Wind Systems that work for Rural Communities

By Al Christensen
Wind Basics
Objective

• Planning process to installation phase.
• Discuss wind resources, site location technology and sizing.
• Review County zoning issues
• To provide a practical understanding of small wind turbine systems.
• Utility interconnection agreements.
• Review costs, incentives and tax credits.
Defining Small Wind Systems

- Small wind systems are rated by their potential generating capacity. The maximum output in watts of the turbines generator is used as a base comparison.

- Example; a 2.5 kW or 2,500 watt turbine system has a generator capable of producing 2,500 watts maximum power.

- Small wind systems are defined as wind turbines with generating capacities between 1 kW and 100 kW.
### Big Wind Milestones / Benchmarks & Values

<table>
<thead>
<tr>
<th>Milestone</th>
<th>Value</th>
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</thead>
<tbody>
<tr>
<td>Site Selection</td>
<td>8%</td>
</tr>
<tr>
<td>Land Lease Agreements</td>
<td>11%</td>
</tr>
<tr>
<td>Wind Assessment / Study</td>
<td>10%</td>
</tr>
<tr>
<td>Environmental Review</td>
<td>4%</td>
</tr>
<tr>
<td>Economic Modeling</td>
<td>2%</td>
</tr>
<tr>
<td>Interconnection Studies</td>
<td>8%</td>
</tr>
<tr>
<td>Permitting &amp; Licensing</td>
<td>10%</td>
</tr>
<tr>
<td>Sales Agreements</td>
<td>17%</td>
</tr>
<tr>
<td>Financing</td>
<td>6%</td>
</tr>
<tr>
<td>Equipment Selection &amp; Purchase</td>
<td>11%</td>
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<tr>
<td>Construction &amp; Contracting</td>
<td>7%</td>
</tr>
<tr>
<td><strong>Operations &amp; Maintenance Agreement</strong></td>
<td>6%</td>
</tr>
<tr>
<td>Power Purchase Agreement (PPA)</td>
<td>100%</td>
</tr>
</tbody>
</table>
Small Wind Stages / Benchmarks

Wind system siting considerations

Wind resource - site assessment, wind maps, shear, turbulence & topography

Wind speed at tower height

Local County zoning requirements, soil types, set backs, neighbor consideration

Wind turbine options - technology, tower options, heights, footings, balance of system

Local Utility interconnection agreements, net-metering

Financial considerations, up front costs less - grants, tax credits, rebates & savings

Insurance, warranty, O & M service
SITING CONSIDERATIONS

- Remember your 2 enemies!
  - Ground drag
  - Turbulence
- Start with 30’ rule—the entire rotor must be 30’ above than anything within 500’...
- ...or the treeline in the area, which ever is higher
- Note prevailing wind direction and site upwind of obstacles
- Rougher surfaces due to complex terrain or ground clutter = gustier winds → highest elevation
- Minimize turbulence due to ground clutter with taller towers + distance ★ vertical separation ★
- Remember: trees grow, towers don’t
- Remember the “3 most common mistakes”
- Short wire runs
- Respect neighbors
- Obey zoning restrictions (setbacks)
Location Considerations & Concerns

- Minimum hub height = bottom of blade + turbine blade radius.
- Minimum tower height = H + 30'-0" + minimum hub height.
- 10H minimum.
- 30'-0" minimum.
120 feet: Water or open grassy areas
90 feet: Row crops, low buildings, or fencerows
60 feet: 60 foot trees
40 feet: 90 foot trees
Visual method of determining height

Figure 5
Adapted from *Energy Alternatives* by Time-Life Books

\[ D = C \times \frac{A}{B} \quad \text{or} \quad D = 180 \text{ feet} \times \frac{10 \text{ inches}}{30 \text{ inches}} = 60 \text{ feet} \]
Shadow method of determining height
Use your wind resource to hit your target
Achieve your energy % goals
Wind Speed
At 30 meters

Minnesota's Wind Resource by Wind Speed at 30 meters

This map has been prepared under contract by WindLogics for the Department of Commerce using the best available weather data sources and the latest physics-based weather modeling technology and statistical techniques. The data that were used to develop the map have been statistically adjusted to accurately represent long-term (40 year) wind speeds over the state, thereby incorporating important decadal weather trends and cycles. Data has been averaged over a cell area 500 meters square, and within any one cell there could be features that increase or decrease the results shown on this map. This map shows the general variation of Minnesota's wind resource and should not be used to determine the performance of specific projects.

