Environmental Engineering and Management Journal

October 2021, Vol. 20, No. 10, 1637-1643
http://www.eemj.icpm.tuiasi.ro/; http://www.eemj.eu

"Gheorghe Asachi" Technical University of Iasi, Romania

ANALYSIS OF WIND TURBINE PERFORMANCE, OPTIMIZATION, TECHNICAL-ECONOMIC AND ENVIRONMENTAL FEASIBILITY

Giuseppe Davide Caruso[1], Francesco Garraffo[1], Rosario Lanzafame[2], Pietro Maddio[2], Agata Matarazzo[1*], Michele Messina[2], Vincenzo Pisano[1], Rosario Sinatra[2], Antonio Zerbo[1]

[1]Department of Economics and Business, University of Catania, 55 C.so Italia, 95129 Catania, Italy
[2]Department of Civil Engineering and Architecture, University of Catania, 64 via Santa Sofia, 95125 Catania, Italy

Abstract

To make wind energy more usable, a new prototype of high efficiency wind turbine will be developed in this work. For this purpose, a new proprietary mathematical model will be implemented, for the design of wind turbines and new design concepts, in order to maximize the energy capturing capacity of the wind turbine. Currently the numerical simulations for predicting the performance of a wind turbine are carried out with 3D CFD programs (Computational Fluid Dynamic) characterized by high reliability, but which at the same time require significant resources and high calculation times. As an alternative to CFD codes, both the scientific and industrial communities use one-dimensional calculation models. These codes, if properly implemented, can provide sufficiently correct results, but characterized by modest resources and very short calculation times. All this allows to carry out numerous simulations runs in reduced times, reaching the optimal configuration of the turbine in a few minutes. An environmental analysis of the proposed technological innovation, measured making use of the most suitable widespread environmental reporting tools, is then proposed and recommended, through an inventory of the emissions of environmental impacts, according to a Life Cycle Assessment perspective. An evaluation of the competitiveness of the new technology has to be implemented, in comparable contexts, to verify its performance in terms of economic and environmental sustainability. Finally, a cost-benefit verification of the investment and its socio-cultural impact is also necessary, considering the production process of the turbine and its implementation, in view of the decarbonization of the economy too.

Key words: CFD, economic analysis, energy, environmental impacts, wind turbine

Received: April, 2020; Revised final: August, 2021; Accepted: September, 2021; Published in final edited form: October, 2021

[*] Author to whom all correspondence should be addressed: e-mail: amatara@unict.it