For
Interconnection Customer: Delaware River Solar
Applicant: Delaware River Solar
2,500 kW Photovoltaic (PV) Generator System
104 Weiner Road
WAWARSING, NY 12428

Interconnection to Central Hudson Gas and Electric Corp.
NY
Kingston District
Grimley Road Substation
13.2 kV Feeder 3096

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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 $284,858.45 for Option 1 and $6,660,223.85 for Option 2.

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 Rd**
Transformer Name	Transformer #2
Transformer Peak Load (kW)	1,340
Contingency Condition Load, N-1 Criteria (kW) (as applicable)	N/A
Daytime Light Load (kW)	500
Generation: Total, Connected, Queued Ahead (kW)	6,989;4,386;0
Contingency Condition Generation: Total, Connected, Queued Ahead (kW)	N/A
Supply Voltage (kV)	13.2
Transformer Maximum Nameplate Rating (kVA)	5000/6250
Distribution Bus Voltage Regulation	Yes
Transmission GFOV Status	Installed
Bus Tie	N/A
Number of Feeders Served from this Bus	2

Connecting Feeder/Line	3096
Peak Load on feeder (kW)	3,009
Daytime Light Load on Feeder (kW)	500
Feeder Primary Voltage at POI (kV)	13.2
Line Phasing at POI	3
Circuit distance from POI to substation	2.44 Miles
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)	2,903;386; 0

System Fault Characteristics without Interconnection Customer DG at POI with System Upgrades Described in Section 6	
Interconnection Customer POI Location	Pole K45114, Weiner Road
I 3-phase (3LLL)	1889 Amps
I Line to Ground (3I0)	1874 Amps
Z1 (100 MVA base)	1.13 + j4.19 Ohms
Z0 (100 MVA base)	1.92 + j6.57 Ohms

4.0 INTERCONNECTION CUSTOMER SITE

The Interconnection Customer is proposing a new primary service connection with Project No. CH-14862.
The proposed project POI is on Feeder 3096 supplied from Grimley Rd Substation Transformer #2. The POI is located approximately 2.44 miles from the substation. The POI is on three-phase 13.2 kV. The interconnection includes 1518 feet of 336 AA WR OH conductor, 120 feet of 336 AA WR OH conductor, and 1720.28 feet of 2/0 Al UG cable. The PV units are interconnected to the low side (600 V wye-Ungrounded) of the 3.42 MVA customer installed and managed pad-mounted transformer. It is necessary to extend the available 3 phase 13.2kV utility network from pole #K45114 to the new POI.

The proposed generating system consists of:

- A total of 5,408 LR5-72HBD 535M PV modules
- One SG 3425 UD-MV SUNGROW 2500 kVA solar inverters at 600 Vac output
- One, three-phase 3.42 MVA, 600 V wye - 13.2 kV wye grounded, step-up transformer with 5% impedance and 4 X/R ratio

5.0 SYSTEM IMPACT ANALYSIS

The analysis was run at the rated project size in normal system configuration connected to Feeder 3096. The following table shows the impact study results of the proposed 2,500 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 106.12% 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, there were no overvoltage violations observed at the project inverter.			
Voltage	Undervoltage	>95% (ANSI C84.1)	Pass
With the addition of the subject generator, there were no undervoltage violations observed at the Feeder.			
Voltage	Substation Regulation for Reverse Power	<100% minimum load criteria	Fail
The total proposed generation on Transformer #2, including this project and any projects ahead in queue, is 6.97 MW. The total minimum load on this Transformer is 0.500 MW. Therefore, the generation to load ratio is 1394%. Reverse flow is expected through Grimley Road Substation Transformer #2. Grimley Road Transformer #2 bus regulator control will 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 3096, including this project and any projects ahead in queue, is 2.9 MW. The total minimum load on this Feeder is 0.5 MW. Therefore, the generation to load ratio is 580%. There is no distribution line regulator installed between substation breaker and POI. Therefore, no mitigation for reverse power is required.			
Voltage	Fluctuation	<3% steady state from proposed generation on feeder	Pass
The maximum resulting voltage fluctuation at the POI location is 1.83% 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 2.63% due to all generation output stepping from 100% to 0%.			
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 Rd Transformer #2 bus regulators will have excessive tap movement with the proposed generation online. The tap movement issue will be mitigated by applying the mitigation options mentioned in Section 6.0.			