January 2006
Wind Speed
At 80 meters
DETERMINING AVERAGE WIND SPEED AT HUB HEIGHT

1. GET ANNUAL/MONTHLY AVERAGE WIND SPEEDS FROM WEATHER BUREAU, LOCAL AIRPORT, OR ENERGY BUREAU (TRIANGULATE, IF NECESSARY)

2. GUESSTIMATE YOUR TOWER HEIGHT (30' - 500' RULE) (DON’T FORGET MATURE TREE HEIGHTS)

3. DETERMINE YOUR SITE’S SURFACE FRICTION COEFFICIENT

4. DETERMINE HEIGHT CORRECTION FACTOR

5. MULTIPLY AVERAGE WIND SPEED BY HEIGHT CORRECTION FACTOR

= AVERAGE WIND SPEED AT PROPOSED HUB HEIGHT AT YOUR SITE

6. SIZE WIND GENERATOR USING THIS AVERAGE WIND SPEED

7. CORRECT FOR AIR DENSITY, IF NECESSARY
# SURFACE FRICTION COEFFICIENT

from: The Wind Power Book by Jack Park

<table>
<thead>
<tr>
<th>Description of terrain</th>
<th>$\alpha$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Smooth, hard ground, lake or ocean</td>
<td>0.10</td>
</tr>
<tr>
<td>Short grass on tilled ground</td>
<td>0.14</td>
</tr>
<tr>
<td>Level country, foot high grass, occasional tree</td>
<td>0.16</td>
</tr>
<tr>
<td>Tall row crops, hedges, a few trees</td>
<td>0.20</td>
</tr>
<tr>
<td>Many trees and occasional buildings</td>
<td>0.22-0.24</td>
</tr>
<tr>
<td>Wooded country; small towns and suburbs</td>
<td>0.28-0.30</td>
</tr>
<tr>
<td>Urban areas, with tall buildings</td>
<td>0.40</td>
</tr>
</tbody>
</table>
Increase in wind speed over a ridge

from: A Siting Handbook for Small Wind Energy Conversion Systems
To extrapolate wind speeds to hub height:

\[ V = \left( \frac{H}{H_0} \right)^{\alpha} V_0, \text{ where:} \]

\[ V = \text{the wind speed at the desired height} \]
\[ V_0 = \text{the wind speed at the original height} \]
\[ H = \text{the tower height} \]
\[ H_0 = \text{the original height that the wind speed was measured at} \]
\[ \alpha = \text{the wind shear coefficient} \]

Values for the equation might fill out as follows:

\[ V = \left( \frac{H}{H_0} \right)^{\alpha} V_0 \]
\[ V = (120' / 200')^{0.240} \times 15 \text{ mph} \]

therefore, \[ V = 13.3 \text{ mph} \]
Betz’s Law:

Doubling the wind speed produces an eightfold increase in power from the wind

from: Don Marier, *Wind Power For The Homeowner*
Theoretical Increase in Wind Speed with Increasing Height above Ground

From: Planning a Wind-Powered Generating System by Enertech Corporation
Theoretical Increase in Wind Speed and Energy with Increasing Height Above Ground

From: Planning a Wind-Powered Generating System by Enertech Corporation
10% increase in wind speed = 33% increase in available power !!!
Wind Rose

Wind rose graphs illustrate the percent time and percent energy in each direction sector. The wide, outlined bars represent the percent of total energy and the narrower, shaded bars illustrate the percent of total time in each of the sixteen direction sectors.
Reviewing The Prerequisites to Installing a Small Wind System

• Investigating land use and zoning restrictions.

• One of the first steps in the process, check with the local permitting and zoning authority, insure they have an ordinance on the books.

• Understand the height restrictions, set back requirements, tower types acceptable and specific process the permitting authority would like to see followed.
736. Wind Energy Conversion Systems

736.1 Purpose – This ordinance is established to regulate the installation and operation of Wind Energy Conversion Systems (WECS) within Brown County not otherwise subject to sighting and oversight by the State of Minnesota under the Minnesota Power Plant Sighting Act (MS 116C.51-116C.697.)

