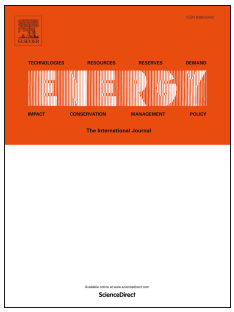
Accepted Manuscript



A critical study on passive flow control techniques for straight-bladed vertical axis wind turbine

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PII: S0360-5442(18)31836-X

DOI: 10.1016/j.energy.2018.09.072

Reference: EGY 13766

To appear in: *Energy*

Received Date: 17 July 2018

Revised Date: 28 August 2018

Accepted Date: 10 September 2018

Please cite this article as: Zhu H, Hao W, Li C, Ding Q, Wu B, A critical study on passive flow control techniques for straight-bladed vertical axis wind turbine, *Energy* (2018), doi: 10.1016/j.energy.2018.09.072.

A critical study on passive flow control techniques for straight-bladed vertical axis wind turbine

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Abstract

The wind energy has positioned itself as a most promising sustainable energy. The straight-bladed vertical axis wind turbines (SB-VAWTs), as a common turbine for harvesting wind energy, have broad prospects of development. However, the SB-VAWTs are usually influenced by dynamic stall which can cause the aerodynamic losses and fluctuating load. Therefore, the passive flow control (PFC) technique is appreciated for SB-VAWTs due to its low cost and no additional energy consumption. Current paper presents the review of PFC techniques which have been used or are worth being utilized in SB-VAWTs. Furthermore, based on the validation of computational model, a numerical uniform-parameter-criterion study using TSST turbulence model has been conducted to present the research prospects of some novel PFC techniques for SB-VAWTs, including Gurney flap (GF), dimple-GF, leading-edge airfoil-slat (LEAS), flow-deflecting airfoil (FDA), non-circular gap (NCG).

Keywords: vertical axis wind turbine; passive flow control; numerical simulation; aerodynamic performance

1. Introduction

During the last few years, wind energy has positioned itself as a most promising sustainable energy [1]. There are two consecutive records of new wind energy capacity obtained, reaching up to 54.6GW in 2016 and 52.6GW in 2017 [2, 3]. By the end of 2019, the wind power capacity in the whole world will reach about 666.1MW [4].

For harvesting wind energy, there are two main kinds of wind turbine: vertical axis wind turbines (VAWTs) and horizontal axis wind turbines (HAWTs) [5]. The first VAWT, adopting airfoil profile, was invented by Georges Jean Marie Darrieus [6]. Darrieus VAWTs were mainly investigated at National Research Council in Canada, Sandia National Laboratories in US and Carmathen Bay Wind Energy Demonstration Centre in UK [7]. By compared with HAWTs, VAWTs possess many advantages [8-10]:

(1) Lower manufacturing cost;

(2) No yaw system;

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