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How Wind Forecasting Can Optimize Plant Performance

The old adage "quality in, quality out" extends to forecasting, as the quality of wind plant performance data can directly impact a forecast's ability to be accurate.

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As the wind industry continues to grow, the demand for more accurate forecasts of wind plant output over timescales of minutes to days becomes increasingly important to ensure success. Current forecasting methods require a range of meteorological and plant-specific data inputs to achieve desirable levels of accuracy. The quality of the input data directly impacts the ability of the forecasts to meet accuracy expectations, and plant performance data is no exception.

Regardless of the forecasting technique, plant performance data can enhance the prediction of energy output, and in the case of statistical models, it is a requirement. Although not essential for physical models, performance data allows the plant output to be predicted using a power curve derived from performance data as opposed to the manufacturer's power curve. The major benefit to employing this approach is the assurance that you are observing performance in actual conditions as opposed to ideal ones only, such as horizontal flow, low shear and low turbulence intensity.

The potential exists for ideal conditions to account for as little as 10% of total turbine operational time. During the remaining time, a turbine experiences numerous conditions outside the bounds of the manufacturer's power curve, such as high shear, high turbulence intensity and veer. All of these conditions have the potential to negatively or positively impact a turbine's power output.

Delivering reliable plant performance data is easier said than done.

In many instances, delivering the plant performance data to the forecaster is easier said than done. Challenges such as old or disparate supervisory control and data acquisition (SCADA) systems, or minimally trained personnel who are inadequately equipped to extract essential information from the SCADA system, can lead to difficulties in getting any data to the forecast provider on a timely basis, let alone the right data.

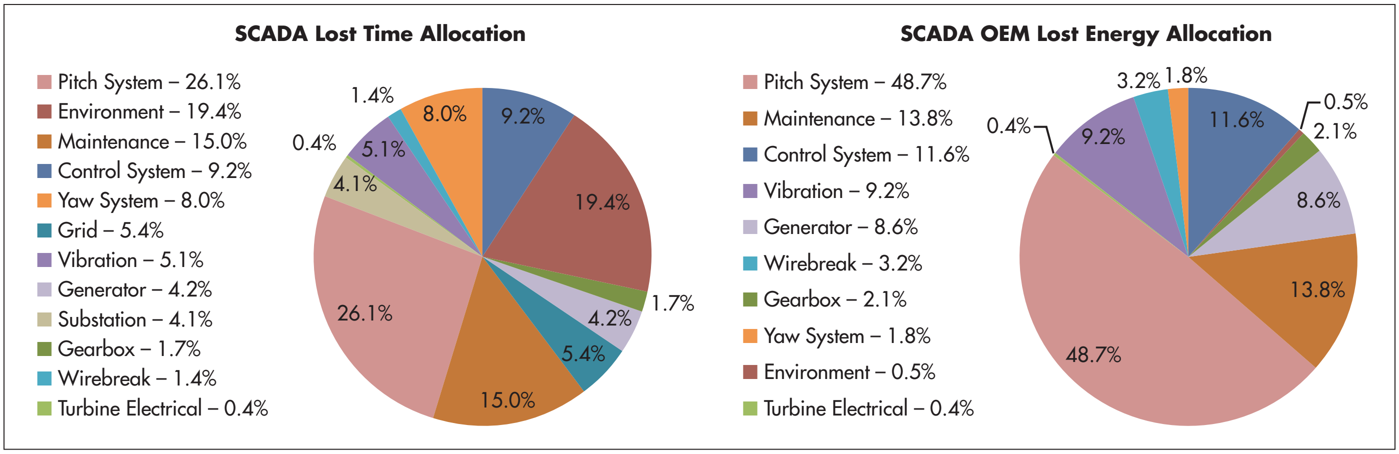
Logistically, it can be difficult and time consuming for plant operators to access, process and transmit their data to others, especially third parties, where data security is an important priority too.

In cases where plant data is provided to the forecaster, one of the more frequently encountered issues is the data parameters provided. It is often the case that production data is supplied but plant availability is not. Without availability, it is impossible to know how many turbines are operating during the time period or whether they are all operating normally.

This lack of vital information makes it challenging to discern the real operating condition of the plant and puts the forecaster at a great disadvantage when trying to consistently hit an accuracy target. Moreover, there are numerous ways to define availability, so it becomes necessary to supply the definition with the value.

When discussing availability, it is important to distinguish between time and energy (see Figure 1). Time-weighted availability is focused solely on the amount of time a turbine is not producing power, but should have been. Energy-weighted availability is based on the fact that all downtime is not created equal – the energy lost during windier periods is more important than during calmer periods. If a plant is experiencing more downtime when it is very windy, the energy-weighted availability will be

Figure 1: Health Monitoring – Energy To Downtime



Source: AWS Truepower

lower. In reality, this tends to be the case because turbines often experience more faults near or at peak loads.

It is also important to always screen data for quality in order to ensure that the forecast is accurately modeling the plant's performance. A number of factors drive quality, including communication errors between the turbine and plant SCADA system or incomplete/partial records.

It is also important to understand that there are times when data may appear to be poor but is actually normal for the given inlet conditions, such as turbulence intensity, wind direction and strong waking. An improper classification of performance data will result in inaccurate production forecasts, even if the free stream wind forecast is correct. This can inadvertently lead to a plant operator scheduling turbine maintenance during energetic periods, with undesired impacts on the plant's economic return.

Understanding conditions and operations

Increasing the awareness of forecasters and plant operators to the conditions that affect plant performance can help filter out poor data and, perhaps more importantly, is a positive first step toward increasing the accuracy of forecasts. Because many factors affect plant performance, understanding all of these conditions is vital. Some factors are relatively easy to spot, such as inclement weather, while others can be more obscure, such as shear, obstacle-induced wakes and component degradation, making it difficult to determine normal plant operations.

