Minimum Technical Guidance for the Renewable Energy Growth (REG) Program

Projects installed under the Renewable Energy Growth (REG) tariff should follow best installation practices as outlined in this document. This guidance is not intended to be all-encompassing, nor are they intended to be a substitute for engineering specifications, relevant codes and standards, or for safety requirements. Site-specific conditions and/or local regulations may stipulate additional requirements not contained in this attachment.

Table of Contents:

Solar Photovoltaic (PV)

Third-Party Inspection and Inspection Process

All installations enrolled in the REG program may be subject to a third-party inspection. Installers should notify customers that their system may be selected for inspection, in which event it is required to provide access to the premises. Failure to comply with inspection requirements may result in suspension or revocation of PBI payments.

Installation Guidance

All installations should follow the most **current Rhode Island adopted edition of the National Electrical Code** with the following changes, as noted below. In all cases where manufacturer instructions, third-party guides/handbooks, or other materials contradict the most current edition of any local, state, or federal code, the applicable code shall take precedence over such materials.

- Twist-on wire connectors (wire nuts) shall not be used in any outdoor enclosure unless listed to UL 486D for use in damp/wet locations. Proof of listing will be required during inspection if applicable. (See Article 110.28 for more information)
- Interconnections on the utility side of service disconnecting means are considered a second "set" of service-entrance conductors as permitted in Article 230.40, Exception 5 and 230.82(6), but not considered an "additional service."
    - PV system disconnect must be suitable for use as service equipment, in accordance with Article 230.70.
    - Utility conductors must always be on the line terminals of the disconnect, otherwise fuses will remain energized when disconnect is in open (off) position.
    - Article 230.79(D) requires a minimum rating of 60A, OCPD AIC rating follows 110.9 & 110.10.
    - Service-entrance conductor set required to be sized to disconnect rating, in accordance with Article 230.42(B).
    - Wiring methods for conductors on the utility side of disconnect shall follow Article 230.43.
- Residential installations of ground- and pole-mounted arrays must have a disconnect switch as described in Article 690.17 exception two, located at the array to isolate all DC current carrying conductors. This is not required where the ground- or pole-mounted array consists entirely of AC modules, DC-DC converters (optimizers), or microinverters.
- Areas where wiring passes through ceilings, walls, or other areas of the building must be properly restored, booted, and sealed. Thermal insulation in areas where wiring is installed must be returned to "as found or better" condition.

- An owner's manual of operating and maintenance instructions should be provided to the PV project owner and preferably also posted on or near the PV project. The owner's manual should include manufacturer's specifications, serial numbers, warranty policies, etc.
- Owners should be provided with, at minimum, a basic training orientation that includes maintenance instructions, troubleshooting, meter reading, and electric production reporting instructions.

Roof Guidance

The National Roofing Contractors Association (NRCA) recommends that PV systems should only be installed on roofs with an expected service life at least as long as that of solar components. Solar PV installations on a roof with a shorter life expectancy can pose safety and warranty concerns, including roof leaks or collapses, or costly system removal and reinstallation to accommodate roof replacements. A rooftop solar PV installation has a useful life of 20 to 25 years, with a typical warranty of 10 years. As asphalt shingle roofs have a 20-year life expectancy on average, best practice dictates solar PV should not be installed on homes with roofs older than approximately five to eight years.

Common Installation Violations

- NEC Articles 705.10, 690.54, 690.56, and 110.21 require permanent and/or environmentally suitable labels denoting power source information and locations.
- Terminal ratings and conductor size/limitations must be followed per Article 110.3(B). Common violations include multiple conductors under a terminal listed for a single conductor, or conductors undersized for the terminals, such as inside a meter enclosure.
- Article 250.24(A)(5) prohibits a grounded (neutral) conductor to be connected to ground at any location downstream of the service disconnecting means. Common violations include this connection in a PV meter enclosure or an AC combiner panelboard.
- Indoor-rated twist-on wire connectors (wire nuts) shall not be used in outdoor enclosures. Article 110.28 indicates this area can be a damp or wet location, and such installation may violate the listing of the product, see also Article 110.3(B).
- Article 300.7(A) requires raceways passing from the interior to the exterior of a building be filled with an approved material to prevent the circulation of warm air to a colder section of the raceway.

Shading and Estimated Production Guidance

While the REG program does not have a shading requirement for system eligibility, the Office of Energy Resources recommends following these best practices regarding system shading:

TSRF is a measure of the actual expected irradiance divided by the total irradiance available to a system with optimal siting characteristics (tilt, azimuth, etc.). Note that shading losses are incorporated into the TSRF and that a low TSRF can be the result of shading, non-ideal orientation, or both. PV projects should be designed so that the estimated annual energy output for the PV project is approximately 70%-100% of the default optimal output for a fixed PV project of the same capacity, as estimated by PVWATTS or a similar tool. Optimal parameters for purposes of a PVWATTS estimate are:

1) 0.89 DC to AC derate factor,
2) 42 degree array tilt, and
3) 180 degree (True South) azimuth. PVWATTS is available at the following website: http://pvwatts.nrel.gov.

