Wind Assessment Report Supplement

focus on energy™

The power is within you.

1) Wind Basics

When talking about generating energy from the wind, there are some basic principles that need to be understood:

- **The site needs to have a good wind resource**; otherwise the wind turbine cannot work at its designed efficiency and will not produce the expected amount of power. A good wind resource includes a sufficiently high wind speed and minimal turbulence. Details about what makes a good wind resource will be discussed later in this document.

- **The surrounding terrain should be relatively free of clutter**; wooded and urban areas are considered very cluttered. This is why you see wind farms in wide open fields and in the water.

  The energy generated by a wind turbine is directly proportional to the "swept area"; the area that is encompassed by the blades when they are spinning. Power is actually proportional to the square of the blade length: $P \alpha (\text{Blade Length})^2$**.** Increases in blade length significantly increase the power output.

- **Wind turbines need to be on tall towers.** Because of the friction between the wind and the earth, wind speed increases rapidly with increasing distance from the ground, especially in the first 60'. Also, obstructions around the turbine, such as trees or buildings cause turbulence, which not only reduces the efficiency of the turbine; it also shortens its life due to the additional wear and tear. A general rule for tower height is that the bottom of the turbine rotor should be 30' above the tallest obstruction within 500'. For trees, this means the mature tree height over the 20 to 30 year life of the turbine, not the tree height when the assessment was done. For residential or small business sized wind systems, towers of 100' or 120' are common.

- Ideally, the **wind turbine should be located within about 500' of the inter-tie point with the utility grid**. The longer the distance, the higher the cost due to the labor cost of trenching, the cost of the longer wire, and because a larger diameter wire (more expensive) will have to be used to minimize line losses.

- **The site for the wind system must be accessible,** either for a crane or with space enough to tilt up a tower. Most wind systems[1], even residential sizes, need a crane during installation to raise the tower and/or to lift and place the turbine on top of the tower.

[1] Tilt-Up towers are an exception

- **Most wind systems that are installed are grid tied** as opposed to battery based systems. This means that there is no need for batteries and the electricity generated by the wind system will be used directly by the loads at the site and that any excess will be "stored" on the utility power grid. This is good news for wind systems in that it eliminates the expense and maintenance of a battery bank, and the system is more efficient. The only downside is that when the utility grid goes down (during a power outage) the wind system also shuts down, for safety reasons, and no energy will be delivered. This is not a significant concern in areas where power outages are rare.

2) Wind System Siting Considerations

a. Prevailing Wind Direction and Turbulence

The turbine should be located where it can intercept the most wind, based on the prevailing wind directions at the site and on the locations of the highest obstructions within 500'. The more wind, the more electricity. Obstructions, such as buildings, rough terrain, and tall trees disrupt the flow of the wind and create turbulence. Turbulence not only reduces the amount of energy that can be extracted, but also creates a harsher environment for the wind turbine, especially the rotor blades, and this may shorten the life of the system. The best sites for wind systems are on wide open land and on the tops of ridges. If wide open land is not available, it is best to site the turbine where the obstructions do not block the wind from the prevailing wind directions, and/or significantly above the tallest obstruction so the tower height must be sufficiently tall to place the rotor above the turbulence. Tower heights are addressed later in the report.

b. Additional Factors

There are several additional factors to be taken into account when siting a wind system. The primary requirement is that the turbine is able to intercept the most wind with the least turbulence as stated above. The other considerations include:

- Length of the wire run to the inverter – shorter the better for cost and for line losses.
- Convenience of location to the property owner - to make sure that the wind system does not interfere with day to day activities.
- Accessibility to the system by a crane - which is needed for raising the tower and placing the turbine on top of the tower and in case of major maintenance or repair. Accessibility issues include steep ridges, low overhead power lines, dense woods, crossing streams, etc...
- Local zoning regulations for setback distance requirements from roads, overhead utility lines, and property lines.

Based on these considerations, the assessor will determine the best location(s) for a wind system on a given property.

3) Wind Resource

a. Wind Map

When considering a wind system it is important to know what kind of wind resource is available. In 2007 a Geographic Information System (GIS) database was commissioned by Focus on Energy from AWS Truewind, a company that specializes in wind maps. This database includes wind speed information for Wisconsin compiled from the historic climatological data of weather satellites and stations, airports, monitoring towers, military sources, etc. It also includes wind directional data, elevation and topography data. Average annual wind speeds are provided in the database at heights of 30m (98'), 40m (131'), 60m (197'), 70m (230') and 100m (328') above ground and have a resolution of 200 m (618yds). There are pdf files of these wind maps on the Focus on Energy website: http://www.focusonenergy.com/Information-Center/Renewables/Wind-Maps-Data/. [2]

In order to determine the wind speed for the sites and tower heights recommended in the report, the wind speed at the 60m height is retrieved from the wind map data base based on the latitude and longitude of the site. This value is then extrapolated down to the tower heights recommended in the report.

A copy of the 30m map can be found at the end of this document. The 30m map is enclosed because it shows more variations in wind speed than can be seen in the 60m map.

A close up image of the site specific wind map will be included with the assessment report.

b. Topography

The topography of a site can affect the wind speed. The tops of hills and wide open farmland are obviously better sites for wind systems than sites located in low spots or down in valleys. Small changes in elevation can sometimes be compensated for with increased tower height. If an assessor specifies 2 potential sites on a property and one of the sites is 20' higher in elevation then, all other factors being equal, the output at the higher site would be expected to have slightly higher energy output. The owner also has the option of using the lower site, but installing a 20' taller tower to get the same output.

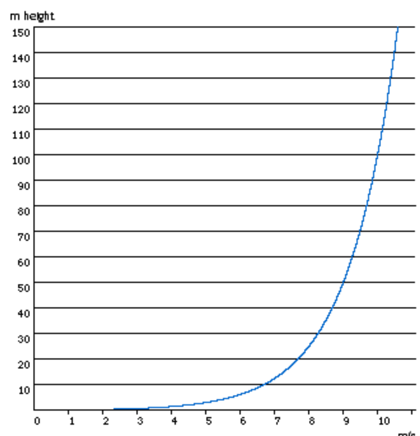
The site assessment report includes 2 topographical maps. The first is a close up of the property which may show local elevation variations on the property, and a larger scale map which reveals how the contours of the surrounding area may affect the wind at a particular site.

