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Performance of Fixed-wing Airborne Wind Energy Systems: A Parametric Study

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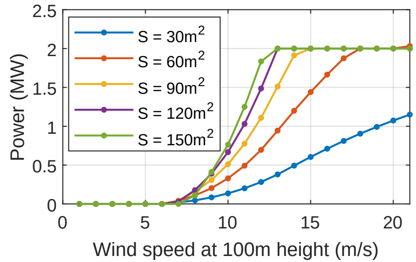
Airborne wind energy (AWE) systems are complex multi-disciplinary systems with many interdependencies within their components. To better understand the systems' behaviour and performance, it is necessary to identify the critical links and the associated trade-offs between design parameters. This work focuses on fixed-wing ground-generation AWE systems.

For example, increasing the kite wing area will directly increase the aerodynamic force, but it will also increase the kite mass, thereby increasing the loss in performance to counter its weight. The Figure shows the computed power curves for a fixed electrical rated power and a range of kite wing areas. It shows a diminishing performance improvement with increasing wing areas since the effect of mass is more pronounced than the increase in the aerodynamic force. These power curves are generated using a quasi-steady model implemented as an optimisation problem, maximising the electrical cycle power of fixed-wing ground-gen AWE systems [1,2].

The objective of this work is to understand the impact of various system design parameters, such as the kite wing area, span, aspect ratio, airfoil polars, tether material, drum, generator properties, etc., on the performance of the system. A systematic parametric study is performed for the same. The performance can be compared purely based on power production or comprehensive metrics such as the levelised cost of electricity (LCoE). Generally, all renewable energy technologies designed to minimise LCoE are comparable. Hence, it could also be one of the key design objectives for AWE systems. For LCoE, besides a performance model, cost models are also required. A reference economic model [3] is being developed as a part of the IEA Wind Task 48 on AWE and is used in this analysis. The LCoE results are expected to further the understanding of dominant design drivers and variables.



Computed power curves for a range of kite wing areas.

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