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An estimation of key metrics from SCADA data: a third-party's view

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Abstract

SCADA-based monitoring is a cost-effective approach to reduce O&M budget in wind energy [1], [2]. From historical data of the machine, several key indicators could be calculated. These indicators provide a global view of the health of the wind turbine. They allows to compare the performance between turbines in the wind farm and also between the real performance and the theoretical performance announced by the turbine manufacturer [3].

However, the estimation of key indicators from SCADA data requires a clean and complete status-code signal, which is usually reconstructed from an error log. This procedure to obtain this signal is complicated and sometimes is not feasible due to the missing or the incompleteness of the error log. Even if the error log is available, it's not easy to identify the errors that related to the bad performance of the machine [4].

Objectives

In this study, we introduce a detailed and dedicated classification algorithm, which reconstructs a valuable status code, including partial stops and curtailments. It requires only the nacelle wind speed and the output power from the SCADA system. When available, other SCADA parameters, such as the pitch control, are automatically added to enhance the precision of the classification algorithm. The operational power curve is then estimated from the dataset of normal status. From the detected status code and the estimated power curve, key metrics of each machine during a given period are identified: total production, losses, time based availability and energy based availability.

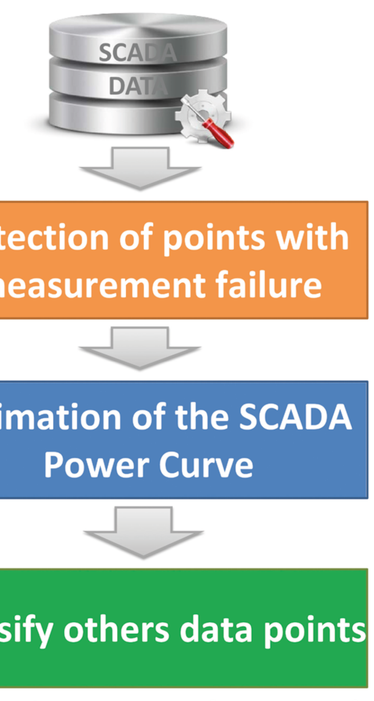
In a second time, the power performance of each machine is calculated on a monthly base. This power performance index, which is insensitive to wind exposure variations, is able to measure simply and rapidly the effect of a maintenance (e.g. repair of a mechanical part), a settings change (e.g. recalibration of an anemometer), and to detect a functional anomaly.

Methods

The SCADA points of each wind turbine will be classified.

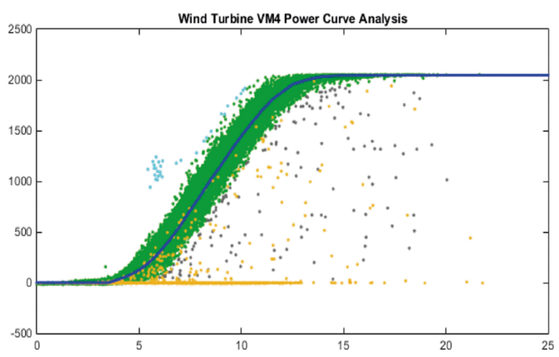
The classification process begins with the detection of points with measurement failure. Theses point will be excluded in further the analysis.

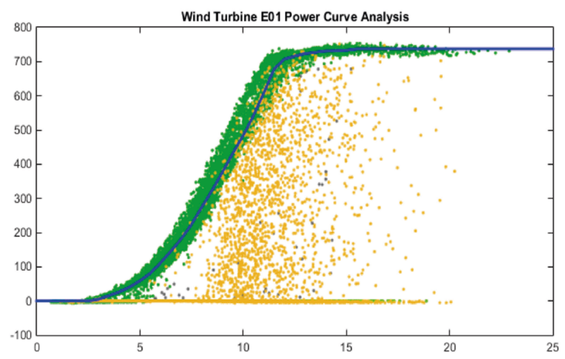
Next, the SCADA power curve of the wind turbine is estimated by an iterative median estimation technique. This detection method has a high robustness, which can give a good estimation of the power curve, even in the case that the normal status takes less than 50% of the total SCADA data.



Using this power curve, others classifications of data points are made: normal, stop, curtailment, under production… And the final power curve is then estimated using only the normal data points.

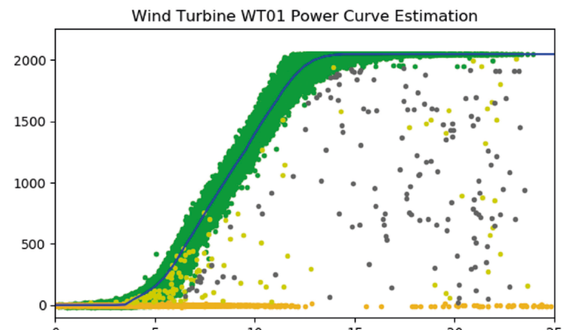
Once the classification has been made, the calculation of key metrics could be done without much effort.

