



# **Small Wind System Installation Requirements**

**Developed by Energy Trust of Oregon**

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## Revisions

Energy Trust updates these installation requirements annually. Many thanks to the industry members and inspectors that invested their time to ensure this document is up to date.

In 2011, the requirements for eligible turbines were removed from this document and turned into the *Eligible Small Wind System Requirements*, which can be found on the trade ally pages of the Energy Trust website.

Numerous other changes to the requirements and the organization of this document were made during the same revision process. As a result, many of the sections have been moved, added and renumbered. In addition, explanations and guidance have been added to many of the requirements. The additional information is intended to assist small wind professionals in following best practices, and clarify the intent of the standards.

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## 1.0 Purpose

This Small Wind System Installation Requirements document details the requirements and minimum criteria for a small wind system (“System”) installed by a Small Wind Program trade ally under Energy Trust’s Small Wind Program (“Program”).

The purpose of these installation requirements is to promote high performance and longevity of Systems that receive Energy Trust incentive funding, as well as to promote the practices that meet or exceed current industry standards. All Systems are required to comply with all applicable building and electrical codes, which address health and safety. Energy Trust reserves the right to require compliance with installation specifications that may differ from those of a manufacturer or exceed applicable codes. Any variations from the Program’s system installation requirements must receive prior approval from Energy Trust.

**NOTE:** Energy Trust does not install energy systems or equipment nor does it guarantee performance, safety or longevity of any System installed through its assistance or programs. Energy Trust is not responsible for assuring that the design, engineering, or construction of any System is proper or complies with any particular laws, regulations, codes, licensing, certification and permit requirements or industry standards. Energy Trust does not make any representations of any kind regarding the results to be achieved by any System or the adequacy or safety of such measures. Installation work is done by independent businesses that are solely responsible for the quality and performance of their installations.

## 2.0 System Requirements

### 2.1 General

- 2.1.1 System shall be grid-connected and installed on real property in Oregon that receives electrical service directly from Portland General Electric or Pacific Power.
- 2.1.2 System shall meet local utility interconnection and net metering requirements, if applicable.
- 2.1.3 Installation shall be of industry standard and workmanlike quality.
- 2.1.4 System design shall be documented with a schematic diagram that accurately describes all electrical components to be installed and the wiring design. Diagram shall include:
  - Major components, with specifications listed
  - Power conductor and equipment ground wire types and sizes
  - Raceway types and sizes
  - Length of wire runs
  - Applicable subpanel(s), main service panel and utility connection
  - AC and DC overcurrent protection device types and sizes
  - Any planned or existing generation inputs (e.g. wind, solar, micro-hydro)
- 2.1.5 System shall be properly permitted, inspected, and in compliance with all applicable building and electrical codes.

- 2.1.6 System equipment installers shall be licensed according to the Oregon Building Codes Division and shall be working for a contractor that is licensed according to the Oregon Construction and Contractors Board.

## **2.2 Materials**

- 2.2.1 Materials used outdoors shall be sunlight/UV-resistant and listed for outdoor locations.
- 2.2.2 Materials used shall be designed to withstand the maximum high and low temperatures to which they are exposed.
- 2.2.3 Dissimilar metals that have galvanic action (such as aluminum and steel) shall be isolated from one another using industry standard practices.
- 2.2.4 Aluminum shall not be placed in direct contact with concrete materials.
- 2.2.5 Only high-quality fasteners appropriate for the environment where they are installed shall be used. Stainless steel fasteners shall be coated with an anti-seize lubricant to prevent galling and allow for removal during System maintenance or repair.

## **2.3 Wind System Equipment and Installation**

- 2.3.1 All installed System components shall be new or approved refurbished.
- Energy Trust may, at its discretion, review and approve for installation completely rebuilt and refurbished small wind turbines with full equipment warranties. Any refurbished turbine is required to comply with the Eligible Small Wind System Requirements.
- 2.3.2 Wind turbine shall be on the list of Energy Trust eligible small wind systems. See Section 3.0.
- 2.3.3 The bottom of the turbine rotor shall be 30 feet or more above any obstacles within 300 feet of the System.
- 2.3.4 System shall be set back from all power lines, property lines and habitable buildings a distance equal to or greater than the hub height plus the rotor radius.
- When taken in consideration with the minimum tower height requirement in Section 2.4.3, this set-back requirement exempts most properties less than one acre in size. The System Owner may receive an exemption from the property line and/or habitable building set back if they submit a signed and completed *Form 765: Turbine Location Consent and Release*<sup>1</sup>. Trade allies should properly inform System Owners of the risks associated with not setting the System back from property lines and habitable structures.
- 2.3.5 Wind turbine shall not be mounted on any pre-existing structures.
- Any structure or tower to which the turbine is mounted must comply with all the requirements in Section 2.4. If the System is attached to a building, the building must be certified by a licensed professional engineer to accommodate the turbine and tower at the site.
- 2.3.6 Clearances for all equipment shall be per manufacturer specifications and applicable code.
- 2.3.7 Diversion load(s) shall be clearly identified as a heat source by a permanent label..
- If the equipment is not clearly visibly labeled as a source of heat by the manufacturer, a label must be provided.
- 2.3.8 Components shall be mounted securely.

