



wind turbines. There are a number of different systems that use either AC or DC motors for the movement of the blade pitch. The systems vary in operating current, voltage, blade size and motor type, which results in the need for different modules.

### WHAT ARE THE ADVANTAGES OF ULTRACAPACITOR SYSTEMS OVER BATTERY-BASED SYSTEMS?

There are a number of advantages, including long life; wider operating temperature range; great low-temperature performance; lighter weight; eco-friendly green technology; and predictable aging. The result is a lower total cost of ownership compared to batteries.

### HOW ARE WIND FARM OPERATORS ABLE TO SAVE MONEY BUY USING ULTRACAPACITORS?

The cost savings stem from the long life of ultracapacitors and the predictability of aging. Batteries need to be replaced three or four times during the lifespan of one ultracapacitor. This maintenance cost is relatively high considering the remote locations of wind farms, the weight of the batteries and the height of the towers. Because of the location of the pitch system in the rotor, it is a two-man job to replace the batteries. The cost is even more if it is offshore. The higher predictability of ultracapacitor-aging results in added savings by reducing unplanned downtime.

### HOW LONG DO ULTRACAPACITORS LAST?

It depends on the operating conditions, of course, but ultracapacitors can last more than 15 years under the right conditions. Some ultracapacitor manufacturers are striving for 20 years. Operating temperature and voltage are the key variables.

### HOW DO ULTRACAPACITORS WORK? TELL US A LITTLE ABOUT THE TECHNOLOGY INVOLVED.

An ultracapacitor is an electric double-layer capacitor. It uses an activated carbon film electrode, where the positive and negative electrodes are identical. The two electrodes are separated by a paper separator and filled with an organic solvent salt solution. It works on ion transfer between the electrodes at an atomic level. Because they are charge accumulators and not electrochemical reactions, ultracapacitors have a wider operating temperature range than batteries and can complete millions of cycles.

### ARE ULTRACAPACITORS AVAILABLE AS AN UPGRADE TO EXISTING SYSTEMS, OR JUST FOR NEW INSTALLATIONS?

Yes, some turbine manufacturers have developed upgrade systems. It is more complex as an upgrade, however. If they design in ultracapacitors from the beginning, manufacturers can simplify charging systems, eliminate heating and cooling requirements for batteries, and streamline mounting and vibration systems. ↙

### TELL US A LITTLE BIT ABOUT THE HISTORY OF MAXWELL TECHNOLOGIES AND HOW IT ENTERED THE WIND ENERGY INDUSTRY.

Maxwell Technologies got its start in 1965 as an engineering and research company called Maxwell Laboratories, which conducted advanced physics, pulsed power and space effects analysis for government agencies. This was the beginning of Maxwell's ultracapacitor products. Since then, many applications have emerged that use ultracapacitors' unique properties of long life and high-cycle capability.

### WHAT PRODUCTS DOES THE COMPANY OFFER TO THE WIND ENERGY INDUSTRY?

We have four Maxwell modules that we developed specifically for the wind industry. These are two 16 volt (V) modules [a 58 farad (F) and a 500F version]; a 75V 94F module; and a 160V 6F module. In addition, we manufacture 350F D-cell ultracapacitors that a number of integrators use to manufacture other unique modules for wind customers.

### WHAT ARE THE APPLICATIONS FOR THESE PRODUCTS?

They are used as the back-up power source in pitch control systems for

For the complete Q&A with Chuck Cook,  
visit [windsystemsmag.com](http://windsystemsmag.com).



For more information about Maxwell Technologies' wind energy ultracapacitors, visit [www.maxwell.com](http://www.maxwell.com).