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Wind turbines take to the skies to seek out more power

By Richard Anderson Business reporter, BBC News

Critics of wind turbines argue vehemently that they are ugly and inefficient - a blot on the landscape and an expensive folly to boot.

Efficiency has always been a strange critique given that the fuel driving turbines - wind - is free. And while electricity generated from wind may currently be more expensive than that from some fossil fuels, costs are coming down fast.

Eye sores? That is simply a matter of opinion.

But a new wave of turbine technologies are looking to end the debate once and for all, by making wind power cheaper, more flexible and, in many cases, less intrusive on pristine countryside.

Some won't make it to market, but those that do could revolutionise wind power.

Wind speed

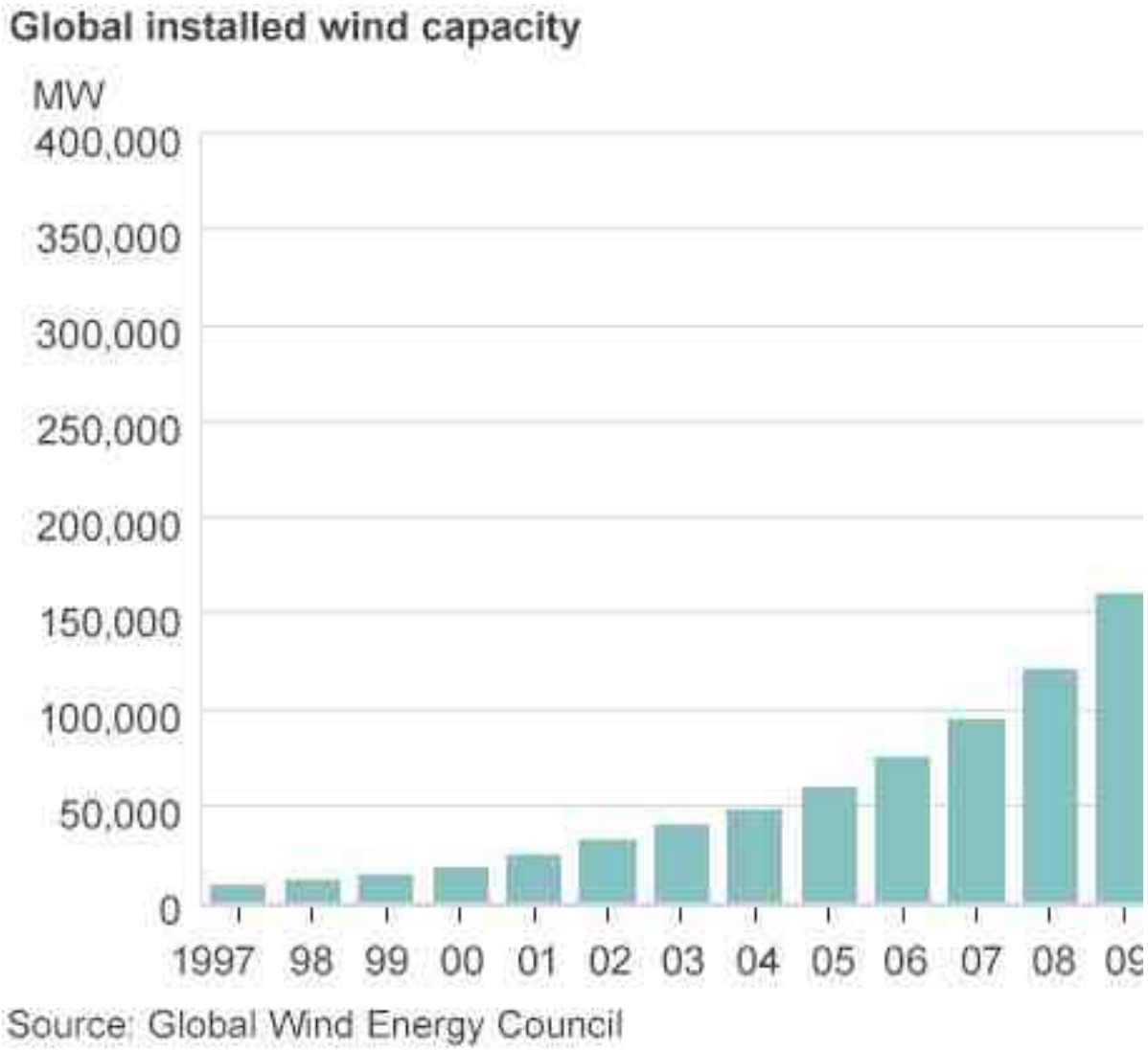
One of the simplest ideas being developed is the wind lens. Inspired by "experience and a eureka moment", Prof Yuji Ohya from Japan's Kyushu University is leading a team designing a conical structure placed round the turbine blades to generate low pressure and accelerate wind speed.

Wind-lens turbines generate more power so the blades don't have to be as large, the designers say

Prof Ohya says the wind lens turbine develops two to three times the power output of its traditional counterpart, while reducing noise substantially - potentially removing one obstacle to more widespread use in populated areas.

Compact turbines producing 1KW-3KW are at the "final stage for global distribution", says the Prof, while two larger 100KW test turbines have been running since 2011. The next stage is to build a 300KW version.