Installers can measure the TSRF of a specific site using Solmetric SunEye technology. When measuring TSRF, installers should take measurements at all four corners of each proposed array location. The TSRF for each array is the mean of the readings taken at each of the four corners of the array. The overall TSRF is a weighted average of the individual array TSRF values, weighted by nameplate capacity. For example, a system with two arrays:

- Array 1: TSRF=90%, Capacity=5kW
- Array 2: TSRF=70%, Capacity=6kW

This system would have an overall TSRF of (0.9)(5kW)+(0.7)(6kW) divided by 11kW, or 0.79.

TSRF values are measured and documented at all system inspections.

Wind Technology

Estimated Production Guidance

Estimated annual electricity generation for wind energy projects may be made using a bin analysis method, such as NREL's WindCAD model or an equivalent tool that combines a wind speed probability distribution with a wind turbine power curve and includes relevant adjustments for local terrain, vegetation, and turbine operational characteristics. Key inputs include:

- Wind Speed: Annual mean wind speed should be obtained from a reputable data source with a minimum spatial resolution of 2.5km x 2.5km
- Anemometer Height: The reference height accompanying the annual mean wind speed. Standard heights include 30m, 50m, and 80m
- Wind Shear: The wind shear is used to adjust wind speeds to match the proposed tower height and reflect, generally, how rough the local terrain is. Commerce RI recommends the following wind shear values based on general nearby terrain:
    - Grass: 0.15
    - Cropland/agricultural: 0.22
    - Scattered trees and hills: 0.29
    - Sparse forest/buildings: 0.34
    - Dense forest/urban setting: 0.44
- Tower Height: The proposed height of the tower
- Adjusted Hub Height: The anticipated hub height of the wind turbine, less the mean canopy height, where mean canopy height is the average height of densely packed obstructions within 10 rotor diameters of the tower location. For example, a 140ft tall tower surrounded by 40ft average canopy height forest would have an adjusted hub height of 100ft. Adjustments to canopy height based on packing density may be made at Commerce RI's discretion.

It is also recommended to include a wind rose, to indicate the directionality of the site wind resource.

Installation Guidance
All wind energy projects should be installed per Article 695 of the current edition of the National Electric Code, as well as all relevant equipment installation instructions and engineering specifications. In addition, the following site-specific characteristics are recommended: • The bottom of the rotor swept area must be at least 30ft above all surrounding obstructions within 500ft of the tower base. • Installers building wind energy projects installed on parcels less than 5 acres in size should make neighbors aware of all possible acoustic and aesthetic impacts of the installation.
Common Installation Violations
• Wind energy projects are frequently sited incorrectly with relation to the available site wind resource. It is important to use the most accurate wind data possible and to position the wind turbine to minimize obstructions to wind flow. Though this is particularly important in the windward direction, obstructions downwind of the wind turbine can also negatively impact the available wind resource. • All towers and associated equipment must be properly grounded to minimize the risk of lightning strikes.

Interconnection Methods for Solar PV Programs in Rhode Island

Based on the 2014 National Electrical Code (NEC)

Introduction

Rhode Island currently has two frequently-used solar PV incentive programs. The Renewable Energy Growth (REG) Program is a tariff-based program overseen by National Grid; this program is strictly for an interconnection on the utility side of any existing meter. The Renewable Energy Fund (REF) program, overseen by the Rhode Island Commerce Corporation, is a grant program for behind-the-meter (Net Metering) PV installations. A PV installation may receive an incentive from only one program; the program-specific interconnection requirements must be adhered to ensure incentive eligibility.

Rhode Island Renewable Energy Growth (REG) Program Interconnection

The Rhode Island Renewable Energy Growth (REG) program is a tariff-based incentive program hosted by National Grid. Because of the very nature of the program, the PV system must be connected to a dedicated utility meter to properly measure system output, as outlined by Section 4 of the REG Program Tariff document (RIPUC No. 2151). Unlike conventional interconnection methods, the PV system for this program is a new "tenant" on the property. With an existing electrical service, the PV system must be connected to the utility side of the existing electric meter, as shown by the top blue arrow in Figure 1. Furthermore, Figure 2 illustrates the addition of the new dedicated electric meter to the existing electrical service. Because this is considered a supply-side connection in the NEC, the requirements of Article 705.12(A) and 230 must be followed. National Grid[1] currently allows two different methods to install the new REG PV meter.

