

# Seeking A Data Model To Match Turbine Advances

*With turbines becoming more innovative, how can developers collect accurate wind data that is centered around lower heights and limited points of measurement?*

BY LARRY LETTENY

In order to sustain wind power's leadership in renewable energy, developers and operators will need to build and manage wind farms that deliver competitive results over the long term. The most important driver of wind farm competitiveness lies at the intersection between a continuously variable wind resource and the efficient, turbine-based conversion of that wind to electricity.

To that end, investors have poured hundreds of millions of dollars into turbine design, development and production to support the growing appetite for wind energy. Advances in turbine design have resulted in larger turbines with higher hub heights and longer rotors to capture more energy from the winds that blow at higher heights. Enercon and Vestas, for example, have turbines that stand at least 100 meters from ground to hub, and other manufacturers are expected to follow suit.

Larger turbines have the potential to efficiently harvest more energy per site, assuming there is a strong understanding of the wind conditions at the higher heights of operation. Herein lie an opportunity and a challenge. The opportunity is for more sites to be developed and be more productive based on the innovations

of the turbine manufacturers. The challenge is that the current process for collecting wind data is centered around lower heights and limited points of measurement. The key to the wind industry's long-term leadership is an integrated approach that combines advances in wind turbine technology with a new set of best practices for wind measurement and wind information management.

Wind data that can predict a wind farm's long-term performance is still

properly characterizing its value and impact on the bottom line. Wind data is an asset that must travel with the wind farm throughout its life cycle, with more information gathered during each stage to create a comprehensive historical record.

This concept of a definitive data set that follows a wind farm site throughout its life cycle imposes continuity on the currently fragmented wind farm development model. The data creates a common thread through the elements of wind farm development, which can be organized into four stages:

■ **Prospecting**, which involves finding sites and

quickly qualifying or disqualifying them for further study. Developers who can conduct the prospecting step quickly gain an enormous advantage by efficiently ruling out sites that do not merit further study.

■ **Assessment**. There are three components in this phase. The first is completing a study of resources at the site. After that, investors decide whether to finance the project based on power performance projections. The last component is designing the site for optimal energy production. The assessment phase can take anywhere from one to three years and must produce highly credible data

*Developers can quickly determine if the proposed site merits further study.*

not viewed as a strategic asset. Until it is, wind farm developers and operators will not fully realize the potential of their investments in property and turbines. The wind power industry needs a new model for integrating multiple wind data streams into a single strategic view that encompasses every phase of a wind farm's development from prospecting through operation. This data can then be the basis for future operational and optimization decisions.

## **Ingredients of a new data model**

Evolving the wind industry's mind-set about wind data starts with

to inform project financing, turbine purchasing decisions and wind farm site design.

■ Monitoring wind conditions during the operation of a site, which is necessary to assess responsibility for turbine underperformance, proactively maintain the turbines, avoid damage to the turbines and avoid costly shutdown events.

■ Optimization, which involves using wind data to aid in improving the operational efficiency of a wind farm. Profitability depends on maximizing power production and minimizing maintenance – especially unscheduled maintenance from equipment breakdowns. The cost of maintaining a wind turbine goes up with age – averaging about 10% of total wind farm operating costs during the early years and approaching 35% of operating costs as the turbine nears the end of its useful life. Minimizing these repair costs and improving operational practices can increase wind farm profitability substantially.

Data collected at each of these phases creates a wind information life cycle. It is the baseline for predicting a site's long-term performance. As meteorology and wind farm technologies continue to evolve, the wind information life cycle data set will grow steadily richer, adding value to wind farm assets.

An example illustrates how such a data set can increase a wind farm site's value throughout the asset's life cycle. One wind farm owner/developer financed its project with 50-meter data collected over a decade ago. After the wind farm became operational, the temporary meteorological masts that were used to finance the farm were taken down and two 50-meter met masts were left standing to provide reference data.

When the owner sold the project, the technical due-diligence process cited high uncertainty in the annual energy-production predictions, re-

sulting in poor financing terms for the buyer. Although the original wind resource assessment and monitoring of the site were conducted according to the industry's then-standard practices, the asset lost value because of the lack of hub-height data at locations around the site.

The industry is also beginning to realize the potential benefits of wind data in operations and maintenance. Several large global wind operators have improved their standard wind measurement practices by measuring in more locations over the site of the wind farm. Beyond this, they have begun measuring up-wind to aid in prediction. The added data provides an improved understanding

*Wind power's variability can be somewhat mitigated by data collected throughout its life cycle.*

of wind speed and direction dynamics, extreme ramps and severe wind characteristics. The expectation is to produce operating savings as well as energy output increase and off-take efficiencies.