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<sup>1</sup> Available online at <http://www.energytrust.org/trade-ally/programs/small-wind/resources/>

- 2.3.9 Manufacturer warranties shall cover:
- Inverter for a minimum of 5 years against manufacturer's defects
  - Wind turbine for a minimum of 5 years against manufacturer's defects
  - Tower for a minimum of 5 years against manufacturer's defects
- 2.3.10 Equipment shall not be modified in such a way that it voids the listing or manufacturer warranty.
- 2.3.11 Means of disconnection from all sources of power (both AC and DC) shall be provided such that inverter source and output circuits can be safely isolated and removed in an emergency or for service. If the disconnection means is not within sight from the utility meter, the location shall be clearly identified on the utility meter.
- In the case of Systems that regulate turbine speed using the turbine output circuit, using a disconnect or plug as a shorting switch is considered an appropriate means of disconnection. Trade allies should refer to Oregon Electrical Specialty Code for further guidance on the use of shorting switches as a disconnection means.
- 2.3.12 Disconnection means shall be designed to be switched under load without an arcing hazard. Pull-out style disconnecting means shall not be used.
- 2.3.13 Electrical terminations shall be torqued to specifications, secured, and strain-relieved as appropriate. Wire ends shall be coated with anti-corrosive compound prior to termination.
- 2.3.14 Cables, raceway, exposed conductors, and electrical boxes shall be secured and supported according to code requirements and in accordance with their performance ratings (i.e. NEMA). Cables, raceway, conductors and electrical boxes on the tower shall be supported for a vibration environment.
- Junction boxes on the tower in the shadow of the rotor should be particularly well secured using secure bolt connections or additional strapping to prevent boxes from becoming loose over time.
- 2.3.15 Raceway used on the tower shall qualify as equipment grounding type raceway in accordance with Oregon Electrical Specialty Code.
- If conductors are directly run inside a monopole tower or tower leg without conduit, the tower or leg should be certified as a raceway to ensure the System is protected from lightning-induced voltage, per Oregon Electrical Specialty Code Article 250.118.
- 2.3.16 Twist-on wire connectors shall not be used on DC conductors or ground wires, or any conductors on the tower. Instead, these wire connections shall be made using terminal strips or blocks in listed enclosures boxes, or other similar mechanical wire splicing devices. When outdoors or exposed to moisture, wire connectors shall be listed for wet locations and mounted in such a way to prevent moisture from being trapped in the connector.
- 2.3.17 Junction boxes shall be listed and suitable for their environment and conditions of use.
- 2.3.18 Permanent labels shall be applied to System components as required by the Oregon Electrical Specialty Code.
- 2.3.19 Disconnect switch coverplates (not switch handles) shall be secured closed for safety such that they require a tool or key to open.
- 2.3.20 Equipment shall include lightning protection and surge suppression.
- The Telecommunications Infrastructure Standard 222 should be referenced in designing lightning protection. The conductivity of the soil, tower type, and use of the site should be taken into consideration in the design. Surge suppression should be designed to protect the primary System components from damage from both the turbine and utility side.

2.3.21 Inverter or controller settings changed in the field shall be documented in the customer manual.

2.3.22 Means for documenting software version upgrades to equipment shall be provided on the equipment or in the customer manual.

2.3.23 Wire size and type, or voltage drop, shall comply with manufacturer requirements.

Conductors should be sized to meet both the inverter and turbine manufacturer's requirements, while maximizing production.

2.3.24 Hardware and structural members shall be either:

- Hot-dip galvanized steel per ASTM standard A123 equivalent or better.
- Coated or painted steel (not allowed in marine environments).
- Corrosion-resistant aluminum.
- Stainless steel (recommended for marine environments).

These structural and hardware requirements do not apply to towers, which must be engineered per Section 2.4.1 and 2.4.2.

## **2.4 Tower and Foundation**

2.4.1 Tower shall be engineered to accommodate the wind turbine at the site.

Manufacturer-provided engineering is acceptable. Certain sites, such as those near train lines, may require special consideration for tower and foundation design. Towers and guy wires should be protected from livestock access to prevent damage.

2.4.2 Foundation shall be engineered to accommodate the load of the wind turbine and tower given the site's soil conditions, and design must be approved and stamped by a licensed professional engineer.

