**Aerodynamic Efficiency Numerical Estimation of 1 kW horizontal axis wind turbine rotor**

**Marin Gutu, Valeriu Odainai, Iulian Malcoci, Trifan Nicolae**

<https://doi.org/10.1109/SIELMEN53755.2021.9600333>

## Abstract

The paper presents an estimated analysis of the aerodynamic performance of a wind rotor with a horizontal axis. It is a design stage of a low power wind turbine, ≈ 1 kW. Several airfoils are considered to indicate high performance at low Reynolds numbers (approx. 100,000). For the analysis of the performance of the wind turbine with horizontal axis, the geometric parameters for a rotor with a power of 1 kW were considered. The required geometric parameters were estimated using a calculation model developed in the MathCad application. The wind rotor was developed and simulated in the QBlade application then, for comparison, it was numerically analyzed in ANSYS Fluent. The parameter of interest is the power coefficient without considering the mechanical/electrical losses and was compared with performance of some existing rotors.

*Keywords: wind energy, blades, rotors, wind turbines, axis wind turbine rotors*

**References**

1. S. Fuentes V, C. Troya, G. Moreno and J. Molina, "Airfoil selection methodology for Small Wind Turbines", International Journal of Renewable Energy Research, vol. 6, no. 4, pp. 1410-1415, 2016.
 [Google Scholar](https://scholar.google.com/scholar?as_q=Airfoil+selection+methodology+for+Small+Wind+Turbines&as_occt=title&hl=en&as_sdt=0%2C31)

**2.** C. I. Coşoiu, "Contribuţii la optimizarea proiectării şi funcţionării agregatelor eoliene", Teză de doctorat. Bucureşti, pp. 178, 2008.
 [Google Scholar](https://scholar.google.com/scholar?as_q=Contribu%C5%A3ii+la+optimizarea+proiect%C4%83rii+%C5%9Fi+func%C5%A3ion%C4%83rii+agregatelor+eoliene&as_occt=title&hl=en&as_sdt=0%2C31)

**3.** E. Hau, "Wind Turbines. Fundamentals Technologies Applications Economics" in , Berlin:Springer, pp. 782, 2006.
 [Google Scholar](https://scholar.google.com/scholar?as_q=Wind+Turbines.+Fundamentals+Technologies+Applications+Economics&as_occt=title&hl=en&as_sdt=0%2C31)

**4.** R. Gasch and J. Twele, "Wind Power Plants. Fundamentals Design Construction and Operation" in , Berlin:Springer, pp. 548, 2012.
 [Google Scholar](https://scholar.google.com/scholar?as_q=Wind+Power+Plants.+Fundamentals+Design%2C+Construction+and+Operation&as_occt=title&hl=en&as_sdt=0%2C31)

**5.** M. O. Hansen, "Aerodynamics of Wind Turbines" in , London:Earthscan, pp. 181, 2008.

 [Google Scholar](https://scholar.google.com/scholar?as_q=Aerodynamics+of+Wind+Turbines&as_occt=title&hl=en&as_sdt=0%2C31)

**6.** D. Marten, M. Lennie, G. Pechlivanoglou, C. N. Nayeri and C.O. Paschereit, "Validation and Application of an Unsteady Lifting Line Free Vortex Wake Module Implemented Within the Open Source Wind Turbine Blade Design Code QBlade", J. of Eng. for Gas Turbines and Power, vol. 138, no. 7, Dec 2015.
 [CrossRef](https://doi.org/10.1115/1.4031872)[Google Scholar](https://scholar.google.com/scholar?as_q=Validation+and+Application+of+an+Unsteady+Lifting+Line+Free+Vortex+Wake+Module+Implemented+Within+the+Open+Source+Wind+Turbine+Blade+Design+Code+QBlade&as_occt=title&hl=en&as_sdt=0%2C31)

**7.** Z. Wang, G.C. Tsai and Y. B. Chen, "One-Way Fluid-Structure Interaction Simulation of an Offshore Wind Turbine", International Journal of Engineering and Technology Innovation, vol. 4, no. 3, pp. 127-137, 2014.
 [Google Scholar](https://scholar.google.com/scholar?as_q=One-Way+Fluid-Structure+Interaction+Simulation+of+an+Offshore+Wind+Turbine&as_occt=title&hl=en&as_sdt=0%2C31)

**8.** H.K. Kelele, T.K. Nielsen, L. Froyd and M. Bayray Kahsay, "Catchment Based Aerodynamic Performance Analysis of Small Wind Turbine Using a Single Blade Concept for a Low Cost of Energy", Energies, vol. 13, pp. 5838, 2020, [online] Available: https://doi.org/10.3390/en13215838.
 [Google Scholar](https://scholar.google.com/scholar?as_q=Catchment+Based+Aerodynamic+Performance+Analysis+of+Small+Wind+Turbine+Using+a+Single+Blade+Concept+for+a+Low+Cost+of+Energy&as_occt=title&hl=en&as_sdt=0%2C31)

**9.** S. Lachance-Barrett and A. Keith, "Fluent - Wind Turbine Blade FSI (Part 1)", Fluent Learning Modules, [online] Available: https://confluence.cornell.edu/.
 [Google Scholar](https://scholar.google.com/scholar?as_q=Fluent+-+Wind+Turbine+Blade+FSI+%28Part+1%29&as_occt=title&hl=en&as_sdt=0%2C31)