[2] Note that the website only has images of the wind map not the entire database which site assessors use.

c. Wind Shear and Turbulence

Wind speed increases with rising elevation above ground level. At ground level, friction caused by the interaction of the wind with vegetation, trees, buildings and the naturally occurring contours and topography decreases the wind speed. At higher elevations above the ground, the wind moves unimpeded and its speed increases. In fact, the power output from a wind turbine is proportional to the wind speed cubed, or wind speed x wind speed x wind speed, so small increases in wind speed produce large increases in power output.

If the wind speed and/or wind direction is not consistent on the blades as they spin from the lowest position to the highest, then the energy in the wind is not being used effectively and it also imposes more stress on the wind turbine. The change in wind speed with height above ground is called **wind shear** and is caused by both the natural friction of the wind with the ground (**ground drag**), and by **turbulence** which is created when the wind encounters local obstructions such as trees, buildings, etc. The graph below shows how the wind speed changes as the height above the ground increases. It is important to note that closer to the ground (under 20m or 66') the wind speed changes very rapidly (high wind shear) with minor changes in height. As height increases above 20m (66'), the rate at which the wind speed changes with increased height is reduced (lower wind shear).



Wind Shear graph from Danish Wind Association

Therefore, adding height to the tower reduces the wind shear on the blades and will allow the turbine to operate more efficiently and with less maintenance. The larger the turbine and the longer the blade length, the more critical it is to have the rotor even further away from the ground onto the more vertical (and so more consistent) part of the wind shear curve.

The wind shear factor is based on the type of ground clutter and the general topography at the site. The table below shows the normal range of alpha values as a function of the site's surface characteristics.

Surface Description	Wind Shear α
Smooth, hard ground, lake or ocean	0.10
Short grass on untilled ground	0.14
Level country with foot-high grass, occasional tree	0.16
Tall row crops, hedges, a few trees	0.20
Many trees and occasional buildings	0.22-0.24
Wooded country - small towns and suburbs	0.30
Urban areas with tall buildings	0.40

Wind shear (α) and surface characteristics.
Source: Analysis of Wind Shear Models and Trends in Different Terrains. M.L. Ray, A.L. Rogers, and J.G. McGowan. *University of Massachusetts, Department of Mechanical & Industrial Engineering Renewable Energy Research Laboratory*

While the wind map does take into account wind shear values based on the general ground cover and topography of a local area; one of the purposes of the site visit is to determine a more site-specific value.

The wind shear factor value will be specified in the site assessment report.

Turbulence is created when the wind's flow is disrupted by encountering local obstructions such as trees and buildings. If a wind turbine is located in a turbulent flow, it cannot operate efficiently, resulting in lower than expected energy outputs, and the increased wear and tear on the turbine blades can significantly reduce turbine life. To avoid this turbulent flow a wind system can be placed upwind of the obstacles towards the prevailing wind direction, or a far enough distance away from the obstructions (20 times the obstruction height), or on a tower that is tall enough to get the rotor clear of the turbulence. The "turbulence intensity (TI) factor" is a parameter that indicates how gusty a wind site is. The following are the common TI factors used in assessment reports.

Site Quality	Terrain	Turbulence Intensity Factor
Good	Well Exposed	15%
Average	Some Ground Clutter, Scattered Trees, Buildings	20%
Poor	Many Trees or Buildings, Lower Elevation than Surroundings	25%

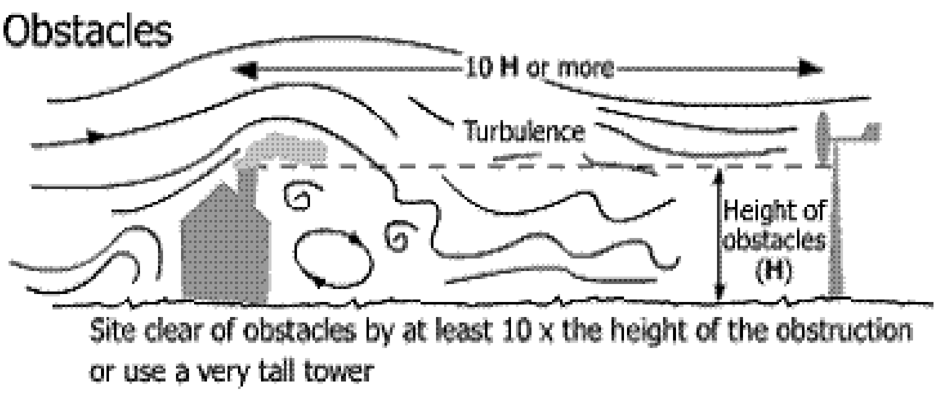


Photo: http://www.ecoheat.co.uk/wind_turbines.html

In the site assessment report the assessor will determine a TI factor based on the site specific obstructions.

d. Determining Wind Speed at Tower height

Once the wind speed at 60m is retrieved from the wind map, the wind speed at the recommended tower heights may be determined by extrapolation using the following equation (ref. *The Wind Power Book* by Jack Park):

$V = (H/H_0)^{\alpha} V_0$ where:

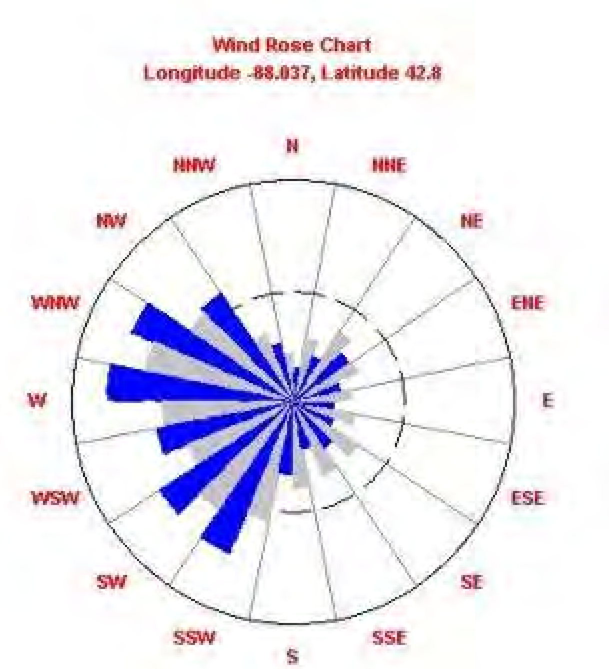
V = the wind speed at the desired height (the tower height)
Vo = the wind speed at the map height (usually 60m)
Ho = the height at which the map wind speed was measured (usually 60m)
H = the tower height(s) specified in report (turbine hub height)
α = the wind shear factor

The values for the average annual wind speed for the site at the recommended tower heights will be given in the site assessment report. These will be the wind speeds used to calculate the average annual energy output of the potential wind turbine choices.

e. Wind Rose

Because most sites will have some sort of obstructions, either trees or buildings, the direction(s) of the prevailing winds become an import factor in determining where to site a turbine.

A diagram called a **wind rose** is available to site assessors from the AWS Truewind GIS database to a grid accuracy of 2km (1.6miles). This diagram illustrates the prevailing wind directions at a site. In the example below it can be seen that the predominant winds come from the southwest, west, and northwest. For the optimal turbine performance it is best to capture the winds coming from all directions, but if there are tall obstructions at the site, the wind rose helps to determine where to position the wind system so as to be upwind of these.



A **wind rose** graph illustrates the percent time and percent energy in each direction sector. The blue bars represent the percent of total energy and the grey bars illustrate the percent of total time in each of the sixteen direction sectors.

The site assessment report will contain the appropriate wind rose for the site.

Visual indicators such as "tree flagging" and wear and tear on one side of a building can also be signs of a prevailing wind direction at a site. Tree flagging is indicated by the deformity of tree growth on one side of the tree. The lack of these visible signs does not imply that there is not a good wind resource at a site.

f. Displacement Height

At some sites, there are so many obstructions in the immediate surroundings that they create, in effect, a new "ground level". This is common in urban areas or in densely wooded areas where the average building or tree height appears to the wind profile as the ground level, which means that the wind shear curve in section c. above begins not at ground level, but at this new "displacement height". In these cases the site assessor must adjust the wind speed accordingly, resulting in lower, but more accurate, wind speeds and energy production estimates for wind system performance.

Displacement Height relevancy will be determined during the site visit.

4) Wind System Towers

There are several types of towers that can be used for residential size wind systems; 20KW and under:

Guyed Lattice towers

- Have three sets of guy wires.
- Least expensive type of tower.
- Guy wires holding up this tower have a radius of 50%- 75% of the tower height from the base.
- Requires climbing the tower for maintenance.
- Installed with a crane

Tilt-up towers

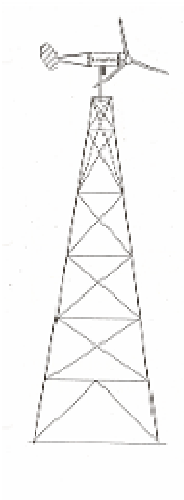
- Have four sets of guy wires.
- Slightly more expensive than guyed lattice towers.
- Maintenance can be performed without climbing the tower.
- Guy wires have a radius of 40% - 75% of the tower height from the base.
- Requires relatively flat terrain for the length of the tower in at least one direction from the base of the tower, in order to lower the tower to the ground. This is not a task to be taken lightly, and requires 2-3 trained personnel (owner can be trained). See photo below.
- Requires a large area that must remain free of obstacles for the life of the system.

On guyed towers, the guy wires are virtually invisible when viewed from a distance.

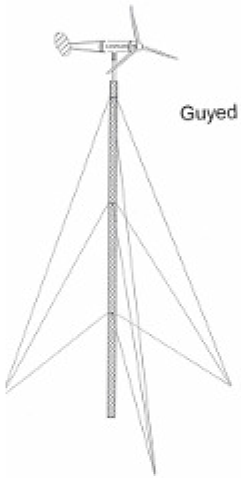
Free-standing towers – Lattice and Monopole

- Have no guy wires.
- Small footprint of approximately 10% of the tower height depending on the strength and gauge of the tower steel. There is less of a footprint with a heavier duty tower. They are good for tight spaces
- Significantly more expensive than guyed or tilt-up; contains more steel and weighs more than the other types.
- More visible on the landscape.
- Requires climbing the tower for maintenance.
- Requires a substantial foundation
- Installed with a crane.

Only free-standing towers are used for larger sized wind systems, 35kW to 100kW. Monopoles are usually only used for larger turbines since they are significantly more costly than the free standing lattice towers and require an even larger and deeper foundation.



Freestanding



Guyed Lattice

Guyed Tilt-Up

Monopole
Photo by Randy Faller

http://www.otherpower.com/guemes04monday.html

Tilt-Up Tower

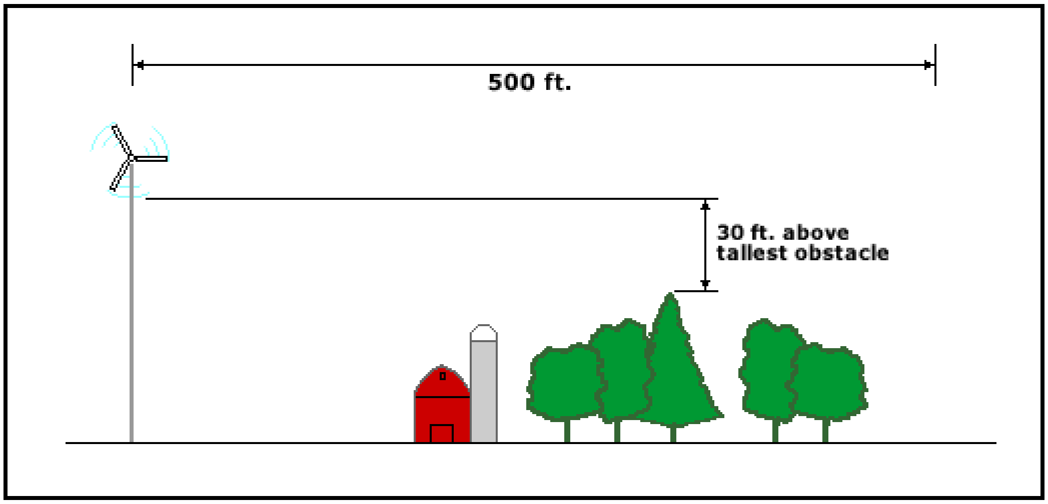
Procedure not to be taken lightly.

