Overcoming Shortcomings in Commercial Software for Correcting Veer in a Wind Resource Grid

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Introduction

Traditional methods of mast-anchoring a wind resource grid file (.WRG) assume wind roses are constant across the windfarm. As this is not always the case, commercial software employs various techniques to correct wind rose veer. Unfortunately, current techniques still do not always adequately address this issue: after modeling turbine location energy production, the mast to turbine wind speed ratios in the energy results can sometimes vary significantly from already natively-defined ratios within the WRG that were input to the model.

Method

1. Several multi-mast pre-construction wind farm sites were modeled in Openwind and Windfarmer. A single mast was used to anchor the WRG and estimate energy.
2. Multiple available WRG correction techniques within the software were tested.
3. Finally, a custom anchoring technique was applied to the WRG:
   - A. As WRGs imply sector windspeed indirectly (using Weibull *A/k)*, Weibull parameter manipulation was used to achieve desired outcome.
   - B. Mast location (i.e. point WRG) sectorwise *k* values assumed constant across the array.
   - C. Ratio of sector mean wind speed to annualized mean wind speed is assumed constant across each WRG grid point, consistent with mast point WRG.
   - D. For each gridpoint, sectorwise Weibull *A* is solved for, which achieves the desired sector mean windspeed ratio.

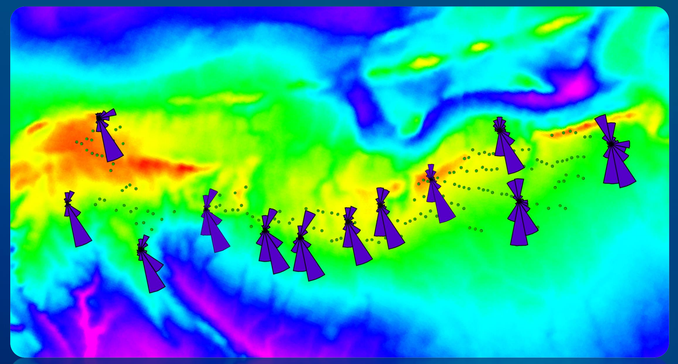

Figure 1. Sample project layout with wind rose variability

- **WRGs and TAB files remain the traditional way to define site wind resource.**
- **A WRG file generated from a flow model includes implied overall (i.e., non-sector-wise) windspeeds at each grid point, turbine, and mast location.**
- **From this, relative wind speed across the site can be defined. (i.e., "speed-ups")**
- **At sites with a constant windrose across the site, WRG speedups are generally respected in the energy output when anchoring the WRG to a mast TAB file.**

At sites with windrose variability, turbine wind speeds out of the energy model may be wildly inconsistent with inherent speedups in the input WRG

- **A basic WRG-processing technique has been developed by Natural Power that allows native WRG speedups to be matched exactly for each mast anchoring .**
- **Anchoring to respect the native WRG overall speedups tends to improve mast-cross prediction test results at complex sites versus other anchoring methods.**
- **Other techniques available within commercial software should also be considered, using mast cross-prediction bias to inform best approach.**

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Results

Three sample projects from 150MW to 2000MW with windrose veer (located in WY, CA, and offshore) were evaluated. Project D was a >200MW control project with minimal veer, located in IN.

Various combinations of available WRG adjustment options were tested, including the following:

- *Apply direction shift to sector probabilities*
- *Enable Ratio Weighting*
- *Enable Ratio Relaxation*
- *Apply direction correction for frequency-table based energy capture*
- *Apply direction correction to bring overall direction frequencies closer to WRG values*

For each project and tested method option, the Ratio between energy report average turbine wind speed, and the implied turbine wind speeds considering the native overall speed-up ratio between initiating mast and the turbines is shown in Figure 2.

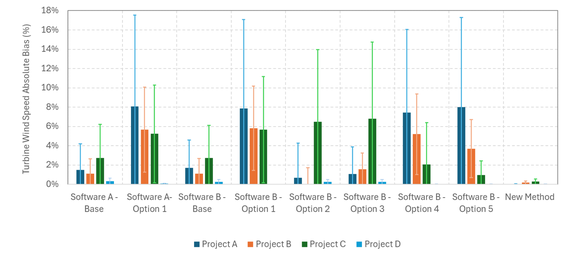

Figure 2. Absolute bias in software-predicted turbine wind speed against WRG-defined overall speedups from a single mast anchoring

Turbine-wise wind speed results for Project C are shown in Figure 3. ***Red dashed line shows that the energy model output using the new proposed method matches closely with the native WRG overall mean speedups.***

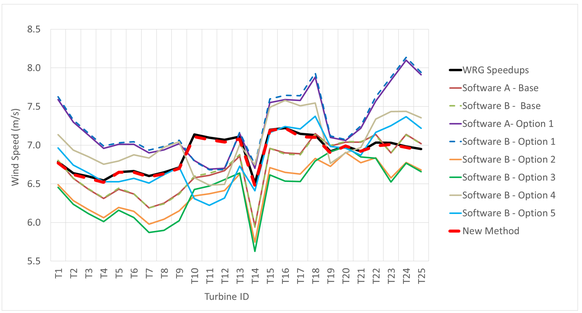

Figure 3. Project C Turbine-wise wind speeds for various anchoring options

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