The application for all WECS shall include the following information:

- The names of project applicant
- The name of the project owner
- The legal description and address of the project.
- A description of the project including: Number, type, name plate generating capacity, tower height, rotor diameter, and total height of all wind turbines and means of interconnecting with the electrical grid.
- Site layout, including the location of property lines, wind turbines, electrical wires, interconnection points with the electrical grid, and all related accessory structures. The site layout shall include distances and be drawn to scale.
- Engineer’s certification
- Documentation of land ownership or legal control of the property
### 736.4 Setbacks – Wind Turbines and Meteorological Towers

All towers shall adhere to the setbacks established in the following table.

<table>
<thead>
<tr>
<th>Wind Turbine – Non-Commercial</th>
<th>WECS Wind Turbine – Commercial WECS</th>
<th>Meteorological Towers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Property lines</td>
<td>1.5 times the total height</td>
<td>1.5 times the total height</td>
</tr>
<tr>
<td>Neighboring Dwellings*</td>
<td></td>
<td>750 feet***</td>
</tr>
<tr>
<td>Road Rights-of-Way [**]</td>
<td>1.5 times the total height</td>
<td>1.5 times the total height</td>
</tr>
<tr>
<td>Other Rights-of-Way (Railroads, power lines, etc)</td>
<td>1.5 times the total height</td>
<td>1.5 times the total height</td>
</tr>
<tr>
<td>River Bluffs</td>
<td>750’</td>
<td></td>
</tr>
</tbody>
</table>

* Meteorological towers are considered a conditional use permit in the A-1 Agricultural Protection Zoning District.

** The setback for dwellings shall be reciprocal in that no dwelling shall be constructed within 750 feet of a commercial wind turbine.
Common Concerns of Wind Turbines

**Table 2: Causes of Bird Fatalities**

<table>
<thead>
<tr>
<th>Number per 10,000 fatalities</th>
<th>Decibels</th>
</tr>
</thead>
<tbody>
<tr>
<td>5,500 – buildings/windows</td>
<td>150</td>
</tr>
<tr>
<td>1,000 – domestic cats</td>
<td>140</td>
</tr>
<tr>
<td>1,000 – other</td>
<td>130</td>
</tr>
<tr>
<td>800 – high tension lines</td>
<td>120</td>
</tr>
<tr>
<td>700 – vehicles</td>
<td>110</td>
</tr>
<tr>
<td>700 – pesticides</td>
<td>100</td>
</tr>
<tr>
<td>250 – communication towers</td>
<td>90</td>
</tr>
<tr>
<td>Less than 1 – wind turbines</td>
<td>80</td>
</tr>
</tbody>
</table>

Source: Erickson et al., 2002. Summary of Anthropogenic Causes of Bird Mortality

**Table 1: Turbine Sound Chart**

- jet airplane: 150
- pneumatic drill: 140
- industrial noise: 130
- stereo music: 120
- inside car: 110
- office: 100
- home: 90
- wind turbine: 80
- bedroom: 70
- whispering: 60
- falling leaves: 50
- 20
- 10

Source: The American Wind Energy Association
Basic Types of Systems
Horizontal Axis Wind Turbines (HAWT)

Vertical Axis Wind Turbines (VAWT)
Can also be done with a battery bank as well

Battery banks or Energy storage systems can help you peak shave or load shift to minimize utility peak time billing
Ideal for remote locations such as irrigation stations or cabins.
courtesy Don Martin, Wind Power For The Homeowner

MW-W
10-12 MPH Wind Speed

MW-W T
25-65 MPH
Freestanding Tower Details

from: Winpower Installation Manual
Guyed Lattice Tower
What They Do and How They Work

• Blades – Blades work when the wind blows over the blades and the blades then lift and rotate.

• Controller – This piece of equipment starts the wind turbine when the wind speed is at about 10 - 16 MPH and stops when the wind speed reaches 55 MPH to avoid any damage to the turbine.

• Generator – Generates 60 cycle AC electricity.

• Towers – Towers are made of tubular steel, steel lattice or concrete and taller towers help generate more electricity since the wind rate increases with height.
The industry is diverse and manufacturers vary widely in degree of maturity. Over 300 different models (in various stages of development) exist worldwide, of which 100 are engineered by U.S. manufacturers.

