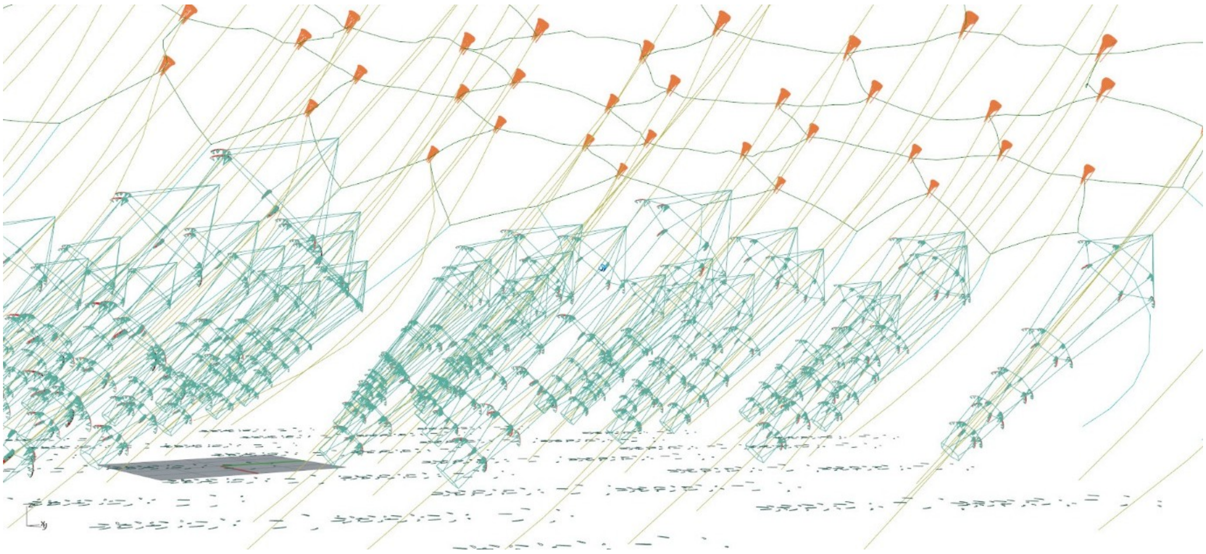
Networked Kite Power

Kite networks provide a more efficient way to harness wind power.



Regular wind turbines are massively expensive. They are heavy, which means they cannot be moved and worse, producing them consumes huge amounts of energy. Worst of all, they are too small. They barely touch the slowest winds in the atmosphere. More valuable, higher power wind is higher up.

Kite Power or “Airborne Wind Energy” is a young field of science and engineering. Kite power designs use less material to make more power, more often. We develop fast flying kites to harvest energy from more powerful winds, reliably found at higher altitudes. A new method coordinates networks of kites, simultaneously harnessing the work of multiple kites in a safer more efficient way.

Why kite power? - Tensile structures can scale

Using kites for wind power has compelling advantages. More power from less material makes cheaper, cleaner energy. The key advantage is, kites work in tension, so they can be both huge and lightweight.

Traditional wind turbines are too heavy and expensive because their towers use compressive and bending forces to lift a generator high up to push blades against the wind. It is like comparing a modern suspension bridge (tension) with an old arch bridge (compression and bending). Arch bridges quickly became too heavy and expensive to build over large spans. The lightweight tensile structure of kites allows kite turbines to work safely through huge volumes of high power wind at high altitude.

We all know the problems with kites though. They love to tangle in trees. They fall from the sky. You have to keep them away from power lines and air traffic. Kites are hard to control.

