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 or for safety requirements. Site-specific conditions and/or local regulations may require 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 faction (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.

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Biomass

Equipment Requirements

Biomass heating systems must meet the requirements in the table below. Commerce RI may periodically modify these requirements as biomass heating technology evolves. If these requirements are modified the equipment requirements at the time of application submission will determine the eligibility of a project's biomass heating system:

REF Commercial-Scale Central Biomass Heating System Requirements		
	Pellet Systems	**Wood Chip Systems**
Thermal Efficiency (HHV)	≥85% at nominal output	≥75% at nominal output*
Particulate Emissions	<0.08 lb PM2.5/MMBTUinput at nominal output (<0.03 lb PM2.5/MMBTU input at Sensitive Receptor Sites)	<0.10 lb PM2.5/MMBTUinput at nominal output (<0.03 lb PM2.5/MMBTUinput at Sensitive Receptor Sites)
CO Emissions	270 ppm at 7% O_2	
Startup	Automatic (i.e. electronic ignition)	
Modulation/shut off	The system must automatically modulate to lower output and/or turn itself off when the heating load decreases or is satisfied	
Pressurized portion of the system	ASME certification required	

*Projects must commit to use wood chips with equivalent or less moisture content than the submitted test data and to conduct new HHV testing on any major feedstock changes. Incentive recipients must also agree to maintain a feedstock log, in which they will record fuel delivery to the biomass system (including weight, wood type, source, and HHV test results).

Applicants are strongly encouraged to include advanced emissions control technology to achieve emissions rates lower than these basis requirements. Emissions control technologies such as condensing economizers can also improve energy efficiency of the heating system.

Thermally-led Combined Heat and Power (CHP) systems are allowed to participate in the Program. Thermally-led CHP systems must be sized based on the thermal load of the building and System Owner must operate the system only when there is a thermal load. The efficiency of the combined thermal and electric output of the system must meet the requirements in the table above, based on fuel type. For example, the combined electrical and thermal efficiencies of a pellet CHP system must be at least 85% at the normal output.

Systems that are capable of burning either pellets or wood chips must be able to meet both sets of requirements based on which type of fuel they are burning.

Commerce RI prefers that higher heating value (HHV) efficiency is tested based on an input/output method. Alternatively a simple full load, steady-state combustion efficiency measurement by a stack loss method (such as the Canadian Standards Association B415) may be used, but in this case, the minimum efficiency requirement is 88% HHV for pellet heating systems and 78% HHV for wood chip heating systems. Where a combustion efficiency measurement is used, the return water temperature must be greater than 130°F. Commerce RI is willing to consider alternative test methods suggested by the installer.

Stack Height

Stack heights should be consistent with good engineering practice to minimize the wake effects caused by buildings or terrain on emissions. The design of the exhaust stack and location should be done carefully to prevent exposure to building occupants and visitors or to people in frequently occupied outdoor areas such as playgrounds. The boiler's stack height must be sufficient to adequately disperse emissions from the immediate vicinity and prevent ingress of exhaust gases and particles into the building air intakes and to minimize exposure at ground level adjacent to the building on which the stack is being located. Poor dispersion characteristics are generally associated with short stacks that have little plume rise. This happens when stacks are too short relative to the building height or the exhaust flow is not sufficient, resulting in the plume not escaping the building's aerodynamic effects and becoming trapped in or near the building. For example, the stack should be a minimum of five feet above the highest point of a large flat building that it is heating and above the roof height of any other taller building within 100 feet of the unit. In no case should the stack height be at or below the building height. In addition, the stack should not be placed in close proximity to an air intake or operable window. Stack design should also minimize horizontal piping and bends.

Note that stack height must follow local zoning and permitting regulations, obtaining a variance where needed to attain the appropriate height for plume dispersal.

Fuel Quality and Sustainability

	Pellets	Chips
Calorific Value	> 8,000 Btu/lb	> 5,950 Btu/lb
Moisture	< 6%	< 30%
Ash	< 1%	< 3%
Source Materials	Only wood pellets or wood chips. Grass, construction & demolition waste are excluded.	

Compliance with the pellet fuel quality standards can be demonstrated through certification against standards such as the PFI Premium or ENPlus A1. The Biomass Energy Resource Center's Woodchip Heating Fuel Specification provides a resource for evaluating wood chip sourcing. Available at: http://www.biomasscenter.org/images/stories/Woodchip_Heating_Fuel_Specs_electronic.pdf

Eligible biomass fuels may be co-fired with fossil fuels, provided that only the renewable energy fraction of production from multi-fuel facilities shall be considered eligible for funding.

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

Bulk Fuel Storage and Delivery Requirements

	Pellet Systems	Wood Chip Systems
Storage Structure	Pellets must be stored in an outdoor silo or in an enclosure built only for the storage of biomass fuel. Access points to site-built or outdoor bulk storage units must be locked at all times when the storage unit is not being accessed. Only professionals utilizing appropriate safety procedures should enter bulk pellet storage units.	Wood chips must be stored in an appropriately sized and covered storage unit suitable for the capacity of the proposed boiler. Commerce RI highly recommends utilizing air flow to partially remove water vapor from wood chip surfaces and to improve the caloric value of the feedstock. Applicants should evaluate incorporating any technology utilizing passive evaporation from airflow such as solar hot air, waste or by-product heating, or active heating such as fan blown air to partially pre-dry chips.
Signage	All enclosed bulk storage units must be labeled with clearly visible, permanent signs at access points stating that access may only be made by qualified professionals.	
Delivery to Storage	The pellet storage unit must be capable of receiving bulk delivery via pneumatic hose from a delivery truck. The delivery point must be located 80 feet or less from the street or driveway and accessible to bulk pellet delivery trucks.	The wood chip storage unit should be accessible to delivery trucks for bulk delivery. Commerce RI highly recommends that the storage unit is capable of receiving bulk delivery via pneumatic hose from a delivery truck.
Capacity	Storage units must have a minimum capacity of 5 tons; there is no maximum capacity.	
Delivery to Heating Systems	The system must have a bulk fuel storage unit that automatically supplies the boiler or furnace with the pellets or wood chips by pneumatic hose or auger.	

Sizing and Heat Load Calculation Requirements

Equipment must be sized according to Air Conditioning Contractors of America (ACCA) Manual CS for commercial buildings or Manual S for residential buildings. For Projects located at residential buildings, the Central Heater must be between 80% and 110% of the building's peak heating load. For Projects at non-residential buildings, Commerce RI will support Projects that are designed to meet only a portion of a Project Site's peak heating load if they are installed in combination with other heating systems, but the capacity of the Central Heater cannot exceed 110% of the building's peak heating load. Commerce RI will evaluate exceptions to these sizing requirements on a case-by-case basis.

Other Project Requirements

The Central Heater must be designed for installation in a weatherproof, insulated space inside the building, either in a basement or a room designed specifically to accommodate the heating system, although if space does not permit, it may be installed in a separate structure. Central Heaters designed for outdoor installation or tested to or designed for EPA test method 28 are not permitted.

The heating system must include a positive closure and/or fire extinguishing device and/or emergency disconnection device between the burn chamber and the bulk storage device to keep fire from reaching the pellet storage area and a grounded or anti-static fuel pipe connecting the boiler or furnace to the storage bin.

The system must adhere to all applicable federal, state and local building codes and regulations, safety standards and certifications.

Steam boilers are not eligible for this Program. Central Heaters that are capable of burning multiple fuel types are not eligible for this Program. Pellet burners that are installed on existing boilers are not eligible for this program.