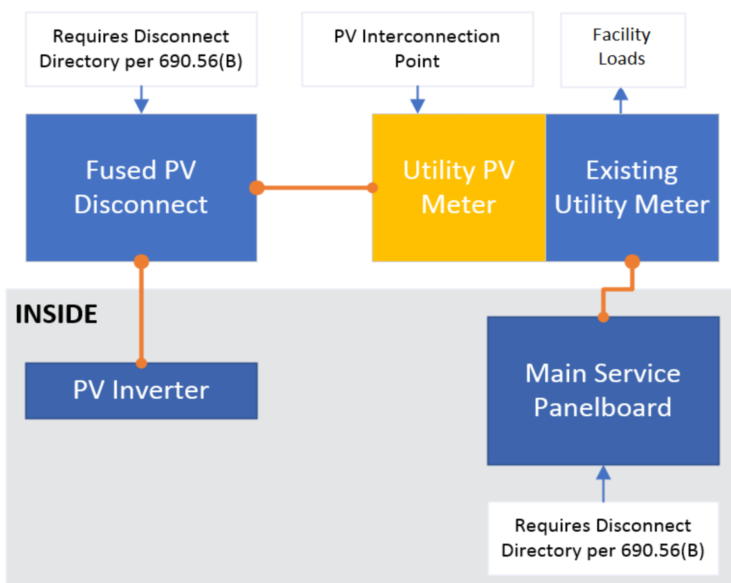

Figure 1. PV Interconnection as New "Tenant" in Existing Electrical Service

Multi-Gang Meters

For both overhead and underground electrical services, the existing meter enclosure can be replaced with a multi-gang enclosure to accommodate the new "tenant" at this location. Figure 3 shows an example of the new multi-gang meter enclosure method. This is currently the only allowable option for underground electrical services.

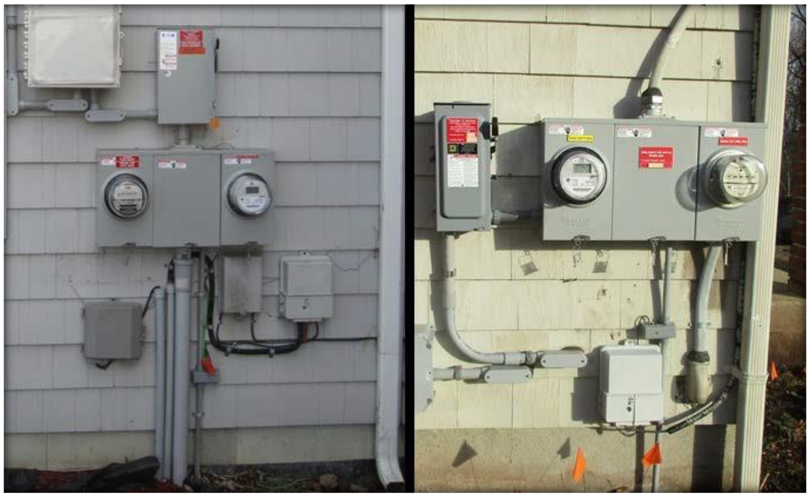

Figure 3. New Multi-Gang Meter Enclosures in Existing Underground (left) and Overhead (right) Electrical Services

Separate Service to each Meter

For overhead electrical services, an alternative to replacing the existing meter is a connection at the service point with a parallel service drop to the new REG meter. Figure 4 shows this alternative connection method with the PV system components. This method does not alter any existing electrical components, however consideration should be taken for the overhead splice methods that will likely be exposed to weather.

Figure 4. New REG Electrical Service in Parallel with Existing Service

Net Metering Interconnection

Upon approval of a net metering facility's interconnection application, the utility will replace the existing electric meter with a NET meter that is capable of recording electricity usage in both directions. At the end of the billing month, the customer pays the net amount, which may be a bill credit if the PV system produced more electricity than the property consumed. Article 705.12 of the NEC identifies two possible interconnection locations: supply-side and load-side of the main service disconnecting means.

Supply-Side Connection

Article 705.12(A) of the NEC provides allowance and guidance for interconnections on the utility side of the service disconnecting means. References are made to Article 230, which are requirements for electrical services. For the REF program, this interconnection would be between the service disconnecting means (main breaker) and utility meter. See the center red arrow of Figure 1.

Load-Side Connection

Article 705.12(D) of the NEC provides allowance and guidance for the various types of connections on the load side of the service disconnecting means. The two primary types are backfed circuit breakers in an existing panelboard and feeder taps. The lower red arrow of Figure 1 shows a backfed circuit breaker. Article 705.12(D)(2)(3) outlines the specific requirements for this type of interconnection, including consideration for existing equipment and overcurrent protection size as well as specific location in the panelboard. Alternatively, Article 705.12(D)(2)(1) provides requirements for feeder tap interconnections, often located between the service disconnecting means and a sub-panel.