#### **Changing perspectives**

The wind information life cycle strategy is subject to the same ground rules as every information system: garbage in, garbage out. To deliver value, the wind information life cycle strategy must be founded on broad-based data gathering, with more emphasis on measurement and less on estimation.

For years, the industry has measured wind by mounting wind speed and direction sensors on meteorological masts. Pre-construction wind measurement campaigns are typically designed by meteorologists, approved by bank engineers, financed and implemented by project developers, and outfitted by a variety of sensor and service providers. To date, the firms that conduct technical due diligence on wind farm financial proposals

assemble mostly lower-height mast measurements and estimate upper-height wind behavior.

Operational wind farm measurement systems typically consist of one or two fixed 80-meter reference towers per site. The reason so few measurement sites are used is the significant cost of fixed-tower erection and maintenance.

This near-exclusive reliance on 80-meter measurements leaves gaps in the wind information because these measurements do not capture any data above hub height. To compensate, meteorologists use formulas to extrapolate the wind speed and direction across the full rotor sweep. This practice creates uncertainty and has been blamed as a contributing factor in the reported 10% underperformance of wind farms in recent years.

Two industry practices contribute to inaccuracies in higher-height wind estimation. The first is extrapolation, a process that requires key, non-measured assumptions to extend data from a 40-meter or 60-meter met tower to 80-meter hub height. The second is the practice of treating the hub-height wind speed as representative of the wind speeds over the entire swept area of the rotor. As the rotor size of modern wind turbines continues to increase, it is becoming necessary to account for wind speed variations across the rotor span.

The wind industry, including many of the meteorologists who use extrapolation to help wind resource assessments, is increasingly recognizing the inaccuracies of extrapolation. In a 2010 comparison study sponsored by the American Wind Energy Association, 11 meteorologists were given the same set of 30-meter and 50-meter data and asked to calculate wind speeds and directions at 80 meters by using various methods of data cleansing and extrapolation. The calculations were then compared to wind speeds that had been

measured at the higher heights. The most striking result was not whose extrapolation was the closest to the measured data, but the enormous range of differences in the wind resource estimates.

Very tall meteorological masts, ranging from 100 meters to 140 meters, are a theoretical option and are in limited use. However, the costs of these masts, including permitting, installation and maintenance, are impeding adoption in most regions around the world. There are several enterprising companies that instrument existing cellular towers for wind data collection. Assuming the boom/anemometer setup is proper and the location is proximate, this can be an additional source of tower-based data.

Ground-based remote sensing has evolved over the past decade from a complex and expensive science experiment to an economically advantaged way to measure higher height data throughout the wind information life cycle. The dramatic growth in the deployment of remote sensing reflects the maturity of the technologies and the industry-wide call for higher height and complete rotor swept area data.

The better the wind resource is understood at a site, the better

chance there is that the wind farm will be designed to ensure maximum productivity, will continue to operate productively and will retain its value during ownership transfer, warranty events or repowering.

Wind power, in the near term, is not likely to be the most manageable or predictable source of energy. However, data collected throughout a wind farm site's life cycle can provide a reasonable window of certainty to a site's potential and is the key to maximizing energy and economic returns.

Because wind data adds so much value to a wind site over such a long period of time, the data itself must be treated as an asset. Potential criteria for a complete wind information system include the following:

**Independence.** Raw, measured wind data – not only extrapolated, filtered or cleaned data – must be stored and available throughout the project's life cycle to provide an unquestionable reference as technology and the needs of various stakeholders change.

**Chain of custody.** To offer testimonial value, wind data must be time-stamped and location-stamped in such a way as to erase any doubt about its origin. The risk involved in misfiling a set of wind data must be eliminated; with millions of dollars

at stake, wind data is no place for debate.

**Organization.** To be usable, wind data needs to be stored together in a single database so that all the data from one asset can be viewed in conjunction and different measurement sites can be easily compared and analyzed.

**Security.** It is not enough to deliver data to one stakeholder in a wind farm. Storing data in a secure location, with reasonable protection against unauthorized access and a reasonable system of backing it up, ensures that the data will continue to add value to the wind farm throughout the life cycle.

Taller turbines and longer rotors are indispensable ingredients of the wind industry's expansive future. Alone, however, they are no guarantee of success. Building bigger turbines to increase site capacity is only one piece of the equation. The industry also needs to devise better wind information practices in order to realize the full potential of the wind. **SNP**

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*Larry Letteney is CEO of Somerville, Mass.-based Second Wind, a developer of wind measurement systems. He can be reached at [larry@secondwind.com](mailto:larry@secondwind.com).*