Specific design advances include:

- Active pitch controls to maintain energy capture at very high wind speeds
- Vibration isolators to dampen sound
- Advanced blade design and manufacturing methods
- Operation capability in lower wind speeds
- Alternative means of self-protection in extreme winds
- Adapting a single model to either on-grid or off-grid use
- Slower rotor speeds (to reduce sound levels)
- Software and wireless display units
- Inverters integrated into the nacelle (rotor hub)
- Rare earth permanent magnets rather than ferrite magnets
- Induction generators in place of power electronics
- Electronics designed to meet stronger safety and durability standards
- Systems wired for turnkey interconnection
- More visually attractive
- Integrating turbines into existing tower structures, such as utility or light poles
Traditional Turbine Parts & Pieces

1. Blades
2. Rotor
3. Pitch
4. Brake
5. Low-speed shaft
6. Gear box
7. Generator
8. Controller
9. Anemometer
10. Wind Vane
11. Nacelle
12. High-speed shaft
13. Yaw drive
14. Yaw motor
15. Tower
Direct drive machine (NO Gearbox) – Northwinds 100 kW
In PM generators, a coil is wrapped around a specially designed disc at the centre axis. Magnetic discs then rotate on the sides of the coiled disc and generate electricity. This kind of power generating technology is therefore ideal for wind power generation because its initial operation torque (cut-in speed) is lower. *The use of PM technology also eliminates the number one casual factor for wind turbine failure – a gearbox.*  

Polaris Company
WTIC Jacobs 20 kW, single phase, up wind
Minnesota made – Prior Lake!
31-20 SPECIFICATIONS

Output........................Grid Interie 240 volt A.C. 60hz
                                 single phase power
Rating..........................................................20 kw
Type................................Horizontal upwind design
Cut in wind speed.................................8mph
Peak output wind speed.........................26 mph
Rotor type..............................3 blade Variable pitch
Rotor RPM @ rated output power...............175
Rotor diameter........................................31 feet
Transmission......................Offset Hypoid gear drive
Ratio - Rotor to alternator...............6.1:1
Alternator type.......................Brushless 3 phase with
                                   outboard exciter
                                   Rating..........................25KVA, 3phase, 0-180 volts
Protection:
  Yaw control......................Dual fold tail vane
  Overspeed.........................Blade actuated governor
  High wind/storm...............Offset rotor axis
Tower:
  Type..............................Free standing, 3 leg design
  Construction......................Angle Iron
  Heights available..............80' - 100' - 120'
  Brake Type.......................Caliper-disc type

Wind Turbine Industries Corp. continually improves its products and therefore reserves the right to change the design, materials and/or specifications without notice.

In the energy conscious person of today we see a desire to reduce electrical usage or cut the cost paid for energy consumption.

A Jacobs® Wind System can provide you a means of offsetting the ever-rising costs of your electrical energy.

Wind Turbine Industries Corp.
16801 Industrial Circle S.E.
Prior Lake, MN. 55372
952-447-6049
wtic@windturbine.net
www.windturbine.net
Net Metering - The power company is required to buy back the excess power generated by Grid Connected systems. This buy back rate varies, please check with your certified dealer or local utility for more information.

For more detailed information on wind energy please visit our site: www.windturbine.net

WIND TURBINE INDUSTRIES
Ventera VT 10, 10 KW, down wind,
Proven 2.5 kW

Proven 6 kW

Proven 15 kW

http://www.provenenergy.co.uk/

From Scotland – it’s a down wind machine

Blades bend in on springs in high winds

Low maintenance, almost 30 years in manufacturing, more expensive than others
Gaia 11 kW, 2 blade, 3 phase, down wind machine, made in the United Kingdom
ARE 442, 10 kW, 3 phase

ARE 110, 2.5 kW, 3 phase

US made, upwind machines
www.AbundantRE.com
Vestas, V 15 35 kW

Vestas V-15 65kW

Vestas V-17 90kW
Endurance, 5, 35, 50 kW, upwind machine, induction gen. set,
Entegrity, 50 kW, down wind, 3 phase machine
Polaris 10, 20, 39, 50, 100, 500 kW
1 MW all direct drive machines
Balance of System
Example Mid Sized Turbine
Example Large Turbines, Wind Farm
Mariah Power, Vertical axis, 1.2 kW, pm gen set, single phase

