

 TALKING POINT

The key to reliable emergency backup power for wind pitch control

Words: Jeff Venegas, Sr. Manager, Technical Product Marketing and Business Development, Wind, Maxwell Technologies, Inc.

As renewable energy adoption grows worldwide, major utilities increasingly rely on wind power to serve homes and businesses with emission-free, clean electricity. Because of this growing interest in cleaner energy sources, the wind industry is experiencing a period of significant growth worldwide, exceeding 500 gigawatts and employing more than 1.2 million people.



This growth has increased focus on issues like the equipment's sensitivity to extreme environmental factors, subsequent power interruptions and revenue loss, increased maintenance, and maintenance-related safety risks.

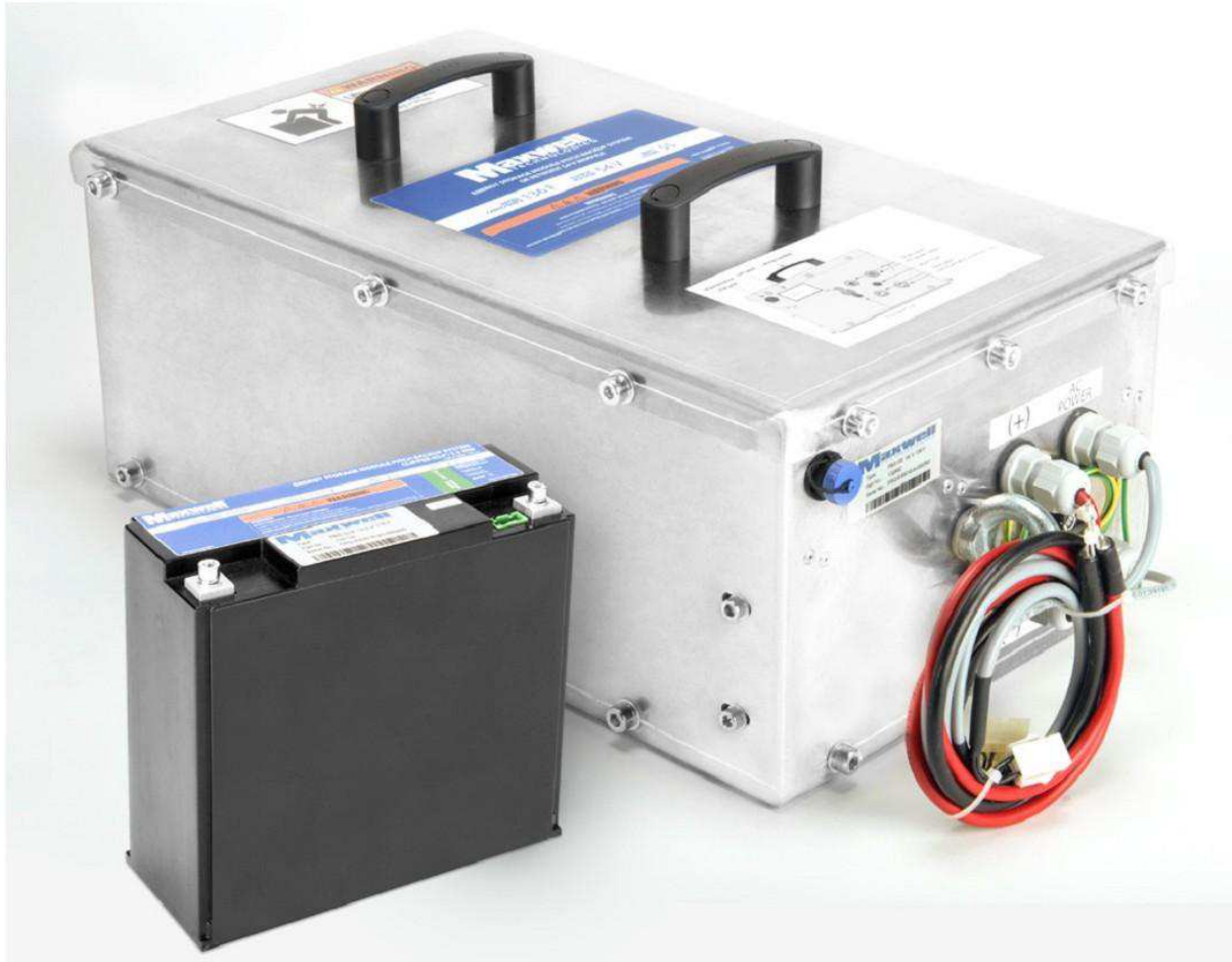
To keep up with this growing demand, operators must continue to stay ahead of potential challenges. Like all power sources, wind turbines are vulnerable to harsh weather conditions and require fail-safe operating systems such as emergency pitch units, commonly referred to as EPUs, which help safely halt turbine operation. As a result, turbine operators and owners are increasingly depending on electrical-based pitch control systems to perform this function.

Traditional EPU (emergency power unit)

In periods of total power failure, the EPU is

to return the blades to a safe position and allow the turbine to shut down effectively. These systems have typically relied on batteries to perform this function. Because of batteries' electrochemical nature, they are prone to faster deterioration, resulting in eventual failure in extremely hot or cold temperatures necessitating wind farm operators to replace them every two to four years. The result of this maintenance requirement is ultimately lost revenue to the wind farm operators.

