# For
# Interconnection Customer: Forefront Solar LLC
# Applicant: Forefront Power LLC
# 5000 kW Photovoltaic (PV) Generator System
# 279 Maple Ave., Goshen, NY 10924

# Interconnection to Orange & Rockland Utilities, Inc.
# NY Central Division
# South Goshen Substation
# 13.2 kV Feeder 89-2-13

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## 1.0 INTRODUCTION

This report presents the analysis results of the Orange & Rockland Utilities ("O&R" or the "Company") interconnection study based on the proposed interconnection and design submittal from the Interconnection Customer. 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 **$859,100.**

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 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, the Company 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 the requirements of the NYSSIR.

## 3.0 COMPANY EPS PARAMETERS

| **Substation** | **South Goshen** |
|---|---|
| Transformer Name (list multiple where normally tied to common bus) | Bank 189 |
| Transformer Peak Load (kW) | 19011 |
| Contingency Condition Load, N-1 Criteria (kW) (as applicable) | None |
| [Daytime, 24 hour] Light Load (kW) | 4922 |
| Generation: Total, Connected, Queued Ahead (kW) | 13266, 1666, 11600 |
| Contingency Condition Generation: Total, Connected, Queued Ahead (kW) | N/A |
| Supply Voltage (kV) | 69 |
| Transformer Maximum Nameplate Rating (kVA) | 20,000 |
| Distribution Bus Voltage Regulation (LTC on substation transformer or voltage regulator at the beginning of a feeder) | No LTC on transformer |
| Transmission GFOV Status | Not installed |

| | |
|---|---|
| Bus Tie (between transformer banks) | open |
| Number of Feeders Served from this Bus | 3 |

| Connecting Feeder/Line | 89-2-13 |
|---|---|
| Peak Load on feeder (kW) | 5182 |
| [Daytime, 24 hour] Light Load on Feeder (kW) | 1288 |
| Feeder Primary Voltage at POI (kV) | 13.2 |
| Line Phasing at POI | 3 |
| Circuit distance from POI to substation | 7.17 miles |
| Distance from POI to nearest 3-phase, (if applicable) | 0 miles |
| Line Regulation | Voltage Regulator |
| Line/Source Grounding Configuration at POI | effective |
| Other Generation: Total, Connected, Queued Ahead (kW) | 5912, 1312, 4600 |

| System Fault Characteristics without Interconnection Customer DG at POI with System Upgrades described in Section 6 | |
|---|---|
| Interconnection Customer POI Location | 279 Maple Ave |
| I 3-phase (3LLL) | 2660 Amps (per ph) |
| I Line to Ground (3I0) | 2542 Amps (Max) |
| Z1 (100 MVA base) use ohm instead | 0.9792+ j3.0891 Ohms |
| Z0 (100 MVA base) use ohm instead | 0.8347 + j3.3695 Ohms |

## 4.0 INTERCONNECTION CUSTOMER SITE

The Interconnection Customer is proposing a new primary service connection. The service voltage is 13.2kV. The applicant is proposing to install 5,000kW Solar PV system (CDG-00352). The proposed POC is on feeder 89-2-13 supplied from Transformer Bank_189 at the South Goshen Substation. The POC is located approximately 7.17 circuit miles from the South Goshen substation.

The proposed generating system consists of:

- Fixed ground mounted solar array with 40 SunGrow inverters
- Total generation capacity is 5000 kW

## 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 105.7% 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 96.1% of nominal. | | | |
| Voltage | Substation Regulation for Reverse Power | <100% minimum load criteria | Fail |
| The total generation on Feeders 89-1-13, 89-2-13, 89-3-13 is 13.26 MW. The total minimum load on these Feeders is 4.92 MW. Therefore, the generation to load ratio is 269.5%. Will reverse flow the substation transformer regularly during Peak PV production hours. | | | |
| Voltage | Feeder Regulation for Reverse Power | <100% Minimum load to generation ratio | Pass |
| No voltage regulator upstream of proposed project | | | |
| Voltage | Fluctuation | <3% steady state from proposed generation on feeder | Pass |
| Voltage | Fluctuation | <5% steady state from aggregate DER on substation bus (75% generation loss) | Pass |
| 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. | Pass |
| No voltage regulator upstream of proposed project | | | |
| Voltage | Flicker | Screen H Flicker | Fail |
| The Pst for the location is 0.65 and the limit is 0.35 therefore the proposed project fails the Screen H test. Would need to reduce PV size to 2675 kW to pass. | | | |
| Equipment Ratings | Thermal (continuous current) | < 90% thermal limits assuming no load | Pass |
| The subject generator's full output current is 218 A. No upstream thermal limits are exceeded | | | |