Simple analytical techniques can be applied to the SCADA data to improve insight and understanding. As the industry matures, the volume of available data will increase, and, as such, it will become essential to utilize automated analysis techniques to translate the expanding data stream into actionable information.

A key benefit of translating data into information is increasing the skills and knowledge base of forecasters. Another is significantly improving a plant operator's ability to diagnose component life and find potential precursors to failure. Advanced analytical techniques or tools can be used to determine when critical turbine parts are going to fail. An operator can couple this information with a highly accurate forecast to minimize the loads experienced by the failing turbine and thereby prolong its life. The forecast can then further be used to schedule the turbine repair during a low-wind period to minimize the amount of lost energy.

Enhanced operations and maintenance

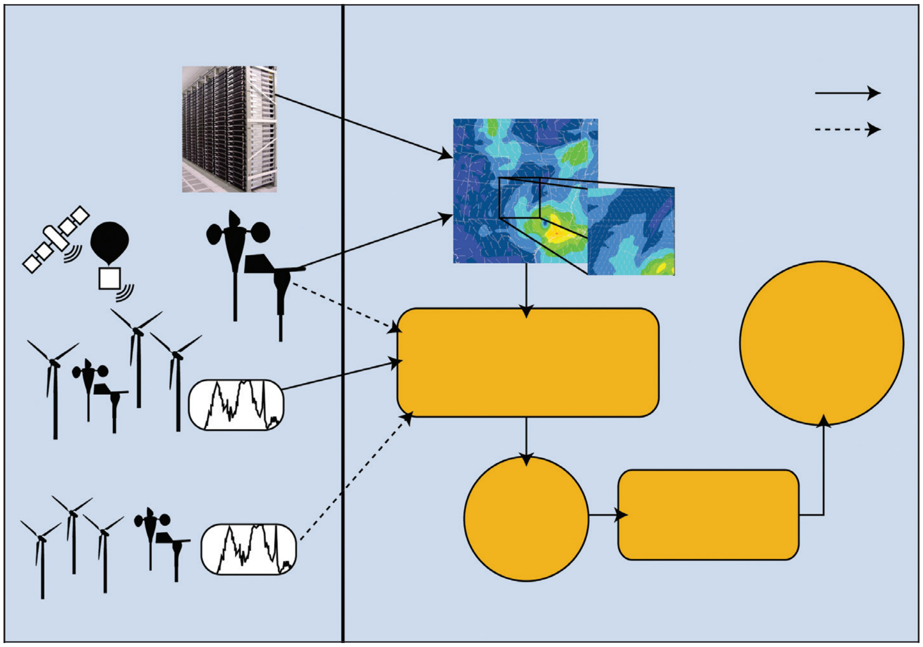
Further plant optimization can be achieved through the use of performance metrics. A metric such as energy to downtime (EDT) can be used to manage when a turbine comes off-line for maintenance. EDT is a measure of the percent of lost energy to the percent of downtime for a given turbine event. It can be used to measure how efficiently maintenance practices are performed or to see how much a downtime event or failure has affected the plant's bottom line production.

Activities that will affect turbine production, such as maintenance, should be managed to achieve an EDT ratio of less than one (percent of lost energy is less than the percent of downtime). Hourly, daily or weekly wind forecasts can be used to schedule maintenance when the plant will be least energetic.

To illustrate this, assume a plant had approximately 26% of its downtime in a month attributed to the turbine's pitch system, but it was determined that this problem accounted for about 49% of its lost energy for the same period, resulting in an EDT ratio of almost two. Addressing this problem promptly holds great upside potential in energy recovery for the plant. Combining this knowledge with a forecast allows the operator to address the problem during low-wind periods and maximizes the plant's revenue at the same time.

There are many instances in the life of a wind turbine when it is available for operation but is not performing at its full potential. Reasons for underperformance can range from an incorrect parameter setting, such

Figure 2: Forecasting System Components



Source: AWS Truepower

as anemometer offset or pitch setting, to blade fouling. Problems like these usually have a negative impact on a plant's bottom line and can be difficult to detect without scrutinizing the SCADA data. Distinguishing between poor data and suboptimal operation can be a real challenge for forecasters.

It is critical to the forecaster that data representing suboptimal operation not be removed unless it is confirmed that the suboptimal operation has been corrected at the plant. Understanding SCADA data and what is normal for a given system can help increase the accuracy of a forecast and allow operators to understand what is treatable.

In order to supply a forecaster with the needed plant availability (ideally energy weighted) and health information, consistent communication between the plant and forecaster is necessary (see Figure 2). Furthermore, supplying the information for each individual turbine will increase the accuracy of a forecast even further.

It is important to remember that the data must be sent at the same or a higher frequency than the forecast resolution. This could be difficult to achieve if the plant operator is manually sending data to the forecaster. An alternative and preferred approach is an automated communications method that transfers the required data to the forecaster at the desired frequency.

Fully understanding performance data and the conditions affecting a wind plant is paramount to increasing the accuracy of forecasts. Analytical techniques applied to the SCADA can serve as a way to translate data into information. This information will increase a forecaster's skills and knowledge base while also improving the plant operator's ability to diagnose component life and uncover potential precursors to failure.

Moreover, enhanced operations and maintenance practices give plant operators the ability to understand what is normal and focus on what is treatable. This information, coupled with the accurate and tuned forecasts, allows maintenance to be scheduled during non-windy periods, thereby minimizing the impact to the plant's economic return. NWP

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