



Help Page

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Welcome to the New York State Small Wind Explorer

Explore the 200 m wind map or define your exact project location and download a free Wind Resource Report.

Step 1:
Zoom in and click on your proposed turbine location or enter the exact turbine coordinates in the Enter Location dialog box.

Step 2:
Click the Generate Report button and follow the onscreen instructions.

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Select Hub Height:

Colors below correspond to map overlay

Enter Location or Click Map

43.04481, -76.14624 -or-
43 20 41.3154N, -76 8 46.464W

Wind Speed

Mean: 10.42 mph (4.66 m/s)

Latitude: 42.48020

Longitude: -74.64111

5

IMPORTANT NOTICE AND DISCLAIMER The wind map and wind rose were created by [AWS Truepower, LLC](#) using the [Met](#) and historical weather data. Annual energy estimates were calculated using the local wind resource, estimated loss factors, and the manufacturer supplied power curve. For more information on the program's methodology, please refer to the [help page](#). AWS Truepower and NYSERDA do not guarantee the above estimates and are not responsible for the contents of this report. For applications requiring greater accuracy, the wind resource estimates should be confirmed by measurement.

17 Columbia Circle | Albany, NY, 12205 | +1-518-862-1090
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How to Navigate the Application:

1. Zoom to a point of interest:
 1. Use your mouse to click anywhere on the map frame or,
 2. Explore the wind map by entering your location in the box provided. Accepted inputs include: latitude and longitude coordinates in decimal degrees or degrees, minutes, seconds, and street address.

When you select a location, the application will automatically zoom to that spot. A push pin will appear and the coordinates will be displayed below.

2. Navigate the New York State wind map using standard Google Maps tools.
 1. Zoom in or out by dragging the line up or down the scale bar. You may also click on either the plus or minus signs to zoom in or out, respectively.
 2. Pan by clicking the up, down, left, right buttons or by holding down your cursor and dragging the mouse.
 3. Zoom to the full extent of valid data by clicking on the center button.
 4. Zoom in to an area using the custom zoom tool.

Please note that the wind map will disappear when you zoom in beyond a certain extent.

3. Toggle the display using standard Google Map overlays:

Click on Map, Satellite, Hybrid, or Terrain buttons to change the underlying base map.
4. Change the wind map's height level.

Select from one of three map heights above ground level: 80, 100 and 120 feet by using the drop-down menu. This affects the both map display and the displayed wind speed underneath the Google Map frame.

5. View your wind speed for the selected location.

The mean annual wind speed (in miles per hour) will be displayed in the informational box provided underneath the Google Map frame. This value is the mean annual wind speed at that location in miles per hour.

6. Generate a Wind Resource Report.

Click the Generate Report button and follow the on-screen instructions.

How to Generate a Report:

After clicking the Generate Report button, the Data Entry Page will load. For the Customer Report, the user must enter his or her name and address to be included on the output report. For the Wind Professional Report, after logging in, the user must enter the following information:

- Installer Name – (required)
- Home Owner Name – (required)
- Address - where the turbine is to be installed (required)
- Turbine Model (required)
- Hub Height (required)
- Terrain description for each directional sector (assumed if not entered)
- Availability Loss (assumed if not entered)
- Additional Known Losses (assumed if not entered)

Turbine Model

Select a small wind turbine model to use in the analysis. Only NYSERDA qualified wind generators are included.

Hub Height

Enter the proposed tower height in feet.

Terrain Description

Select a terrain description that best matches each given direction, as seen from the tower. This description will help estimate the effects of upwind terrain and obstacles on energy production

Availability Loss

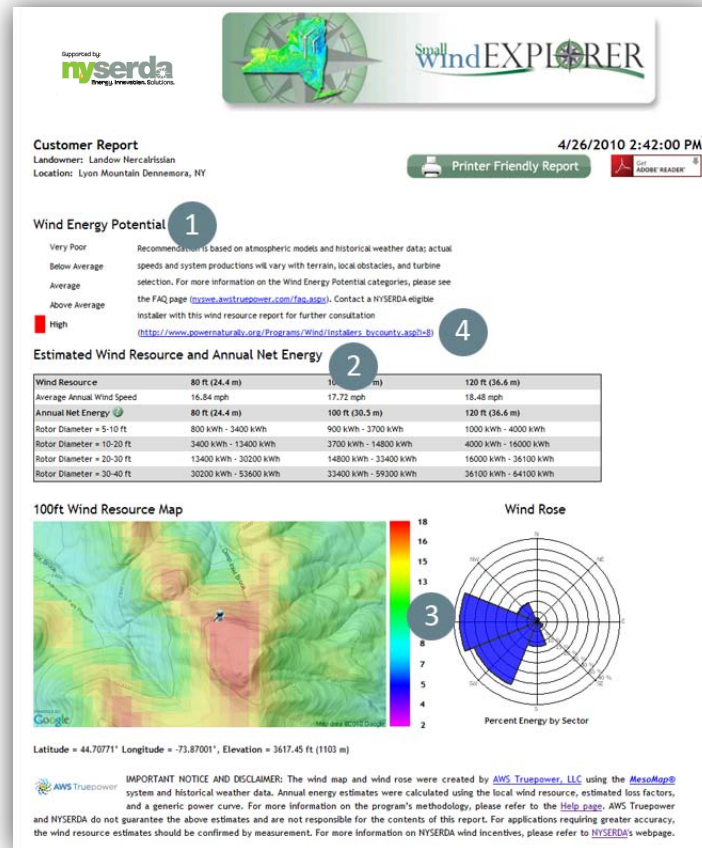
Enter the expected loss due to turbine availability.

