Maxwell TECHNOLOGIES
Enabling Energy's Future™

CASE STUDY

How Iowa Lakes Electric Cooperative Reduced Pitch Faults and Battery Replacements Using Maxwell Technologies' Retrofit Solution for Emergency Pitch Backup Systems

Iowa Lakes Electric Cooperative (ILEC) runs two wind projects, both rated at 10.5 megawatts. Since the turbines were commissioned in 2009, the wind farms have been a positive force in the local communities by supplying clean power for neighboring ethanol production facilities and providing economic support for landowners who host wind turbines. But running a wind farm is no easy feat. When battery component replacement for the turbines' emergency pitch systems became a more frequent and costly task that required additional climbs per week, ILEC approached Maxwell Technologies to integrate its ultra-capacitor-based retrofit solution for greater reliability and performance in the field.

Pitch faults required ILEC's wind technicians to climb the turbines 2 – 3 times per week to replace batteries and related components sooner than their expected lifetime.

THE CHALLENGE

When wind technicians Zach Herum and Shannon Lehmkuhl monitor ILEC's wind turbines from headquarters and see a pitch fault appear on their SCADA system, it's the beginning of what could potentially become an entire day's work of troubleshooting the cause.

A turbine's emergency pitch control system rotates the blades to a safe position during a power failure or high wind speeds to protect the turbine from damage. Battery-related pitch faults coming from the systems were so common that Herum and Lehmkuhl climbed the turbines two to three times per week to investigate and fix the root causes of the faults. The work related to pitch faults alone consumed a large part of ILEC's maintenance program, and at least once every other week an issue with a pitch system's battery caused a turbine to completely shut down.

"The batteries are the root issue here," says Al Zeitz, ILEC's manager of renewable energy services. "A lot of the challenges that we have with these battery pitch systems is that there are a lot of associated faults with the components related to the batteries."

Replacing batteries and charge cards took a toll on ILEC's components budget, not to mention the lost production due to downtime. In addition to recurring pitch faults, Zeitz says pitch system batteries fail long before their expected lifetime, and they tend to fail more frequently in cold weather. "So it's a double whammy," says Zeitz. "The batteries just don't last as long as they were expected to last."

Two years ago, ILEC completed a full battery replacement for the farm's 14 turbines. "After we went through and replaced all of those batteries, we still had some fail within a year after replacing them," says Zeitz.

"It's just a pain it happens so often," says Herum, referring to all the battery system issues. Then he adds, "And it usually happens at 5 o'clock on a Friday."

Zeitz remembers, "We were having a conversation about the issue and wondered 'is there a better solution?'"

THE SOLUTION

Herum learned of Maxwell Technologies' ultracapacitor-based emergency pitch retrofit solution from a friend who also works as a wind technician. Maxwell's solution, an alternative to traditional lead-acid batteries, uses high-power ultracapacitor technology designed specifically to address the common challenges that wind farm operators face in the field. Herum took the recommendation to Zeitz, who did more research on the solution.

Straightforward install for fielded pitch systems

Maxwell Technologies' retrofit solution for GE 1.5 megawatt turbines consists of three drop-in ultracapacitor modules per turbine (one module per blade). Each ultracapacitor module replaces the pitch system's four batteries and four chargers per blade. During the retrofit module installation, battery chargers are disconnected; the ultracapacitor retrofit modules are designed with built-in chargers and communication interface for seamless integration with the emergency pitch unit's existing communication system.

Fast-responding, high-power performance

Maxwell's ultracapacitor-based retrofit solution specializes in delivering short-term, high-burst power, a perfect fit for the needs of an emergency pitch backup system that requires quick power to pitch the blades to a safe position during a power loss or excessive wind speeds. Maxwell's solution performs the same emergency pitch function as the original battery system but provides significantly more reliable ultracapacitor energy storage technology.