Dry-stamped foundation design should be appropriate for the soil type at the location or the worst possible soil conditions. Otherwise, the foundation must be certified by an Oregon engineer.

2.4.3 Tower shall be a minimum of 60 feet tall.

2.4.4 Guyed tower turnbuckles shall be secured by lacing with the guywire or a cable no smaller than the guywire.

2.4.5 Lay-down area for tilt-up towers shall remain clear of permanent vegetation or structures to provide access for maintenance and repair.

System Owners should be advised to keep the area where the tower is tilted down for maintenance access clear from all obstructions. The lay-down area should be identified on the site plan.

2.4.6 Tower shall be straight and plumb.

2.4.7 Permanent safety signage shall be visibly posted on the tower per American National Standards Institute (ANSI) Z535.2.

On the bottom ten feet of the tower, climbing access should be restricted by removing the climbing apparatus or erecting some other means of limiting access. It is strongly recommended that climbing safety equipment be permanently installed on the tower during System installation.

## **2.5 Wind Monitoring Equipment and Installation**

2.5.1 Monitoring equipment shall carry a minimum one-year equipment warranty.

2.5.2 Monitoring software, if applicable, shall include a one-year minimum software license.

2.5.3 Monitoring equipment shall meet the following specifications:

- Data logger shall be mounted to allow convenient data recovery.
  - If located outside or in a wet environment, the data logger shall be mounted in a weather-tight enclosure unless it is designed for outdoor applications.
  - System shall be capable of measuring and recording wind speed within  $\pm 5\%$  accuracy.
  - System shall be capable of measuring either i) wind speed, sampled every two to ten seconds and recorded at ten-minute average intervals, or ii) wind run. Data shall be reported to the Program as average and min/max monthly wind speed..
- 2.5.4 Wind monitor shall be mounted one rotor diameter below the turbine hub and a minimum of three feet away from any point of the tower. The sensor shall be located with reference to the prevailing wind direction in such a way that it is neither directly upwind nor directly downwind of the turbine tower.

Locating the anemometer in this way minimizes the impact the tower and blade have on the wind at the location of the monitor, resulting in more accurate data collection.

## **2.6 Wind Resource**

- 2.6.1 Annual average wind speed at the hub height of the System shall be equal to or greater than 10 mph. See *Program Guide for Small Wind Trade Allies*<sup>1</sup> for instructions on calculating annual average wind speed at hub height.

## **2.7 Output Meter**

- 2.7.1 “Revenue quality” electric meter which measures the AC output of the wind System shall be installed on the AC output side of the inverter(s) or controller and meet the following specifications:
- ANSI C-12 tested and certified revenue meter
  - Electromechanical meters accurate to within 2% of actual System output (ANSI C-12.10)
  - Electronic meters accurate to within 1% of actual System output (ANSI C-12.16)
  - One of the following configurations
    - Single-phase 120 volt – Form 1S – Class 100
    - Single-phase 240 volt – Form 2S – Class 200
    - Three-phase 120-480 volt – Form 14-16S – Class 200
  - Meter warranty of not less than 1 year
  - Refurbished meters may be used with the Program’s pre-approval.
- 2.7.2 Multiple-inverter Systems shall either combine output through a dedicated sub-panel from which the output is metered or use one electric meter for each inverter.
- 2.7.3 Meter(s) shall be identified with a permanent label as “*Wind Turbine Output.*” If located outdoors, this label shall be UV-resistant.
- 2.7.4 Meter(s) shall be set at 000000 at time of shipment to the installer to ensure accurate and consistent start readings for every System.

## **2.8 Battery-based Systems**

- 2.8.1 Batteries shall be located in a secure enclosure that meets seismic requirements and is weatherproof, as needed.
- 2.8.2 Access to live battery terminals shall be limited per Oregon Electrical Specialty Code.
  - For safety, batteries should be placed in an enclosure that is well secured and requires a tool to open.
- 2.8.3 Flooded lead acid batteries shall be housed in an enclosure with adequate spill containment and vented to the outdoors, with a nearby, clearly marked safety kit.
- 2.8.4 Battery connection and inverter cables shall be properly sized, with secured crimps and lugs on ends. Lugs and terminals shall be listed for the wire type used.
  - Set-screws have been shown to damage fine-stranded conductors and are not recommended.
- 2.8.5 Charge controller, inverter, and associated equipment switches, jumpers and settings shall be appropriate for the System configuration and documented in the customer manual.
- 2.8.6 Components for which a temperature compensation option is available shall be installed per manufacturer instructions to control battery charge properly.
- 2.8.7 If the turbine may produce voltages that could damage the System in the absence of grid power, diversion equipment (controller(s) and load(s)) shall be installed and properly adjusted per Oregon Electrical Specialty Code.
- 2.8.8 Control system shall be capable of limiting or handling the output of all generating sources in the absence of grid power or user load.
- 2.8.9 Customer manual shall include instructions for operation, maintenance and safety procedures for batteries and charge controller.
- 2.8.10 AC output meter shall be of the 5-jaw type, and correctly wired to meter power flows to both utility and AC loads.

