mitigated by applying the mitigation mentioned in Section 6.0.			
Equipment Ratings	Thermal (continuous current)	<100% thermal limits assuming no load	Pass
There are no thermal violations at any fuse, overhead or underground line sections with the proposed generation online.			
Equipment Ratings	Withstand (fault current)	<90% withstand limits	Pass
The maximum calculated phase fault current at the 13.8 kV source is less than 8000 A.			
Protection	Unintentional Islanding	Unintentional Islanding Document & Company Guidelines	Fail
The subject generator is a 3.9 MW solar PV system. The total interconnection of 4.992 MW exceeds the 2/3 of the minimum feeder loading criteria, as the generation to minimum load ratio is 123%. The proposed interconnection also fails the criteria where the feeder power factor is higher than 0.99 (lag or lead) for an extended period of time. Therefore, reclose block is required.			
Protection	Protective device coordination	Company Guidelines	Pass
There are no protective device between the substation breaker and POI. Feeder relay settings are not required to be upgraded for proper coordination.			
Protection	Fault Sensitivity	Rated capabilities of EPS equipment	Fail
The ground fault current change is greater than 10% at the point of interconnection but not at the 13.8 kV source. Neutral grounding reactors of 4 Ω or higher can limit the fault current change below 10%.			
Protection	Ground Fault Detection	Reduction of reach >10% (by Utility)	Pass
Screen passes based on type SB inverter capabilities.			

Category	Criteria	Limit	Result
Protection	Overvoltage - Distribution System Fault	<125% voltage rise	Pass
Screen passes based on type SB inverter capabilities.			
Protection	Effective Grounding	0<R0/X1<1 0<X0/X1<3	Pass
With the neutral grounding reactors, the modeled R0/X1 is 0.12448 and X0/X1 is 0.55694.			
SCADA	Required EMS Visibility for Generation Sources	Monitoring & Control Requirements	Yes
The 3.9 MW subject generator triggers the requirement for SCADA reporting to the Utility via the use of an electronic recloser at the PCC.			
Other	Open-Phase Protection		Pass

6.0 MITIGATIONS FOR SYSTEM IMPACT ANALYSIS FAILURES

The detail below is intended to provide sufficient information and clarity to give the Interconnection Customer an understanding of the relationship of costs and scope associated with the DER interconnection and the system modifications due to the DER impact. This includes any required EPS equipment upgrades. 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	Failures Addressed
Reduce the total project size from 3.9 MW to 0.7 MW	Customer Responsibility	Overvoltage, Undervoltage, Tap movement, Voltage fluctuation, Pst voltage flicker
Upgrade feeder relay settings	$3,662	Unintentional Islanding
Reconfigure regulator controls	$4,225	Substation Regulation for Reverse Power Flow
Install Electronic Recloser at PCC	$66,500	Monitoring & Control Requirement
Install plant controller for Volt-VAR function. Project inverters will operate in accordance with the NY standard volt-var curve for UL1741-SB certified smart inverters.	Customer Responsibility	Overvoltage
New Service	$10,600	N/A

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

- Reconfigure regulator controls.
- Upgrade feeder relay settings to ensure the feeder will not close into an energized line during feeder outages when the inverters may not detect the island and shut off automatically.

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

- Reduce the project size from 3.9 MW to 0.7 MW
- Install an electronic recloser at the site to enable SCADA reporting to the Utility.
- The customer shall install a three-phase voltage transformer on the primary side of the interconnection between the customer air-break disconnect switch and customer transformer, which will be considered the reference point of applicability (RPA) and act as the voltage reference point for the plant controller which will dictate the UL 1741 SB inverter Volt-VAR function. The plant controller shall monitor phase-to-ground voltage independently for each phase and provide the inverters with the most extreme voltage value, furthest away from the Volt-VAR curve (VVC) deadband (highest value of overvoltage or lowest value of undervoltage), to determine the VVC control point. The customer shall provide an updated Three Line Diagram (System Diagram), via the IOAP, when the change is made.
- Please note that the customer will be responsible for opening a new service account at this site. Please contact Central Hudson's New Business Department for further details.

This study was conducted based upon this facility being served by the interconnecting circuit during normal utility operating conditions. The terms, conditions, notification requirements, and other obligations of both the Company and the facility pertaining to disconnection of the facility are set forth in the applicable section(s) of the NYSSIR and the Interconnection Agreement that will be executed for the project(s) that were studied in this CESIR. Any change in system size and/or design is subject to the requirements of the NYSSIR, as well as supplemental documents developed by the Interconnection Technical Working Group and Interconnection Policy Working Group.

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

Construction Worksheet - CH-17574 - Reduced to 0.7 MW

CH Account #	N/A	**Project #**	CH-17574	**Site Voltage (kV)**	13.2
Customer Name	Delaware River Solar	**Generator Type**	PV	**Phasing at Site**	3-Phase
Site Address	Moore Hill Road, Neversink, NY, 12765	**Net Meter Type**	CDG	**Distance to 3Ø 13.2kV**	N/A
Contractor/Agent	Delaware River Solar	**Rating (kW AC)**	700	**Estimated In-Service Date**	TBD

Upgrade Budget Category	*Upgrade Details*	*Estimated Costs*

Substation Upgrades	Equipment Components	Qty	Equipment & Materials	Labor	Overhead	Total
Upgrade feeder relay settings	Reconfigure the 3091 SEL-651R settings for reclose block function	1.00	$0	$1,750	$1,912	$3,662
3091 regulator reconfiguration for reverse flow	Update regulator controls for reverse flow	1.00	$0	$2,000	$2,225	$4,225
		Estimated Substation Total	$0	$3,750	$4,137	$7,887
		Contingency (15%)				$1,183
		Estimated Substation Total Including 15% Contingency				**$9,070**

Distribution Upgrades	Equipment Components	Qty	Equipment & Materials	Labor	Overhead	Total
New Service – Primary Metered on customer pole	3 PTs, 3 CTs, test switch, wire	1.00	$7,000	$1,600	$2,000	$10,600
Install new Electronic Recloser (Viper) at PCC	Electronic Recloser, control box, Sensus radio	1.00	$39,250	$5,000	$22,250	$66,500
Install New Distribution Pole	Wooden distribution pole, guy wire	1.00	$1,200	$2,800	$2,000	$6,000
Estimating (Unclassified)	Design work	N/A	N/A	$2,840	$3,891	$6,731
Project Management		N/A	$0	$2,840	$2,386	$5,226
		Estimated Distribution Total	$47,450	$15,080	$32,527	$95,057
		Contingency (15%)				$14,259
		Estimated Distribution Total Including 15% Contingency				**$109,316**

Total Estimated Upgrade Cost	**$118,386**

Additional Upgrades - Customer Responsibility

☐	Extend/Install Primary 13.2kV Distribution Line to PV Site
☑	Install Customer-owned pole and meter pan for primary metering
☐	Install Customer-owned cabinet or switch gear, and meter pan for primary metering
☑	Install Customer-owned Transformer
☐	Adjust Customer-owned Transformer Taps
☑	Install plant controller for Volt-VAR function
☐	Upgrade Secondary Service
☐	Install DTT (Communications Medium)

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
   - 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
   - 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.

8.0 REVISION HISTORY

Version	Date	Description of Revision
1.0	09/20/2023	Initial Report
2.0	10/03/2023	Final Report