*** See NREL Report
Vertical Axis Wind Turbines
<table>
<thead>
<tr>
<th>Manufacturer</th>
<th>Models (Rated Capacity)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abundant Renewable Energy</td>
<td>ARE110 (2.5KW), ARE442 (10KW)</td>
</tr>
<tr>
<td>Aerostar</td>
<td>Aerostar 6 Meter (10KW)</td>
</tr>
<tr>
<td>AeroVironment</td>
<td>AVX-1000 (1kW system)</td>
</tr>
<tr>
<td>Bergey Windpower Co.</td>
<td>BWC XL.1 (1 kW), BWC EXCEL (10 kW)</td>
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<tr>
<td>Energy Maintenance Service</td>
<td>E15 (35 kW or 65 kW)</td>
</tr>
<tr>
<td>Entegrity Wind Systems</td>
<td>EW50 (50 kW)</td>
</tr>
<tr>
<td>Gaia-Wind Ltd</td>
<td>11kW</td>
</tr>
<tr>
<td>Northern Power</td>
<td>NPS 100 (100 kW)</td>
</tr>
<tr>
<td>Proven Energy, Ltd.</td>
<td>Proven 2.5 (2.5kW), Proven 6 (6kW), Proven 15 (15kW)</td>
</tr>
<tr>
<td>ReDriven Power, Inc.</td>
<td>2kW  5kW  10kW  20kW</td>
</tr>
<tr>
<td>Southwest Windpower Co.</td>
<td>AIRX (400 W), Whisper 100 (900 W), Whisper 200 (1 kW), Whisper 500 (3 kW),</td>
</tr>
<tr>
<td></td>
<td>Skystream 3.7 (1.8 KW)</td>
</tr>
<tr>
<td>Ventera Energy, Inc.</td>
<td>VT10 (10kW)</td>
</tr>
<tr>
<td>Wind Turbine Industries Corp.</td>
<td>23-10 Jacobs (10 kW), 31-20 Jacobs (20 kW)</td>
</tr>
</tbody>
</table>
Blade Diameters & Swept Area

- **Endurance E-3120:**
  - 3,120.0 sq. ft., 63.0 ft. diam.
- **Gaia-Wind 133-11:**
  - 1,425.0 sq. ft., 42.6 ft. diam.
- **Proven 35:**
  - 684.5 sq. ft., 29.5 ft. diam.
- **Fortis Alize:**
  - 426.0 sq. ft., 23.3 ft. diam.
- **Excel-R:**
  - 380.0 sq. ft., 22.0 ft. diam.
- **Scirocco:**
  - 265.0 sq. ft., 18.4 ft. diam.
- **Evance Iskra R9000:**
  - 246.0 sq. ft., 17.7 ft. diam.
- **Whisper 500:**
  - 176.0 sq. ft., 15.0 ft. diam.
- **Kestrel e400i:**
  - 135.0 sq. ft., 13.0 ft. diam.
- **ARE 110:**
  - 110.0 sq. ft., 11.8 ft. diam.
- **Kestrel e300i:**
  - 76.0 sq. ft., 10.0 ft. diam.
- **Whisper 200:**
  - 63.5 sq. ft., 9.0 ft. diam.
- **Northwind 100:**
  - 3,725.0 sq. ft., 69.0 ft. diam.
- **Halus Power Systems V-17:**
  - 2,462.0 sq. ft., 56.0 ft. diam.
- **WTIC 31-20:**
  - 754.0 sq. ft., 31.0 ft. diam.
- **ARE 442:**
  - 442.0 sq. ft., 23.6 ft. diam.
- **Excel-S:**
  - 415.0 sq. ft., 23.0 ft. diam.
- **Endurance S-343:**
  - 343.0 sq. ft., 21.0 ft. diam.
- **Proven 11:**
  - 255.6 sq. ft., 18.0 ft. diam.
- **Fortis Montana:**
  - 211.0 sq. ft., 16.4 ft. diam.
- **Raum 3.5:**
  - 135.0 sq. ft., 13.2 ft. diam.
- **Skystream 3.7:**
  - 113.0 sq. ft., 12.0 ft. diam.
- **Proven 7:**
  - 103.0 sq. ft., 11.5 ft. diam.
- **Raum 1.3:**
  - 73.0 sq. ft., 9.5 ft. diam.
- **XL.1:**
  - 53.0 sq. ft., 8.2 ft. diam.
U.S. MARKET TRENDS

At A Glance: The market for small wind in the U.S. in 2008 Units sold 12,092, of which 11,487 (95%) were sold by U.S. by manufacturers.

