Optimising wind turbine operations with
smart algorithms

Introducing Power Performance Optimisation to boost your wind turbine's energy output

At Vestas, we work tirelessly to improve the performance of wind turbines. For more than 30 years, we have harnessed innovation to produce ever more efficient wind turbines. Our Power Performance Optimisation software upgrades are the latest opportunity for wind turbine owners to improve their annual energy production and boost profits.

Wind turbine technology has come a long way since the first modern day turbines were built some 30 years ago. Not only have they grown significantly in size and power, their efficiency and sophistication has also increased dramatically.

The control strategy of a wind turbine has a key part to play in driving efficient operations and making sure the turbine converts the available wind into electricity with minimal waste. In many ways the controller is the brain of a wind turbine, and it manages operation based on the input signals it gets. The more accurate the signals are, the better the controller can adjust operation to the conditions.

Out of the hundreds of signals a turbine controller handles, two are above all in importance. Wind field measurements – that is wind speed and wind direction – in front of the rotor are two critical signals needed to achieve optimal operation of a turbine and capture all available energy.

The wind speed measurement is used for setting the optimal blade pitch angle and rotor speed for achieving maximum power output at the given wind speed, while an accurate wind direction measurement is needed for keeping the turbine upwind.

On most state-of-the-art wind turbines the wind speed and wind direction measurements are based on wind sensors placed on the nacelle of the turbine, behind the rotor. Due to the disturbance of the rotor and the nacelle shape, the wind speed and wind direction measured behind the rotor are not equal to the wind speed and wind direction in front of the rotor. Wind turbine controllers will therefore use added correction factors or so called wind correlation parameters to account for the disturbance.

The correction factors are based on prototype turbine measurements, and are sensitive to the alignment of the nacelle anemometer, special site conditions such as complex terrain, or obstacles in front of or close to the nacelle anemometer.

When a wind turbine's wind speed and wind direction readings are inaccurate, the result is lost production as pitch angles and other parameters are not optimally aligned. Moreover, turbine loads are negatively impacted when the turbine direction is not aligned with the wind.

Smart Algorithms

Vestas®

Pure. Performance

With Power Performance Optimization, Vestas has now developed smart algorithms that significantly improve the accuracy of wind turbines by making continuous and automatic correction factor calculations for wind speed and wind direction measurements possible.

With Wind Speed Estimator, one of the features in the software upgrade, your turbines will be able to set the right pitch angle and rotor speed much more accurately than conventional wind turbines, resulting in more AEP.

Using information from key operational parameters, such as power, pitch angle, and speed, Wind Speed Estimator is able to calculate the incoming wind speed over the entire rotor area based on how the turbine operates and performs under specific wind conditions. This information is then used to automatically replace the wind correlation parameters below rated power – and improve turbine operations.

At the same time, the software uses the directional variation (e.g. +/- 6 degrees) of the incoming wind together with a control algorithm that allows the wind turbine to identify actual wind direction based on maximum power, thereby reducing dependency on the wind sensors.

The feature, Adaptive Wind Sensing, effectively eliminates static yaw misalignment by continuously and automatically correcting the nacelle transfer functions for the optimum upwind position. Importantly, as the solution is dependent only on the natural directional variation of the wind, there is no increase in required yaw activity.

Together, these newly developed software algorithms represent a milestone in wind turbine technology, and can improve annual energy production for thousands of Vestas wind turbines already in the field by up to 1.0% through more accurate wind readings. Moreover, the software algorithms will reduce turbine loads.

Power Performance Optimisation software is made available for previously installed Vestas turbines through Vestas PowerPlus™, the suite of products designed to improve the annual energy production of wind turbines by incorporating the latest innovations in the wind industry.

In addition to Power Performance Optimisation, Vestas PowerPlus™ includes Power Uprate, Extended Cut Out and Aerodynamic Upgrades. Vestas PowerPlus™ upgrades have already been implemented on more than 1,300 wind turbines worldwide, delivering up to 5%* more energy.