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Evaluating the Methodologies of Assessing Long-Term Variability of Wind Speed

Joseph C. Y. Lee (1), M. Jason Fields (1), Julie K. Lundquist (1,2)

(1) National Renewable Energy Laboratory, Golden, Colorado, United States, (2) University of Colorado Boulder, Boulder, Colorado, United States

Wind resources vary from year to year, and hence the long-term variability of wind speed is a key component of the overall uncertainty in the wind resource assessment process. Because wind-turbine power generation is highly sensitive to wind speed, the variability of wind resources has important implications for renewable power production. As many approaches of calculating the spread of distribution exist, we aim to identify the methods most appropriate for all types of wind-speed distributions. We review and compare various methods, such as the Coefficient of Variation (CoV) and the Robust Coefficient of Variation (RCoV). Because the length of data available also affects the resultant spread, we determine the minimum length of wind-speed records to quantify variability accurately.

We use the net monthly energy production of 607 wind farms in the United States from the Energy Information Administration and the wind speeds of the MERRA-2 reanalysis dataset from NASA. After filtering the energy data via linear regression, we assess the accuracy of the variability calculations by comparing the correlations between the wind-speed variability estimates and the variabilities of wind-farm power productions. Results from statistically robust and resistant methods yield higher correlations between wind-speed and energy-production variabilities, as robust methods do not assume Gaussian wind-speed distributions and resistant methods are insensitive to wind speed extremes. We recommend RCoV to systematically estimate long-term variability, with 10 years of monthly mean data to achieve 90% statistical confidence. We will also provide generalized guidance on how to estimate long-term variability including case studies where we identify regions with high wind speeds and low wind-speed RCoVs, such as the Great Plains and the Upper Midwest in central United States.