| | | | |
|---|---|---|---|
| Equipment Ratings | Withstand (fault current) | <90% withstand limits | Fail |
| The additional fault current contribution from the generation contributes to interrupting ratings in excess of existing EPS equipment. The project size would need to be reduced to 3600kVA (however, the flicker screen reduced system size to 2675kW). | | | |
| Protection | Unintentional Islanding | Unintentional Islanding Document & Company Guidelines | Pass |
| The subject generator is a 5 MW PV generation system. It passed SANDIA anti-Islanding screening criteria | | | |
| Protection | Protective device coordination | Company Guidelines | Pass |
| The project will require a DGR. The DGR will coordinate with upstream protective devices. | | | |
| Protection | Fault Sensitivity | Rated capabilities of EPS equipment | Pass |
| No impact from the proposed project. | | | |
| Protection | Ground Fault Detection | Reduction of reach > x% (by Utility) | Pass/Fail |
| The developer hasn't proposed a viable grounding scheme. The grounding shown in the 3LD shows inverter neutrals connected to GSU grounded neutral. However, a review of the inverter manual confirms the proposed inverter doesn't have a neutral. | | | |
| Protection | Overvoltage - Transmission System Fault | Company 3V0 criteria | Fail |
| 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. | | | |
| Protection | Overvoltage - Distribution System Fault | < 138% voltage rise | Pass |
| With subject generator interconnected the modeled voltage rise on the unfaulted phases of the system is 125% | | | |
| Protection | Effective Grounding | IEEE-142 (0<R0/X1<1; 0<X0/X1<3) | Pass |
| With subject generator interconnected the modeled R0/X1 is 0.27 PU and the X0/X1 is 1.09 PU. However, effective grounding isn't achieved because the inverters do not have a neutral (per manufacturer's user manual). A supplemental grounding study is required to size a grounding bank, a zig zag transformer or a neutral grounding reactor. | | | |
| 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. | | | |
| Other | | | |
| [List any unique or other interconnection problems here] | | | |

## 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. 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 | Failures Addressed |
|---|---|
| Operate at fixed power factor of 0.99 lagging | Steady-State Overvoltages |
| Reduce PV size to 2675 kW | Screen H Flicker |
| Reduce Upper setpoint of Capacitor bank 6873119 to 124V. | Overvoltages and Flicker when Capacitor is ON during light load, high PV output. |
| 3V0 protection at substation for new PV site and other substation upgrades for reverse flow | Substation reverse flows |
| Reducing PV size to 3600 kW would reduce the fault current increase to <10% and avoid this | >10% change in fault current |

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:

- Install 3V0 protection
- Upgrade station LTC controls to work properly with the reverse power flow
- Upgrade the existing substation meter with bi-directional meter

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

- Reduce the project size to 2675 kW due to Flicker. Operate the project at 0.99 PF (consuming VARS). Alternatively, request a time-series flicker study to potentially increase allowable system size
- Conductor from Maple Ave to POI.
- Install smart capacitor
- Install an electronic recloser at PCC

- Delay reclosing on the upstream protective devices to 2 seconds to avoid reclosing into live island.

## 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**

| | |
|---|---|
| Primary Metering Cluster Installation | $6,800 |
| Smart Capacitor Installation | $40,700 |
| New conductors from Maple Ave to PCC (1700 ft.) | $115,600 |
| Recloser Installation | $76,000 |
| Commissioning Time Post Installation | $5,500 |
| Design and Inspections | $5,000 |
| Monitoring | $40,000 |
| Contingency (25%) | $72,400 |
| **Total Distribution Estimate** | **$362,000** |

**The following table shows the costs for $3V_0$ installation:**

| | |
|---|---|
| Engineering, Design, Drafting, Admin | $48,590 |
| ECC | $6,500 |
| OH Line | $29,400 |
| SS Ops – Electricians | $117,810 |
| SS Ops – Relay Techs | $96,900 |
| Crane and Rigging | $2,060 |
| Conduits | $10,300 |
| Steel | $1,030 |
| PTs | $35,700 |
| Relays and Panels | $41,200 |
| Connectors, Wire, Misc. | $8,190 |
| Contingency (25%) | $99,420 |

| | |
|---|---|
| **Total Substation Estimate** | **$497,100** |

The total interconnection cost estimate is **$859,100.**

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.

## 8.0 REVISION HISTORY

| Revision | Date | Description of Revision |
|---|---|---|
| 1.0 | 04/16/2019 | Initial document |