5) Minimum Tower Height

The minimum tower height determination is a critical part of a wind site assessment. Focus on Energy feels strongly that the biggest mistake that can be made when installing a wind system is to install the turbine on a tower that is too short for the site.

The goal is to position the entire rotor (the area swept out by the blades) in an area of consistent wind. If the wind speed and/or wind direction is not consistent on the blades as they spin, then the energy in the wind is not being used effectively and it also imposes more wear and tear on the wind turbine, resulting in more maintenance and a reduced turbine life. By increasing the tower height, the rotor can be positioned above the most severe effects of wind shear and turbulence caused by the local ground cover and obstructions.

To ensure that the rotor is above the worst of the wind shear and turbulence, Focus on Energy requires a minimum tower height of at least 30’ above any obstacles within 500’, or 30’ above the prevailing mature tree height for the area...



The site assessment report will state the minimum tower height for the site based on the surrounding obstructions and the prevailing wind directions. Keep in mind that this is the ***minimum*** height. Wind speed increases with increasing distance from the ground so a taller tower increase the wind speed at the turbine height.

The energy generated by a wind turbine is proportional to the cube of wind speed, $P \propto (\text{Wind Speed})^3$, so any increase in wind speed makes a significant increase in power output. For this reason, tower heights taller than the minimum that is recommended in the assessment report should always be considered.

The Focus on Energy incentive is based on estimated production so the cost of increasing the tower height will be at least partly covered by the increase in the amount of the incentive, and the owner will enjoy higher energy outputs for the life of the system.

Towers usually come in 20’ sections and heights of 80’, 100’, and 120’ are commonly installed towers in states like Wisconsin which have fence rows of trees, wooded areas, and rolling hills. A few turbine manufacturers offer slightly different tower heights, such as 106’ and 126’, and this will be noted in the wind assessment report.

6) Wind Turbines

Currently there is no standardized rating system for small wind turbines (although this standardization is in the works). Some manufactures rate their wind system based on the output at 25mph, while other may rate their turbine at 40mph. For that reason a turbine rated a 6kW may actually produce more than a turbine rated at 10kW, so it is important to look at the annual energy output (AEO) rather than the name plate rating. Until a standard rating is adopted, Focus on Energy rates the turbines based on their output at 11m/s (25mph).

One good indicator of energy production is the rotor diameter. Power is directionally proportional to the blade length squared [$P \alpha (\text{Blade Length})^2$] so, with few exceptions, the turbine with the longest blade will generate the most electricity.

Focus on Energy funds wind turbines that have a proven track record to ensure that the customer is getting a reliable wind system. The following is a list of turbines currently funded by Focus on Energy. If the client would like to install a turbine other than the ones listed, Focus on Energy will consider each case individually. Contact Rich Hasselman Rich.hasselman@gdsassociates.com. Phone: 608-273-0182 x2211

Sky Stream 3.7

- **1.8kW** Rating at **11 m/s** (24.6mph) - Name Plate rating 2.4kW
- Southwest Windpower Flagstaff, Arizona
- Rotor Diameter 12'
- Downwind – No Tail
- 170 lbs
- Unique curved blade design.
- 5 year limited warranty
- http://www.windenergy.com/index_wind.htm

Proven 2500, 6000, 15000

- **2.2 kW, 6.0kW, and 14.8kW** Rating at **11 m/s** (24.6mph) - Name Plate ratings are 2.5kW, 6.0kW, 15.0kW
- Proven East Kilbride Scotland, UK
- Rotor Diameter 11', 18', 30'
- Downwind Turbine – no tail
- 420lbs, 1320lbs, and 2420lbs
- Mechanical Brake
- Hinged blade design automatically adjusts to varying wind speeds (auto governing)
- 5 year limited warranty
- http://www.provenenergy.co.uk

Endurance S-250

- **4.3 kW** Rating at 11 m/s (24.6mph)   Name Plate Rating 5 kW
- **Endurance Wind Power** - British Columbia, Canada. Engineering/Manufacturing in Spanish Fork, Utah.
- Upwind with tail
- Rotor Diameter 18'
- Uses an induction generator and so the energy output is "grid-ready"; this means that no inverter is needed.
- Fault safe dual redundant braking system on rotor shaft
- Inline helical 9:1 gear box
- 600lbs
- 5 year limited warranty
- http://www.endurancewindpower.com/

Scirocco

- **5.7 kW** Rating at 11 m/s (24.6mph)   Name Plate Rating 6 kW
- Eoltech, France
- Upwind turbine – has tail
- **2 blade** machine
- 450lbs
- Rotor Diameter 18.4'
- Centrifugal Pitch governor
- 5 years warranty
- Expensive because of the exchange rate of the Euro.
- http://www.eoltec.com/English/Main_en.htm

Bergey Excel-S

- **6.8 kW** Rating at 11 m/s (24.6mph)   Nameplate rating 10 KW
- **Bergey Windpower Company** Norman, Oklahoma
- Upwind system with tail
- 1200lbs
- Rotor diameter 21 feet
- Side facing governing/furling system
- Mechanical crank out tail shut down mechanism.
- 5 year warranty.
- http://www.bergey.com/

