NREL
NATIONAL RENEWABLE ENERGY LABORATORY

An Update on NREL's Small Wind Site Assessor Guidance Document

2014 Small Wind Conference

Stevens Point, Wisconsin

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June 18, 2014

NREL/PR-5000-61881

Background

The purpose of the Small Wind Site Assessor manual is to provide:

- A resource on how to conduct a small wind site assessment, in lieu of a small wind site assessor certification which may be available in the future
- A resource for state incentive managers (i.e., Interstate Turbine Advisory Council, or others)
- A resource for consumers.

The intent is to serve as a:

- Resource for small wind site assessment, highlighting the impacts on installation and productivity and the guiding principles using currently available tools and experience
- Guide for small wind turbine selection and siting decisions based on costs, benefits, and risks.

What the manual is NOT:

- **Training for site assessment (although it could be a resource for a training program)**

Bergey Excel 10, 10-kW turbine, Klickitat County, Washington
Photo by Gwen Bassetti, NREL 26429

Document Development Process

Completed

- Workshop held at end of SWC 2013
  - 20+ attendees
  - Reviewed/modified draft outline
  - Solicited volunteers
  - Identified experts team
- Contractor developed 1st draft
- Experts team reviewed 1st draft
- Contractor developed 2nd draft

In progress

- Complete peer review of 2nd draft
- Develop final document
- Post on OpenEI

Entegrity EW50, 50-kW turbine, Kittery, Maine
Photo by Donald Doval, NREL 28427

Document Content

A. Executive Summary
B. Introduction
C. Site Description
D. Wind Characteristics
E. Micrositing and Analysis
F. Other Considerations
G. Site Assessment Report
H. Conclusions
I. Glossary
J. References
K. Sample Checklist
L. Sample Report Outline
M. Case Studies and Lessons Learned

Endurance E3120 turbine; 50-kW turbine,
Appleton, Wisconsin
Photo by Kettle View Renewable Energy, LLC, NREL 28428

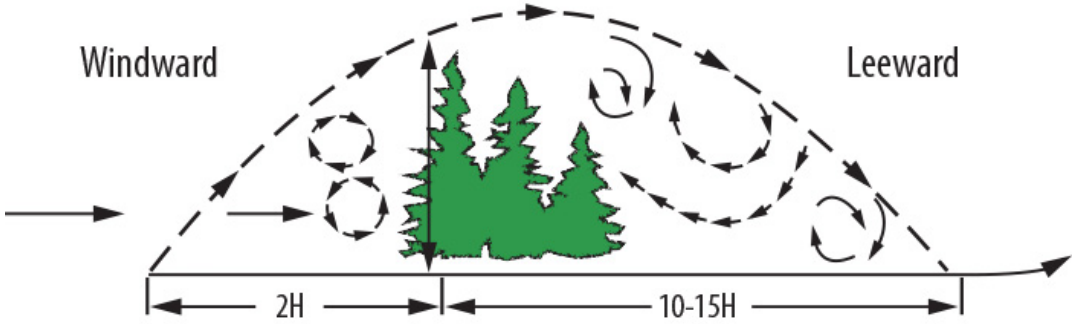
Primary Resources

- *Small Wind Site Assessor Job Task Analysis* developed for the North American Board of Certified Energy Practitioners (2011)
- *A Siting Handbook for Small Wind Energy Conversion Systems* (PNNL, 1980)
- *Wind Power Basics* (Chiras, D., 2010)
- Expert team

Northwind 100, 100-kW wind turbine; Hempstead, New York
Photo courtesy of the Town of Hempstead, NREL 28963

Site Description

- Land use considerations
- Site information and administrative data
- Safety and environmental concerns
- Topography
- Vertical wind shear
- Obstacles

