An Analysis to Identify Critical Component Failure in Onshore Wind Turbine Generators

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Motivation

Turbine availability only provides a measure of the time in which a turbine is operational but does not consider the key components that affect it-to bring forward results that can be used to address a problem of non-conformance or minimise reoccurrence in emerging renewable energy markets such as South Africa.

Problem Statement

Maintaining a system such as a wind turbine through its operational life is a continual task which requires good maintence strategies and practices. This is to gain maximum value from the turbine as an asset throughout its operational life.

Studying turbine availability at sub-system level can provide detailed results, which can be used to address a problem of non-conformance and minimise re-occurrence of failure in wind turbines.

Methodology

A methodology that uses statistical and quantitative techniques was used to precisely study the wind turbine failure alarm data. The analysis was performed using real operational wind turbine SCADA data that spans over a 2 year period; a total of 17575 hours and 14595 alarms were studied.

Results

The 6 critical sub-systems identified: (3 electrical, 3 mechanical) Generator inverter, Grid Inverter, Converter, Yaw, Hydraulics and the Hub.

• 49.39% of failure alarms last between 1-10min, 29.59% last between 10-59min and 21.09% last longer than 59min.

• Failure duration of the electrical sub-systems are typically between 10-59 min but occur frequently however their total duration amounts to a significant loss in turbine availability.

• 6 sub-systems (Brake, Controller, Environmental, Generator Inverter, Generator Inverter, Grid Inverter, Rotor, Systems) indicated a significant decrease in the number of failures as they age.

• Converter,Grid. Inverter and Generator.inverter are the sub-systems identified to have the most failure alarms, however a single malfunction in one sub-system of failure can trigger a cascade of failure alarms in multiple sub-systems.

• The turbines with the lowest turbine availability in the turbine population and the component associated with high failure durations in the turbines.

Conclusion

Mechanical failures in sub-system are the common cause for low turbine availability mostly due to the overheating of hydraulic fluids and components. Excellent turbine availability is a combination of good maintenance strategies which must be consistently optimised for excellent equipment reliability and minimal downtime.