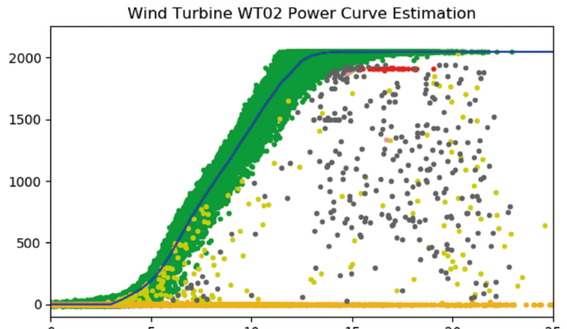


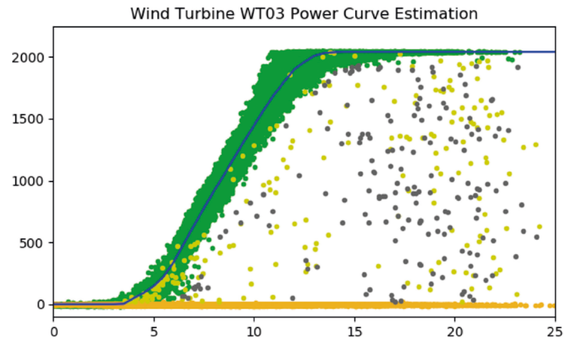


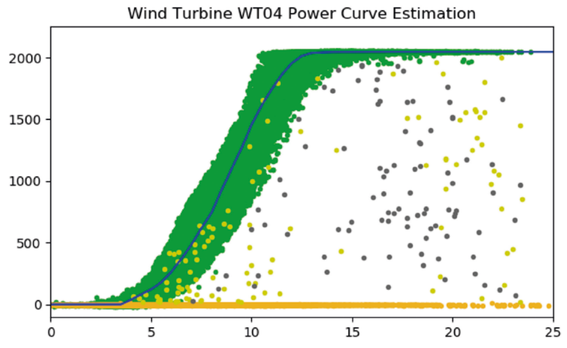
Results

The proposed approach is tested on a wind farm composed of 4 wind turbines MM82. The SCADA data of 2 years is collected and analysed.



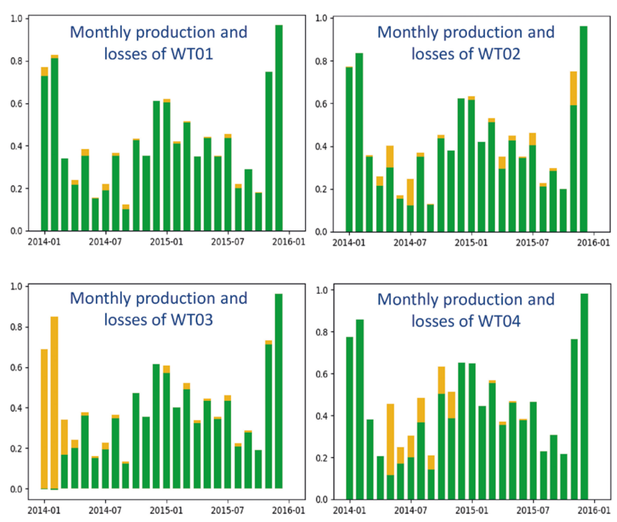


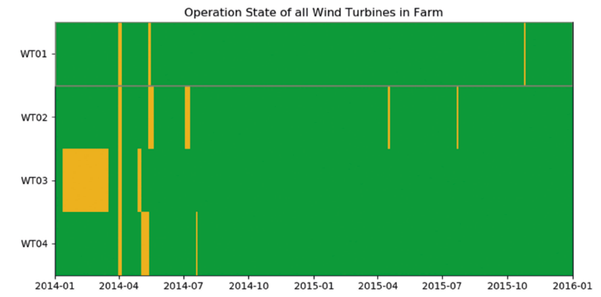




Normal Points - Stops - Partial Stops - Curtailment - Under Production - Over Production

Name	Production (MWh)	Losses (%)	C. Factor (%)	Avg. Prod. (MWh/day)	Avg. Wind (m/s)	TBA (%)	PBA (%)
WT01	10119	1.86	28.58	14.05	6.58	96.45	98.33
WT02	9928	5.84	28.00	13.77	6.45	94.00	94.54
WT03	8327	18.94	23.58	11.55	6.57	86.87	81.29
WT04	10570	4.22	29.82	14.64	7.08	96.26	95.92





Name	Number of failure	MTTR (days)	MTTF (days)	MTBF (days)
WT01	3	3.7	277.1	281.5
WT02	5	5.1	111.7	117.4
WT03	3	24.5	17.9	52.6
WT04	3	6.1	46.1	54.1

Conclusions

In this study, an approach to estimate the key metrics from only SCADA data has been proposed. This approach is based on a solid classification algorithm of operation SCADA points.

A wind farm with 4 turbines has been used as test case. Several key indicators have been calculated for these turbines, such as: production, losses, capacity factor, daily average production, average wind speed, time based availability, production based ability, MTTR, MTTF, MTBF. The monthly production of each turbine has also been investigated.

It is pointed out that the low performance of WT03 is caused by a period of maintenance which last 2 months. This is also the turbine with the highest MTTR and lowest MTTF.

References

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