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Performance monitoring of renewable production assets

By ENFOR and Ørsted

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Introduction

Renewable production assets, such as wind or solar farms or individual wind turbines or PV panels, ideally produce energy following a static mapping from weather to energy.

However, in real life, they do not because of reasons like: Some of the energy-producing units are out for maintenance. Export restrictions prevent full energy production, due to e.g. a general system failure on the export cable, due to grid restrictions or because the produced energy cannot be sold on the market. Wear and tear or system upgrades have caused the mapping to change.

In the project, CITIES ENFOR and Ørsted have worked with performance monitoring of renewable production assets, considering wind farms as an example.

The solution approach is a software solution PMON™ from ENFOR, which Ørsted uses for proactive monitoring in their production today. The software can automatically detect if wind or solar farms or individual wind turbines or PV panels are not performing as they are supposed to, given the actual weather conditions and can also be used for estimation available power during curtailments or other situations where the farms are down-regulated.

Solution

PMON™ is a self-learning and self-calibrating software system based on a combination of physical models and advanced machine learning. This combines the best of artificial intelligence with relevant domain knowledge in order to provide a system which automatically can identify faulty assets.

For fault detection, PMON™ can use either a warranted power curve or build an expected power curve, based on historical data, which are then locked down for future fault detection. PMON™ will then identify and issue a warning if an asset starts producing less power than expected, given the actual weather conditions.

As the turbines get worn down or get major overhauls, the expected power curve will need to be retrained/re-calibrated, such that fault detection stays accurate.

Due to the highly configurable system, it is possible to minimize or avoid false alarms, by defining a data validation and rules for data correction, which will reduce or prevent false alarms to occur.

The software can run in two different modes: for estimating and calculating losses. Either the PMON™ power curve can be used to estimate available (max) power production from the farm/turbines during curtailment or outages, which can be compared to actual production in order to estimate losses. Alternatively, losses can also be calculated using a set of pre-determined rules. Such rules can be specified in a contractual relationship with a third party like a Transmission System Operator. In both modes, either weather measurements or weather forecasts can be used as input to assessment of losses.

The self-learning and self-calibrating algorithms will continuously learn about the asset characteristics and will adapt to changing conditions, seasonal variations and as the assets age, such that the performance monitoring and loss estimations stay accurate over time.

Key benefits

- Automatically identifies faulty assets and issues warnings such that corrective actions can be taken
- Estimates the available (max) power during curtailment and other outages to assess and document economic losses
- Can calculate losses based on either estimated power curves or pre-determined rules which have been contractually agreed with external third parties
- Can identify different types of losses and categorise them into losses arising due to curtailments, due to unavailability or due to 'other losses' which can not be explained.
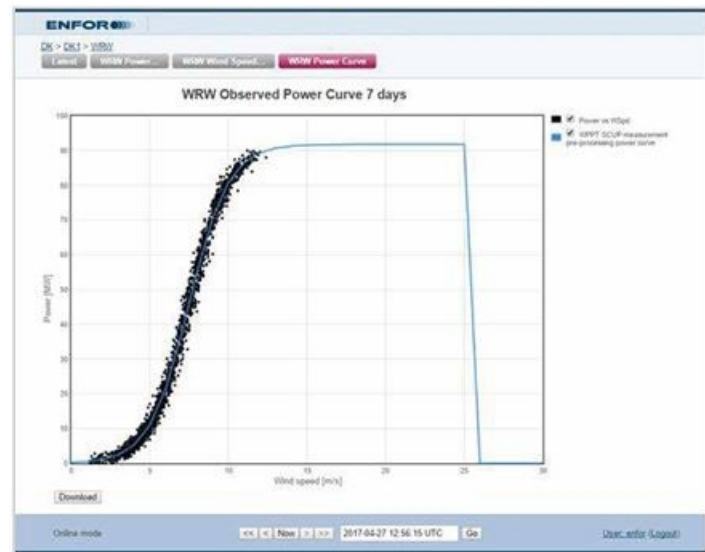
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