14% growth since 2007, representing 9.7 additional megawatts (MW) of capacity, Sales of $42,000,000

Figures in all charts in this study represent additional units/kW/\$ sold, not annual accumulation. See the data revision to the 2008 AWEA Small Wind Turbine Global Market Study http://www.awea.org/smallwind/documents/Data_Revision_to_the_2009_AWEA_Small_Wind_Gl
Why Consider Small Wind?

**Price Stability:** The price of electricity from fossil fuels and nuclear power can fluctuate greatly due to highly variable mining and transportation costs. Wind can help buffer these costs because the price of fuel is fixed and free.

**Free Fuel:** Unlike other forms of electrical generation where fuel is shipped to a processing plant, wind energy generates electricity at the source of fuel. Wind is a native fuel that does not need to be mined or transported, taking two expensive aspects out of long-term energy costs.
Why Consider Small Wind?

• The potential for wind energy is immense, and experts suggest wind power can supply up to 20% of U.S. and world electricity. Nevertheless, the United States currently produces less than 1% of our electricity from wind.

• Distributed Generation & more Independence

• Revitalizes Rural Economies: Wind energy can diversify the economies of rural communities, adding to the tax base and providing new types of income
• **Creates Jobs:** Wind energy projects create new short and long term jobs. Related employment ranges from meteorologists and surveyors to structural engineers, assembly workers, lawyers, bankers, and technicians.
Net Metering

Excess Returns to Grid
Connecting to the utility grid

Most Utilities now have a Distributed generation Agreement in place and will send, fax or email. Have an experienced wind installer complete.

One time connection fee, approximately $250, includes a required anti-islanding test and a meter swap to a net meter, billing setup.
Working with your local utility & availability of Net Metering

• The states of MN has passed laws giving residents the legal right to interconnect or grid tie their wind turbine system or PV system to the utility grid.

• MN has a net meter limit of 40 kW, over which the clients retail rates will no longer apply.

• Contact the electric utility and request their distributed generation agreement form.
DISTRIBUTED GENERATION INTERCONNECTION REQUEST
Interstate Power and Light Company (IPL)

INSTRUCTIONS:
1. This request is required for customers who are intending to install generation on its premises that will operate connected to the Interstate Power and Light Company (IPL) distribution system.
2. This request is intended to provide IPL personnel with information to determine requirements for interconnection of the customer's generation to the IPL distribution system.
3. This completed request form with application fee should be mailed to the following address:
   • Include $200.00 application fee.
   Alliant Energy - IPL, Distributed Generation Interconnection, G017, P.O. Box 351, Cedar Rapids, IA 52406-0351

OWNER/APPLICANT INFORMATION

<table>
<thead>
<tr>
<th>Owner / Company (Legal Entity Name)</th>
<th>Contact Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phone No.</td>
<td>( )</td>
</tr>
<tr>
<td>Fax No.</td>
<td>( )</td>
</tr>
<tr>
<td>Street Address</td>
<td>E-mail Address</td>
</tr>
<tr>
<td>City</td>
<td>State</td>
</tr>
</tbody>
</table>

PROPOSED LOCATION OF GENERATOR UNIT

<table>
<thead>
<tr>
<th>Street Address</th>
<th>Account No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>City</td>
<td>State</td>
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DESIGN ENGINEER

<table>
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<th>Contact Name</th>
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</tr>
<tr>
<td>Fax No.</td>
<td>( )</td>
</tr>
<tr>
<td>Street Address</td>
<td>E-mail Address</td>
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<tr>
<td>City</td>
<td>State</td>
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ELECTRICAL CONTRACTOR

<table>
<thead>
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<th>Contact Name</th>
<th>Phone No.</th>
<th>Fax No.</th>
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</thead>
<tbody>
<tr>
<td>Street Address</td>
<td>E-mail Address</td>
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</tr>
<tr>
<td>City</td>
<td>State</td>
<td>ZIP</td>
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</table>

GENERATOR/INVERTER DATA

<table>
<thead>
<tr>
<th>Manufacturer</th>
<th>Model No.</th>
<th>Total Number of Units Installed</th>
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<tbody>
<tr>
<td>Total Rated Output (kW)</td>
<td>Rating Voltage (volts) at Utility Meeting Point</td>
<td></td>
</tr>
<tr>
<td>Phase(s) Required at Utility Meeting Point</td>
<td>Energy Source</td>
<td></td>
</tr>
<tr>
<td>1 Phase</td>
<td>3 Phase</td>
<td></td>
</tr>
<tr>
<td>Type</td>
<td></td>
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<tr>
<td>[ ] Inverter</td>
<td>[ ] Induction Generator</td>
<td>[ ] Synchronous Generator</td>
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</table>

