An optimal sizing tool for airborne wind energy systems

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Abstract

AWE companies are scaling up their system in order to be more cost effective and therefore to be competitive on the energy market. The scaling process requires numerous iterations and trade-offs so as to satisfy both technological and economical viability. In this poster we provide an overview on how to deal with this task via an optimal control approach combined with statistical analysis. This approach is applied to the rigid wing pumping mode AWE System built by Ampyx Power B.V..

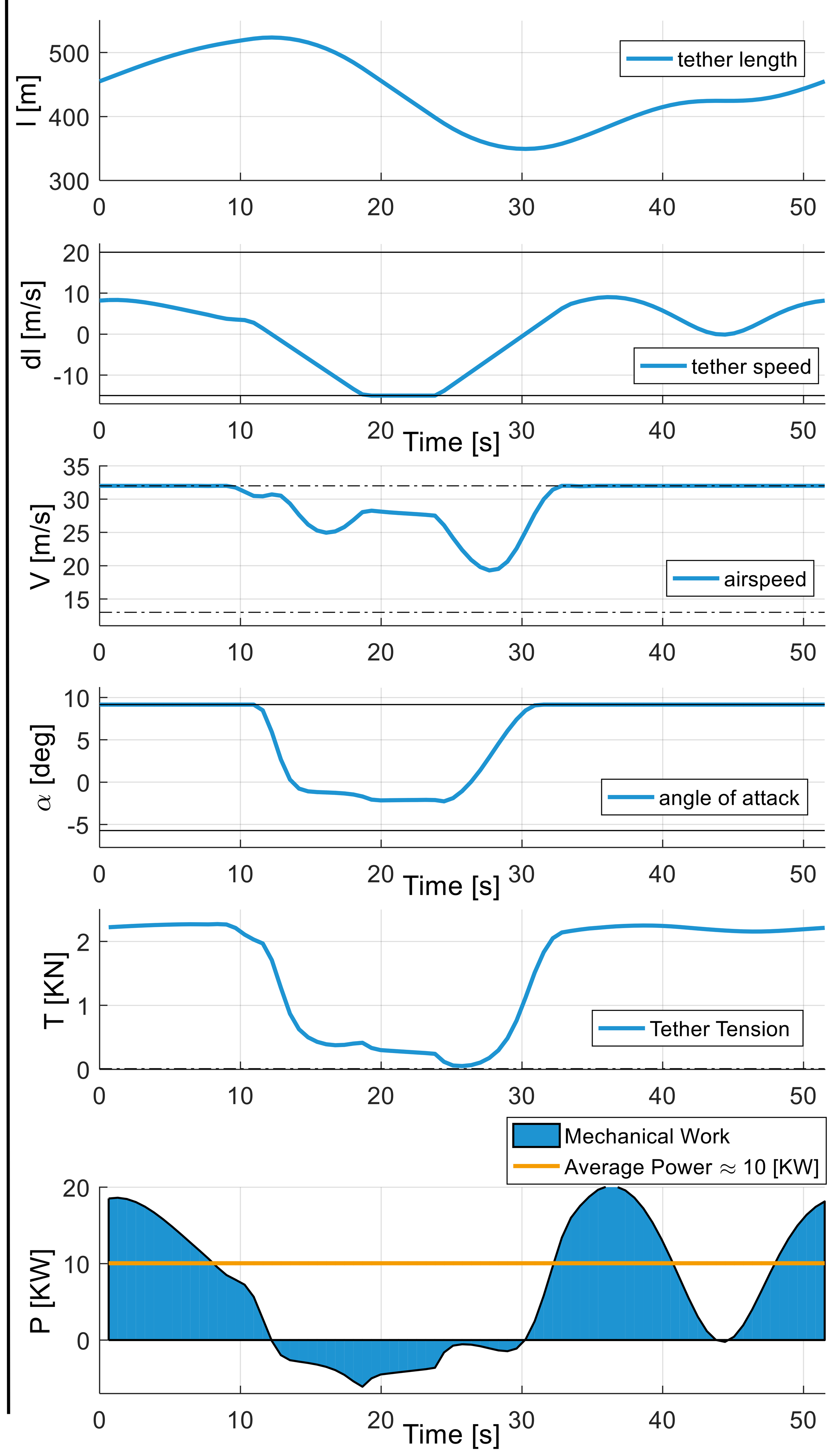
Motivations

In order to deal with the complexity of a typical AWE system, tools such as **OpenAWE** can be used to assess system performance in a quick and efficient way. The tool allows to perform analysis which are related to the upscaling of an AWE system, for instance:

