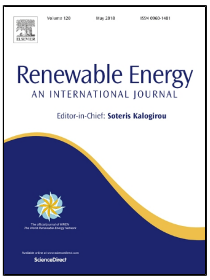
Accepted Manuscript



The analysis of turbulence intensity based on wind speed data in onshore wind farms

Guorui Ren, Jinfu Liu, Jie Wan, Fei Li, Yufeng Guo, Daren Yu

PII:	S0960-1481(18)30224-6
DOI:	10.1016/j.renene.2018.02.080
Reference:	RENE 9811
To appear in:	*Renewable Energy*
Received Date:	30 March 2017
Revised Date:	03 January 2018
Accepted Date:	17 February 2018

Please cite this article as: Guorui Ren, Jinfu Liu, Jie Wan, Fei Li, Yufeng Guo, Daren Yu, The analysis of turbulence intensity based on wind speed data in onshore wind farms, *Renewable Energy* (2018), doi: 10.1016/j.renene.2018.02.080

The analysis of turbulence intensity based on wind speed data in onshore wind farms

Guorui Ren[a,b], Jinfu Liu[a,*], Jie Wan[a], Fei Li[a], Yufeng Guo[a], Daren Yu[a,*]

[a]School of Energy Science and Engineering, Harbin Institute of Technology, Harbin, China
[b]Department of Electric Power and Energy Systems, KTH Royal Institute of Technology, Stockholm, Sweden

Abstract

Wind speed turbulence intensity is crucial for wind turbine structure design and aerodynamic loads calculation. In the study, the actual turbulence intensity observations are compared with the Normal Turbulence Model defined by IEC standard. The results show that the Normal Turbulence Model overestimates the turbulence intensity. A new turbulence intensity model is proposed based on the actual observations, which shows better performance than the Normal Turbulence Model. Then the variation pattern of turbulence intensity during a day is analyzed. The turbulence intensity exhibits obvious daily periodicity in two wind farms. Furthermore, the causes of daily periodicity are discussed and verified by the wind speed dataset 3. Finally, an improved time-varying turbulence intensity model is developed according to the daily periodicity.

Keywords: turbulence intensity model; wind speed; daily periodicity; time-varying

1. Introduction

With the increasing concern of energy demand and environmental protection, wind power has been developed rapidly all over the world [1]. Wind farm is consisted of numerous wind turbines. When the wind flows past wind turbines, the kinetic energy of wind speed can be converted into electric energy by wind turbines. The hub height of the wind turbine is approximately 100 meter, which just locates in the atmospheric boundary layer [2]. It is well known that the atmospheric boundary layer is characterized by high turbulence [3]. Therefore, wind turbines are influenced by the turbulence in the atmospheric boundary layer. Some studies have focused on the impacts of turbulence intensity on wind turbines, including the impacts on power output and aerodynamic loads.

The current IEC standard considers that wind power curve is only influenced by the mean wind speed at hub height and the air density [4]. However, some studies have found that wind power output is also influenced by turbulence [5]. Sheinman and Rosen [6,7] found that the wind power output might be overestimated by about 10% without considering the turbulence effects. Therefore, they proposed a new method to predict wind power based on the coupled effects between the wind and turbine dynamics

* Co-corresponding author.
E-mail address: yudaren_hit@126.com, yudaren@hit.edu.cn