For
Interconnection Customer: Delaware River Solar
Applicant: Delaware River Solar
5,000 kW Photovoltaic (PV) Generator System
Camp Road, Wawarsing, NY 12428

Interconnection to Central Hudson Gas and Electric Corp.
NY
Kingston District
Grimley Road Substation
13.2 kV Feeder 3095

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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 is $5,327,043

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	**Grimley Road**
Transformer Name (list multiple where normally tied to common bus)	Transformer #1
Transformer Peak Load (kW)	2,344
Contingency Condition Load, N-1 Criteria (kW) (as applicable)	n/a
Daytime Light Load (kW)	337
Generation: Total, Connected, Queued Ahead (kW)	5,150; 134; 15
Contingency Condition Generation: Total, Connected, Queued Ahead (kW)	n/a
Supply Voltage (kV)	13.8
Transformer Maximum Nameplate Rating (kVA)	3,750
Distribution Bus Voltage Regulation	Yes
Transmission GFOV Status	Installed
Bus Tie	Open
Number of Feeders Served from this Bus	1

Connecting Feeder/Line	3095
Peak Load on feeder (kW)	2,344
Daytime Light Load on Feeder (kW)	337
Feeder Primary Voltage at POI (kV)	2.4
Line Phasing at POI	1
Circuit distance from POI to substation	4.17 mile(s)
Distance from POI to nearest 3-phase (if applicable)	1.43 mile(s)
Line Regulation	Yes
Line/Source Grounding Configuration at POI	Effective
Other Generation: Total, Connected, Queued Ahead (kW)	5,150; 134; 15

System Fault Characteristics without Interconnection Customer DG at POI with System Upgrades Described in Section 6	
Interconnection Customer POI Location	Pole K42518, Camp Road
I 3-phase (3LLL)	1,323 Amps
I Line to Ground (3I0)	1,002 Amps
Z1 (100 MVA base)	2.04+j6.33 Ohms
Z0 (100 MVA base)	4.16+j11.81 Ohms

4.0 INTERCONNECTION CUSTOMER SITE

The Interconnection Customer is proposing a new primary service connection with Project No. CH-16681.

The proposed project POI is on Feeder 3095 supplied from Grimley Road Substation Transformer #1. The POI is located approximately 4.17 miles from the substation. The POI is on single-phase 2.4 kV. The interconnection includes 118.62 feet of 250 kcmil OH conductor and 909.63 feet of 500 kcmil Al 15kV UG cable. The PV units are interconnected to the low side (600 V wye) of the two customer-owned 3,425 kVA interconnection transformers. Approximately 1.43 miles of single-phase 2.4 kV will need to be reconductored to three-phase 336 ACSR 13.2 kV to facilitate the interconnection.

The proposed generating system consists of:

- A total of 12,480 LONGI LR5-72HBD 545M 545 W PV modules
- Two SUNGROW SG 3425 UD-MV 3,425 kW solar inverters (de-rated to 2,500 kW), totaling 5,000 kW at 600 Vac output.

  (Use Central Hudson settings:

  https://cenhuddg.powerclerk.com/Library/Public/User_Notifications/CenHud_Smart_Inverter_Settings_Required_20230101.pdf)
- Two, three-phase 3,425 kVA, 600 V wye – 13.2 kV wye grounded, step-up transformers with 5.84% impedance and X/R = 11.41

5.0 SYSTEM IMPACT ANALYSIS

The analysis was run at the rated project size in normal system configuration connected to the Feeder 3095. The following table shows the impact study results of the proposed 5,000 kW system at unity power factor 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 greater than 105% of nominal. The overvoltage will be mitigated by applying the mitigation mentioned in Section 6.0.			
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 100.88% 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 less than 95% of nominal.			
Voltage	Substation Regulation for Reverse Power	<100% minimum load criteria	Fail
The total proposed generation on Transformer #1, including this project and any projects ahead in queue, is 5.04 MW. The total minimum load on this transformer is 0.34 MW. Therefore, the generation to load ratio is 1,494.60%. Reverse flow is expected through the Grimley Road Substation Transformer #1 LTC due to the interconnection of the proposed project. Grimley Substation Transformer #1 LTC control needs to be upgraded to handle reverse power flow.			
Voltage	Feeder Regulation for Reverse Power	<100% minimum load to generation ratio	Fail
The total proposed generation on Feeder 3095, including this project and any projects ahead in queue, is 5.04 MW. The total minimum load on this feeder is 0.34 MW. Therefore, the generation to load ratio is 1,495%. Reverse flow is expected through circuit 3095 due to the interconnection of the proposed project. Line regulators K40608 and K42425 are installed between substation breaker and POI. Line regulators K40608 and K42425 controls need to be upgraded to handle reverse power flow.			
Voltage	Fluctuation	<3% steady state from proposed generation on feeder	Fail
The maximum resulting voltage fluctuation at the POI location is 4.53% due to the proposed generation output stepping from 100% to 0%. The voltage fluctuation will be mitigated by applying the mitigation mentioned in Section 6.0.			
Voltage	Fluctuation	<5% steady state from aggregate DER on substation bus	Fail
The maximum resulting voltage fluctuation at the feeder location is 10.63% due to all generation output stepping from 100% to 0%. The voltage fluctuation will be mitigated by applying the mitigation mentioned in Section 6.0.			

