Optimal Design of Wind Farm Layout and Control Strategy

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Abstract

Wind energy as one of the alternative energy sources is growing at a rapid rate for its property of renewability and abundancy. However, high power losses have been witnessed due to the intervention of air flow induced by the upstream wind turbines in the wind farm. Through optimal design of wind farm layout and control strategy, the power losses can be reduced to a large extent. However, up to now only separate optimization of wind farm layout or control strategy, i.e., either the layout study with constant operation conditions of wind turbines or the control strategy study with fixed wind turbine positions is reported in the literatures. Meanwhile, even though it is convinced that the unrestricted coordinate method is superior to the grid based method for the separate wind farm layout optimization due to its flexibility to place wind turbines, the comparison between these two wind farm design methods is not made by considering the control optimization. Therefore, this paper aims to fill these research gaps. The optimizations of wind farm layout and control strategy are carried out separately and simultaneously with the two wind farm design methods, respectively. The comparative results show that the layout optimization is most inefficient in optimal design of the wind farm. For the control optimization, it has most stable performance with almost no deviations for repeated calculations and it finds the best optimization results under 45 degree wind direction condition with the unrestricted coordinate method. In comparison, even though the simultaneous layout and control optimization is theoretically superior to the others, it is dependent on the optimized wind conditions and tends to be stuck into the local minima.

Keywords: layout optimization; control optimization; grid based method; unrestricted coordinate method; self-optimum control strategy.