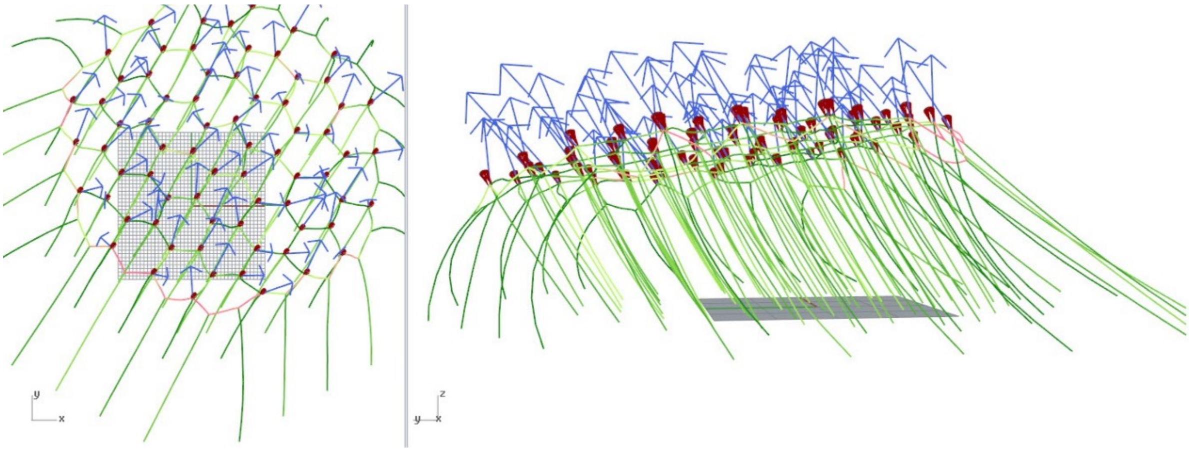
The initial kite power research

This control problem dominated early research in Airborne Wind Energy Systems (AWES). The research considered standard, single kite wing models on a long line. Because a single kite is so hard to control, multi-kite stacks and arches were considered too hard for the initial research work. It is a little recognised truth that multi-kite stacks and arches hold records for altitude, power, efficiency and stability. Single-line kite power designs contend with serious compromises and drawbacks including line wear, weight aloft, drag and what happens in the case of a line failure.

Kite Networks, for stable lift and stable power

Kite tether networks have demonstrated critical advantages over single line kites in control, power density, reliability, safety, efficiency, stability, cost of energy, output quality, scalability and more. Here's how.

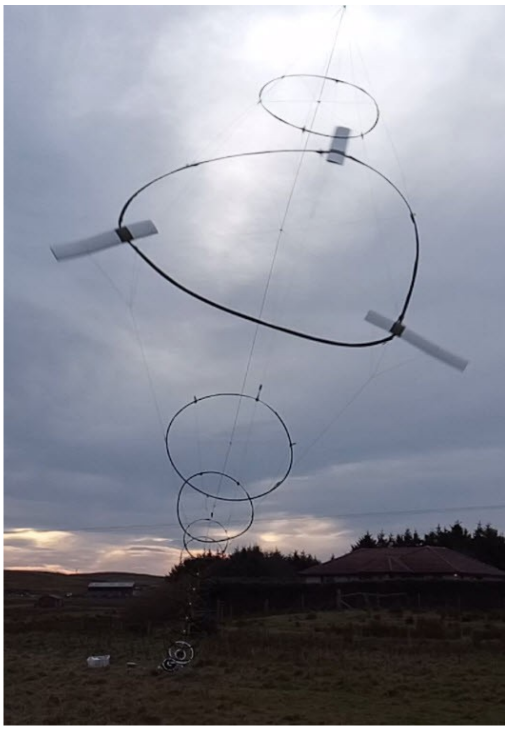
Network kite designs exploit wide tethering patterns. A kite set on a widely tethered network, is fixed in position like a fly stuck in a spiders web. This lucky "spider" caught a whole swarm of "kite midges."



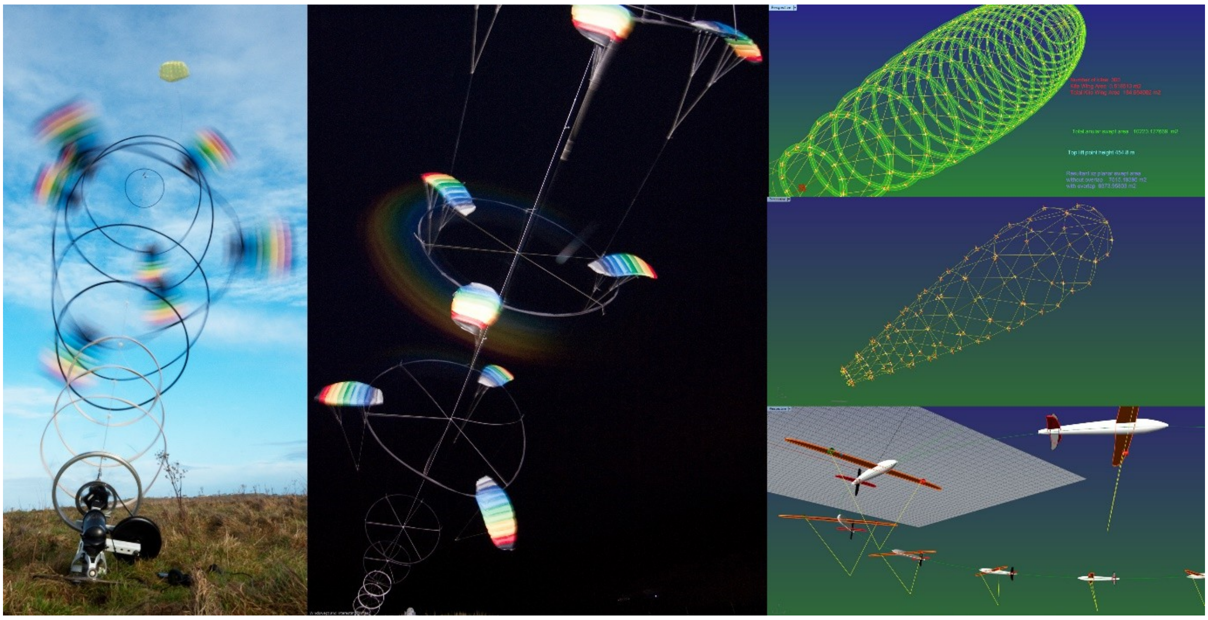
Kites linked in a network keep their position, despite hugely turbulent winds. Whereas individual kites on single lines, will scatter and tangle in turbulent wind, by adding a top layer of networking lines, the individual kites hold on station, even without a control system. This give a stable lifting platform.