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 Grimley Road Substation Transformer #1 LTC and the distribution line regulators K40608, K42425, and K42463 will have excessive tap movement with the proposed generation online. There is a voltage change at the Grimley Road Substation Transformer #1 LTC and the line regulators K40608, K42113, K42425, and K42463 >½ the bandwidth of the voltage regulating device. The tap movement and voltage change issue 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 = 0.456 at a 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	Fail
There are five protective devices between the substation breaker and POI: five fused cutout banks. The loading on fused cutout banks K40565, K40587, K40589, K42097, and K42500 and solid blade fuses k42426 and K40611 exceed their current thermal rating with the proposed project online. There are thermal violations at regulator K42425 with the proposed generation online. There are thermal violations at overhead line sections with the proposed generation online. The thermal violation on the fuses, regulator, and overhead line sections will be mitigated by applying the mitigation mentioned in Section 6.0.			
Equipment Ratings	Withstand (fault current)	<90% withstand limits	Pass
Protection	Unintentional Islanding	Unintentional Islanding Document & Company Guidelines	Fail
The subject generator is 5 MW solar PV system. The total interconnection of 5.15 MW does exceed the 2/3 of the minimum feeder loading criteria, as the generation to minimum load ratio is greater than 67% of the feeder minimum load. 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	Fail
There are five protective devices between the substation breaker and POI: five fused cutout banks. Feeder relay settings must be upgraded for proper coordination, there are at least two relay coordination setting changes required at Grimley Road Substation.			
Protection	Fault Sensitivity	Rated capabilities of EPS equipment	Fail
The proposed interconnection causes more than 10% fault contribution.			

Category	Criteria	Limit	Result
Protection	Ground Fault Detection	Reduction of reach >10% (by Utility)	Fail
Phase and ground fault current changes >10% at both the point of interconnection and the substation bus.			
Protection	Overvoltage - Distribution System Fault	<125% voltage rise	Fail
With subject generator interconnected, the modeled voltage rise on the unfaulted phases of the system is >125%.			
Protection	Effective Grounding	0<R0/X1<1 0<X0/X1<3	Pass
With subject generators interconnected, the modeled R0/X1 is 0.98589 and X0/X1 is 1.89259.			
SCADA	Required EMS Visibility for Generation Sources	Monitoring & Control Requirements	Yes
The 5 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		Fail
Customer is required to send open phase settings			

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
Upgrade Grimley Road Substation Transformer #1 LTC control	$58,000	Substation Regulation for Reverse Power Flow
Build a dedicated feeder for 4.17 miles	$4,003,266	Overvoltage, Undervoltage, Tap movement, Voltage change, Voltage fluctuation, Voltage flicker, Thermal, Feeder Regulation for Reverse Power Flow
Install dedicated feeder regulator	$527,266	Overvoltage, Undervoltage, Tap movement, Voltage change, Voltage fluctuation, Voltage flicker, Thermal, Feeder Regulation for Reverse Power Flow
Install reclose block	$24,150	Unintentional Islanding
Install electronic recloser at PCC	$66,500	Monitoring & Control Requirement

Upgrade feeder relay settings	$10,000	Protective Device Coordination
New Service	$10,600	N/A

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

- Upgrade Grimley Road Substation Transformer #1 LTC control to operate properly with the reverse power flow.
- Reclose blocking is required 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.
- Upgrade feeder relay settings for proper coordination. There are at least two relay coordination setting changes required at Grimley Road Substation.