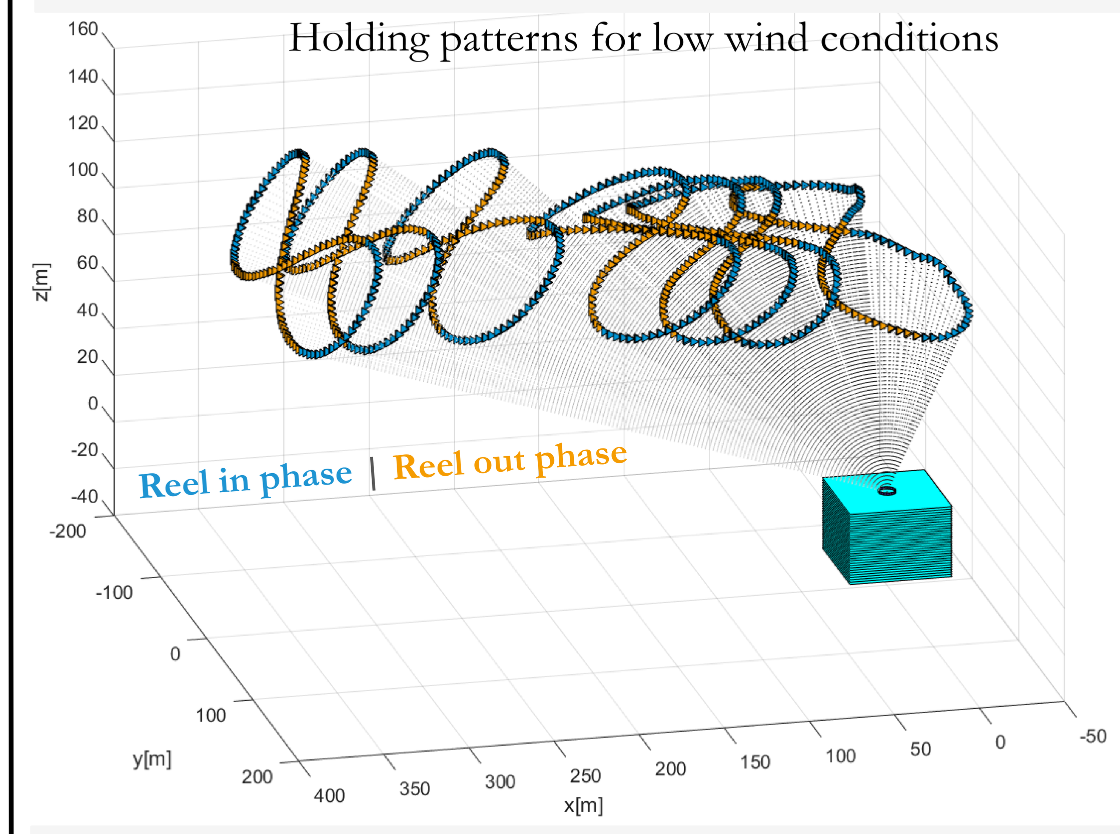
- **Viability Analysis** i.e. obtain the annual energy production (AEP), in other words estimate how much energy can be harvested over one year;
- **Sensitivity Analysis** i.e. assess the system performance for given parameters such as mass and inertia of the airborne component or evaluate the impact of winch inertia;
- **Performance Analysis** Obtain the best feasible flight path for a given system configuration;
- **Control Strategy Analysis** i.e. obtain efficient control strategies for critical boundary condition such low and high wind speed conditions;
- **General purpose Analysis** such as comparing different patterns and evaluating the accelerations that occur along the pattern for further structural analysis.

OpenAWE is implement in **Matlab** and it provides an easy access to the state of the arts of Optimal Control Theory together with accurate mathematical models.

