ETH zürich

Multidisciplinary analysis and optimization of a morphing wing for Airborne Wind Energy applications

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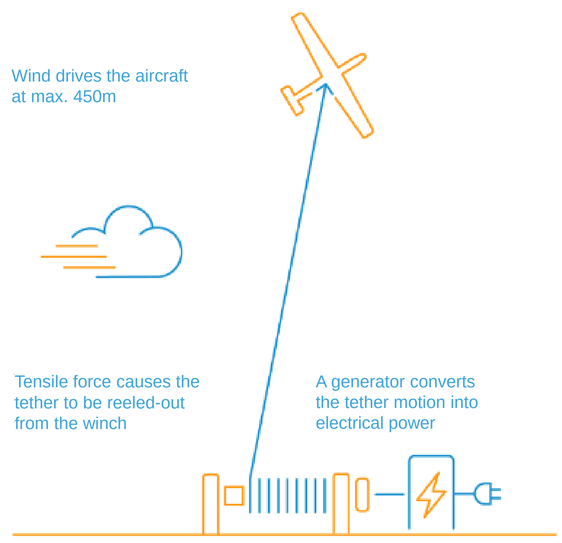
1 Airborne Wind Energy

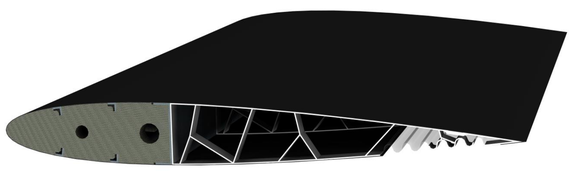
Airborne Wind Energy (AWE) systems harvest wind power at altitudes not reachable for traditional wind turbines. AWE systems are based on an aircraft that reels out a tether connected to a ground-based electric generator. As the airplane reaches higher altitudes than conventional wind turbines, it can exploit the stronger and more consistent winds.
The control aspects of such systems have been extensively investigated in the past decade. By optimizing the flight path and power generation routine, the generated power can be maximised.
The structural and aerodynamic aspects of the aircraft have yet to be optimized, in order to maximize the energy extraction, which is the main goal of this project at CMASLab.



Source: www.ampyxpower.com

2 Aero-structural analysis and optimization

Morphing wings expand the operational envelope of aircrafts and increase the aerodynamic efficiency. They are primarily utilized to overcome design conflicts between various flight and speed regimes.
Structures of morphing wings have two main tasks: They need to provide enough stiffness to prevent any undesired deformations, and they need to allow the wing skin to deform in the desired ways to achieve high aerodynamic efficiency.
This project at CMASLab analyses the structural and aerodynamic behaviour of such wings. The aerodynamic forces acting on an AWE aircraft are exceptionally high, resulting in large structural deformations.
The goal of the project is to develop an aircraft for AWE applications utilizing morphing to control its flight.
In order to achieve the desired shapes and shape changes, all structural components need to be analysed and optimized. This is achieved by simultaneously optimizing its aerodynamics and structure.



3 Student project AWE system

A group of eight students in their final BSc year are developing an AWE system at CMASLab. The students goal is to design, build, and demonstrate a fully-functional AWE system at the end of their one-year project.
The challenges the students need to tackle are:

- Multidisciplinary design problem
- Very high load factors
- Lightweight design requirements
- Complex manufacturing processes
- Dynamic system control
- System integration

The project is expected to offer significant insights in the problems of trajectory identification, ground station design, and flight control laws implementation for an AWE system.