Drawing inspiration from the wings of insects, flexible wind turbine blades could generate more power in a wider range of wind conditions.

Wind turbines inspired by insect wings are 35% more efficient

By **David Shultz** Feb. 14, 2017, 7:15 PM

Wind turbines produce 4% of the planet's energy, but they only work well when the wind is blowing just right. Now, by drawing inspiration from the flexible wings of insects, scientists have found a way to make wind turbine blades 35% more efficient at producing energy. If commercialized, the advance could make this green technology a more viable alternative to fossil fuels in the coming years.

Increasing the efficiency of a wind turbine isn't simply a matter of getting the rotors to spin as fast as possible. In addition to becoming more prone to catastrophic failure, the turbines also become less efficient at higher speeds because they become more like a wall than

a rotor, blocking the wind from flowing past the rapidly rotating blades, says **Asfaw Beyene**, a professor of engineering at San Diego State University in California, who was not involved with the work.

The optimal amount of power comes from intermediate rates of rotation, says study author Vincent Cognet, a physicist at the Paris-Sorbonne University. In order for them to produce power most efficiently, the wind must strike their blades at just the right “pitch angle” to apply just the right amount of torque to a generator.

Insect wings don’t have this problem. Because they’re flexible, the wings of bees and dragonflies are able to direct the aerodynamic load in the direction of their flight, increasing the power. And because they naturally bend in the wind, they can minimize drag to avoid damage.

To see whether such flexibility would improve the efficiency of wind turbines, Cognet and his team built small-scale turbine prototypes with three different rotor styles. One was completely rigid, one was somewhat flexible, and one was very flexible. All three turbines had three rotors, but the flexible ones were made with a pliable material called polyethylene terephthalate, whereas the rigid version was made with a stiff synthetic resin.

In wind tunnel tests, the most flexible blades proved to be a bit too flaccid, and they failed to produce as much power as their stiffer brethren. But the moderately flexible blades outperformed the rigid ones, creating up to **35% more power** and allowing the blades to operate efficiently in a wider range of wind conditions, the team reports today in the *Proceedings of the Royal Society A: Mathematical and Physical Sciences.*

The tests also showed that the improvement came from changes in the pitch angle: As the turbine blades flexed back or forth thanks, respectively, to wind pressure and centrifugal effect, the pitch angle changed slightly. Higher pitch angles (more “open") performed more efficiently at lower wind speeds, whereas lower pitch angles (more “closed”) did better at high speeds. Indeed, faster winds lead to a higher rotation rate, which bends the rotor forward and closes the pitch angle slightly—helping to generate more power.

The next challenge, says Cognet, is scaling the technology up to work in full-sized turbines. “We have to find the material, which is flexible, but not too flexible.”

Beyene says the engineering side will take time, but his own experiments on morphing blades indicate that the 35% increase in power demonstrated in the new study is a perfectly reasonable expectation and would be a huge boon to a fully renewable future. His team is already actively planning larger prototypes that operate using the same principles. “The fluid mechanics and the physics make absolute sense,” he says. “There’s no reason why we cannot make morphing blades that will adapt to wind conditions.”

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