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Title: Real-time energy market arbitrage via aerodynamic energy storage in wind farms

Abstract: Selective storage and discharge of energy storage devices, such as batteries and pumped hydro plants, that takes advantage of fluctuations in real-time energy market prices can generate significant revenue for storage device operators. In this paper, we investigate the potential of using aerodynamic energy storage in wind farms to conduct price arbitrage in real-time (five minute) energy markets. This aerodynamic storage is provided by deferring energy extraction at upwind turbines which is then partially available to downwind turbines after the wind has traveled between turbines. This novel aerodynamic storage mechanism requires minimal capital costs for implementation and could potentially provide additional revenue to wind farm operators, particularly as the "must-take" economic model evolves. We use a simple wind plant model and a deterministic optimization algorithm to demonstrate that the potential for revenue generation depends on the energy arbitrage (storage) efficiency and the wind travel time between turbines. We then investigate the effect of arbitrage efficiency on real-time energy market revenue under different price volatility scenarios. The simulation results show that with low price volatility, which is the historic norm, noticeably increased revenue is only achieved with high arbitrage efficiencies. However, revenues increase by several percent when there is high price volatility, which is expected in the future.

Key words: real-time market arbitrage, wind energy