Ventera VT10

- **7.1 kW** Rating at 11m/s (24.6mph) Name plate rating 10 kW
- **VENTERA Energy Corporation** Duluth, MN
- Downwind system with no tail.
- 500 lbs
- Rotor diameter is 22 feet
- Blade pitch governing system
- Warranty period is 5 years.
- http://www.venteraenergy.com/index.htm

ARE 110 & 442

- **2.5kW and 10.3kW** Rating at 11m/s (24.6mph) Name plate rating 2.5kW and 10kW turbines
- **Abundant Renewable Energy, Newberg, Oregon**
- Upwind system with tail
- 315 lbs and 1,350lbs
- Rotor diameter 11.8 and 23.6 feet
- Side facing governing/ furling system
- Dynamic brake shut down mechanism
- Warranty period is 5 years.
- http://www.abundantre.com/

Jacobs 31-20

- **17.0 kW** Rating at 11m/s (24.6mph) Name Plate Rating 20 kW
- **Wind Turbine Industries** Prior Lake, Minnesota
- Upwind turbine with tail
- 2500lbs - medium duty turbine.
- Rotor diameter is 31 feet.
- Offset Hypoid Gear Drive 1:6.1
- Blade pitch governing/ furling system.
- Mechanical disc brake shut down mechanism.
- The system requires more maintenance than turbines without a gear box.
- 1 year warranty with an extended 5 year warranty available.
- Only available with a free-standing tower from WTIC due to it's weight.
- http://www.windturbine.net/

Gaia 133-11 kW

- **13.9kW** Rating at 11m/s Name Plate Rating 11.0 kW
- **2 blade** machine
- **Gaia-Wind** Glasgow, United Kingdom
- **Requires 3 phase power** – not usually found at a residence, may be available for single phase in the near future.
- Rotor diameter is 42.6 feet
- Gear Box 18:1
- 1980 lbs - heavy duty residential turbine
- Uses an asynchronous generator and so the energy output is "grid-ready"; no inverter needed
- 3 level shutdown – 1:passive stall, 2 mechanical break, 3:centrifugal tip breaks
- http://www.gaia-wind.com

All wind systems require preventative maintenance and an inspection 1 to 2 times every year. Generally, turbines with gear boxes require more maintenance than the others because there are more moving parts.

The best turbine options for specific site will be determined by the assessor based on the electrical needs and the desires of the client as discussed during the site visit.

Turbines

Sky Stream 3.7 1.8kW

ARE 110 2.5kW

Proven 2500 2.5 kW

Endurance 5kW

Proven 6000 6kW

Eoltec Scirocco 6kW

Ventera 10kW

Bergey XL-S 10kW

Abundant Renewable 442 10kW

Proven 15000 15kW

10kW Jacobs 31-20 20kW

Gaia 11kW

Wind System Outputs
Once the wind speed at the recommended tower height(s) is determined by the assessor, the expected power output of the various turbines recommended for a client can be computed. The estimated energy outputs of a turbine can be predicted based on a manufacturer's "power curve" for their turbine. A power curve shows how much energy a turbine will produce at varying wind speeds. The outputs are calculated using the "7th Wind Turbine Performance Model, version 10.72", an Excel spread sheet developed by Seventh Generation Energy Systems and used by the Wisconsin State Public Benefits renewable energy program.

Taken into account in the model are factors such as:

- the elevation of the site,
- the wind speed from the wind map,
- wind shear
- turbulence intensity factor[3]
- the probability of the distribution of wind speeds,
- the tower height, and
- the manufacturers' power curve for the turbine
- the turbine rating at 11 m/s (25 mph).

The energy output calculated is also de-rated by 5% if it is an inverter based machine.

The assessment report will provide a table of the estimated annual outputs for a selection of wind turbines for the wind system site(s) identified on the property.

The wind speeds and turbine output values presented in the site assessment are computed using the best tools available to Focus on Energy; however, they should not be interpreted as a guarantee of the average annual wind speed or the average output of a particular wind turbine at your site.

[3] The "Turbulence Intensity Factor" and the "Wind Shear Factor" are both determined by the site assessor based on the obstructions and ground cover at the site.

7) Economics

Incentives

There are several incentives available which can reduce the up front cost of a wind system. In addition, net metering provides savings over the life of the turbine.

a. Focus on Energy

Focus on Energy offers Cash Back Rewards (turbines rated ≤ 20kW) and Implementation Grants (turbines rated > 20kW up to 100kW) based on how well a wind system is expected to perform at a specific site as estimated by the site assessment report. A "Reward Factor" is generated for each turbine based on:

- the expected annual energy production of the turbine at a 20% capacity factor (i.e. The expected output at a good site)
- the installed cost of the wind system
- the turbine's **rated capacity** at 11m/s (24.6mph)

The amount of the incentive is determined by multiplying the reward factor of the turbine by the estimated turbine output at the evaluated site. The Focus incentive program is therefore designed to reward wind systems that will perform well at exposed sites and on taller tower rather than wind systems that will perform poorly at compromised, cluttered sites or on short towers.

The Cash Back amount is capped at 25% of the installed cost or $35,000, whichever is less. The Implementation Grant amount is capped at 35% of the installed cost or $100,000, whichever is less.

In order to receive the Focus n Energy CBR or IG grants, the client must have the installer provide the following:

Wind Speed Logger and Anemometer: A cup anemometer must be mounted on the tower one rotor diameter below the top of the tower. The anemometer must be installed on at least a four foot boom in the approximate direction of the annual prevailing winds. The anemometer must be connected to a wind speed data logger of the owner's choice.

(A second anemometer can be installed to help determine wind shear at the site. If a second anemometer is installed, it should be placed approximately 15 feet below the upper anemometer. Thirty feet would work but only if the site is very open with no upwind obstacles towards the prevailing wind direction.)

System Performance Meter: A utility-style kilowatt-hour meter and meter base must be installed between the inverter and the AC circuit breaker for the system. The inverter kWh meter does not satisfy this requirement.

The wind speed monitor and kWh meter are intended to enable the customer and installer to accurately monitor the performance of the system based on actual wind speed recordings.

b. Utility – Net Metering

Wisconsin is a net metering State, meaning all investor-owned and municipal utilities are mandated to credit a customer at the retail rate for any excess power generated by a wind system that is up to 20kW in size. Net metering may include time-of-use (TOU) rates as well standard rates.

