Power Smoothing and Energy Storage System Sizing Strategy for Airborne Wind Energy Farms

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We tackle the challenge of balancing the power output from an Airborne Wind Energy Farm to ensure a stable power flow into the grid. This is crucial to prevent the imbalances commonly seen in ground-gen systems, given the significant oscillation between power production and consumption during the reel–in and reel–out phases.

We analyse two synchronization strategies regarding the units of a farm. The first approach creates groups of synchronized units according to wind direction, e.g. [1], with all units in the same group operating simultaneously and phased in the same cycle step. In the second approach, the reel–in phase occurs inside the flight envelope, which allows kites in different phases to operate independently, mitigating high–amplitude oscillations in the farm power output [2].

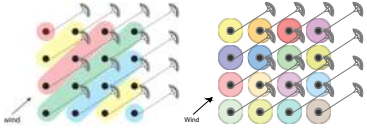
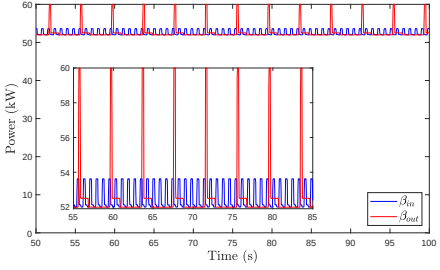


Illustration of the different arrangement approaches. Left: four synchronization groups (one for each colour). Right: sixteen synchronization groups (all different)

Additionally, we enhance power output smoothing by implementing an energy storage system (ESS). We then compare the ESS performance under both approaches. The first approach results in larger power deviations implying a larger ESS, while the second approach reduces deviations but increases oscillation frequency, potentially impacting degradation rates.

This study compares both methods, aiming to identify the best suitable approach for the large–scale integration of the wind farm with the grid.



Resultant power waveform for each approach

References:

[1] Pietro Faggiani and Roland Schmehl, Design and economics of a pumping kite wind park. In Airborne Wind Energy – Advances in Technology Development and Research, Green Energy and Technology, chapter 16, pp. 391—411. Springer, Singapore, 2018.

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