TECHNICAL REQUIREMENTS

| Customer agrees to comply with the Generation, Testing and Maintenance Requirements as Specified in Section 6 of the IPL Technical Guidelines? |
| YES | NO |

ESTIMATED CONSTRUCTION DATES

<table>
<thead>
<tr>
<th>Start Date</th>
<th>Completion Date</th>
<th></th>
</tr>
</thead>
</table>

ECRM15057973 REV. 4 12/09
ONE-LINE DIAGRAM OF GENERATOR INSTALLATION

Draw or attach a one-line diagram of the installation to this request form per requirements of Section 8 and Appendix 1 of the Technical Guidelines. The one-line diagram should show the specific location of the external disconnect.
Incentives
What is REAP / USDA Grant?

This is a GREAT program for people in the rural areas to receive funding help with Renewable Energy (RE) and Energy Efficiency (EE) projects related to BUSINESS use (not residential). Both GRANT opportunities (up to 25% of eligible project cost) and Guaranteed Loan opportunities (up to 50% of project cost) exist. You can also apply for a Combination Grant and G. Loan. The Guaranteed Loan is a Guarantee from the Govt. to your local lender, who may then be willing to give you a lower interest rate on the loan.

There is $100 Million in this program for FY 2010, nationwide, up from $60 Million last year. Applicants can be either Rural Small Businesses or Agricultural Producers. Non-profit organizations cannot apply, but “Blocker Corporations” can be utilized.

Projects can be any of the following – Wind, Solar, Geothermal (Ground Source Heat Pump), Bio-energy including production of bio-fuels, Anaerobic Digesters, Hydrogen, Energy Efficiency (grain dryers, irrigations, building envelope and lighting improvements, equipment switch-out for lower energy, etc.) EE grant applications require either an energy assessment or an energy audit (if projects costs > $50,000) performed by a utility or a knowledgeable energy manager or engineer.
MN Small Wind Rebate Program

- The Minnesota Small Wind Turbine Rebate for Residences provides financial support for the installation of small wind turbine systems completed after July 1, 2009 with rated capacities not more than thirty-five kilowatts (35 kW) at 24.6 miles per hour (mph). The rebate amount is 35% of eligible system and installation costs up to $10,000. To be eligible:
  - a small wind turbine system must be installed at an existing primary residence in Minnesota;
  - a system must be installed by a bonded and/or licensed contractor as applicable under state and local requirements;
  - a system must have a minimum average wind speed of 12.0 mph at hub height;
  - an installation must comply with all applicable federal, state and local requirements; and
  - an installation must be completed within six months (180 days) of approval of the rebate application.
Rebate Requirements

1. All major system components must be new or remanufactured.

2. A 5-year warranty is required on major system components and installation, with the exception of batteries, for which a 2-year warranty is required.

3. The tower design must be approved by a professional engineer for use with the proposed turbine. Page 4 of 10 4/10-1

4. The minimum tower height allowed for rebate is 80 ft, measured at hub height, unless it can be demonstrated that a minimum wind resource of 12 mph is available at a lower hub height.

5. Rooftop or building integrated wind turbines are not eligible for rebate.

6. For grid-connected systems, inverters must be UL 1741 listed or listed by another nationally recognized testing laboratory.

7. Eligible Equipment
Eligible Equipment for Rebate

MANUFACTURER MODEL

• Abundant Renewable Energy ARE110
• Abundant Renewable Energy ARE442
• Aerostar Aerostar 6 Meter
• Bergey Windpower Co. BWC XL.1
• Bergey Windpower Co. BWC EXCEL-S
• Endurance Wind Power S-250
• Endurance Wind Power G3120
• Enertech 44a
• Gaia-Wind Ltd 11 kW
• Proven Energy, Ltd. Proven 7
• Proven Energy, Ltd. Proven 11
• Proven Energy, Ltd. Proven 35-2
• Southwest Windpower Co. Skystream 3.7
• Southwest Windpower Co. Whisper 100
• Southwest Windpower Co. Whisper 200
• Southwest Windpower Co. Whisper 500
• Ventera Energy Inc. VT10
• Wind Turbine Industries Corp. 23-10 Jacobs
• Wind Turbine Industries Corp. 31-20 Jacobs
Obtaining a wind energy assessment and finding a consultant

• In MN please see the following web site link to find wind assessors, consultants & installers in MN,
  http://www.state.mn.us/mn/externalDocs/Commerce/Hiring_a_Renewable_Energy_Dealer_121302010223_How2Hire.pdf

• www.energy.mn.gov, new web site for information about renewables in MN
• Making sure you receive a comprehensive assessment.