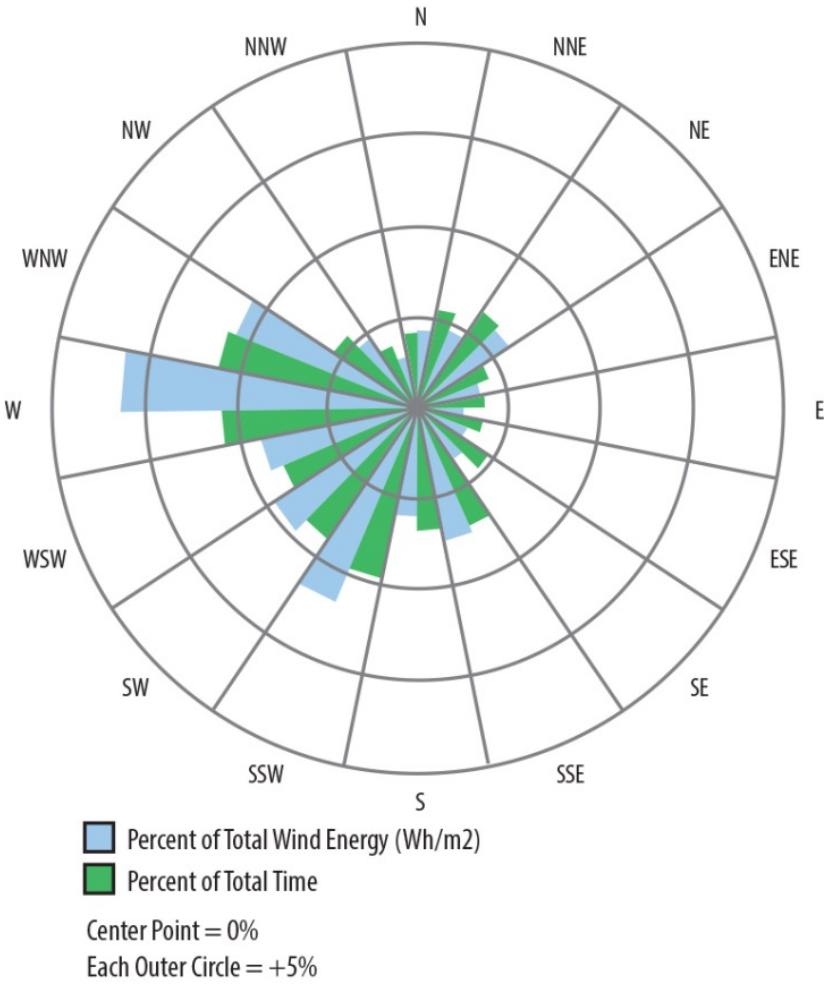


Airflow near a shelterbelt[1]

1. Harry Wegley, James Ramsdell, Montie Orgill, Ron Drake. A Siting Handbook for Small Wind Energy Conversion Systems, US DOE/Pacific Northwest Laboratory/Battelle Memorial Institute, Contract DC-AE06-76 RLO 1830, 1980

Wind Characteristics

- Wind characteristics and analysis
- Wind maps
- Wind data
- Wind measurement instruments



Example of wind rose

Micrositing and Analysis

- **Micrositing (site selection)**
- **Wind resource data and analysis (example: remote and/or low resolution wind information)**
  - Source Wind Data: Use map estimates or actual wind data sets as described above.
  - Topography Adjustment: Derive a factor and rationale to adjust wind speeds from source data.
  - Wind Direction Adjustment: Derive an angle in degrees and rationale to adjust wind rose from source data.
  - Roughness Adjustment: Derive a factor and rationale to adjust wind speeds.
  - Wind Shear Adjustment: Apply displacement height, vertical wind shear exponent, data height, and hub height to adjust wind speeds.
  - Wind Shade Adjustment: Set up a wind direction sector analysis to derive the effects of each nearby obstacle by applying its shade factor with a weighting for the amount of wind in that direction from the obstacle to the turbine.

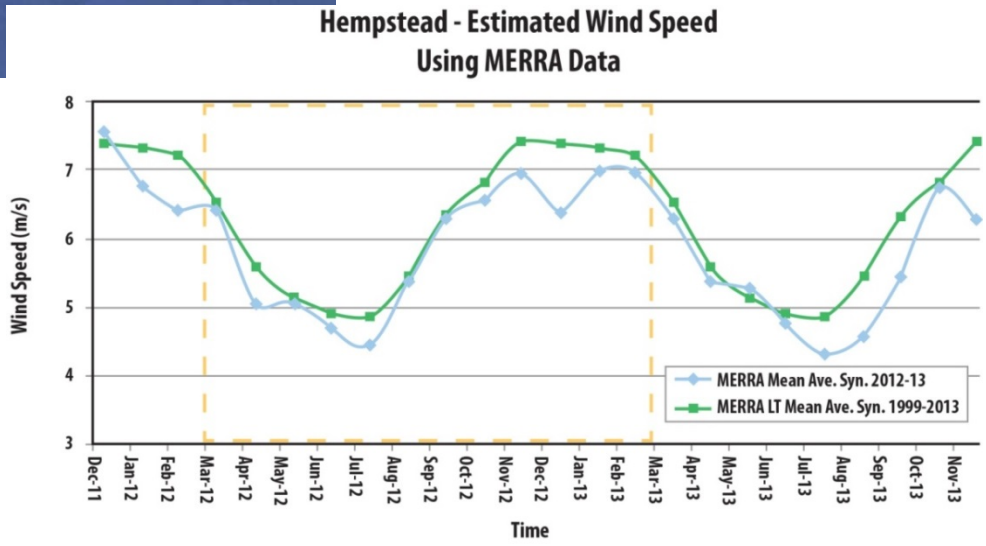
Micrositing and Analysis (continued)

- Adjusted Wind Speeds: Summarize the composite results of the steps above to produce new estimates for average wind speed, range, distribution, Weibull parameters, turbulence intensity, and other parameters at the selected site.
- Gross Annual Energy Production Estimate (GAEP): Apply this estimated wind distribution to the wind turbine power curve (and possibly multiple options) to estimate monthly and annual energy production.
- Loss Estimation: Determine or estimate other factors that could further reduce the actual energy produced, including downtime for faults and servicing, blade soiling, turbulence intensity causing control error/hysteresis and yaw error losses, icing losses, grid outages, wire losses, inverter losses, and possibly several others.
- Net Annual Energy Production Estimate (NAEP): Reduce the gross annual energy production by the estimated losses to estimate the net annual energy production.
- Uncertainty Analysis: Apply composite uncertainty estimates. Because each step of this process introduces uncertainty to the estimated results, these uncertainties also need to be estimated so that a composite uncertainty can be calculated and applied to the final results for winds peed and energy production.

