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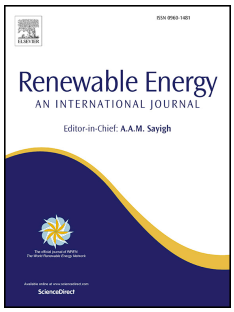

A reference open data vertical axis wind turbine, with individual pitch control, for code validation purposes

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A reference open data vertical axis wind turbine, with individual pitch control, for code validation purposes

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Abstract

This paper presents the features and capabilities of a vertical axis wind turbine (VAWT) designed and built by the authors, which is meant to be the reference machine for open data code validation purposes under the project VODCA, VAWT Open Data for Code Assessment. The machine, whose design details are provided openly and summarized in the present document, has Individual Pitch Control (IPC) capability and it will be used for wind tunnel tests. Related results will be shared with participants who want to validate their own code, in terms of prediction of the aerodynamics or assessment of IPC strategies. The article reports a comprehensive overview of the state of the art of laboratory tests for VAWTs as well as the motivation of VODCA project, further to the need of code validation against experimental tests in controlled environment. The various phases of the project are also presented. Furthermore, the design of the carbon fiber blades, the structural components, as well as the mechatronics of the machine are summarized in this paper. Moreover, the experimental characterization of the machine's effective capabilities and properties, carried out after the completion of the building process, is reported and then the testing possibilities are defined and discussed.

Keywords: VAWT, IPC, VODCA, benchmark, open data, code validation, self-starting

1 Introduction

The technology of vertical axis wind turbines (VAWTs) has been extensively studied in the 70's-90's [1], without taking off as effectively competitors of the more commercially accepted horizontal axis wind turbines (HAWTs).

Nevertheless, as wind energy is moving to deep offshore sites for exploiting higher quality wind resources as well as overcoming social acceptance related issues, VAWTs are recently being considered as potential alternative to HAWTs for floating offshore wind turbines (FOWTs) [2, 3]. Among others [4], one of the main advantages of floating VAWTs is that the generator is placed at the base of the tower, rather than at hub height, with obvious enhancement on the stability of the floating system, bringing about smaller floaters and then reducing the overall costs of the system itself [5, 6]. Therefore, the study of the technical aspects behind VAWTs and the feasibility of such a technology, especially for deep offshore applications, is living a revival through novel concept being recently considered, thanks to scientific and commercial partnerships (e.g. Spinfloat by EOLFI [7], Twinfloat by Nenuphar [8] or the FP7 funded project DeepWind [9]).

However, the aerodynamic efficiency of lift based VAWTs (i.e Darrieus) is lower than HAWTs in that the different working principle is characterized by inherently unsteady aerodynamics and distorted and time-dependant wake, which greatly affect the efficiency of the downwind sector of the machine, not to mention