Additional Known Losses

The program assumes that the turbine power curves were measured using the AWEA Small Wind Turbine Performance and Safety Standard as a guideline and certified per the requirements of clause 1.4.1 of this standard. If the manufacturer supplied power curve was not created using this standard, an adjustment factor can be entered.

Once all fields are entered, click the Submit button to generate the report.

How to Interpret the Customer Report:



1. Determine your site's Wind Energy Potential.

This ranking will give you a qualitative assessment of the site's available wind resource.

2. Determine your site's estimated wind resource and annual net energy.

The table presents data at three different heights (80, 100, 120 ft). The energy estimates provide information for various rotor diameters.

3. View your site's 200 m (656 ft) wind map and wind rose data.

The site's wind resource map shows the average annual wind speed at 100 ft above ground level. The wind rose provides an estimate for the amount of energy located in each directional sector (N, NE, E, SE, S, SW, W, NW).

4. Contact a NYSERDA eligible wind installer with this wind resource report for further consultation.

How to Interpret the Wind Professional Report:

1. Determine the site's characteristics and available wind resource.

The site's latitude, longitude, elevation, average annual wind speed at hub height, frequency distribution parameters, and surface roughness are displayed.

2. View the site's 200m wind map and wind rose data.

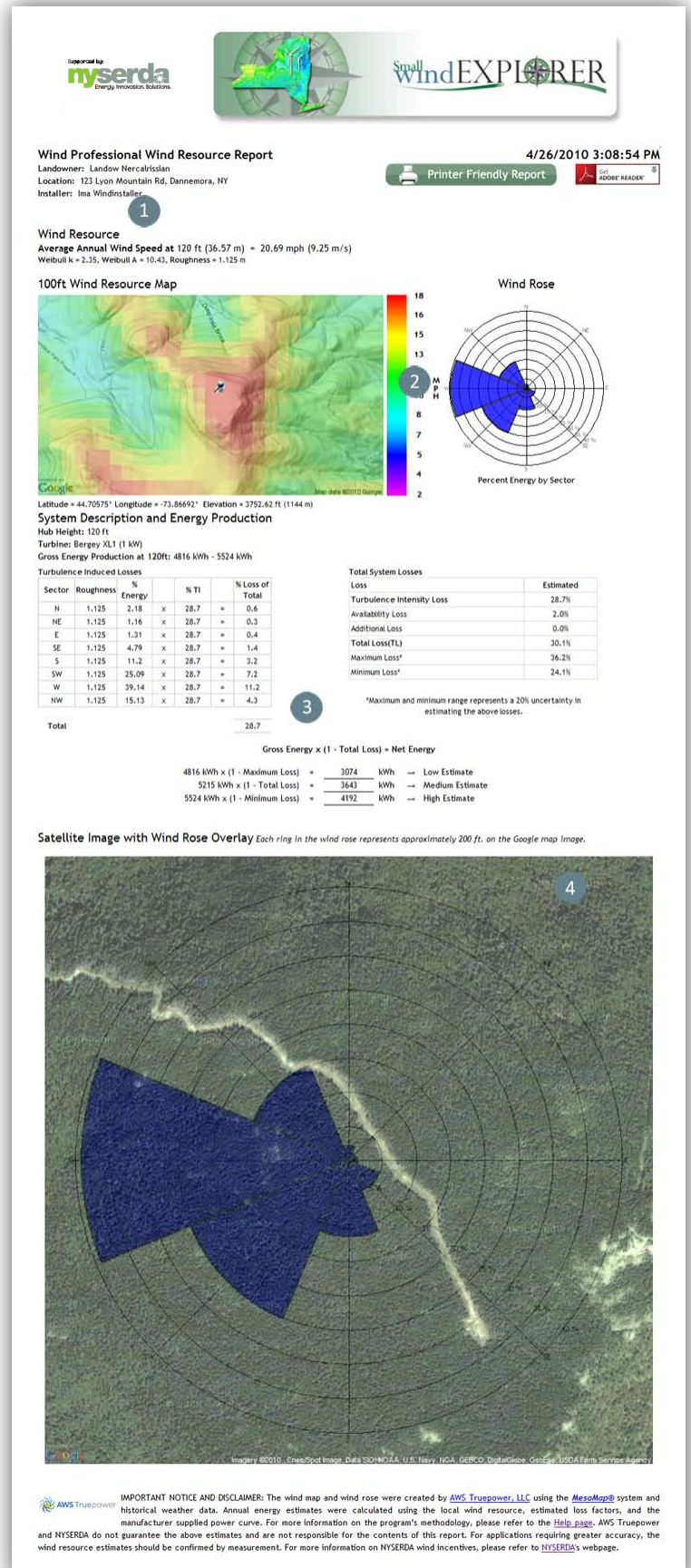
The site's wind resource map shows the average annual wind speed at 100ft above ground level. The wind rose provides an estimate for the amount of energy located in each directional sector (N, NE, E, SE, S, SW, W, NW).