Long life, rugged and reliable

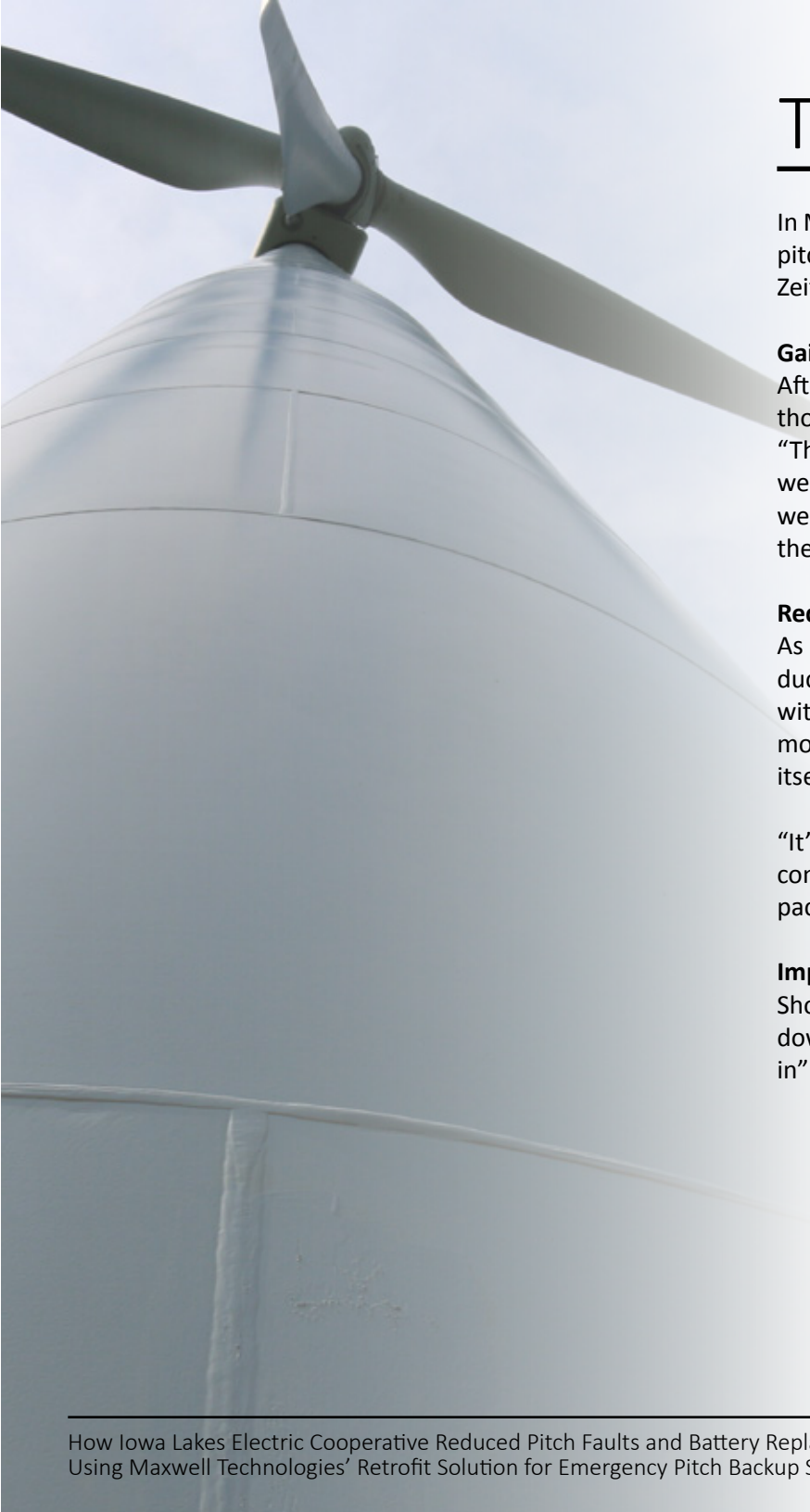
Battery lead-acid chemistry is susceptible to faster degradation over time. Maxwell's ultracapacitors store charge electrostatically and are significantly more resilient under varying ambient temperature conditions, performing reliably from –40°C to 65°C with an average lifespan of 15+ years dependent on use. The unique properties of Maxwell's ultracapacitor cell design results in a retrofit solution that requires minimal maintenance and outperforms batteries in a turbine's remote and highly demanding environment.

Considering the hundreds of dollars in expenditures for batteries, chargers and related components, plus the extra turbine climbs and maintenance hours to address battery system problems, Zeitz felt confident that Maxwell's solution would save him and his team valuable time and budget dollars.

"It didn't take me long to realize this was a no-brainer and that we needed to go forward with Maxwell Technologies' ultracapacitor retrofit solution," says Zeitz.

> **"We replaced batteries quite often throughout the year. That's why we installed Maxwell's retrofit units. They're going to save us a lot of money just in parts, not even counting the labor involved and the lost production in the wind turbines. It's big."**

Al Zeitz, Manager of Renewable Energy Services
Iowa Lakes Electric Cooperative



THE RESULT

In March 2017, Herum and Lehmkuhl climbed two of ILEC's GE 1.5 megawatt turbines to remove the pitch system batteries and install Maxwell's ultracapacitor-based retrofit solution. Four months later, Zeitz was impressed with the results.

