Advancing Wind Systems Design through Optimization and Improved Modeling

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Abstract

Wind energy plays an important and growing role in the US energy profile. While other countries have expanded their wind industries into offshore development, large in-vestment costs have hindered progress in the US offshore market despite the larger and more consistent resource available offshore. In this research, I explore the optimization of floating offshore farms specific to the US west coast, with the goal of curbing currently prohibitive monetary barriers to market expansion. I begin by selecting the best optimization algorithm for the offshore wind farm layout problem using a simplified wind case. I then compare the optimization of onshore and offshore wind farms under both simplified and more realistic wind scenarios. My third study explores the trade-offs between the accuracy and computational expense of high-fidelity computational fluid dynamics wake models and the lower-fidelity, linearized PARK model (a common analytical representation of wind turbine wake interactions). Finally, I analyze the performance differences as a result of turbine manufacturer through a turbine availability analysis of two turbine vendors. Results from this study implicate best practices for onshore and offshore wind farm optimization pertaining to algorithm type, wake model selection, and turbine manufacturer. This information may be used by developers and policy makers to inform decision making and increase profits and farm-wide power production.

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