Viability Analysis Example

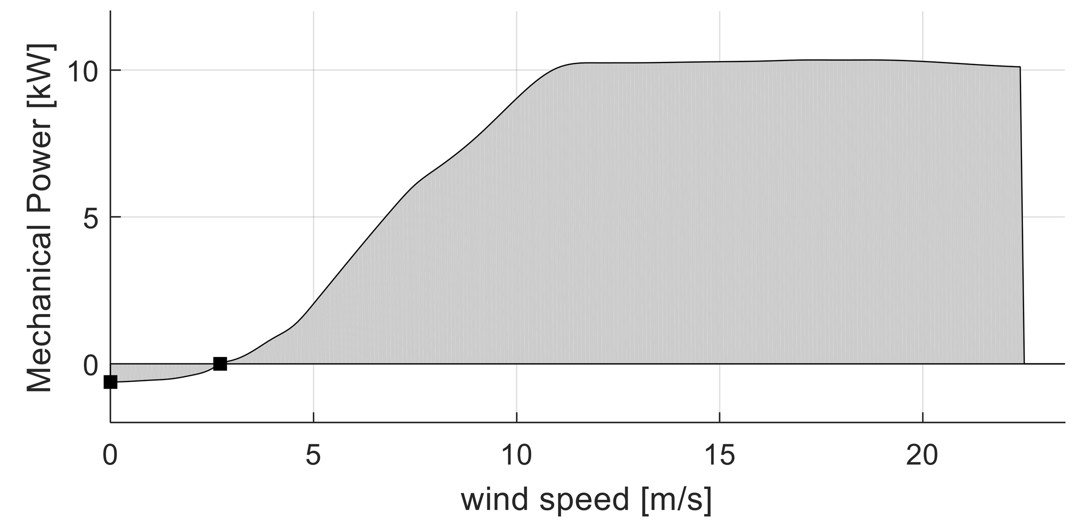


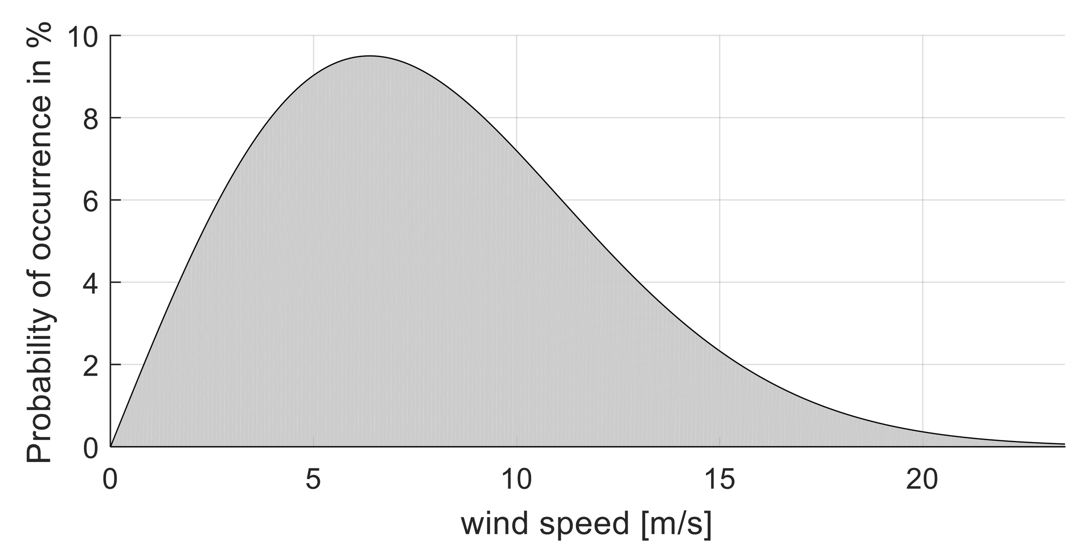
Control Strategy Example

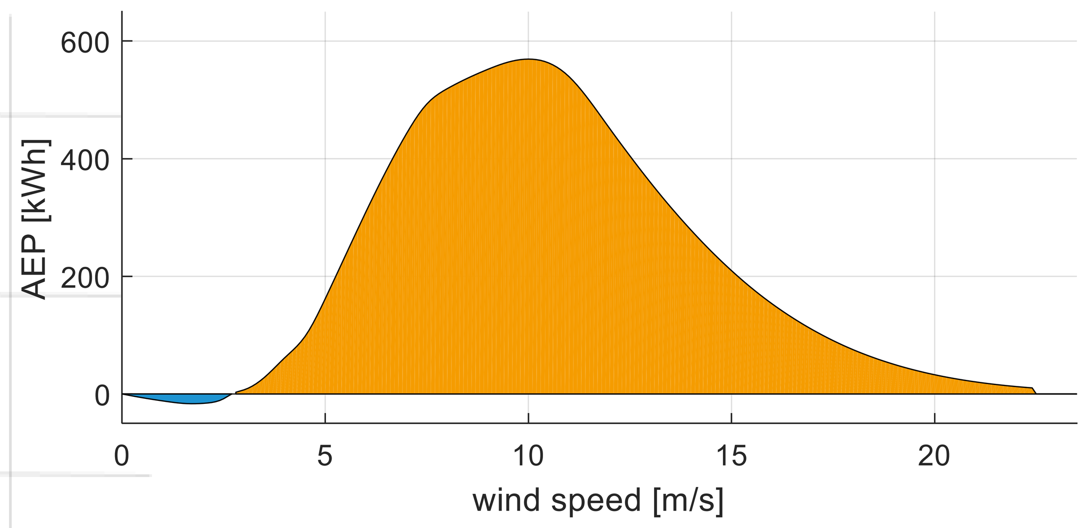


Viability Assessment

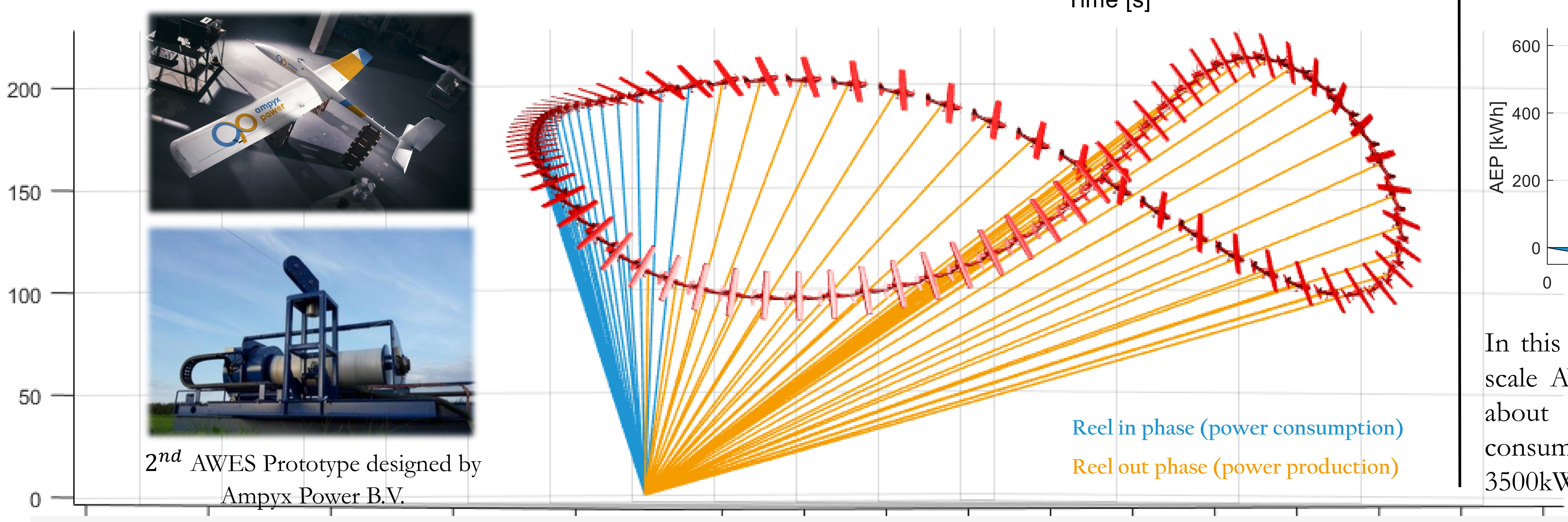
The tool allows to easily obtain the AWES power curve i.e. the net electrical power output which is required for the assessment of the Annual Energy Production (AEP).







In this case, the viability analysis has shown that a small scale AWES with a wing area of 5.5 $[m^2]$ can produce about 50 MWh per year which equivalents to the consumption of 15 households that each consume 3500kWh per year.



2^{nd} AWES Prototype designed by Ampyx Power B.V.

References

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[2] Licitra, G., Koenemann, J., Horn, G., Williams, P., Ruiterkamp, R. and Diehl, M.. *Viability Assessment of a Rigid Wing Airborne Wind Energy Pumping System.* In Process Control (PC), 2017. IEEE.

[3] Koenemann, J. OpenOCL: Open Optimal Control Library https://www.openocl.org/.

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