



KEEPING RENEWABLES RUNNING SMOOTHLY

BLADEcontrol with web-based visualization from Weidmuller provides an intelligent solution for blade condition monitoring. (Courtesy: Weidmuller)

The development of innovative technology will help ensure wind and solar energy operates efficiently and economically as their need continues to grow globally.

By PETE TECOS

Wind-farm operators know that the bolted connections between the hub and rotor blade of a wind turbine are constantly subjected to dynamic loads, leading to stud and bolt failures. To help prevent the possibility of failure, technology is needed to detect broken bolts or studs in the blade root. This system should be able to prevent fractured components from falling into the hub, thereby avoiding costly damages to pitch systems and other critical components.

Broken bolts can be held securely in place with detection plates, preventing consequential damage that would result if the pieces fell into the hub and ricocheted as it rotated. By continuously monitoring the rotor blade bolts, downtime is minimized, while repair costs are reduced, ensuring the safe uninterrupted operation of the turbine.

This type of system has the potential to bring many benefits, including:

- ✔ **Prevention of damage:** Broken bolts are held securely in place to avoid damage to the hub and components.

- ✔ **Ensures continued operation:** Safety at the turbine site is improved, while reducing the number of climbs needed for repairs.

- ✔ **Safe and economical:** Downtime is reduced and O&M costs are more easily controlled when the blade bolts are continuously monitored.

- ✔ **Quick and easy to retrofit:** Must be adaptable and have the ability to be customized to different turbine types.

BLADE CONDITION MONITORING

Along with the need to monitor the condition of a turbine's bolts, it is also paramount to introduce an intelligent solution for blade condition monitoring as well.

A logical solution would measure the vibration response inside the blade to detect structural-related issues such as cracks, delamination, debonding, blade bearing damage and blade-tip damage caused by such factors as lightning strikes or ice accumulation. Wind turbine performance can also be optimized through detection and aerodynamic imbalances.

Additionally, wind-park managers could unlock turbine insights using a web-based visualization and analysis suite. To make such analysis as user friendly as possible, this software should be able to highlight single turbine and fleet-wide diagnostics to help identify anomalous behavior, minimize unplanned downtime, and maximize productivity. Advantages would include increased turbine availability, extended service life of the rotor blades, reduced downtime, ability to plan repairs, optimum turbine efficiency, and a measurable increase in revenue.

Advantages of such a system should include:

- ✔ Ice detection in the millimeter range during operation and standstill.

- ✔ Automatic stop in case of ice accumulation.

- ✔ Automatic re-start when blades are ice-free per threshold definition.

- ✔ Yield maximization through less downtime.

- ✔ Installation in any type of wind turbine.

- ✔ Optimization of rotor blade heating systems.

- ✔ Support from knowledgeable specialists.

- ✔ Icing status, data visualization in graphic user interface.

- ✔ Should be tested and certified.

SOLAR ENERGY SOLUTIONS

Other renewables, such as solar energy, also need innovative approaches to make the process more efficient and economical.

For example, with solar power, monitored and unmonitored combiner box technology that can provide reliable power distribution is needed along with real-time string monitoring. This advanced feature will allow operators to pinpoint potential revenue losses by detecting performance issues or defects that, if undetected, could lead to low output, overheating, increased costs, and unplanned downtime.

Why is string monitoring important? When it comes to monitoring utility scale photovoltaic arrays, the U.S. has lagged behind other countries as it was deemed too expensive to routinely incorporate the string monitoring process. However, PV system integrators are well aware that a blown fuse negates the output of an entire string. Without monitoring, finding a blown fuse requires manual inspection at each combiner box and could go undetected for months. This results in output losses, higher maintenance costs, and diminished ROI.

Advantages of monitored or unmonitored combiner boxes should include:

- ✔ **Optimized design:** Product variants should operate at the maximum mechanical and thermal efficiency in the most compact housing site.

- ✔ **All technical data is available online:** User-friendly web tools should support any selected model for the best application.