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

- Build a dedicated feeder for 4.17 miles to interconnect the proposed 5 MW project.
- Install a dedicated feeder regulator.
- Install an electronic recloser at the site to enable SCADA reporting to the Utility.
- 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 - Cost Share 2.0 Calculator for Qualifying Upgrade vs. Project Specific Costs

CH Account #	New Service	**Project #**	CH-16681	**Site Voltage (kV)**	13.2 kV
Customer Name	Delaware River Solar	**Generator Type**	PV	**Phasing at Site**	3-Phase
Site Address	Camp Road, Wawarsing, NY, 12428	**Net Meter Type**	CDG, Value Stack Phase Two	**Distance to 3Ø 13.2kV**	4.17 miles
Contractor/Agent	Delaware River Solar	**Rating (kW AC)**	5,000	**Estimated In-Service Date**	TBD

Budget Category	*Details*		*Estimated Costs*				
Substation Upgrades	**Equipment Components**	**Qty**	**Equipment & Materials**	**Labor**	**Overhead**	**Qualifying Upgrade**	**Project Specific**
Install Reclose Block	JVM 8400-120V PT, Steel Attachment, Junction Box, Connectors and Misc. Fittings	1.00	$3,369	$11,014	$9,767		$24,150
Dedicated Feeder - Extend Substation Bus ("Open Bus" station)	Buswork & connectors, foundation, steel, Does not include breaker (next line)	1.00	$40,000	$70,000	$99,274	$209,274	
Dedicated feeder - Install new breaker position ("Open Bus" station)	RMAG breaker (w/ relaying), (6) Hookstick disc switches, control cable, relay settings	1.00	$55,000	$60,000	$100,000	$215,000	
Dedicated Feeder - New Circuit Exit	6" conduit, 750MCM cable, riser.	1.00	$30,000	$27,500	$45,492	$102,992	
Upgrade Grimley Road Substation Transformer #1 LTC control for Reverse Power Flow	Install M-2001D LTC controller	1.00	$12,000	$23,000	$23,000		$58,000
		Estimated Substation Total				$527,266	$82,150
		Contingency (15%)				$79,090	$12,323
		Qualifying Upgrade/Project Specific Substation Totals Including 15% Contingency				**$606,356**	**$94,473**
		Estimated Substation Total Including 15% Contingency					**$700,828**

Budget Category	*Details*		*Estimated Costs*				
Distribution Upgrades	**Equipment Components**	**Qty**	**Equipment & Materials**	**Labor**	**Overhead**	**Qualifying Upgrade**	**Project Specific**
New Service – Primary Metered on customer pole	3 PTs, 3 CTs, test switch, wire	1	$7,000	$1,600	$2,000		$10,600
Install New Viper at PCC	Electronic Recloser, control box, Sensus radio	1	$39,250	$5,000	$22,250		$66,500
Install New Distribution Pole	Wooden distribution pole, guy wire	1	$1,200	$2,800	$2,000		$6,000
Install New Feeder Regulator and Controls	Install 328A regulators and controls	3	$27,040	$16,380	$65,000		$108,420
Estimating (Unclassified)	Design work	N/A	$0	$28,400	$38,908		$67,308
Permitting/Surveying	Highway, Railroad, etc.	N/A	$0	$75,000	$16,500	$91,500	
Tree Trimming	Trimming easements	N/A	$0	$200,000	$44,000	$244,000	
Project Management	Supervision	N/A	$0	$8,520	$7,157		$15,677
New Feeder – Construct Distribution Circuit	New feeder from new breaker position in Grimley Road substation, 4.17 miles of 3 phase 336 ACSR to POI at pole# K42518	22018	$659,806	$1,615,387	$1,137,597	$3,412,790	
		Estimated Distribution Total				$3,748,290	$274,505
		Contingency (15%)				$562,244	$41,176
		Qualifying Upgrade/Project Specific Distribution Totals Including 15% Contingency				**$4,310,534**	**$315,681**
		Estimated Distribution Total Including 15% Contingency					**$4,626,214**
		Qualifying Upgrade Total Estimate					**$4,916,889**
		Project Specific Total Estimate					**$410,153**
		Total Estimated Upgrade Cost					**$5,327,043**

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
- ☐ Adjust Inverter Power Factor (CH-____ operating at Unity PF)
- ☐ 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	03/31/2023	Initial Report
2.0	05/02/2023	Final Report