## **3.0 Eligible Wind Systems**

To qualify for Energy Trust incentives, Systems must demonstrate that they meet standards for durability, acoustics, longevity and performance. Qualified Systems can be found on the Program's list of eligible small wind Systems on the Energy Trust website<sup>2</sup>. The requirements and minimum criteria for a System to qualify to be added to the eligible wind Systems list can be found in the *Eligible Small Wind System Requirements*<sup>1</sup> document.

**NOTE:** Energy Trust does not endorse any particular manufacturer or product in promoting its programs. The fact that the names of particular manufacturers, products or systems may appear on Energy Trust program materials does not constitute an endorsement. Manufacturers, products or systems not mentioned are not implied to be unsuitable or defective in any way. Energy Trust is not responsible for assuring that the design, engineering, or construction of any wind system project is proper or complies with any particular laws, regulations, codes, licensing, certification and permit requirements or industry standards. Energy Trust does not make any representations of

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<sup>2</sup> Available online at <http://energytrust.org/shared-resources/info/small-wind-turbines.aspx?src=business>

any kind regarding the results to be achieved by any eligible turbine listed or any wind energy system or the adequacy or safety of such systems.

## **4.0 Customer Manual**

Upon completion of the installation, the Program trade ally shall provide the System Owner with a manual (the “Customer Manual”) and instruct the owner on proper system operation and maintenance.

The Customer Manual provides accurate System documentation for the current System Owner, as well as future owners and service personnel. The Customer Manual shall be bound in a durable and professional-looking binder, and shall contain, at minimum, three sections: 1) System Design and Operation, 2) Warranties and Installation Documentation, 3) Manuals and Data Sheets.

### **4.1 Section 1 — System Design and Operation**

- 4.1.1 **System Overview Page:** *Form 721: Small Wind System Overview*<sup>1</sup> or an equivalent overview page summarizes the System’s operating conditions and provides emergency information.
- 4.1.2 **Operation & Maintenance Instructions:** Installer’s written instructions for System start-up and shut-down procedure, troubleshooting guidelines and recommended routine maintenance schedule. Battery-based systems shall include items noted in Section 2.8.9.
- 4.1.3 **Electrical As-built Diagram:** Schematic diagram that accurately depicts all electrical components installed, as detailed in Section 2.1.4.
- 4.1.4 **Site Plan:** Diagram showing layout, including indication of lay-down area for tilt-down tower.
- 4.1.5 **Mechanical Design:** Description of wind turbine and tower, including engineering specifications of structural elements, foundation blueprints and manufacturer installation instructions.
- 4.1.6 **Upgrades, Modifications, Repairs & Service:** Documentation of all field modified settings, software upgrades, repairs, performed maintenance and other System changes.

### **4.2 Section 2 — Warranties and Installation Documentation**

- 4.2.1 **Contractor Warranty:** Program trade ally’s 2-year minimum full System warranty covering labor, workmanship and materials.
- 4.2.2 **Manufacturers’ Warranties:** Written warranties and product registration instructions for wind turbine, inverter(s) and other primary components.
- 4.2.3 **Incentive Application:** Final version of the signed form showing incentive and System configuration approved by Energy Trust.
- 4.2.4 **Permit(s):** Copy of approved electrical and building permits and final inspection reports for the System.
- 4.2.5 **Utility Net Metering Agreement:** Copy of the agreement between the utility customer and the utility.

### **4.3 Section 3 — Manuals and Data Sheets**

- 4.3.1 **Parts and Source List:** If not documented elsewhere, bill of material listing all System components including part numbers. If feasible, inverter and wind turbine serial numbers shall be recorded to facilitate replacement in the case of product recall or recovery in the case of theft.
- 4.3.2 **Inverter Owner's Manual:** Documentation from inverter manufacturer.
- 4.3.3 **Wind Turbine Owner's Manual:** Documentation from turbine manufacturer.
- 4.3.4 **Tower & Foundation Documentation:** Documentation of tower and foundation from tower manufacturer.
- 4.3.5 **Wind Monitoring System Owner's Manual** (if applicable): Documentation from wind monitoring System manufacturer.
- 4.3.6 **Manufacturer Data Sheets or Manuals for Major Components:** Including but not limited to: charge controller, controller, diversion load, batteries, disconnect switches, ground fault protection equipment, lubricants, and lightning arrestors, unless covered in the manuals listed above.