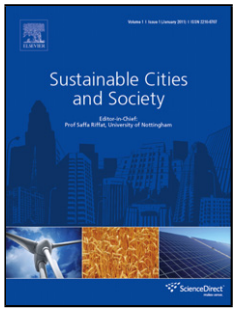

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Centralized Control Strategy for Energy Maximization of Large Array Wind Turbines

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Abstract

Currently, the operation of most commercial wind turbines is optimized individually for maximum energy capture without consideration of the aerodynamic effect of neighboring turbines. However, when installed in a potential wind farm, operation of each device is highly affected by wake effect generated by surrounding turbines and the operation of the whole wind system is no longer optimized. Many studies have highlighted from a quantitative perspective the potential benefit of operating some wind turbines at sub-optimum points, so that the total power of the wind farm is increased. In this paper, a wind farm level control strategy is designed and evaluated. Its main objective is to achieve better energy extraction. Optimization is performed by operating some wind turbine at non-optimum speeds. Through this paper, it has been shown that rotor sub-optimal speeds for power maximization are highly sensitive to wind speed and direction. Consequently, in the proposed control strategy, optimal rotational speeds are continuously adapted in function of wind conditions taking into consideration the shadowing impact. Artificial Bee Colony algorithm (ABC) was implemented to calculate and update optimal speed references. To evaluate the performances of this controller, a wind farm model consisting of 9 (3 × 3 wind turbine array) turbines was developed. Simulations results show that genetic algorithms can be used to maximize energy production of wind farms when operating point information for each turbine are available.

Keywords — Wind farm, Optimal control, Wake effect, Artificial bee colony, Energy maximization.

1. Introduction

During the past decade, global wind energy sector has seen an increased competition between all involved players, particularly after the huge growth of Asiatic manufacturers. Indeed, many countries worldwide have realized the economical and environmental benefits of this sector. Thus, many incentives and policy choices were introduced to promote their markets, both in terms of manufacturing and installed capacity [1]. Faced with these facts, wind turbines manufacturers have been constrained to increase performances of their devices in order to maintain their market share positions. In this context, many research works were carried out to maximize energy production of wind turbines. At the