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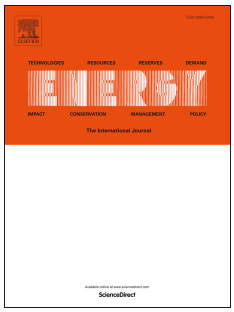

Parametrical evaluation of the aerodynamic performance of vertical axis wind turbines for the proposal of optimized designs

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Abstract

Many studies have tried to give insight into the optimal values of solidity and the airfoil geometry that maximize the performance and self-starting capability of vertical axis wind turbines, but there is still no consensus. In addition, most studies focus on one particular airfoil or airfoil family, which makes the generalization of the results difficult. In this work, these research gaps are intended to be assessed. An exhaustive analysis of the influence of solidity, blade Reynolds number and airfoil geometry on the performance of a straight-bladed vertical axis wind turbine has been performed using a methodology based on streamtube models. An airfoil database of 34 airfoils has been generated, developing a practical and cost-effective tool for the quick comparison of turbine designs (70 different configurations were analyzed). This tool, validated with results from the literature and computational fluid dynamics simulations performed by the authors, has allowed to propose an optimal solidity range from 0.25 to 0.5 and the use of almost symmetrical airfoils (camber $< 3\%$). Finally, this tool has been applied to design two vertical axis wind turbines optimized for low and medium wind speeds.

Keywords: VAWT design tool; streamtube models; airfoil data generation; CFD simulation

Nomenclature

α	Angle of attack
α_1	Upwind angle of attack
α_2	Downwind angle of attack

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