INFORMATION SHEET
RENEWABLE DEVELOPMENT FUND

Investing in Renewable Energy

REDUCING UNCERTAINTY IN WIND POWER PROJECT ENERGY ESTIMATES

Project Description

Typically, when a wind power project is planned, a wind energy assessment is performed to determine the wind speeds at different locations across the proposed project area and the amount of electricity that will be generated by the project over time. Often these assessments have a significant amount of uncertainty. The calculations use data from nearby towers, computer modeling, and manufacturing specifications for the wind turbines expected to be installed. The uncertainty is due to the limited number of measured data sets that may be available, incomplete details about terrain wind flow patterns and wind speeds at various heights, computer modeling limitations, and the assumptions used when estimating long-term trends and variability.

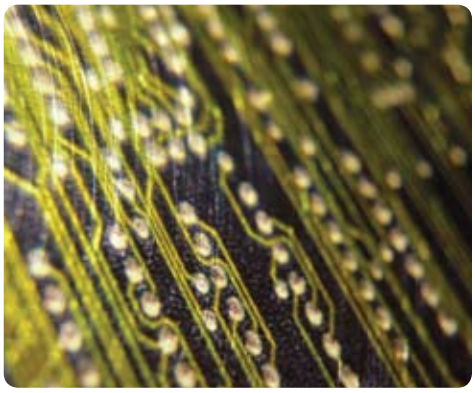
Methodology

Five operating wind farms provided data that included pre-construction wind speed measurements and post-construction electrical generation data. The data and computational modeling were used to explore the accuracy and cost-effectiveness of various methods for estimating long-term energy generation at proposed wind farms. The results of the estimating methods were compared with actual measured wind speeds and generation data collected after the facility was built. The project determined the accuracy and cost-effectiveness of various estimation models.

Executive summary

Reducing uncertainty in energy projections at specific wind project sites through more accurate wind speed estimates should help reduce the cost of energy for wind power projects. The research was to determine the most cost effective combination of modeling approach and wind data sets to reduce the uncertainty of wind resource estimates.

This study should help wind projects achieve more favorable financing terms due to reduced uncertainties, improved electrical power estimates, and more accurate electrical sale projections, which may reduce the cost of electricity.



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RDF Mission: To increase renewable energy market penetration, assist renewable energy projects and companies, and support emerging renewable energy technology through research and development.

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Benefits

- Provided methods to reduce the uncertainty of estimates of wind energy generation from planned wind projects
- One site studied was in Xcel Energy's Minnesota wind production footprint
- Three study sites were in low complexity terrain similar to low to moderate wind areas in Minnesota that could be developed for wind power
- Limits uncertainty, which reduces project finance risk and costs, which translates to lower wind development costs and cheaper wind power

Lessons learned

- All the analytical methods (nearest tower, distance weighted and similar exposure) provide results with similar uncertainties and all of the numerical models (WAsP, WindSim and the NWP models at the sites where NWP data was available) provide results with similar uncertainties
- Increasing the number of meteorological (met) towers to determine site-wide wind speeds is the primary method to decrease uncertainty. Uncertainty reductions of one percent can be obtained for about $12,500, which is the approximate cost of a tower
- There is no completely reliable model for estimating wind speeds or capacity factors for wind projects
- Automated Surface Observing Systems (ASOS) and balloon data sets provide results with reasonably low uncertainty at sites characterized as flat or with rolling hills

Outcomes

- Estimating long-term wind characteristics has an uncertainty of about four to six percent in the U.S.
- Eight different methods were considered for long-term wind speed extrapolation. Of those tested, the Joint Probability Distribution Measure-Correlate-Predict method (JPD MCP) worked the best at almost all sites when using site data of more than one year duration. The Variance MCP method worked well for shorter data lengths. The Linear Regression MCP algorithm provided excellent estimates of mean wind speeds, but poor estimates of wind speed distributions when used with hourly data
- ASOS, balloon data, and Model Output Statistics (MOS) Wind Forecasts provide good results, although daily thermal effects can result in uncertainty
- The only direct method identified for reducing uncertainties of wind speed estimates is to deploy additional met towers

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