Basics - Wind Power

Adapted from Rose & Ian Woofenden, 2003

Carbondale/Paonia Colorado  www.solarenergy.org
Quality working hardware...
Installation requires hands-on skills
Tower erection is the major part of most wind projects.
Topics of Importance

- Principles
- Siting
- Towers
- Maintenance
- Living with Wind Energy
Principles

• Energy vs. power
• Rotor size
• Tall towers
Wind generator users want energy, not power!

- Energy = Watt-hours
- Power = Watts

This is analogous to:

- Distance = Miles
- Speed = Miles per hour
Wind generator output is directly related to rotor size

- 3 ft. rotor: 7 square feet
- 6 ft. rotor: 28 square feet
- 12 ft. rotor: 113 square feet

Swept Area
Power Formula

\[ P = \frac{1}{2} DAV^3 \]

Where:
- \( P \) = the power available in the wind
- \( D \) = the air density
- \( A \) = the rotor's swept area
- \( V \) = the wind's velocity
Effect of Wind Speed

$$V^3 = V \times V \times V$$

- $10 \times 10 \times 10 = 1,000$
- $12 \times 12 \times 12 = 1,728$
- $20 \times 20 \times 20 = 8,000$

Small increases in wind speed mean large increases in available power (going from 10 to 12 mph almost doubles output).

Doubling wind speed increases available power by eight times.
Siting Your Wind Generator
Wind Siting Basics

- Live on site with eyes and ears open
- Recording anemometer at proposed generator height
- Small machine with AH meter
- Talk with neighbors
- Local weather data
- Vegetation
The degree to which conifers have been deformed by the wind can be used as a rough gauge of average annual wind speed. (Battelle, PNL)

<table>
<thead>
<tr>
<th>Wind Speed</th>
<th>Index I</th>
<th>II</th>
<th>III</th>
<th>IV</th>
<th>V</th>
<th>VI</th>
<th>VII</th>
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<tbody>
<tr>
<td>MPH</td>
<td>7-9</td>
<td>9-11</td>
<td>11-13</td>
<td>13-16</td>
<td>15-18</td>
<td>16-21</td>
<td>22+</td>
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<td>m/s</td>
<td>3-4</td>
<td>4-5</td>
<td>5-6</td>
<td>6-7</td>
<td>7-8</td>
<td>8-9</td>
<td>10+</td>
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<tr>
<td>Km/h</td>
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<td>14-18</td>
<td>18-21</td>
<td>21-25</td>
<td>25-29</td>
<td>29-32</td>
<td>36+</td>
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Site wind generators at least 30 feet above anything within 500 feet.
"Putting a wind generator on a short tower is like putting a solar-electric panel in the shade"
Towers

A tower can cost 2 to 10 times as much as the wind generator.
Types of Towers

- Tilt-up Tower
- Guyed Tower
- Freestanding Tower
Safety & Maintenance…
• Most problems are caused by lack of maintenance

• Be aware of your wind generator—regular visual inspection

• Check machines at least twice a year by climbing or lowering tower

• Check more often on severe sites, less often on mild sites

• Tighten bolts, grease bearings, check for blade wear and repair, etc.
Wind Power!

Solar Energy International

SEI
www.solarenergy.org
GeoExchange, BioEnergy and Wind Power