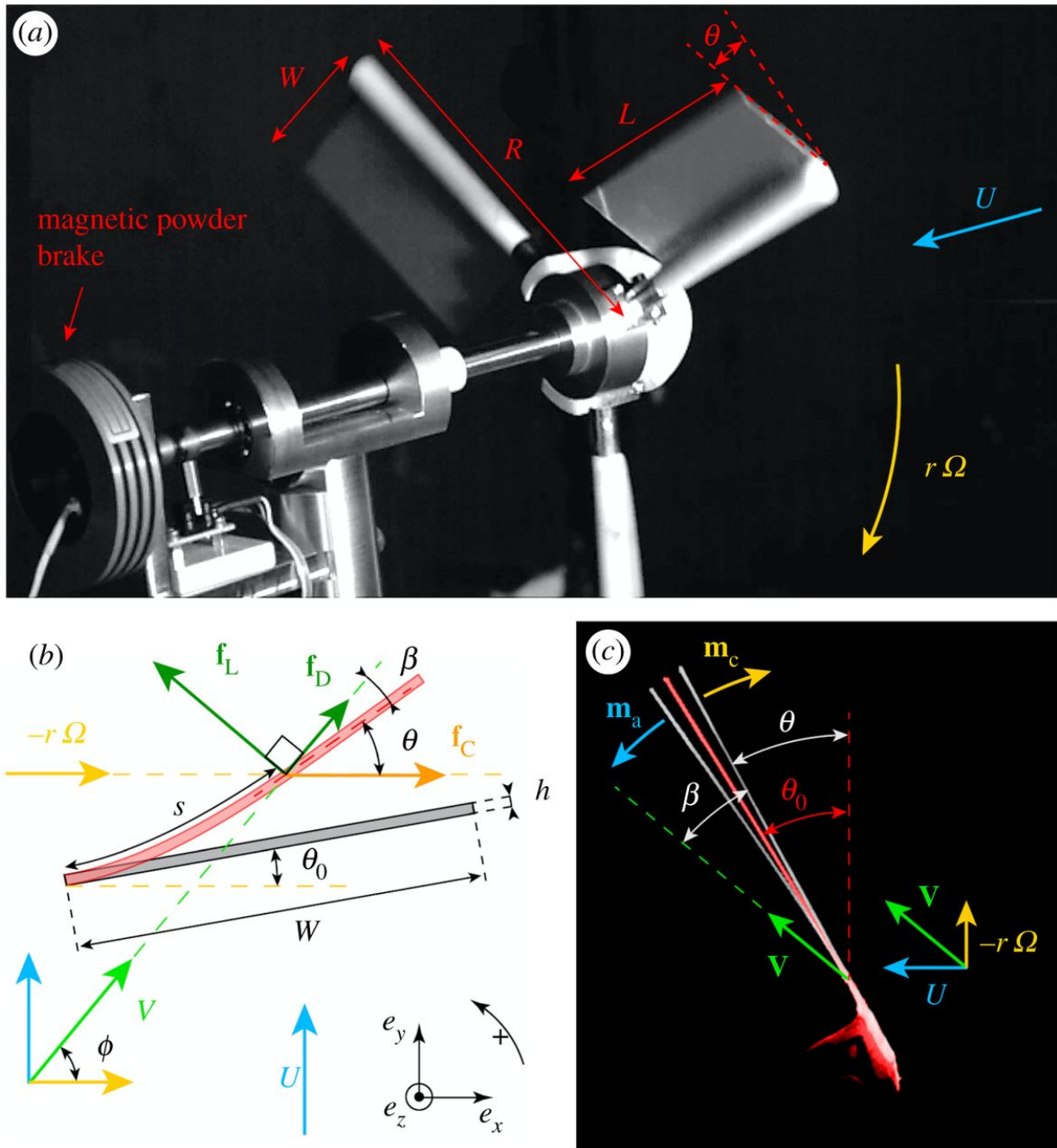


# Wind turbines with flexible blades found to be more efficient

February 22 2017, by Bob Yirka

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(a) Three-bladed turbine model used in this work. (b) Sketch of a blade section in the rotating frame of reference, showing symbols and notation. During the operating regime, the blade is subjected to the aerodynamic force (decomposed into lift  $f_L$  and drag  $f_D$ ), which tends to fold the blade through the action of the torque  $m_a$ , and the centrifugal force  $f_C$ , which conversely tends to align the blade with the rotation plane due to the torque  $m_c$  exerted in the opposite

