Load prediction by stochastic model in Global Tech I

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Summary

We report on first results of the RAVE project "OWP Control" and related works. A stochastic model for the generator torque is derived from operational data of one turbine in the German offshore wind farm "Global Tech I". From this model, the loads at other turbines in the wind farm are predicted. This opens the perspective of, among other benefits, an extremely efficient wind farm load monitoring.

1 Introduction

Wind farms operators currently are experiencing strong and growing cost pressure, especially offshore. Improved wind farm control strategies aiming at, among others, optimized energy yield and reduced operational loads, could offer contributions to the necessary progress in cost efficiency.

Within the project "OWP Control" funded by the German ministry for economic affairs and energy, strategies and approaches to wind farm control are investigated. Here we report on selected results of this project from the German wind farm "Global Tech I".

2 Stochastic model of wind turbine loads

To model wind turbine loads with special emphasis to fast fluctuations, we use a stochastic differential equation of the Langevin type,

$$\dot{T}(T,u) = D^{(1)}(T,u) + \sqrt{D^{(2)}(T,u)} \cdot \Gamma(t) \; . \qquad (1)$$

Here, T is the load (in our example, the generator torque), u is the wind speed, and $\Gamma(t)$ is an uncorrelated, Gaussian-distributed noise term. The drift and diffusion functions $D^{(1)}$ and $D^{(2)}$, respectively, are estimated directly from load measurement data.

Once the model in equation (1) has been derived, it can be used to reconstruct or predict loads using only a wind speed time series as an input. Moreover, also loads at other turbines of the same type can be modeled. The limits of this transferability, however, are still to be explored.

3 Example analysis

The approach has been applied to historical data of an example wind turbine and derived promising results, cf. figure 1.

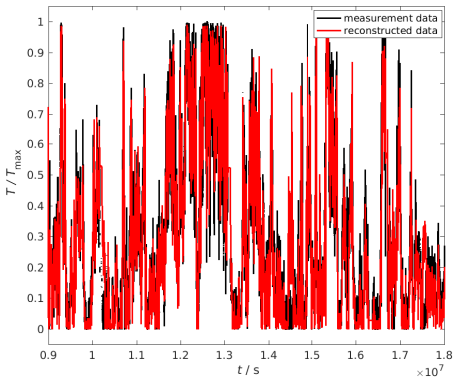

Figure 1: Reconstruction of the generator torque T at an example wind turbine from measured wind speeds.

4 Application to Global Tech I

Using operational data from turbines at Global Tech I, the generator torque at several turbines of this wind farm shall be modeled. We will also investigate to what extend a model derived at one turbine can be transfered to other turbines in the same wind farm.

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