3. Review the system losses and estimated annual energy production.

Turbulence induced losses, availability losses, and additional known losses are summarized along with the estimated minimum and maximum total losses. The net energy summary displays the estimated range in annual energy production based on the chosen wind turbine, local wind resource, selected loss factors, and interannual variability in the wind.

Review the satellite image with wind rose graphic to verify that the selected terrain roughness values match each direction.

4. Review the NYSERDA incentive requirements.



SMALL WIND EXPLORER METHODOLOGY:

The *Small windExplorer* follows several steps to estimate the annual energy production of a small wind system. The following sections provide some background into the program's methodology.

Wind Shear Adjustment

To begin the energy prediction process, the average annual hub height wind speed must be known for the turbine site. Since, the actual height of the turbine may differ from published wind resource estimates and maps, the average annual wind speed may need to be adjusted to account for wind shear. Therefore, the *Small windExplorer* models the vertical wind shear profile using the following mathematical equation, known as the Power Law.

The Power Law is described using the following equation:

$$\frac{V_2}{V_1} = \left(\frac{h_2}{h_1}\right)^\alpha$$

Where:

ρ = air density

A = swept area of blades

V = wind speed

The wind shear exponent, α , is calculated using the following expression:

$$\alpha = \frac{\ln(V_2/V_1)}{\ln(h_2/h_1)}$$

Combining the above two expressions results in the following expression for V_3 (extrapolated hub height wind speed at h_3) as a function of known parameters:

$$V_3 = V_1 \left(\frac{h_3}{h_1}\right)^{\left[\frac{\ln(V_2/V_1)}{\ln(h_2/h_1)}\right]}$$

Frequency Distribution

The frequency distribution of the wind is needed to accurately estimate the available power and is approximated using the Weibull distribution. The average hub height wind speed, U, the Weibull shape factor, k, and the Weibull scale factor, c, are used to calculate the frequency distribution; these parameters are given as output in the *Small windExplorer* Wind Professional Report. The wind speeds are separated into regular increments, or bins, and the probability of a wind speed falling into a given bin is calculated using the Weibull expression.

While the bins can be sized to any wind speed range, the bins in the *Small windExplorer* are sized to 1 m/s increments. This bin width gives the needed accuracy for the calculations without being too complicated.

The Weibull distribution is modeled using the following equation within the Small windExplorer:

$$p(U) = \int_U^{U+1} \left(\frac{k}{c}\right) \left(\frac{u}{c}\right)^{k-1} \exp\left[-\left(\frac{u}{c}\right)^k\right] du$$

Where:

p(U) = Probability wind speed will be between U and U+1 (in m/s)

k = Weibull scale factor

c = Weibull shape factor

Power Curve

Once the wind speed frequency distribution is binned, the *Small windExplorer* uses the turbine's power curve to determine the gross energy production of the system. The power curve displays the turbine's power output for varying wind speeds using the same bin concept as above. The customer report uses a generic power curve weighted by swept area and the Wind Professional Report uses the manufacturer supplied power curve for the user selected turbine.