Category	Criteria	Limit	Result
Voltage	Flicker	Screen H Flicker	Pass
E_{Pst} = 0.350. Pst at POI = 0.119 at a generation output stepping from 100%-0%.			
Equipment Ratings	Thermal (continuous current)	<100% thermal limits assuming no load	Fail
Thermal overloading was observed at Grimley Rd Transformer #2 with the proposed generation online. The thermal violation 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 2.5 MW PV. The total interconnection of 2.9 MW exceeds the 2/3 of the minimum feeder loading criteria. The proposed interconnection also fails the criteria where the feeder power factor is higher than 0.99 (lag or lead) for an extended period. Therefore, reclose block is required.			
Protection	Protective device coordination	Company Guidelines	Pass
There are four protective devices between the substation and POI. There are no coordination setting changes required at Grimley Road Substation.			
Protection	Fault Sensitivity	Rated capabilities of EPS equipment	Pass
The proposed interconnection causes less than 10% fault contribution.			
Protection	Ground Fault Detection	Reduction of reach >10% (by Utility)	Pass
The Interconnection Customer has not proposed a grounding transformer at the customer side of the interconnecting transformer.			
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 generator interconnected, the modeled R0/X1 is 0.51286 and X0/X1 is 1.66242.			
SCADA	Required EMS Visibility for Generation Sources	Monitoring & Control Requirements	Yes
The 2.5 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		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 Option 1	Cost Option 2	Failures Addressed
Reduce the project size for CH-14862 to 1.0 MW in total and interconnect at -98% (Consuming Vars) power factor	Customer Responsibility	N/A	Overvoltage, Tap movement
Install 600 kVAr switched capacitor bank	$31,500	N/A	Overvoltage, Tap movement
Build a dedicated feeder for 2.44 miles	N/A	$2,348,696	Overvoltage, Tap movement
Install a dedicated feeder regulator	N/A	$67,330	Overvoltage, Tap movement
Upgrade Grimley Road Transformer #2 Bus Regulator control	$95,347	$95,347	Substation regulation for reverse power flow
Install reclose blocking	N/A	$24,150	Unintentional Islanding
Upgrade Grimley Road Transformer #2 to 11.2/14.0 MVA @65°C	N/A	$2,633,674	Thermal overloading
Install electric recloser at PCC	$66,500	$66,500	Monitoring & Control requirement
New Service	$10,600	$10,600	N/A

The substation upgrade required to facilitate the proposed installation for Option 1 include the following:

- Upgrading Grimley Road Transformer #2 Bus Regulator control to operate properly with the reverse power flow.

The substation upgrades required to facilitate the proposed installation for Option 2 include the following:

- Upgrading Grimley Road Transformer #2 Bus Regulator control to operate properly with the reverse power flow.
- Install reclose blocking to ensure the feeder will not close into an energized line during feeder outages when the inverters may not detect the island shut off automatically
- Upgrade Grimley Road Transformer #2 to 11.2/14.0 MVA @ 65°C
- Expand Grimley Road substation 13.8 kV Bus #2 for a new feeder breaker and install reclose block

The distribution upgrades required to facilitate the proposed installation for Option 1 include the following:

- Reduce the project size for CH-14862 to 1.0 MW in total and interconnect at -98% PF (Consuming Vars).

- A 600 kvar switched capacitor bank shall be installed at the overhead conductor closest to the substation to account for power factor impacts due to the project consuming vars.
- 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.

The distribution upgrades required to facilitate the proposed installation for Option 2 include the following:

- Build a dedicated feeder for 2.44 miles to interconnect the proposed 2.5 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.