direction. As a result, the blade bends, which modifies the angle of attack  $\beta$  between the apparent wind  $V$  and the blade and  $\theta$ , the angle between the blade and the plane of rotation. (c) Bent elastic blades for three characteristic values of the speed ratio  $\lambda$  measured at the tip blade. The red profile shows the reference configuration ( $\lambda=0$ ,  $\theta_0=28^\circ$ ). The two white profiles show the bent blades for ( $\lambda=0.25$ ,  $\theta=30.8^\circ$ ) and ( $\lambda=2.35$ ,  $\theta=25.3^\circ$ ). Credit: (c) *Proceedings of the Royal Society A: Mathematical, Physical and Engineering Science* (2017). DOI: 10.1098/rspa.2016.0726

(Tech Xplore)—A small team of researchers with Sorbonne Université and École Nationale Supérieure des Arts et Métiers-ParisTech has found that using flexible blades on a wind turbine can dramatically increase its efficiency. In their paper published in the journal *Proceedings of the Royal Society A*, the team describes their approach and the results they obtained through physical testing of their idea.

After many years of research, modern wind turbines have become an effective source of alternative energy—but only under the right conditions. Big turbines used by utilities must reside in locations that offer a steady stream of the right wind speeds—too fast, and there could be damage or high maintenance costs; too slow, and the [turbine](#) blades will not turn. Now, it appears that there might be an alternative solution—using flexible blades that optimize the torque applied to the generator.

The idea for flexible blades came to the researchers after noting that most insects have flexible wings, which prior research has suggested provides creatures such as the dragonfly more power without expending more energy, by contrast with inflexible wings. That led them to create [wind turbine blades](#) that were flexible, contrary to the industry standard hard blades. After coming up with a suitable design, the researchers tested their ideas by applying them to actual wind turbines. In their tests,

some of the turbines ran with the standard hard blades, some ran with very flexible blades, and some ran with blades that were approximately in the middle—not hard, but not as floppy as the other blades. They then tested each of the turbines for efficiency.

The researchers report that the hard-bladed turbines performed as expected, but the floppy blades did not work well at all—they were less efficient than the hard blades. But the middle option proved to be approximately 35 percent more efficient than the standard hard-blade turbine. They also found that the turbines worked over a wider range of wind conditions than standard turbines—they would turn under lower [wind](#) conditions and were not as susceptible to wear and tear under high [wind conditions](#).

The researchers suggest the use of flexible blades on [wind turbines](#) offers the advantage of increased versatility and efficiency. More research is required to discover optimal flexibility and to determine if such blades are commercially viable.

**More information:** V. Cagnet et al. Bioinspired turbine blades offer new perspectives for wind energy, *Proceedings of the Royal Society A: Mathematical, Physical and Engineering Science* (2017). [DOI: 10.1098/rspa.2016.0726](#)

## Abstract

Wind energy is becoming a significant alternative solution for future energy production. Modern turbines now benefit from engineering expertise, and a large variety of different models exists, depending on the context and needs. However, classical wind turbines are designed to operate within a narrow zone centred around their optimal working point. This limitation prevents the use of sites with variable wind to harvest energy, involving significant energetic and economic losses. Here, we present a new type of bioinspired wind turbine using elastic

blades, which passively deform through the air loading and centrifugal effects. This work is inspired from recent studies on insect flight and plant reconfiguration, which show the ability of elastic wings or leaves to adapt to the wind conditions and thereby to optimize performance. We show that in the context of energy production, the reconfiguration of the elastic blades significantly extends the range of operating regimes using only passive, non-consuming mechanisms. The versatility of the new turbine model leads to a large increase of the converted energy rate, up to 35%. The fluid/elasticity mechanisms involved for the reconfiguration capability of the new blades are analysed in detail, using experimental observations and modelling.

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