Fluid Structure Interactions of Inflatable Kite Wings

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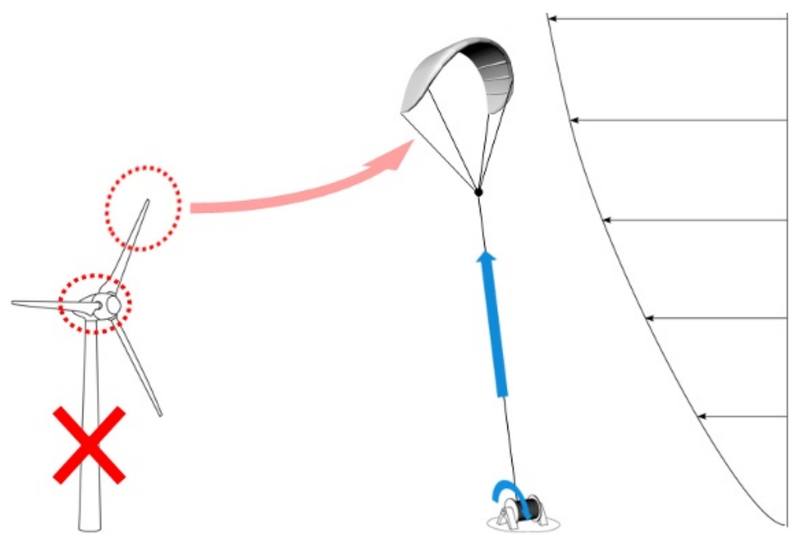
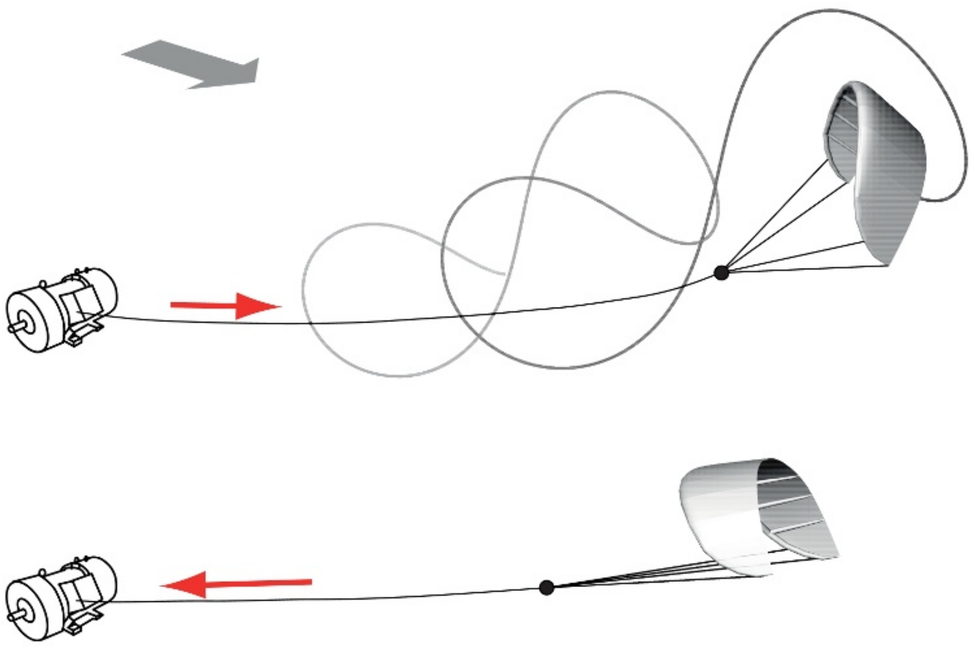
Aerospace Engineering

Kite Power

As a rule of thumb, wind velocity increases with altitude. Compared to low altitude winds, it also becomes more consistent as the altitude gets higher. Kites have tremendous application in the field of High Altitude Wind Energy and are superior to the existing ground based methods. [1]

