

US Conference

Harnessing the power of high-altitude wind



TAKING OFF: Ampyx Power's PowerPlane in action. The Dutch-owned company suffered a setback when Norwegian utility Statkraft reduced its level of promised support

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Stronger, more consistent high-altitude winds offer the prospect of a "dramatically reduced" cost of pollution-free energy. The airborne-wind-energy technology that would harness it — once thought of as "just science fiction" — is becoming a reality.

That was the optimistic note struck by Joe Ben Bevirt in opening the second Airborne Wind Energy Conference at California's Stanford University last month, where some 150 entrepreneurs, technologists, investors and regulators discussed the state of an admittedly nascent industry.

There is a wide array of approaches to capturing what some industry backers describe as a natural energy source second only to solar in its strength and consistency.

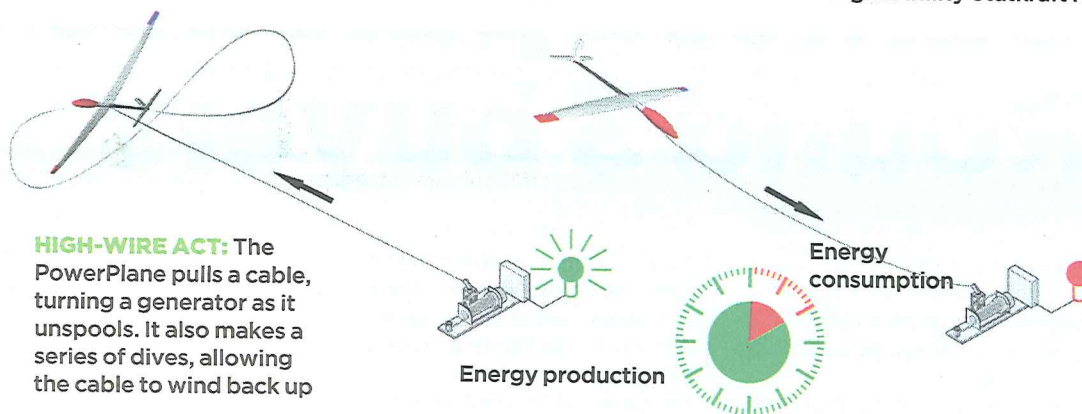
Bervit's Joby Energy is working on airborne generators mounted on propeller-driven aircraft with wingspans as great as ten metres. They would fly across the wind to maximise power, sending the resulting electricity down to earth.

Dutch company Ampyx Power has a crosswind PowerPlane that pulls a high-tension cable, spinning a ground-based generator as it unspools. The 10kW prototype makes a series of dives, allowing the cable to wind back up so it can be pulled out again.

Magenn Power is floating a lighter-than-air, inflatable turbine design that rotates on its horizontal axis in the wind, sending electricity down the line tethering it to the ground.

One thing they all have in common, though, is myriad challenges, including regulatory uncertainty, access to capital and a sceptical public.

The entrepreneurs remain



undeterred. Bevirt says his company has visions of capacity factors that are twice the 30-40% seen today in terrestrial wind, and a levelised cost of electricity in the range of \$40 per MWh, competitive with coal. "Twice the energy. Twice the consistency. Two thirds the capital cost," he says, expressing confidence that Joby will reach commercial scale in the "next couple of years".

Bervit is pumping a great deal of his own money into Joby. However, there is a wide range

of opinions on how to finance a start-up airborne-wind company. Such an endeavour has the attributes that venture capitalists tend to look for: huge potential market; technology focused; high risk.

But Saul Griffith, an inventor who co-founded Makani Power, one of the better-known airborne-wind companies, sees typical venture capital as inadequate for bringing a technology in this field through development to commercialisation.

"Everyone in the room is trying to get to small, one-off prototypes of the machines we're building," says Griffith, who also advises a top venture-capital firm. "But to actually get across the valley of death, as they call it, requires utility-scale prototypes operating for sufficiently longer, to prove insurability, reliability, and operations and maintenance costs.

"If you think about how long it takes to do that, and how much money, it's \$25m minimum

cost of entry — \$100m, more realistically — and a three- to five-year process just to get [a] real cost model." By then, most venture investors expect to see the beginnings of a return.

While he advises airborne-wind entrepreneurs to take all the venture money they can, the key to success is a partnership with an established energy or aerospace company — such as GE, Northrop Grumman or Honeywell — that has the resources to get a promising technology to the market "on a time scale that matters".

Ampyx was on the right track, having collected an investment from Norwegian utility Statkraft and the promise of help in promoting airborne wind. But those more ambitious efforts were scrapped because of budget cuts at the utility, which is now participating only as an investor, says Bas Lansdorp, general manager of Ampyx.

Aviation companies will also be more adept at working with aviation authorities, whose approach to regulating airborne wind is still evolving.

"The regulatory issue is a big question," says Will Coleman, a partner at venture-capital firm Mohr Davidow Ventures. "It's tough to invest as a venture investor if you've proven your technology but you don't know whether or not it will ever fly with the public or with the government."

Griffith says airborne wind offers a potential growth engine to an aerospace industry that should be thinking about its future in a carbon- and energy-constrained world. But before that can happen, Griffith suggests, the industry needs to convince the general public, not to mention the chief executive of GE, that airborne-wind energy is more than just science fiction.

Looking for space in a crowded sky

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Two of the biggest questions for the airborne-wind industry are whether and how companies will be allowed to fly their machines.

Elizabeth Lynn Ray, a US Federal Aviation Administration (FAA) director responsible for obstructions evaluation, airspace rules and classifications, is leading the agency's look at the emerging industry, which proposes to fly and float all manner of energy-generating devices at altitudes ranging from hundreds to

thousands of metres. "It's a very crowded sky," Ray tells *Recharge*.

Airborne wind — just like terrestrial wind — could potentially interfere with radar, navigation aids and the air-traffic control system, and the FAA is at the beginning of the process of learning about and evaluating it. The FAA's primary mission is to ensure safe and efficient use of airspace.

"It's a burgeoning industry," Ray says. "It's exciting and what we want to do is to start those discussions, to try to

make those definitions, see what regulations we do have that do fit... I think one of the challenges is that there's a huge diversity of technology. There's all kinds of different ideas associated with airborne wind."

It is not immediately clear whether current FAA rules and regulations can even be applied.

"That's because a lot of our rules... were initially developed many decades ago," Ray says. "We're in the process of updating them as technologies have improved."