# Minimum Technical Requirements for the Renewable Energy Fund

All Rhode Island Renewable Energy Fund projects must demonstrate compliance with the Minimum Technical Requirements set forth in this document. These requirements are 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. Commerce RI reserves the right to withhold payment to any project that does not satisfy the Minimum Technical Requirements.

## Solar Photovoltaic (PV)

### Shading and Estimated Production Requirements

The PV project must be designed so that the estimated annual energy output for the PV project is at least 80% 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/.

The PV project must have a measured total solar resource fraction (TSRF) of 0.8 or greater and is subject to TSRF verification by Solmetric SunEye (or equivalent shade measurement tool) during onsite inspection. 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. When measuring TSRF, applicants must 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, and would therefore be ineligible for an incentive.

Commerce Rhode Island has approved the Solmetric SunEye and Solar Pathfinder shading tools as program-compliant means of measuring and reporting TSRF for project applications. Helioscope, Bright Harvest and Aurora shading tools are also approved provided they utilize a method that measures onsite obstructions. All other methods must be proposed to, and approved by, Commerce RI prior to submitting an incentive application. All shading reports edited to indicate the future removal of obstructions must submit proof of such removal.

### Installation Requirements

All installations must follow the most **current 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)
- 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 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.
- Commerce RI requires that photos be taken of the following system components for all rooftop solar arrays, including: array and PV modules, DC disconnect, string inverters (including transformerless units), microinverter/DC optimizer, AC disconnect/AC combiner, and interconnection (supply side and load side). These photos shall be kept on record with the primary installer and made available to Commerce RI upon request.
- An owner's manual of operating and maintenance instructions must 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 must be provided with, at minimum, a basic training orientation that includes maintenance instructions, troubleshooting, meter reading, and electric production reporting instructions.
- Solar PV projects designed to be installed on pitched, non-flat roofs, are required to have an azimuth that is the same as the roof azimuth, in order to be eligible to receive a rebate.

## Roof Requirements

PV arrays shall not be installed on any roof that is expected to be replaced within 10 years, or that contains damage that may require repair or early replacement.

## Common Installation Violations

- 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).
- NM-B cable (Romex®) shall not be sleeved in outdoor raceways. Article 300.9 defines the interior of such raceways as a wet location and Article 334.12(B)(4) prohibits this cable to be installed in a wet location.

- 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.
- 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.
- 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.

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## Wind Technology

### Estimated Production Requirements

Estimated annual electricity generation for wind energy projects must 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 shall include:

- Wind Speed: Annual mean wind speed shall 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.

Commerce RI also recommends including a wind rose, to indicate the directionality of the site wind resource.

For projects with rated generator output, at 11 m/s, greater than 1MW must estimate annual generation based on at least 6 months of onsite meteorological data and a measure-correlate-predict (MCP) analysis correlating short-term monitoring with long-term local weather conditions.

### Installation Requirements

All wind energy projects must 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, Commerce RI has the following specific requirements:

- The bottom of the rotor swept area must be at least 30ft above all surrounding obstructions within 500ft of the tower base
- Applicants seeking grant funding for wind energy projects installed on parcels less than 5 acres in size shall include signed letters of support from all abutting neighbors as attachments to the grant application. These letters must indicate that neighbors have been made aware of all possible acoustic and aesthetic impacts and have no opposition to the proposed project.

## 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

# Anaerobic Digestion

## Estimated Production Requirements

Because the energy production from anaerobic digestion is highly dependent on feedstock, operating conditions and selected digestion process, these requirements are provided as guidance. The feedstock to the anaerobic digestion system should meet the following guidance values for methane gas production:

**Methane Gas Production by Feedstock***

| Feedstock | Total Solids (%) | $CH_4$ Yield ($m^3$ per metric ton) |
|---|---|---|
| WWTP sludge | 3-20 | 40-75 |
| Livestock manure | 3-12 | 14-18 |
| Food waste | 10-30 | 60-110 |
| Organic MSW | 15-35 | 50-95 |

* adapted from Cenex, June 2009

As noted in the table below, the efficiency of the overall anaerobic digestion system depends on the selected energy conversion technology. It is recommended that the energy efficiency of the selected technology meet these ranges of guidance values.

| Technology | Net Electrical Efficiency | | Net Thermal Efficiency | | Size Range kW |
|---|---|---|---|---|---|
| | Range % | Typical % | Range % | Typical % | |
| Internal Combustion Engine | 25 – 45 | 33 | 40 – 49 | 40 | 50 – 5K |
| Internal Combustion Engine – Lean Burn | | 37 | | | |
| Gas Turbines | 23 – 36 | 30 | 40 – 57 | 40 | 250 – 250K |
| Microturbines | 24 – 30 | 27 | 30 – 40 | 35 | 30 – 250 |
| Steam Turbine | 20 – 30 | 25 | 20 – 45 | 45 | 500 – 1,300K |
| Stirling Engine | 25 – 30 | 27 | 45 – 65 | 60 | 1 – 50 |

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## Installation Requirements

Depending on the proposed technology (low or high solid, single stage/multistage, mesophilic, thermophilic), the anaerobic digestion system must be installed in accordance with the manufacturer instructions and design engineer specifications.

## Common Installation Violations

As noted above, the design and construction of anaerobic digestion depends on the process configuration.

The construction contractor/installer must also comply with all local permitting requirements.