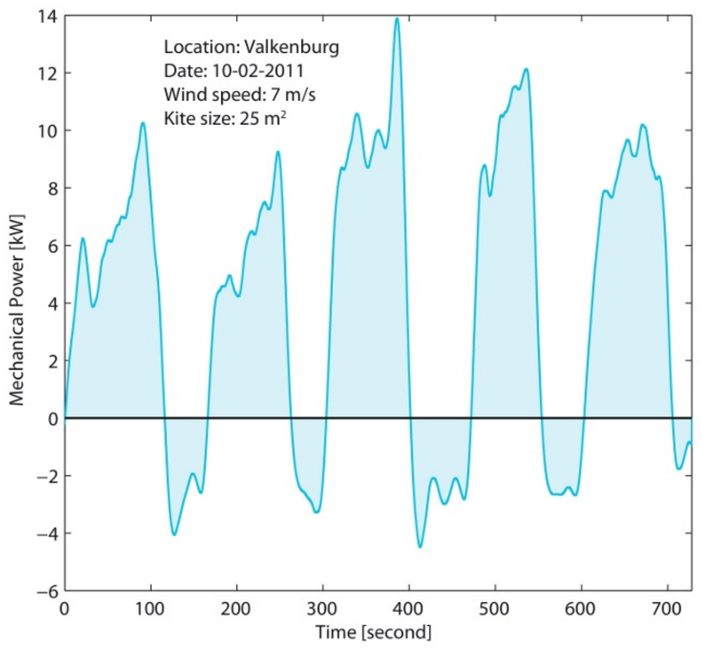
The Laddermill technology invented by Wubbo Ockels marked the start of high altitude wind research at the Delft University of Technology. A leading edge inflated wing is tethered to a ground based generator. With successive reel-in and reel-out phases the wing iterates through pumping cycles. [2]





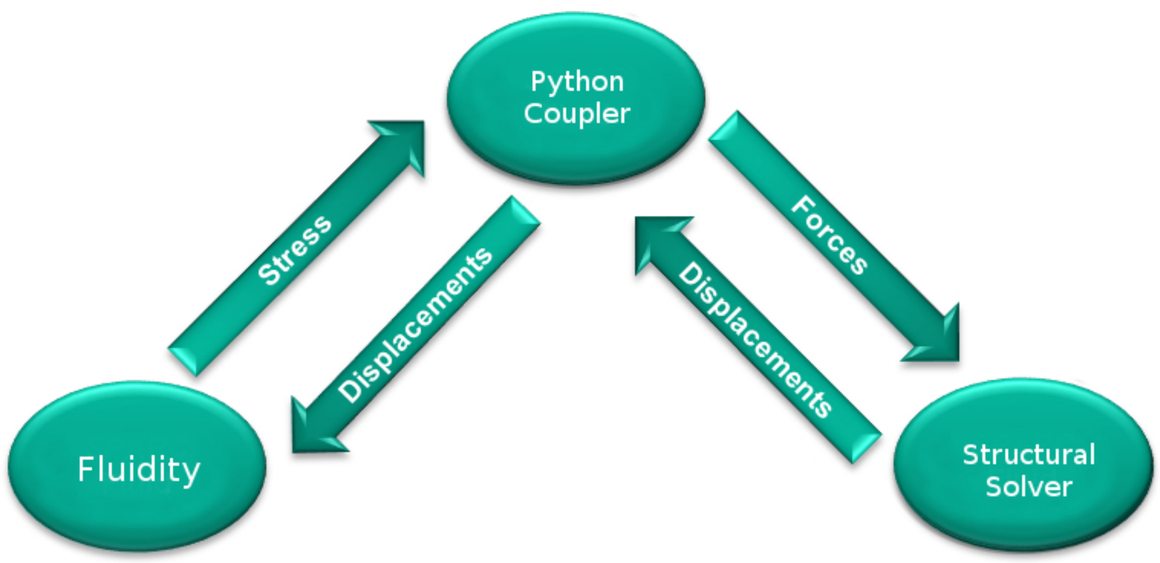
In the reel-out phase the kite flies in figure eight patterns capturing crosswind energy.

In the reel-in phase the motor spends part of the generated power to pull the kite back.



FSI Solver

The complex flight patterns, the unpredictable nature of cross-winds, and the highly flexible and inflatable design of the kite wing make the dynamics and control of the wing highly complex. A novel fluid-structure interaction (FSI) simulation framework is being developed at the KitePower group of TU Delft.



Stage 1: Fluidity [3] coupled with an in-house structural solver on membrane elements.