This stable network of lifting kites was not popularly investigated because power extraction needs fast kites. What we need for power extraction and generation is a steady network of fast moving kites.

For power, we need another kite network, **a fast spinning autogyro kite turbine called "Daisy".**



Earlier kite power research exploited line pulling and retraction (the yo-yo method) or using a kite to lift a wind turbine & send electricity down the tether (drag method) But Daisy auto-gyro kites transmit continuous torque power to ground using multiple tethers around rings as a tensioned flexible shaft. This provides better quality, constant output, with less tether drag per kite, making it more efficient.



The Daisy design relies on two things. Firstly, a little lift from a lifting kite, (yellow in pictures above) this holds the turbine in the most powerful position. Secondly, Daisy needs tension in the spinning lines, to allow torque transmission. With more tension, more torque can be transmitted more efficiently. More kite layers on the stack, means more tension and therefore more power available. It's a win win.

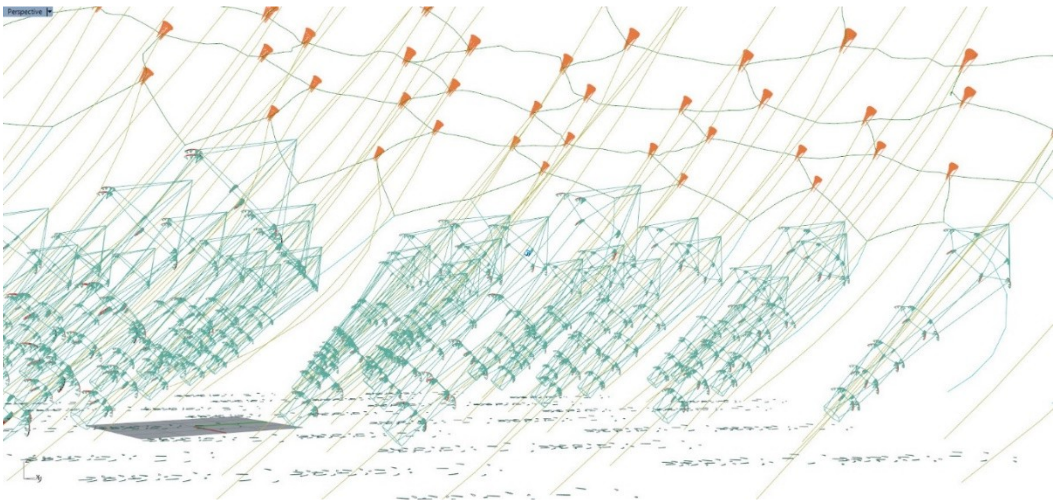
Reliable and safe even when damaged

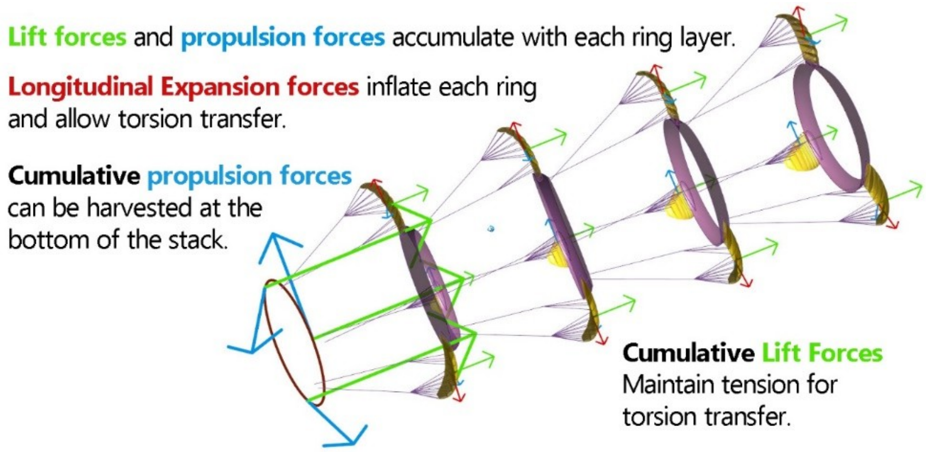
Kite networks are amazingly resilient. Kite turbines continue to fly in a degraded state. In a recent extreme test, a kite turbine failed spectacularly, but safely. With <2kg flying material, at >1.4kW a problem developed. There was no line tension sensor on the generator controller. At high torque & high speed with low line tension, seven lines over twisted and eventually snapped. Despite seven lines breaking, because the network had a backstop line, nothing broke away from safe anchoring.