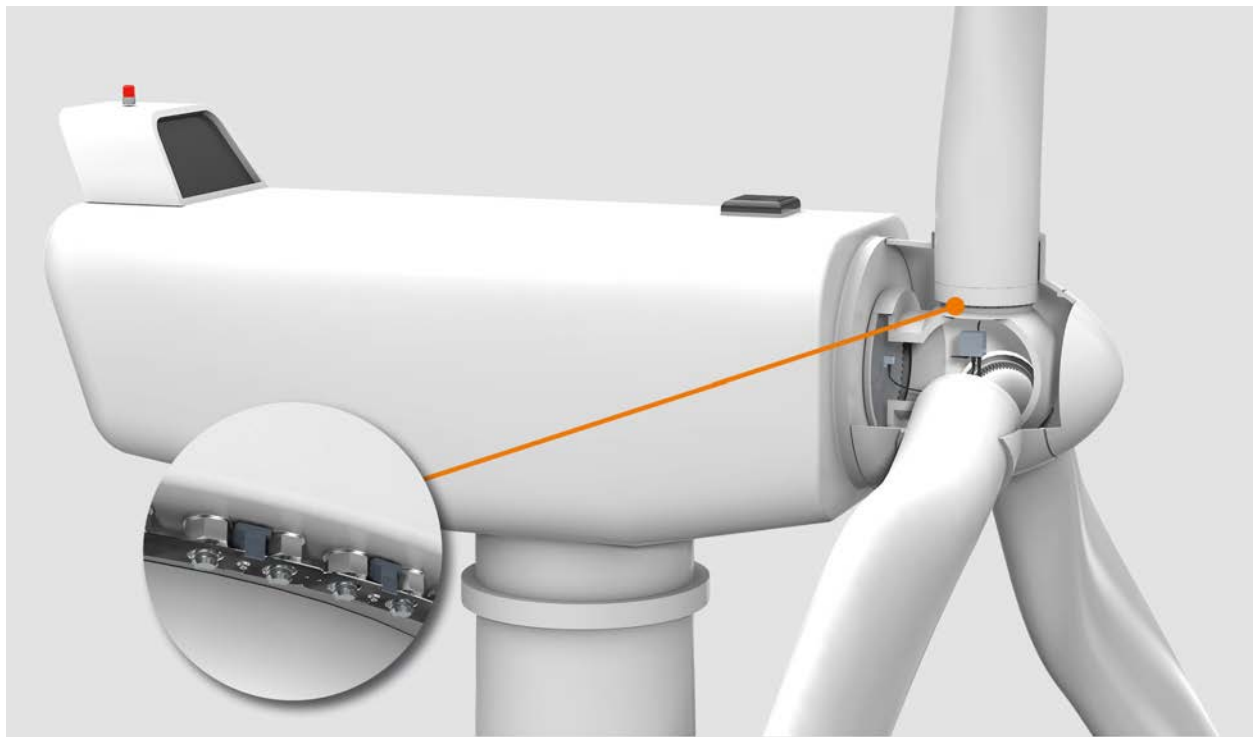
- ✔ **Cost-optimized variants:** Cost-optimized models with special accessories should be designed to cover the most common applications in PV power plants.

- ✔ **Longer lifetime:** Design should allow for longer lifetime and higher performance under extreme climate conditions.

- ✔ **Better LCDE and ROI:** Should be able to greatly simplify product due-diligence and insurance contracts while increasing the value of the asset in case it is sold in the future.

COMBINER BOXES FOR HIGH POWER PANELS

To allow solar energy to be collected on the back of the



Weidmuller's BOLTcontrol blade monitoring system detects broken bolts or studs in the blade root that connects to the hub and alerts operators immediately. (Courtesy: Weidmuller)

panel and increase the energy yield of the solar energy system, combiner boxes for high power panels should feature bifacial solar panels with solar cells on both the front and back of the panel. Using four combination boxes for bifacial half-cell modules also can allow for a higher current consumption due to the fuse holders used. These combiner boxes should be compact and durable solutions for bifacial half-cell modules.

Advantages for combiner boxes for high power panels should include:

- Easy available standard options:** Combiner boxes for high power panels should fit into the installation concepts of many brands of PV modules.

- Overvoltage protection:** Several configurations of surge protection should be possible.

- Optimized design:** Product variants should operate with maximum mechanical and thermal efficiency in the most compact enclosure possible.

- Special fuse protection:** This new technology should include specially developed fuses and fuse holders.

WEIDMULLER USA SOLUTIONS

For the wind industry, Weidmuller USA has recently released its innovative BOLTcontrol root connection monitoring system to complement its Blade Monitoring CMS with web-based visualization features that both address the necessity of monitoring any potential damage from broken bolts and structural-related issues in the turbine blades to aerodynam-

ic imbalances that decrease overall turbine yield.

For solar energy, Weidmuller has introduced its PV DC combiner boxes that are assembled in its Richmond, Virginia, headquarters and feature a five-year warranty. The PV DC combiner boxes are available in monitored and unmonitored versions. Those with monitoring can receive up to 16 inputs and the unmonitored version can handle up to 32 inputs.

Weidmuller USA is proud to celebrate its 50th anniversary in 2025, marking five decades as a pioneer of innovation in smart industrial connectivity and automation products and solutions. The company will be exhibiting at CLEANPOWER 2025 in Phoenix, Arizona, May 19-22, at Booth 1763. Weidmuller will showcase some of its innovative clean energy solutions with a focus on the wind and solar industries. ↗

ABOUT THE AUTHOR

Pete Tecos is the director of New Energy Solutions for Weidmuller USA, where his passion for clean energy is a core driver for the development of a solution portfolio focused on helping customers accelerate the energy transition. Over the past four years, he has tripled Weidmuller sales to GE Vernova globally, and is leading Weidmuller's initiative into the fast-growing PV segment with combiner boxes and string monitoring. Throughout his 30-plus year career, Tecos has held a variety of executive-level roles with leading companies in the industrial automation space. Tecos has worked in multiple industries including automotive, aerospace and defense, and energy. For more information, go to www.weidmuller.com/en.