Each utility has a cap on the size of the turbine for which they will provide net-metering at the retail rate. For most utilities it is the mandated 20kW; however, there are utilities that have a higher cap or offer an alternative tariff for turbines rated above 20kW. Most utilities offer a lower "buyback" rate for the excess generation when the turbine is rated above the cap.

The assessment report will list the specifics for whichever utility is servicing the site.

c. Federal Tax Credit

There is a Federal Investment Tax Credit for Renewable Energy Systems in the amount:

Max. Federal Tax Credit = 30% * **(Installed Cost - Focus on Energy grant)**

A tax credit is a reduction in taxes owed, not a deduction on income earned. This tax credit substantially improves the financing of small wind projects provided the client has the tax appetite to take advantage of it. Eligible systems must be placed in service from January 1, 2008, through December 31, 2017. For more information on this incentive go to http://www.dsireusa.org and follow the link for Federal incentives. Clients should discuss this with their tax account to determine the extent to which they will be able to take advantage of this incentive.

d. State

<u>Sales Tax Exemption</u>

Beginning in July of 2009, wind energy equipment (as well as solar and anaerobic digester systems) will be exempt from sales and use taxes in the State of Wisconsin. In order to be considered an eligible wind system, devices must be capable of producing at least 200 watts of alternating current. The law also exempts "receipts from the sale of and the storage, use, or other consumption of electricity or energy" produced by a qualifying system. Generally, purchasers must complete Form S-211, Sales and Use Tax Exemption Certificate and provide the completed form to the seller in order to claim the sales tax exemption. Questions should be directed to the Wisconsin Department of Revenue.

<u>Property Tax Exemption</u>

In Wisconsin, wind systems are exempt from property taxes, making renewable energy an investment you can make on your property without increasing your tax liability.

8) Costs

The installed cost for a wind system includes the materials and labor for installing a turn-key wind system. This includes having the foundation for the tower and/or the guy wire anchors poured, tower assembly, crane rental for raising the tower and attaching the turbine, trenching, installing the balance of system (BOS - inverter, disconnect, etc) and all the wiring for the electronics. You may be able to save on some of the cost by purchasing a used tower (some wind system dealers may have access to these), and by doing the tower assembly and/or the trenching yourself. You would have to work this out with the installer and Focus on Energy to see if it would be approved. Note that because this reduces the installed cost of the system the Cash Back Reward may also decrease.

The installed cost for a wind system can vary widely because there are so many different factors to take into account depending on the site. These factors include, but are not limited to:

- Soil Type – affects the size and type of foundation
- Tower type and height
- Distance from Installer's place of business
- Wire Run Length and Trenching Difficulties
- Accessibility issues – open or cluttered, flat or hilly, wooded, fences, crane difficulties, hilly areas, wet soils, etc…
- Component Choices

For this reason the costs in assessment report are Focus on Energy ballpark cost estimates and should not be considered as any sort of bid. Contact installers on the Focus on Energy Full Service Installer List for actual costs.

<u>Other Financial Considerations</u>:

- **Maintenance**: In addition to the installation costs, the owner of a wind system should expect to put aside funds for ongoing maintenance. This amount may not be used every year, but down the road there may be some replacement parts needed, e.g. new blades or electronic components. The installer/manufacturer should be able to advise you on the amount of the annual maintenance costs; estimate about 1% of the installed cost. Maintenance can be done by the system owner or the installer may offer a service contract.

- **Insurance:** When the wind system is rated at under 20kW, the system is usually covered under the normal home owners' policy as an "uninhabited structure" like a detached garage. When the wind system is rated between 20 kW and 100 kW, the insurance required is typically $1 million dollars (the usual level of insurance that is held for a farm or business). You should verify this with your insurance agent.

- **Loan interest**: It is common for installers to ask for a down-payment to begin the turbine and tower manufacturing process. The delivery times for turbines may vary from 6 weeks to 6 months from the time of down-payment. Most incentives, including the Focus on Energy grant and tax incentives can only be received after the project is installed; therefore, if a turbine owner takes advantage of a loan to finance their project, there may be interest payments on loans from the time of down-payment until the point of project completion and wrap-up, and continuing interest costs until the turbine is paid for. One way to create financial security is to request that the installer includes the expected date of delivery on the Purchase Order with the manufacturer, and if possible, compensation for the turbine if it is not received on by the agreed on delivery date.

- **Income Tax:** Another factor to take into account is that income tax may have to be paid on any income received when the utility is paying for the excess generation. If the size of the turbine is matched well with the load, than this should not be significant. This is still a grey area and many utilities do not send out a tax form for this credit.

9) Other Considerations

a. Soil Type

The type of soil at a site will determine the level of difficulty necessary to install the tower foundation and/or anchors. If a site has shallow bedrock, very sandy or marshy soil the foundation cost will be affected. For this reason the installer may request a soil test.

b. Airport Proximity

If the extended height of a wind system is 200' tall (unlikely with a residential wind system) or if the wind system is within 4 miles of a ***public access airport,*** then the local FAA representative must be consulted to determine the maximum tower height allowed. In Wisconsin the FAA representative is Gary Dikkers, Airspace Manager. (608)267-5018 You may also file an FAA application online at this website: https://oeaaa.faa.gov/oeaaa/external/portal.jsp (see the e-filing section on the left side of the page).

c. Electrical Service and BOS

The power produced by a residential wind system must be electronically manipulated to meet the strict specifications of the electrical utility so that the system can be connected to the grid. These electronic components, including the inverter, the wiring, disconnect switches, circuit breakers, etc, are called the Balance of System (BOS) and usually reside next to an existing service panel in the house or garage. The BOS takes up about 15ft^2± of wall space and is usually located inside a building since warranties for the electronics usually do not cover operating temperatures under -10 degrees.