Wind Speed Estimates

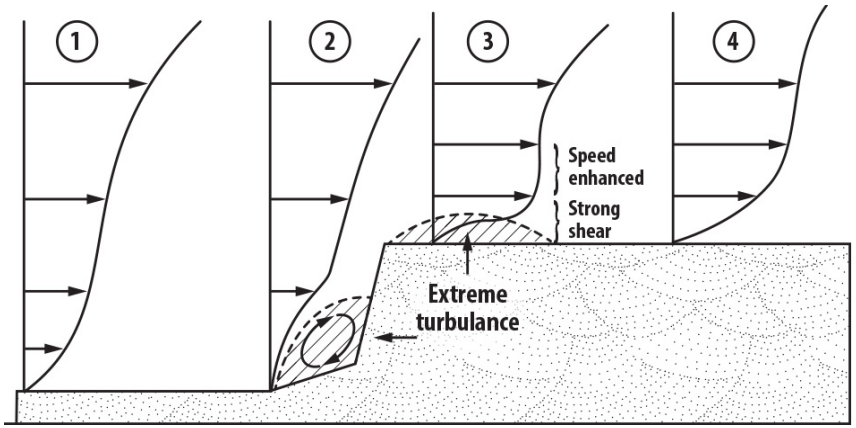
Wind data was both measured and estimated for the project site (Hempstead). These data were validated using historical long term average and one-year average data from two MERRA sites.

The graphic shows the synthesized mean monthly averaged wind speed from two nearby MERRA[1] sites at 37 m for the period 1999-2013 (green) and for the period since the NW100 was installed (blue). The yellow-dotted area is the 12-month period used for the Wind Analysis Summary Report prepared for the Town of Hempstead.

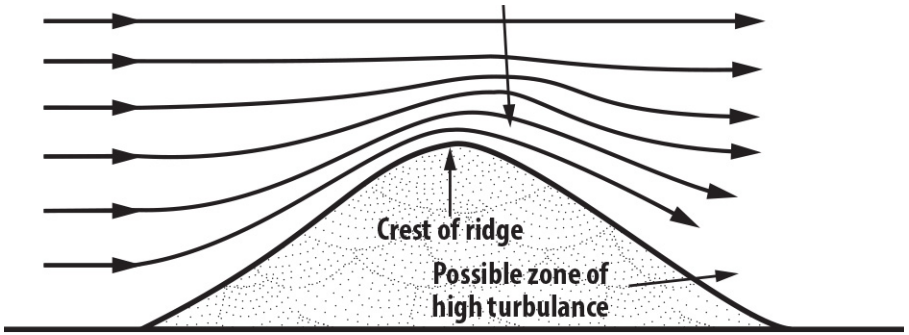


[1] MERRA: Modern-Era Retrospective Analysis for Research and Applications – a NASA reanalysis (http://gmao.gsfc.nasa.gov/research/merra/)

Terrain Influence on Wind Flow



Vertical profiles of air flowing over a ridge



Acceleration of wind over a ridge

Source: *A Siting Handbook for Small Wind Energy Conversion Systems,* US DOE/Pacific Northwest Laboratory/Battelle Memorial Institute, Contract DC-AE06-76 RLO 1830, 1980

Obstructions – Case Study Example

Photo courtesy of Northern Power

Photo source: Google Maps

Aerial photo of the Hempstead NW100 turbine site. Pre-installation (left) with obstructions. Post-installation (right) with obstructions removed and turbine installed.

Obstructions – Case Study Example

- Same turbine; different locations.
- Performance differences:
  - Left: 500 kWh actual annual compared to 8,000 kWh estimated
  - Right: Averaging 17 MWh annually compared to 16 MWh estimate
- No on-site anemometry data was collected at either site

Bergey Excel 10, 10-kW turbine; Peshastin, Washington,
Photo by Abigail Krich, NREL 13495

Bergey Excel 10, 10-kW turbine;
Ellensburg, Washington
Photo by Randy Brooks, NREL 29553

Next Steps

- Revisit need/timing/options for small wind site assessor credential
- Monitor manual on OpenEI – update as appropriate

Associated activity:

- Revisit need/timing/options for small wind installer credential
  - North American Board of Certified Energy Practitioners suspended program

Contributors

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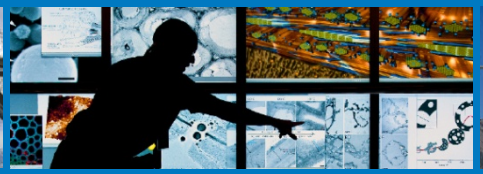

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