When batteries fail, low-voltage alarms are sent to the wind farm control center where operators can view battery faults on a monitoring system. These periods of downtime are harmful to the wind farm's production and, in turn, revenue generation. All components in a wind turbine must work reliably to maximize energy generation and profit. Wind farm



retrofit solution that seamlessly upgrades their battery-based EPUs, eliminating the need for frequent battery and/or charger replacements and minimizing the high maintenance costs and revenue losses that batteries inflict on their operations.

Safety challenges associated with batteries

With wind turbine heights as high as 300 feet, the fewer times technicians need to climb the turbine, the better. That's why replacing batteries is a significant pain point for wind farms. In some cases, the battery failure also affects the battery charger in the circuit, which then also needs to be replaced. When a battery

for extended periods.

Ultracapacitors have several advantages to support a wind turbine's pitch control system. Most importantly, they generally maintain a high degree of operability in extreme conditions, which improves turbine operations and safety. Installing reliable energy storage and power delivery solutions like ultracapacitors can also help minimize risk and improve safety conditions for technicians, by reducing the number of times they need to climb the turbines.

As an alternative energy storage device to batteries, ultracapacitors typically offer a longer lifetime, performing for hundreds

in conditions from -40°C to $+65^{\circ}\text{C}$.

These features make ultracapacitors a durable energy storage alternative to batteries, requiring little to no maintenance. Additionally, they can deliver quick bursts of power in short timeframes. When power is lost or high winds threaten turbine safety, ultracapacitors provide the power that is needed to bring the blades back to a safe position, protecting the turbine from detrimental wind force.

Easy-to-install ultracapacitor-based retrofit solution

Almost half of all turbine OEMs are already building new turbines with ultracapacitor-

needs to be replaced. When a battery fault occurs, at least two technicians are required to assist in the replacement process. It can take several hours to complete this work, which monopolizes technicians' time and keeps them at risk

longer lifetime, performing for hundreds of thousands of cycles compared to batteries' only hundreds of cycles. They are also electrostatic, which makes them particularly resilient in extreme temperatures enabling them to perform

based EPU systems to ensure ideal turbine uptime and safety conditions, and existing turbines can also benefit from this technology.

For wind turbine owners/operators, the

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'Wind farm owners and operators need to consider cost-effective, reliable ultracapacitor-based emergency wind pitch control systems.'

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Jeff joined Maxwell in 2012 as a Senior Product Manager of Module Products responsible for the product management of all Maxwell module products.

In 2016, Jeff assumed the technical product marketing and business development role specific to all wind related products. Jeff is the wind subject matter expert as it relates to Maxwell's ultracapacitor module products.

Jeff has over 17 years of product management and development experience with products such as mobile telephones, consumer audio products, and different types of modules and packages.

Prior to joining Maxwell, Jeff had key technical roles at Altec Lansing, Huawei and Kyocera among others.

Jeff obtained his BSEE from California Polytechnic State University, San Luis Obispo with a concentration in power systems.

Maxwell Technologies, Inc.

Founded: 1965

switch to an ultracapacitor-based emergency pitch control system is generally not difficult. Ultracapacitor-based retrofit modules make it easy to replace a battery-based emergency pitch control system for reliable and fail-safe pitch system performance.

There is no specialized training needed to install these solutions. These retrofit modules replace fielded batteries and are

In comparison, in Clipper 2.5 MW turbines, the ultracapacitor is a direct drop-in replacement for batteries. Eighteen ultracapacitor modules replace the eighteen batteries for each turbine blade.

The future of wind turbines

As countries around the world continue to adopt renewable resources and wind power grows, wind farm owners and

modules replace fielded batteries and are designed to fit seamlessly into the turbine's existing EPU. Typically, they can be installed in less than a few hours.

There are specific retrofit solutions for different wind turbine models. For example, in GE 1.5 megawatt (MW) turbines, there is one ultracapacitor module per turbine blade which replaces the original four batteries and chargers.

operators need to consider cost-effective, reliable ultracapacitor-based emergency wind pitch control systems.

Installing an ultracapacitor-based retrofit can help ensure that turbines consistently produce power, generate revenue and improve safety conditions in their day-to-day operations.

□ www.maxwell.com

Founded: 1969

Headquarters: San Diego, California

CEO: Dr. Franz Fink

Number of employees: 492

Products: Ultracapacitors, high voltage capacitors

NASDAQ: MXWL

48 PES Wind

MAXWELL ULTRACAPACITORS.

RETROFIT SOLUTIONS FOR IMPROVED UPTIME AND RELIABILITY



Retrofit modules designed for the following turbines:

- Clipper 2.5MW (pictured left)
- GE 1.5MW (pictured right)

Introducing ultracapacitor-based solutions for optimal wind turbine performance:

- Enables reliable and fail-safe pitch performance
- Replaces fielded batteries in emergency pitch control systems
- Reduces battery-related service and maintenance costs

- Reduces battery related service and maintenance costs
- Estimated life: Up to 15+ years*
- Easy to install

Learn more at maxwell.com/windretrofit

*Results may vary. Additional terms and conditions, including the limited warranty, apply at the time of purchase. See the warranty details and datasheet for applicable operating and use requirements.