During the assessment the assessor will examine the load center to determine the size of the service and the availability of any slots to tie in the wind system. The installer will need this information and may recommend a service upgrade if necessary to meet the National Electric Code requirements. Many of the small turbines require 40 amp capacity circuit breaker, or more, to be added. This may add some material and labor costs for a properly designed hookup.

d. Zoning

Because wind systems are a relatively new issue for zoning authorities, some municipalities have no zoning ordinance for wind systems while others may have antiquated overly restrictive ordinances. Common restrictions include a setback distance equal to the extended height of the wind system from roads and property lines. The site assessor will often try to site the wind system to meet this common setback restriction. Some municipalities also have height restrictions. Wind system owners do have Wisconsin law on their side through State Statute 66.0401 **(Regulation relating to solar and wind energy systems)** which states:

(1) AUTHORITY TO RESTRICT SYSTEMS LIMITED.

No county, city, town, or village may place any restriction, either directly or in effect, on the installation or use of a solar energy system, as defined in s. 13.48 (2) (h) 1. g., or a wind energy system, as defined in s. 66.0403 (1) (m), unless the restriction satisfies one of the following conditions:

(a) Serves to preserve or protect the public health or safety.

(b) Does not significantly increase the cost of the system or significantly decrease its efficiency.

(c) Allows for an alternative system of comparable cost and efficiency.

(2) AUTHORITY TO REQUIRE TRIMMING OF BLOCKING VEGETATION.

A county, city, village, or town may provide by ordinance for the trimming of vegetation that blocks solar energy, as defined in s. 66.0403 (1) (k) , from a collector surface, as defined under s. 700.41 (2) (b) , or that blocks wind from a wind energy system, as defined in s. 66.0403 (1) (m) The ordinance may include, but is not limited to, a designation of responsibility for the costs of the trimming. The ordinance may not require the trimming of vegetation that was planted by the owner or occupant of the property on which the vegetation is located before the installation of the solar or wind energy system.

10) Educational Opportunities

Focus on Energy offers assistance for educational programs. The Midwest Renewable Energy Association (**MREA**) offers workshops on wind system installation and maintenance. Contact the MREA to get details. See http://www.the-mrea.org/

The **Renew Wisconsin website** has current news on renewable energy in Wisconsin. This website promotes clean energy, energy conservation, renewable energy and the state's energy policies. http://renewwisconsin.org/index.html

Also see the **Small Wind Toolbox** at the Renew Wisconsin site for a list of fact sheets on wind issues as well as forms and applications, numerous letters and magazine articles with helpful hints on wind power. http://www.renewwisconsin.org/wind/windtoolbox.html

Useful Websites

- Focus on Energy web site (www.focusonenergy.org) great for lots of information on Renewable Energy.
- Fact sheets covering all issues with small wind in: toolboxes at www.renewwisconsin.org
- Home Power Magazine/Website (www.homepower.com) – Case studies and stories of renewable energy installations around the country.
- Midwest Renewable Energy Association (www.the-mrea.org) – Hands-on workshops in Wind, PV, Solar Hot water, and more.
- American Wind Energy Association www.awea.org
- Danish Wind Industry Association www.windpower.org

11) Energy Efficiency

When using renewable energy systems it is critical to first look at energy efficiency.

Focus on Energy has provided most libraries with a Watt Meter (also available at a hardware store for $25). This is a simple device that you can plug any 110v appliance into and then plug the meter into an outlet and it will measure and record the electrical usage in watts and in kWh for the appliance for as long as you leave it plugged in. This is a useful tool for determining exactly what your electrical loads are.

Heating and cooling loads draw the most electricity; refrigerators, freezers, electric dryers, electric stoves, space heaters, dehumidifiers, etc, with lighting coming in second. Replacing outdated appliances with Energy Star rated appliances and keeping lights and computers off when not in use are obvious steps toward energy efficiency. Evaluating priorities when it comes to electrical loads is up to the owner.

Home energy audits are available through Focus on Energy as well.

The site assessment report will provide specific efficiency steps if there are clearly some energy efficiency offenders at the site, or steps that can be easily taken to reduce the load.

12) Follow Up

A. Energy Efficiency is always the first and most economical step. Investigate ways to reduce the electricity usage; eliminating unnecessary appliances, replace older appliances with Energy Star rated ones, switch lighting to CFLs, change behavior patterns to use less energy, and consider having a professional energy audit.

B. Decide if the economics work out to your satisfaction based on all the costs and incentives, and the energy savings/income from the estimated energy output of the wind systems provided in this report for this site. Remember that electrical rates will probably continue to rise. An accountant or tax advisor is recommended to do a detailed analysis which takes into account the projected increase in electricity rates, the federal tax credit eligibility, interest on a loan, inflation, etc.

C. Contact several of the qualified full-service wind installers (list provided in this report) or the manufacturers directly to get the **latest prices** for installation and maintenance, choose a turbine and other system components, determine delivery timelines, as well as discussing what permits may be needed.

D. It would be a good idea to go see the suggested turbines in action and talk to the owners. The installers on the attached installers list should be able to suggest some locations.

E. Check with the township building and zoning offices to make sure that there are no local ordinances or other problems with installing wind turbines and towers (including set backs from the road and property lines), and begin the permitting process. **You will need to apply for a building permit or conditional use permit(CUP) within 30 days of receiving the Focus on Energy CBR/Implementation Grant approval notification, and secure the building permit or CUP w/in 90 days. If no permit is required, you must submit a letter saying so and include the name and contact information of the zoning official who supplied this information.** If any of these conditions are not met, the Focus on Energy Program will terminate your Wind Energy Grant. You will be notified in writing that your reward has been cancelled.

F. Begin to inform the neighbors of the desire to install the system, to educate them on wind systems in general, and to meet with the local zoning authorities. This will help to avoid problems and get the support of your neighbors, and pave the way for continued contact with local authorities to identify and address any building permit or zoning issues such as required set backs. There are several helpful articles on zoning issues in the “small wind toolbox” at http://www.renewwisconsin.org/wind/windtoolbox.html. Look for the link to “small wind toolbox” on the left side of the home page. You can also contact Mick Sagrillo for help with zoning issues msagrillo@wizunwired.net phone: 920-837-7523.