The *Small windExplorer* uses power curves obtained from the manufacturer websites. The program assumes that the turbine power curves were measured using the AWEA Small Wind Turbine Performance and Safety Standard as a guideline and certified per the requirements of clause 1.4.1 of this standard. As such, the power curve will be sea level normalized and will be measured at the connection to the load; therefore, the losses associated with the turbine, inverter, and wiring will be included in the performance testing. It is the responsibility of the installer to adjust the output estimates if the turbine has not been certified and to account for siting related losses in power. The AWEA Small Wind Turbine standard can be found [here](#). For siting related losses, refer to the NYSERDA [Customer Sited Wind Handbook](#).

The power level for each of the binned wind speeds is imported into the frequency distribution table. Multiplying the power output at each wind speed by the probability of that wind speed gives the average power available in each bin. Adding the individual powers for all wind speed bins gives the total average power available from the system. Finally, to calculate the annual gross energy available from the system, the total average power is multiplied by the number of hours in the year, as shown in the following equation.

Air Density Adjustment

The above energy estimate assumes that there are no additional loss factors in the system and that the turbine will perform exactly as stated on the power curve. However, the production of the system will depend on multiple variables and the energy estimate needs to be adjusted accordingly.

The power curves are given for standard sea level air density, so a density adjustment must be applied to give an accurate description of the available power at the turbine location. Air density varies with changes in temperature and pressure and the amount of power in the wind is directly proportional to the density. The program estimates the temperature and elevation of each site and calculates the site specific air density, which is subsequently used to adjust the gross energy.

The site specific air density is calculated using the following equation:

$$\rho = \frac{P_0}{RT} e^{\left[\frac{-gz(1.0397 - 0.000025z)}{RT} \right]}$$

Where:

ρ = Air density (kg/m³)

P_0 = Standard sea-level atmospheric pressure in Pascals (101325 Pa)

R = Specific gas constant for dry air (287 J/Kg-K)

T = Air temperature (K), $T(K) = T(^{\circ}C) + 273.15$

g = Acceleration due to gravity (9.8 m/sec²)

z = Elevation of temperature sensor (m)

Losses

There are many losses in small wind systems that need to be taken into account in the energy estimate. The customer report assumes generic losses and the Wind Professional Report allows users to enter their own estimated losses.

Local obstructions and terrain can impact the available wind resource by decreasing the observed wind speed and increasing turbulence. Since these environmental factors may not be accounted for in available wind resource maps, they must be manually entered. The losses due to turbulence are approximately equal to the site's turbulence intensity. The customer report assumes a generic loss of 20% for turbulence intensity and the Wind Professional Report includes a data entry page to help estimate the losses caused by the local terrain.

The *Small windExplorer* estimates turbulence losses by calculating the estimated ambient turbulence intensity using the surface roughness and turbine hub height.

$$TI \text{ Loss (\%)} = \frac{1}{\ln\left(\frac{\text{hub height}}{\text{roughness}}\right)} \times 100$$

Turbulence losses are weighted by the percentage of energy that is expected from each direction and then combined to compute a total turbulence loss for the site.

In addition to the losses associated with the surrounding environment, the turbine's performance will be affected by losses due to the collection system, inverter efficiency, and system availability. As noted earlier, the power curve will include inverter and collection system losses. Availability can be associated with the electrical grid downtime and any downtime due to maintenance or system failures. These losses depend on the model of turbine and inverter and the level of maintenance the system will experience. To account for the availability of the system, the customer report includes an Availability Loss factor of 2.0% and the Wind Professional Report allows the user to enter the expected Availability Loss.

If the inverter or wire specifications are different than those in the power curve performance test or if the system is expected to have additional environmental/system losses, the losses can be adjusted accordingly in the Wind Professional Report using the Additional Known Losses field on the data entry page.

Uncertainty

There are many uncertainties in the energy prediction process, which lead to uncertainties in the annual energy estimate. The main sources of uncertainty include the estimation of the wind speed and loss factors. The customer report does not take these factors into account and instead gives a basic approximation for net energy. The Wind Professional Report uses approximated uncertainties for the different sources to create a range in energy production.

The wind speed estimates used in the *Small windExplorer* have an uncertainty of approximately 7.0%, which accounts for the inter-annual variability of the wind speed. Therefore, the upper and lower bounds of the gross energy estimate are calculated by increasing and decreasing the annual average wind speed by 7.0%, respectively. Adjusting the wind speed changes the frequency distribution, which has a direct effect on the total amount of energy available in the wind; therefore, the program runs three different scenarios for the varying wind speeds to calculate the range in energy production.

The uncertainty in estimating the losses is much harder to predict. Therefore, this uncertainty is estimated at 20% of the total loss, which is directly applied to the above energy range.

For more information on wind energy in general or sample calculations for the above steps, please refer to the Customer Sited Wind Handbook.

Additional Questions

For answers to additional questions please [contact us](#).