Do ultracapacitors make wind energy a sustainable option?

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The idea of using wind to create energy isn't exactly new. The first examples can be traced back to 200 B.C. in Persia – a creation of Heron of Alexandria. That particular device simply harnessed the wind to power a machine, so a case could be made that the first real windmills were built a little bit later, in the 7th century in Sistan, modern day Iran.

Though wind turbines today are sleeker, more efficient versions of their 7th century predecessors, they're still problematic. For example, they can be expensive, bulky, and difficult to transport. Commercial units can cost around $3.5 million, and can weigh up to 334 tons – sometimes requiring entirely new roadways so they can be moved. A turbine producing enough energy to run your house might run up to $35,000.

Despite the large – no pun intended – downsides, wind energy holds great potential for greener, renewable energy. Not to mention an entirely new "crop" for farmers. The key to making wind a viable energy alternative is continuing the evolution of the technology.

For example, wind turbines traditionally rely solely on batteries for an energy

storage system, which is necessary for providing power to generators that create the electricity. The system ensures the turbines move regardless of weather conditions. However, batteries often fail to supply the frequent, short bursts of high power required and can be unreliable in extreme weather conditions. Designers have discovered ultracapacitors might hold the key to a better energy storage system.

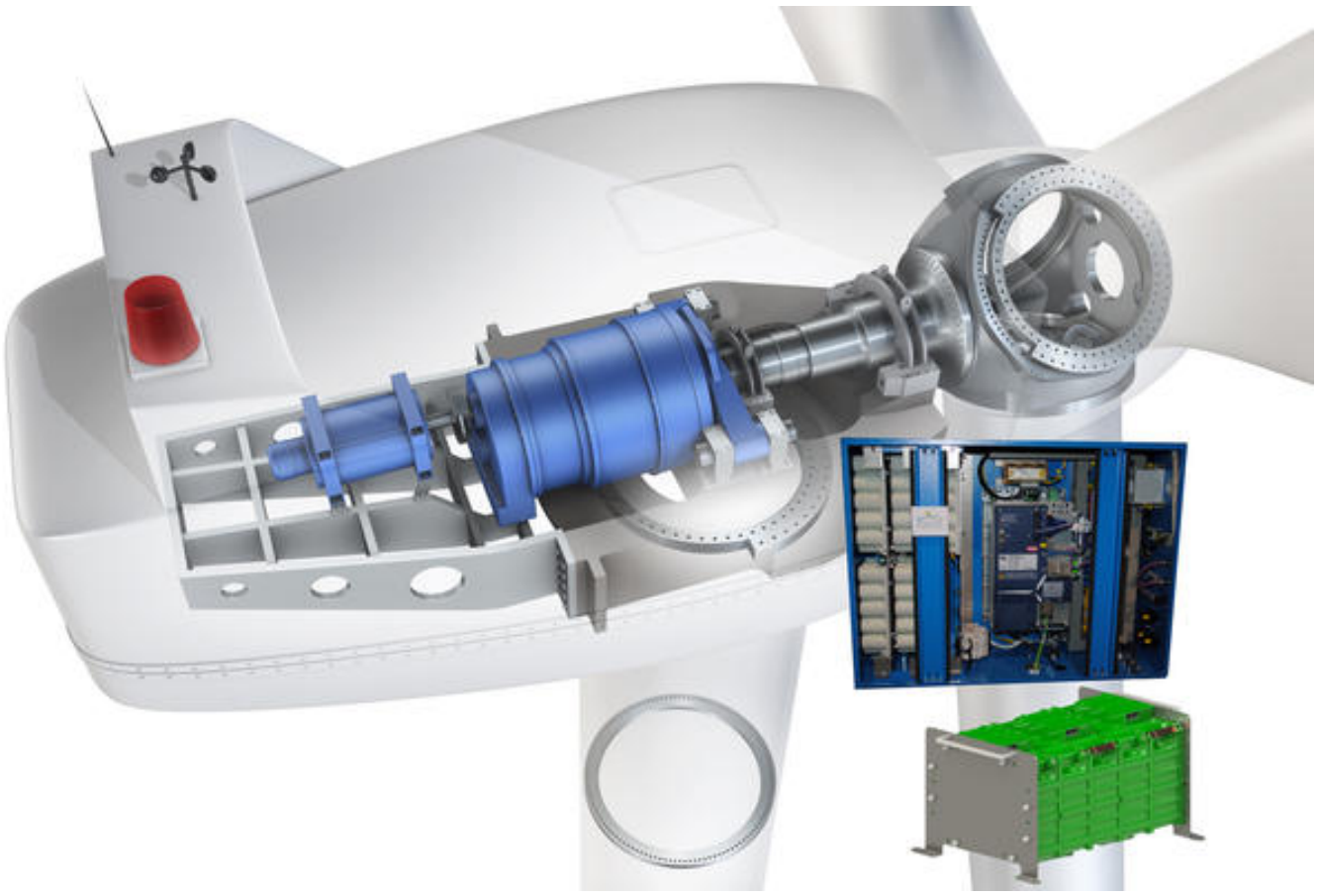
Fixing an obvious problem

Wind speeds can fluctuate up to 10 percent in just seconds, so a reliable energy storage system that responds whether there is a hurricane or no wind at all is key for a successful machine.
The ultracapacitor is just what the wind farmer ordered.

Though batteries are traditionally used for energy storage systems, they're very susceptible to severe weather conditions, particularly cold temperatures. Most have an operating temperature of -20 to 40 degrees Celsius and a lifespan of 10,000 to 15,000 charge and discharge cycles, usually about two to four years. Their short lifecycles means frequent maintenance trips and if the turbines are located offshore, this can prove a costly, dangerous trip for a repair crew, says Chad Hall, co-founder of Ioxus.

Ultracapacitors can offer more than one million cycles with limited performance since they require no plating or chemical reactions, according to Hall. They can last up to 10 years and what little wear naturally occurs is predictable, so maintenance trips can be safely planned.

The initial cost of ultracapacitors is more than batteries, but the return on investment could justify the original expense. Plus, for certain applications, like pitch control, ultracapacitors would completely replace batteries. For other systems, they would work in tandem to create a hybridized system.



he system, depending on the size of the turbines, can be stored either in a nearby shed or in the actual unit and serves as an “interface” between the grid and the wind farms, according to Ioxus, Inc.

Pitch control
To maximize effectiveness, wind turbines require pitch control systems, which ensure the blades are in the optimum position and help minimize tower shadow. The system serves as a failsafe if wind conditions are too strong or connection to the turbine is lost. During these potentially dangerous, emergency situations, the system puts the blades in a neutral position, essentially shutting down the machine. To create an entire pitch control system, each blade requires its own ultracapacitor.

Because of the compact space of the blade, options for energy storage devices are limited. Ultracapacitors are compact, lightweight, and require only limited moisture protection. Batteries, because of their weight and the hydrogen gas they release during a life cycle, require a specialized, vented, insulated structure. By eliminating specialized structure, designers are able to reduce both the cost and the size of the wind turbines.

Future improvements
Just because ultracapacitors are more efficient, that doesn’t mean designers are done tweaking the devices.
Traditionally, ultracapacitors are cylindrical in shape, containing highly porous electrodes, activated carbon for energy storage, aluminum foil to carry the current, paper as a separator, and either propylene carbonate (PC) or acetonitrile as the electrolyte, says Hall. But Ioxus has a new design that can further improve the

ultracapacitor. Ioxus is hoping to replace the cylindrical ultracapacitor with a prismatic, thin cell ultracapacitor called THiNCAP for a smaller footprint.

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