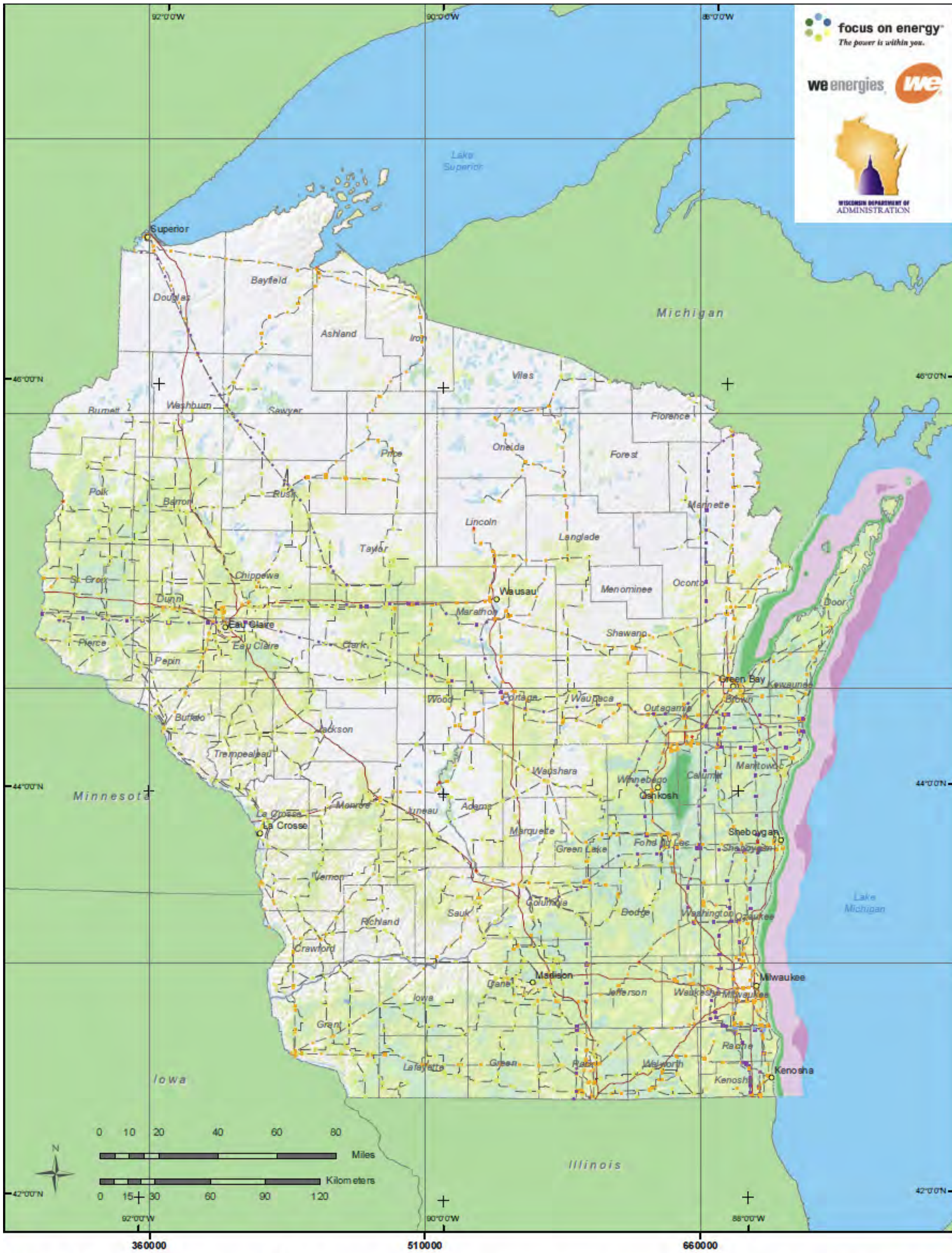
G. Complete the Focus on Energy Incentive application and submit. A copy of this application can be obtained by contacting Wisconsin Focus on Energy at (800)762-7077, or on their website: http://www.focusonenergy.com/Incentives/Renewable/#installation_section

H. Contact your insurance agent about insuring the wind system

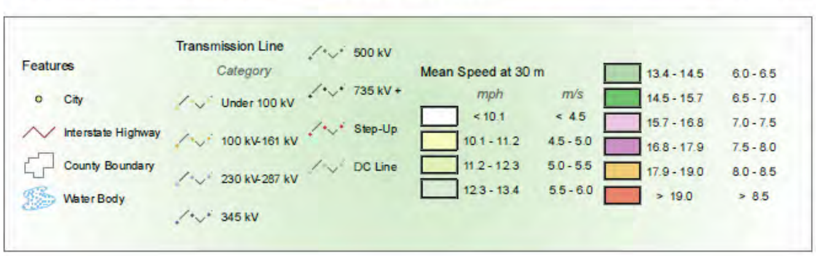
I. Check with **your utility** to discuss the grid intertie procedures and requirements, insurance issues, and to verify buy-back rates.

J. Insure that all zoning, utility agreements, financial incentive and any other required approvals are in hand prior to making any commitment to purchase!

K. If generating clean energy is the goal of the project, but this report concludes that you do not have a good site for a wind system, you always have the option of purchasing renewable energy for your home through your utilities' "green pricing" program. Most utilities offer a renewable energy purchasing program for about $0.012/kwh on top of your current electrical rate. Contact your utility for further information.



Wind Resource of Wisconsin *Mean Annual Wind Speed at 30 Meters*



AWS Truewind

Projection: NAD 1983 HARN Transverse Mercator
Spatial Resolution of Wind Resource Data: 200m
This map was created by AWS Truewind using the MesoMap system and historical weather data. Although it is believed to represent an accurate overall picture of the wind energy resource, estimates at any location should be confirmed by measurement.

The transmission line information was obtained by AWS Truewind from the Global Energy Decisions Velocity Suite. AWS does not warrant the accuracy of the transmission line information.
Source date: December 2006

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