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Review of performance optimization techniques applied to wind turbines

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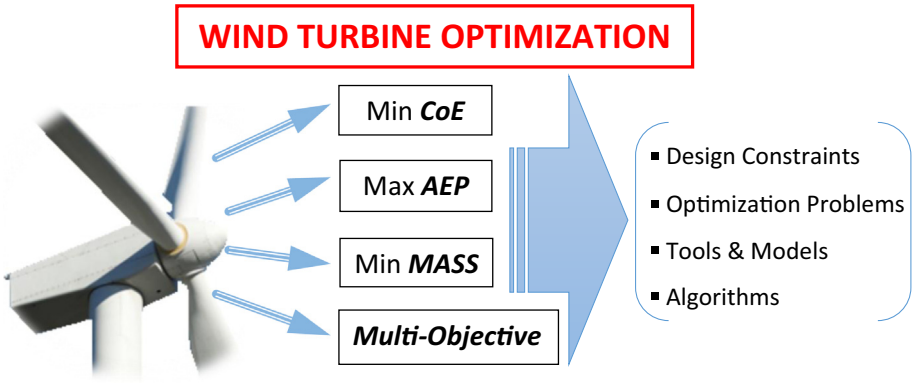
HIGHLIGHTS

- We review the optimization strategies for horizontal axis wind turbines (HAWT).
- Identify the objectives, targets and optimization formulations.
- Present the design constraints, tools, models and optimization algorithms.
- Discuss the challenges, issues and future developments in the design of HAWT's.

GRAPHICAL ABSTRACT



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ABSTRACT

This paper presents a review of the optimization techniques and strategies applied to wind turbine performance optimization. The topic is addressed by identifying the most significant objectives, targets and issues, as well as the optimization formulations, schemes and models available in the published literature.

The current energy demand combined with depletion of fossil-fuel reserves and stricter environmental regulations have led to the development of alternative renewable energy solutions like wind energy. The current 2030 United States target is to have at least 20% of the US energy supply by onshore and offshore wind farms. To meet these demands, wind energy costs have to be able to compete with traditional fossil fuel sources. Hence, it is essential and vital that wind turbine designers and manufactures search the optimal solution that fits the objectives under a set of design constraints. Throughout the last 30 years, the objective function has evolved from the earlier maximized metric of the power coefficient to the maximization of the annual energy production. Common alternatives such as blade mass minimization and maximization of the rotor thrust and torque have been examined. However, the main objective has been focused on the minimization of the cost of energy in order for wind energy to become more competitive and economically attractive.

The purpose of this paper is to review previous work that undertakes the performance optimization of horizontal wind turbines by highlighting the main aspects when tackling the wind turbine optimization

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problem such as: objective functions, design constraints, tools and models and optimization algorithms. In addition, in a conclusion of the review, a discussion and argument about the challenges, issues and future developments are identified.

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