Wind energy enhancement: UC research establishes real-world wind turbine performance metrics

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The production of wind-derived renewable energy is growing, and so, it's important to help wind farm owners operate at higher efficiencies with lower costs.

In fact, figures from the World Wind Energy Association report that installed global capacity for wind-energy production was approximately 240,000 megawatts of power in 2011, up nearly ten fold since 2001.

That growth, which is expected to continue, will increase demand to facilitate plant efficiency and lowered operational costs along with just-in-time turbine maintenance among wind farms. And to that end, University of Cincinnati researchers have been conducting real-world tests of new predictive software that does just that – increases efficiency and lowers costs when it comes to commercial wind-turbine operations.

The test results, which analyze two years' worth of operating and environmental data from a commercial wind turbine, have just been published in the *Journal of* Renewable Energy, along with information on the predictive maintenance software.

The paper, "Wind Turbine Performance Assessment using Multi-regime Modeling Approach," is authored by Edzel Lapira, doctoral student in the Center for Intelligence Maintenance Systems at UC. Co-authors are Dustin Brisset, engineering master's student; Hossein Davari and David

Siegel, engineering doctoral students; and Ohio Eminent Scholar Ohio in Advanced Manufacturing Jay Lee, professor of engineering.

In addition, the UC researchers continue to track and analyze the operation and environmental factors of three more commercial megawatt-class wind turbines, data from which will be used to validate these initial findings.

Historical data on megawatt-class wind turbines that have operated in real-world conditions is rare simply because the industry is so new and the technology is changing so quickly.

The UC team is among the first to begin analyzing data from turbines currently operating in wind farms, as opposed to being limited to data that was collected in a controlled lab or workshop environment or to data from smaller wind turbines. UC's data collection has been underway for two years and is ongoing. The current data collection is taking place on a wind farm near Shanghai, China.

Often, the real-world data based on sufficient amounts of operating history that is available to researchers is data from smaller wind turbines that have not implemented many of the rapidly changing technologies that are used in today's more common megawatt-size turbines.

The aim of this initial research by UC was to provide a quantitative measure of commercial turbine power-generation performance so that wind farm operators can objectively and optimally schedule maintenance before more catastrophic, and costly, degradation or failures may occur.

In addition, their research aims to identify the most critical turbine components. In other words, which components have the highest failure rates, along with the average down time of a particular component. The UC analysis software monitors the change of performance of the unit.

The change in performance is caused by components requiring maintenance, which contributes to a gap between actual sustained power production and what is expected for the current environmental conditions.

According to Lapira, "It's impossible to monitor all the parts of a turbine, which is why we worked to determine which are the key components, the most likely to fail and the most expensive failure situations. It's about establishing the performance metrics for turbines because, until now, there has been a lack of real-world performance metrics."

For example, according to Lapira, manufacturers of gear boxes for wind turbines predict a 20-year lifespan for their products; however, since no wind farms have been in operation for 20 years, it's impossible to know the accuracy of that prediction, especially since turbines in the field operate under a wide variety of environmental conditions.

"On some farms, up to 20 percent of the turbines are failing for various reasons, and we need a technique to be able to predict these failures and minimize downtime," stated Lapira, adding that generators and rotor blades are also good candidates for a predictive maintenance system or even redesign.

The goals of the predictive software the UC team has developed are simple:

-- To predict maintenance needs so a wind turbine experiences near-zero downtime for repairs.

-- To aid just-in-time maintenance functions and delivery of needed parts.

-- To decrease spare-parts inventory.

-- To ultimately predict and foster needed redesigns for wind turbines and their parts.

Provided by University of Cincinnati

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