Efficient and scalable by design

Daisy kites exploit the amazing scalability, (from speed, power to weight ratio and wing loading) of multiple small rigid kites, rigged as a turbine. Spinning kites give continuous torque output and provide tension to transmit the torque. The "shaft" of kites works exactly in the "kite power zone." To stall the shaft the kites can be pulled to the side of the kite wind window.

By **combining the two network types**. The Daisy (rotary power networks) are held in place by lifting kite networks. Tensile network architecture, efficiently harvests power at scale, across wide areas.



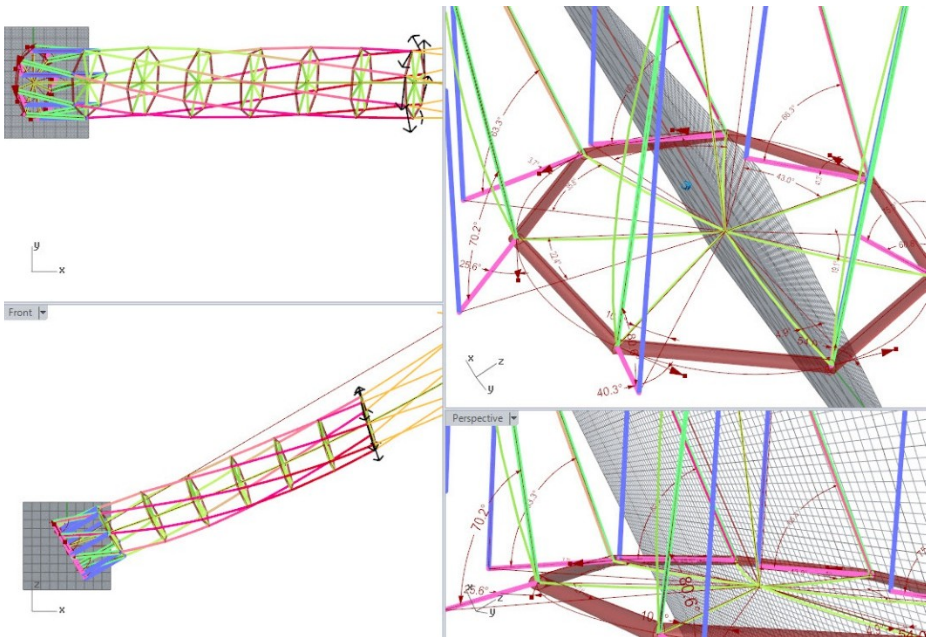


Daisy kite networks use multiple kites stacked in layers. Kite layers can be added from close to the ground all the way up a stack. Rotary kite layers help to expand the "shaft stack" which keeps powerful torque transmission viable.

Going Places

Kites are lightweight, so they transport easily. We have taken kite power networks camping and charged an EV car with its own kite turbine. Kite networks use minimal land to farm wind power. There is no road needed and because their forces are in line with their material, they do not need a foundation, just an anchor under the generator.

Analysis of the dynamics, control and scalability by Oliver Tulloch (University of Strathclyde) and Roderick Read (Windswept and Interesting Ltd) is revealing how vast volumes of wind energy can be harvested in an incredibly clean, cheap and safe way.



Look forward to more about kite networks soon.

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