# Preliminary Analysis and Design of Small Vertical Axis Wind Turbines

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The past two decades have seen a rapid development of technologies for the design and manufacture of very large wind power plants. Only more recently the world of Small Wind Turbines (SWTs) has also begun to be investigated closely. In fact, these machines can contribute to the further increase of electricity production from renewable sources by working in parallel, for some types of applications, to large plants.
In their small size, however, these machines present a complexity, not significantly lower than multi-MW wind turbines. Very recently, a study on the current status and grand challenges related to small wind technologies has been published [1]. In this work, critical issues related to aerodynamic, structural and aeroelastic modeling of these plants are highlighted, as well as the increased emphasis on Vertical Axis Wind Turbines (VAWTs) [1].
Typically, the manufacture of these SWTs is carried out by small or medium-sized companies, which often invest in this emerging field by stepping from related but not identical branches of industry. Thus, there is a theoretical know-how gap but also a lack of modeling and design tools suitable for this type of machine.

This paper presents the ongoing activity over the past year aimed at this type of industrial support. Starting with the development of a parametric analysis tool based on engineering models, such as the Double Multiple Stream Tube model [2], the idea is to build up a tool for the multidisciplinary analysis and design of VAWTs. The design, as is now largely explored for very large Horizontal Axis Wind Turbines (HAWTs) [3], is conceptualized as a constrained optimization problem, with the merit function being the Cost of Energy (CoE) (or some others Key Performance Indexes) and the constraints are implemented to translate technological limitations, geometric bounds, structural restraints, etc.

Preliminary results refer to an Italian industrial case of a 20kW VAWT, the study of which started from the current 10kW prototype.

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[2] Paraschivoiu, I., Wind turbine design, with emphasis on Darrieus concept, PIP, 1st edition (June 4, 2002), ISBN 978-2553009310
[3] Sartori, L. , Cacciola, S. , Croce, A. , Riboldi, C. E. D. . A Research Framework for the Multidisciplinary Design and Optimization of Wind Turbines. In: Maalawi, K. Y. , editor. Design Optimization of Wind Energy Conversion Systems with Applications [Internet]. London: IntechOpen; 2020 [cited 2023 Jan 09]. Available from: https://www.intechopen.com/chapters/70217 doi: 10.5772/intechopen.90172