In addition, as per the interconnection guidelines, the DER may not increase the ground fault current contribution at the POI by more than 10%. Project CH-14862 does not meet this requirement. Two options to mitigate the issue are listed below:

Option 1:

- Provide documented proof that the inverters can meet UL1741-SB fast tripping requirements per IEEE 1547-2018 Section 7.4.2 Transient Overvoltage Limits

Option 2:

- Perform a transient analysis study to prove there is no overvoltage per IEEE 1547-2018 Section 7.4.2 Transient Overvoltage Limits or that the inverters have fast tripping capability

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 – Option 1

Construction Worksheet; Grimley Rd - 3096; OPTION #1 *(Reduce Project Size, Switch Cap Bank, Reclose Block)*

CH Account #		**Project #**	CH-14862	**Site Voltage (kV)**	13.2 kV
Customer Name	Peter Dolgos	**Generator Type**	PV	**Phasing at Site**	3-Phase
Site Address	104 Weiner Road, Wawarsing, NY, 12428	**Net Meter Type**	CDG	**Distance to 3Ø 13.2kV**	N/A
Contractor/Agent	Delaware River Solar	**Rating (kW AC)**	2,500	**Estimated In-Service Date**	TBD

Upgrade Budget Category	***Upgrade Details***	***Estimated Costs***

Substation Upgrades	**Equipment Components**	**Qty**	**Equipment & Materials**	**Labor**	**Overhead**	**Total**
Upgrade Substation Bus #2 Regulators and Controls	(3) Bi-directional Reverse Flow Regulators w/ Beckwith M-6200A Controllers	1	$44,925	$20,000	$30,422	$95,347
		Estimated Substation Total	$44,925	$20,000	$30,422	$95,347.00
		Contingency (15%)				$14,302.05
		Estimated Substation Total Including 15% Contingency				**$109,649.05**

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	$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
Estimating (Unclassified)	Design work	N/A	$0	$4,800	$5,832	$10,632
Permitting/Surveying	Survey along Route ??	N/A	$0	$4,650	$2,350	$7,000
Tree Trimming	Trimming easements	N/A	$0	$1,780	$740	$2,520
Project Management		N/A	$0	$2,400	$1,704	$4,104
Install New Switched Capacitor Bank	Rack Capacitor, Vacuum Switches, Line Sensor, Capacitor Controller and Control Box, and Tropos Radio	1	$12,500	$6,500	$12,500	$31,500
		Estimated Distribution Total	$65,950	$32,530	$53,876	$152,356.00
		Contingency (15%)				$22,853.40
		Estimated Distribution Total Including 15% Contingency				**$175,209.40**

Total Estimated Upgrade Cost	**$284,858.45**

Additional Upgrades - Customer Responsibility

- ☐ :end/Install Primary 13.2kV Distribution Line to PV Site
- ☑ :all Customer-owned pole and meter pan for primary metering
- ☐ :all Customer-owned cabinet or switch gear, and meter pan for primary metering
- ☑ :all Customer-owned Transformer
- ☐ ,ust Customer-owned Transformer Taps
- ☑ ,ust Inverter Power Factor (CH-14862, reduce project size to 1.0 MW and interconnect at -98% power factor; Consuming VARs)
- ☐ grade Secondary Service
- ☐ :all DTT (Communications Medium)

Planning Grade Estimate – Option 2

Construction Worksheet - Cost Share 2.0 for Qualifying Upgrade vs. Project Specific Costs; Grimley Rd - 3096; OPTION #2 *(New Feeder and Tr. #2 Upgrade)*

CH Account #		**Project #**	CH-14862	**Site Voltage (kV)**	13.2 kV
Customer Name	Delaware River Solar	**Generator Type**	PV	**Phasing at Site**	3-Phase
Site Address	104 Weiner Road, Wawarsing, NY, 12428	**Net Meter Type**	CDG	**Distance to 3Ø 13.2kV**	N/A
Contractor/Agent	Delaware River Solar	**Rating (kW AC)**	2,500	**Estimated In-Service Date**	TBD