But not everyone is convinced. Dr Gordon Edge at Renewable UK questions the amount of additional material needed for both the lens and the structure to support it. Besides, he says, "this idea has been around before and didn't make the grade".



A more radical idea is being trialled by US company SheerWind.

While researching how to reduce noise and vibrations from traditional turbines for the US Department of Energy, Dr Daryoush Allaei thought there had to be a better way to harness wind power.

In 2009, he and his team set about designing a system for collecting wind much closer to the ground. The resulting Invelox system captures wind at speeds as low as 2kph, funnels it to increase speed before passing it through a small turbine. Not only is the design able to capture winds at low speed, thereby "making wind power viable in most of the world", but the system is smaller, simpler, cheaper and quieter than traditional turbines, says SheerWind's Carla Scholz.

Sheerwind's rapid deployment model is designed to set up quickly to provide power where needed

Sceptics point to the small surface area and lack of height, but the company claims the cost of electricity generated by Invelox is almost three times less than that from an equivalent, existing turbine.

High fliers

Rather than focusing on the ground, however, there are many more companies looking to the skies. As Dr Edge says, "there are definite advantages to going further up", where the winds are both stronger and more consistent.

Research by the Politecnico di Torino, for example, has found that wind speeds at 800m are more than twice those at 10m, with power, as measured by watts per minute squared, 10 times greater.

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One company pioneering flying turbines in Germany's EnerKite. The team has designed a carbon fibre wing that is "controlled to fly crosswind in turning eights, pulling strong on the tether, driving reels on the ground", explains co-founder Alexander Bormann. The wing is then reeled in and the process begins again.

Dr Bormann says a 100KW kite produces the same amount of electricity as a 200KW-300KW turbine, which means cheaper power. He argues the design is low maintenance, can be serviced on the ground and is easily transported. And like all flying wind generators, it uses far less

materials than tower-mounted turbines.

At small scale, the kites are most suitable for more remote communities that may rely on diesel generation to fulfil some or all their power needs, but, in the longer term, they could "be scaleable to utility-level production", says Mr Bormann.

EnerKite generates electricity by using the wind to reel out a specially designed carbon-fibre wing

Italy's KiteGen Research is working on a similar design, while others are looking at balloon technologies to carry turbines hundreds of metres into the sky.

US-based Altaeros Energies uses a helium-filled shell within which sits a traditional but lightweight turbine. It can be raised or lowered to seek out the optimal wind speed and is attached to the ground by three tethers, one of which transmits the power generated back to earth. The company says the design produces two to three times the power output of standard turbine, with installation and transport costs 90% lower.

Canada's LTA Windpower is developing a similar concept, but using an airship designed to contain hydrogen.

Altaeros Energies' BAT uses helium gas to take the turbine hundreds of metres into the sky

The notoriously secretive Google X is also getting in on the act, having bought wind power company Makani in 2013. Its solution involves a tethered, carbon fibre glider flying in circles at an altitude of up to 350m, carrying up to 8 small turbines producing 600KW of power. Makani claims each glider can generate 50% more energy than a traditional, fixed turbine.

Makani's radical design uses a tethered "kite" to fly up high to catch strong winds

With variability one of the key drawbacks of wind power, the logic of going higher is indisputable. But Jan Matthieson at the UK's Carbon Trust argues there are "a lot of questions and a lot of risks with airborne power".

"A lot more work and testing needs to be done for these companies to build up a track record, and with very high [development] costs it will be difficult for new technologies to break into

the market."

He believes it will be at least 10 years before flying turbines reach widespread commercialisation.

Sea change
Developments in offshore floating turbines are happening far quicker.

There are already prototypes operating off the coast of Norway, Portugal and Japan, while a number of companies are working hard to unleash the potential of technologies that could transform wind energy generation.

For countries where the coastal seabed drops steeply, such as Japan and the west coasts of the US and France, traditional offshore turbines fixed to the seafloor are simply not an option.

Floating turbines offer great potential for wind power where sea beds drop away very quickly
Not only, then, do floating turbines open up possibilities for wind generation in new places, but they hold some advantages over their fixed counterparts. They can be built and assembled onshore and then towed out to sea, and if repairs are needed they can simply be towed back again, making maintenance easier and cheaper.

As Dr Edge says, "they have the potential to reduce costs massively".

For to increase wind power generation, bigger turbines are needed, and these will always be restricted onshore by public opposition, not only to their appearance but to the noise they create - already big blades are often run at sub-optimal speeds onshore to keep the noise down.

Offshore, there are no limits. Stronger winds help bigger turbines generate more power, thereby lowering the unit cost of the electricity they produce.

"For wind energy to really make a difference, it needs to be up-scaled, and to really scale up you have to go offshore, there is no other way," says Mr Matthieson.

Flying turbine developers may disagree, but with such an array of new technologies, the case against harnessing the wind's power appears to be weakening by the day.

Top 10 countries by installed wind capacity

Country	MW	% of total
China	114,763	31
US	65,879	17.8
Germany	39,165	10.6
Spain	22,987	6.2
India	22,465	6.1
UK	12,440	3.4
Canada	9,694	2.6
France	9,285	2.5
Italy	8,663	2.3
Brazil	5,939	1.6

Source: Global Wind Energy Council