Art of Seeing the Unseen: Wind Turbine Performance Analysis Using Unconventional Matrices

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Motivation
The wind energy sector has grown rapidly and has made a significant mark in the global sustainable energy production. This has raised the stakeholder’s interest in optimal windfarm operation. High availability and good quality of power performance during operation is the key for stable and consistent performance of every Wind Turbine Generator (WTG) for recovering the Return on Investment (ROI).

With the development in technology over the major and minor components of a WTG, the amount of data being generated has also grown to an enormously complex size. This paper focuses on a methodology for properly analyzing the data that will help in getting the insight and visibility of emerging trends for improving the performance and raising uptime. This has been done using the Power curve of the turbine along with various other operational curves like the Rotor Speed Vs Power Curve, Pitch Angle Vs Power Curve, Pitch Angle Vs Wind Speed Curve etc.

Objectives
The major objective of this work is to organize a structured framework for effectively monitoring the performance of any WTG by efficiently analyzing the data. Several case studies have proved the productiveness of this methodology.

Methods
The power curve of a WTG is considered as the key indicator of its performance. While analysing these data for detecting underperformance of the WTG, the primary parameter considered is its state of operation. Only the data points or timestamps during the complete production period of the WTG are taken into account for developing the operational power curve rather than incorporating all states in order to sight the real performance.

Similar approach is employed in analysing other operational curves of the WTG also to visualize an overall overview regarding its performance. The other operational curves being Rotor Speed Vs Power Curve, Pitch Angle Vs Power Curve, Pitch Angle Vs Wind Speed Curve etc.

Conclusion on the operational performance of a WTG is made based on the behavior of these operational curves instead of the sole belief on power curve. Even the reference curves are derived from the operational data for validation.

Conclusions
Everyone has eyes to view the data and deliver results from their own perspective, but acquiring meaningful relationships and worthwhile observations from these accumulated data plays the major role in improving the performance of a WTG thereby increasing its uptime. As the demand and interest in sustainable energy production is expanding at an alarming rate, performance monitoring of WTGs has become an integral and crucial element of wind energy sector. The proposed architecture is an organized and foolproof architecture for every WTG owner to approach the vast database of SCADA data in a very productive manner to interpret the real picture of their WTG’s operation and will assist in taking necessary efforts to maintain the health and wealth.

References