Qualifying Upgrade Budget Category	*Qualifying Upgrade* Details		*Qualifying Upgrade* Estimated Costs			
Qualifying Upgrade Substation Upgrades	**Equipment Components**	**Qty**	**Equipment & Materials**	**Labor**	**Overhead**	**Total**
Upgrade Tr. #2 to 11.2/14.0 MVA	Upgrade Transformer #2 (Field Service, Foundation, Grading, Contractors)	1	$2,051,515	$135,275	$446,884	$2,633,674
Dedicated feeder - Extend Substation Bus ("Open Bus" station)	Buswork & connectors, foundation, steel, Does not include breaker (next line)	1	$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	$55,000	$60,000	$100,000	$215,000
Dedicated Feeder – New Circuit Exit	(2) 6" Conduit, 750 MCM Cu cable	1	$21,000	$41,000	$42,572	$104,572
Upgrade Feeder and/or Bus Relays	Reconfigure feeder and/or bus relays	1	$0	$5,480	$4,876	$10,356
Reclose Block (Open Bus)	JVM 8400-120V PT, Steel Attachment, Junction Box, Connectors and Misc. Fittings	1	$3,369	$11,014	$9,767	$24,150
Upgrade Substation Bus #2 Regulator Control	(3) Bi-directional Reverse Flow Regulators w/ Beckwith M-6200A Controllers	1	$44,925	$20,000	$30,422	$95,347
		Qualifying Upgrade Estimated Substation Total	$2,215,809	$342,769	$733,795	$3,292,373.00
		Contingency (15%)				$493,855.95
		Qualifying Upgrade Estimated Substation Total Including 15% Contingency				**$3,786,228.95**
Qualifying Upgrade Distribution Upgrades	**Equipment Components**	**Qty**	**Equipment & Materials**	**Labor**	**Overhead**	**Total**
New Feeder – Construct Distribution Circuit	New feeder from new breaker position in Grimley Rd substation to approx. K45127; 2.44 miles. Conductor, poles, crossarms, guy wires.	12883	$383,275	$1,352,736	$518,549	$2,254,560
Estimating (Unclassified)	Design work		$0	$7,200	$5,112	$12,312
Permitting/Surveying	Survey along Route 9W (New Baltimore, NY)	N/A	$0	$22,000	$3,520	$25,520
Tree Trimming	Trimming easements	N/A	$0	$45,000	$7,200	$52,200
Project Management			$0	$2,400	$1,704	$4,104
		Qualifying Upgrade Estimated Distribution Total	$383,275	$1,429,336	$536,085	$2,348,696.00
		Contingency (15%)				$352,304.40
		Qualifying Upgrade Estimated Distribution Total Including 15% Contingency				**$2,701,000.40**
		Qualifying Upgrade Total Estimated Upgrade Cost				**$6,487,229.35**

Project Specific Budget Category	*Project Specific* Details		*Project Specific* Estimated Costs			
Project Specific Substation Upgrades	**Equipment Components**	**Qty**	**Equipment & Materials**	**Labor**	**Overhead**	**Total**
		Project Specific Estimated Substation Total	$0	$0	$0	$0.00
		Contingency (15%)				$0.00
		Project Specific Estimated Substation Total Including 15% Contingency				**$0.00**
Project Specific 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	$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 new three-phase regulator and controls on new feeder. Sensus radio.	1	$21,760	$11,905	$33,665	$67,330
		Project Specific Estimated Distribution Total	$69,210	$21,305	$59,915	$150,430.00
		Contingency (15%)				$22,564.50
		Project Specific Estimated Distribution Total Including 15% Contingency				**$172,994.50**
		Project Specific Total Estimated Upgrade Cost				**$172,994.50**
		Total Estimated Upgrade Cost (Qualifying Upgrade + Project Specific)				**$6,660,223.85**

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:

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
- 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

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	8/04/2022	Initial Report
2.0	8/25/2022	Cost Estimate Update