Gained back a significant portion of maintenance program hours

After installing Maxwell's retrofit solution, the number of pitch faults fell to an astounding zero. "On those two turbines we haven't had to climb for anything related to batteries or pitch," says Zeitz. "The end result of Maxwell's retrofit solution was no more pitch faults." Herum adds, "And those were the two turbines that we had the most problems with." Thanks to the dependability of Maxwell's ultracapacitor technology, the ILEC team gained back valuable time and significantly reduced the number of maintenance hours spent on the retrofitted turbines.

Reduced spending on component replacements

As mentioned previously, ILEC's expenditures on batteries, charge cards, downtime and loss of production in one year was a considerable amount for its 14 wind turbines. Retrofitting two turbines with Maxwell's streamlined solution eliminated 48 pieces of battery/charger equipment—the common culprits for costly, time-consuming pitch faults. Zeitz says that Maxwell's retrofit solution paid itself back in no time.

"It's pretty easy to justify the cost of installing the ultracapacitor retrofit," says Zeitz. "And when we considered it we were looking at three battery replacements over the estimated life of the ultracapacitor unit. Just that alone was enough to say 'let's do this.'"

Improved system performance and reliability

Shortly after the retrofit was installed, the ILEC wind farm experienced a grid power failure that shut down the whole site. Lehmkuhl says that Maxwell's ultracapacitor retrofit modules "instantly kicked in" to feather the blades back to a safe position when the power loss happened.

THE RESULT *(continued)*

"The ultracapacitor units operated just the way they were supposed to," says Herum. "They provide emergency power to pull the blades back to 85 degrees to slow the rotor down and stop it."

In addition to effectively feathering the blades after the power loss, Maxwell's ultracapacitor-based retrofit had no pitch faults during the reboot and contributed to a streamlined process for getting the turbines back online. Zeitz says that the retrofit's seamless performance during the power outage is "proof that the Maxwell system is working."

Increased turbine uptime

When an ILEC turbine went offline because of a pitch fault, it could remain idle for an extended period of time, resulting in hundreds of dollars in lost revenue. Maxwell's solution eliminated battery-related pitch faults in the retrofitted turbines and has helped keep them online, increasing uptime and production hours. With plans to retrofit the remaining turbines for maximum efficiency, Zeitz expects Maxwell's solution will contribute to higher turbine availability which could increase production each year.

Improved safety for wind technicians

As a result of eliminating the climbs related to battery system failures, Maxwell's retrofit solution reduced the number of times the technicians are exposed to safety risks inherent in climbing turbines. Additional safety advantages: Unlike batteries, which store energy electrochemically and are kept fully charged while in storage, Maxwell's ultracapacitors store charge electrostatically and can be fully discharged for transport. The retrofit solution does not require changes to lockout/tagout procedures.

Zeitz summed up his satisfaction with the new solution. "Maxwell's ultracapacitor retrofit solution more than paid for itself. We're going to save time because we don't have to climb turbines for battery-related pitch faults. We're saving money because we're not replacing as many components as in the past. And we're not losing production because a turbine is standing idle waiting for us to get out there and fix it. I would absolutely recommend Maxwell's emergency pitch retrofit to other turbine operators."


“It’s a great, simple install.”
Shannon Lehmkuhl, Wind Technician

> **“Maxwell Technologies delivered what we were promised.”**
>
> Zach Herum, Wind Technician

> **“I’ve worked with a lot of different people over the last 20 some years, and working with Maxwell has been a very positive experience. They listen. Maxwell’s ultracapacitor pitch backup system retrofit is an awesome product. We look forward to continuing to work with them.”**

Al Zeitz, Manager of Renewable Energy Services

Are you ready for next-level emergency pitch backup systems performance?

Maxwell Technologies works with wind farm project owners and operators to enhance the performance and reliability of emergency pitch backup systems. Today, more than 54,000 wind turbines worldwide operate with Maxwell's proprietary ultracapacitor energy storage technology. We're proud to support the growing wind industry and look forward to partnering with you to resolve common operation and maintenance challenges related to emergency pitch backup systems.

To begin a conversation, get in touch with us.

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About Maxwell Technologies

For over 50 years, our world-class research and product development teams have established Maxwell Technologies as a global leader in the design and manufacture of energy storage and power delivery solutions for automotive, heavy transportation, renewable energy, backup power, wireless communications and industrial and consumer electronics applications. Today, more than 50 million Maxwell ultracapacitor cells are integrated into systems for a variety of applications, including emergency wind pitch control systems, bridge power, start-stop systems in automotive applications, regenerative braking systems for railways, and grid firming. Our goal is to build long-term customer relationships by listening, understanding customer-specific requirements and exceeding expectations for value and performance.

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