• A good wind site assessment should cover a thorough review of the wind site characteristics.

• Including permitting and zoning approvals, setbacks, tower types and heights, wind resource at the site to various hub heights, distance to interconnection and obstacles, electrical use, electrical interconnections, NEC 2010 code compliance, utility interconnection, a review of estimated costs, performance/output and incentives that would apply.
30% Federal Tax Credits

U.S. Treasury Department
Application for Section 1603:

Payments for Specified Renewable Energy Property in Lieu of Tax Credits

• This is one of two parts of the application package for payment under the Section 1603 program. The other document is the signed Terms and Conditions. All applicants must submit
• this application form before October 1, 2011. Applicants who place a qualified property in service during 2009 or 2010 should submit the application form and the Terms and Conditions
• form at the same time after the property has been placed in service. Applicants who have begun construction of a qualified property during 2009 or 2010 and have not yet placed the
• property in service by the date of application, should submit only this application (not the Terms and Conditions) before October 1, 2011 to demonstrate that construction began during
• 2009 or 2010. Once the qualified property is placed in service, the applicant should submit both an updated application form and the signed Terms and Conditions document, indicating
• the identification number (issued by Treasury) of the applicant's preliminary submission.
• While there are directions in this application, they are not a substitute for reading and understanding the Program Guidance, Terms and Conditions, Section 1603 of the American
• *All fields are required unless otherwise noted. Fill out the form in order, as lower sections are affected by upper section choices. Allowed values are marked in italics, items in square
Overview of the installation process

- Permit in hand
- Interconnection agreement with utility
- Qualified and experienced contractor
- Any and all incentive programs reviewed and pre-approved if needed prior to purchase
- Engineered plans, electrical and structural, warranty agreement
Repair, maintenance and longevity of the system

Expected system life is 20 to 25 years with proper maintenance.

Qualified wind installers provide yearly maintenance visits. Each system has a manufacturers yearly maintenance routine.
Can you do it yourself

Yes, check with permit and zoning to see if there are restrictions and manufacturer restrictions if any for warranty issues.

Requires project managing sub contractors, may end up costing more than experienced crew.
Case Studies of Small Wind Installations
Camden Park, SW MN
NREL
http://www.nrel.gov/wind/smallwind/independent_testing.html

NREL Maps
http://www.nrel.gov/gis/wind.html
http://www.nrel.gov/gis/mapstore/
http://www.nrel.gov/wind/international_wind_resources.html

NREL In My Backyard
http://www.nrel.gov/eis/imby/about.html
http://mercator.nrel.gov/imby/

NREL School Wind Projects
http://www.windpoweringamerica.gov/schools/projects.asp

Large Developers
http://en.openei.org/wiki/Main_Page
http://windpoleventures.com/wpv/
http://www.3tier.com/en/
http://www.awstruepower.com/
US DOE Maps
http://www.windpoweringamerica.gov/wind_maps.asp

MN Office of Energy Security
http://www.state.mn.us/portal/mn/jsp/content.do?subchannel=-536895045&id=-536893809&agency=Energy

MN Small Wind Rebate Grant
http://www.state.mn.us/mn/externalDocs/Commerce/Minnesota_Small_Wind_Residential_Rebates_042910043316_MNWindRebateAppl.pdf

MN Maps
http://www.state.mn.us/portal/mn/jsp/content.do?subchannel=-536895045&programid=536917310&sc3=null&sc2=null&id=-536893809&agency=Energy

MN Small Wind Speed Tool
http://host.appgeo.com/MinnesotaWind/

AWEA, American Wind Energy Association:
www.awea.org
http://www.windustry.org/

Midwest Renewable Energy Association
http://www.mreacsa.org

Rebates throughout United States
www.dsireusa.org
Resources and References

Map Resources

• Google Earth and Virtual Earth
• Mapquest.com
• Maps.yahoo.com
• Terraserver-USA.com
Books


Sponsored By

Region Nine
Renewable Energy Task Force

Al Christensen
alc@energyconcepts.us
612-636-9499