Stage 2: Build in 3D structural solver for Fluidity.

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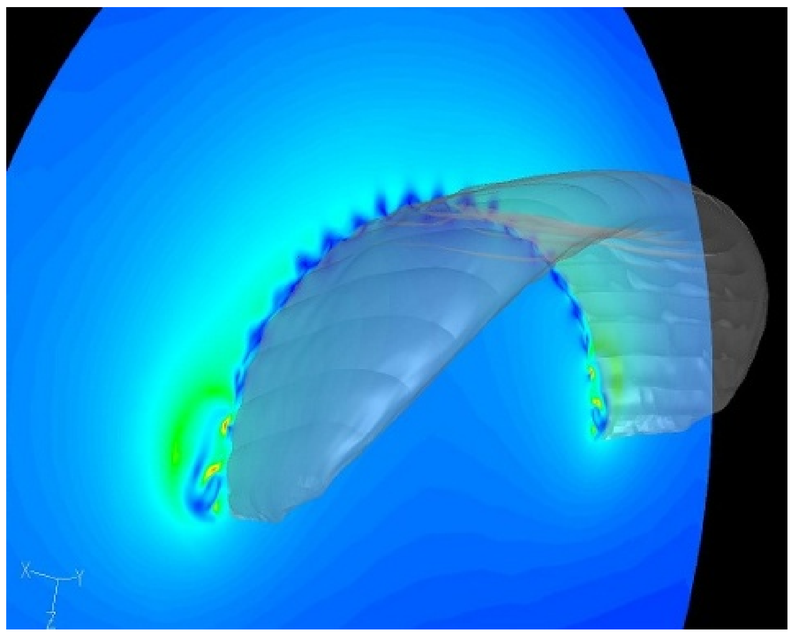

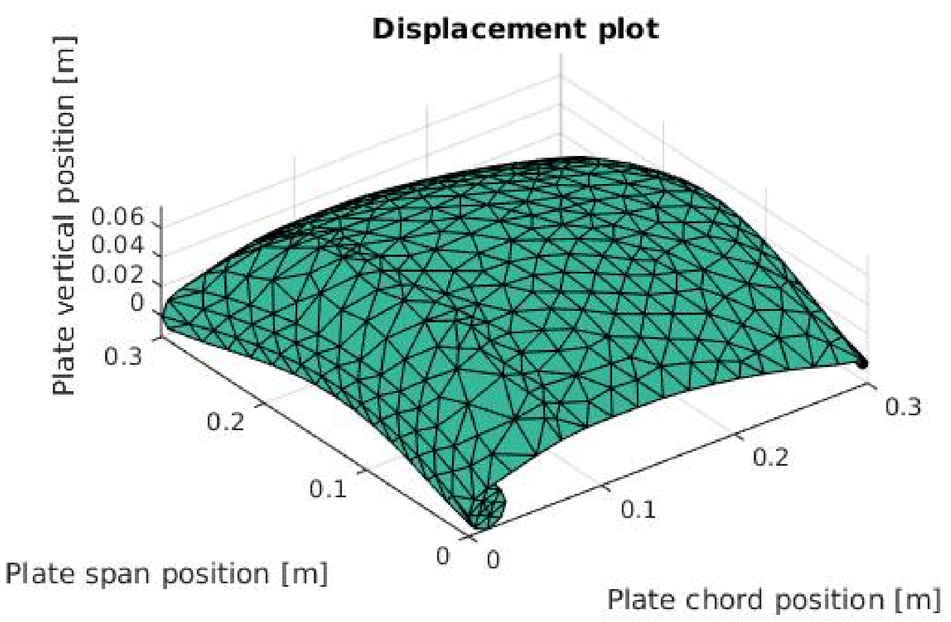

References

[1] R. Schmehl, “Kiting for Wind Power”. Wind Systems, No. 7, pp.36-43, 2012.

[2] C. Grete, “The Economic Potential of Kite Power”. Leonardo Times - Journal of the Society of Aerospace Engineering Students 'Leonardo da Vinci', No. 4, pp. 10-11, 2014.

[3] Fluidity Manual. Applied Modelling and Computation Group, Imperial College London.

TU Delft Delft University of Technology

SEVENTH FRAMEWORK PROGRAMME

KitePower LADDERMILL