The sound of integrity

Spotting the onset of damage to turbine blades quickly allows for fast decision-making in a wind farm's maintenance planning efforts. Using sensor technology to remotely monitor turbines can help avoid severe damage and reduce the need for turbine shutdowns that pause energy production and revenue generation. Having heard about a new solution from MISTRAS Group, PES spoke with Obdulia Ley, Technical Support Manager and Subject Matter Expert, Acoustic Emission and a Sensoria™ expert, to learn more about this innovative new wind blade monitor.

PES: Hi Obdulia, it's great to welcome you to PES Wind and to get to know a little bit more about MISTRAS Group. It would be good to focus on your new solution, Sensoria™, as this is relevant for our readers, isn't it?

Obdulia Ley: It's a pleasure to be here. As you know, MISTRAS Group is one of the world's largest suppliers of integrity and inspection services, specialising in providing asset integrity solutions. These include asset monitoring, engineering services, advanced and conventional non-destructive testing (NDT).

Obdulia Ley

Our Sensoria™ 24/7/365 wind blade monitor is particularly relevant for PES readers, as it helps to redefine the wind blade integrity management process. Anyone involved with wind turbine blade operations, from technicians and site managers to fleet engineers, can benefit from the edge-to-edge intelligence this new technology provides.

Essentially, it is a remote rotor blade monitor that detects and reports blade damage in real-time, including cracks, lightning strikes, skin ruptures and perforations, delaminations, and more. The blade integrity data that it detects is visualized on a web-based data portal, enabling operators to review integrity data at any time, from anywhere.

The technology can estimate the state of blade integrity using a proprietary quantity called Probability of Damage Activity (PDA). This allows operators to keep track of how blade health evolves over time, helping them make more informed decisions on inspection and maintenance planning, by effectively targeting blades that have been damaged or are displaying deteriorating trends.

PES: Can you talk us through the thinking behind the technology? How does it work?

OL: Blade monitoring with Sensoria is based on acoustic emission (AE) technology. MISTRAS Group has a long-standing history in utilizing AE technology and we have earned a reputation for being a leader within the asset protection industry for our use of this non-destructive testing method to find integrity issues on critical assets.

Our technicians install one sensor inside each rotor blade on a wind turbine and we use the data they collect to establish a blade's normal operating background noise. The sensors 'listen' for changes in the background noise over time, which could indicate that damage is present.

After studying composite structures over time, we know how acoustic signatures change when defects are present. We are continuously collecting data and identifying why the acoustic noise of the blade is changing.

PES: Is this technology best suited to large fleets, or can it also be used for wind turbines in small numbers?

OL: Sensoria is designed to monitor turbines at any capacity. We like to think the more the merrier; as the more turbines that are instrumented, the better the database becomes. Though operators may want to initially monitor turbines with a history of known issues, having turbines in better condition being monitored is important for comparison purposes.

The system can be used to monitor a single turbine, with the data used to identify when an inspection should be performed, or in what capacity the wind farm should devote maintenance resources to a particular turbine.

If there are multiple turbines instrumented, the information collected from all of them can be used to prioritize fleet maintenance, and therefore increase fleet-wide efficiencies.

The system can be installed in turbines with defects that should be tracked for safety considerations or in a large fleet and use the information to guide inspection and maintenance resources.

PES: One of the biggest challenges that operators face is in maximising performance of their turbines in a cost effective and sustainable way. Presumably, remote monitoring helps with this?

OL: Remote blade monitoring is transformative in helping to maximize turbine performance in a cost-effective and sustainable way. The AE technology behind

Sensoria's sensors is responsive to acoustic changes and measures active damage growth in between traditionally-scheduled inspections, which typically involve manned or drone inspections anywhere from every six months to three years.

The ability to spot the onset of damages quicker on turbine blades allows decision-making initiatives to happen rapidly and with more accurate data to support inspection and maintenance planning efforts. This avoids the likelihood of damage forming and evolving into severe damage, and greatly reduces the need for turbine shutdowns that pause energy production and revenue generation.

Remote 24/7/365 monitoring results in less downtime and more targeted inspections when they're necessary. Always 'having an eye' on wind turbine blades reinforces the blades' integrity and greatly reduces the occurrence of costly damages that form and fester over time.

PES: Overall, how does this data help improve the integrity of wind blades?

OL: The asset integrity data improves wind blade integrity by keeping operators informed of the true state of blade conditions. If data reported and viewed in the Sensoria Insights web-based portal alerts of worsening blade condition, operators can utilize this to inform their inspection and maintenance process. Rather than allowing damage to grow and not catching it until the next scheduled inspection six months later, operators have data at their fingertips to identify which of their blades have experienced integrity concerns in real-time.

PES: Does having more data readily help predict when maintenance might be needed so it can be planned ahead of time to help with inventory planning, transportation, and so on?

OL: Having not just more data, but transforming data into accurate, actionable information that is on hand and accessible at any time can help to predict when maintenance may be necessary on a blade. The knowledge that is gained at the onset of damage and as it evolves can help the planning stage of maintenance.

Sensoria also helps the entirety of an organization, even in ways you may not expect, like spare blade inventory planning, transportation, and storage. By knowing when a blade has been damaged and identifying immediately if it needs to be taken out of service or replaced, spare parts can be purchased only when necessary, optimizing the spend and resources that need to be allocated towards having excess spare parts, just in case.

This more mindful planning also reduces the transportation and storage of spare parts, which is a demanding process for procurement and logistics teams throughout a wind energy organization.

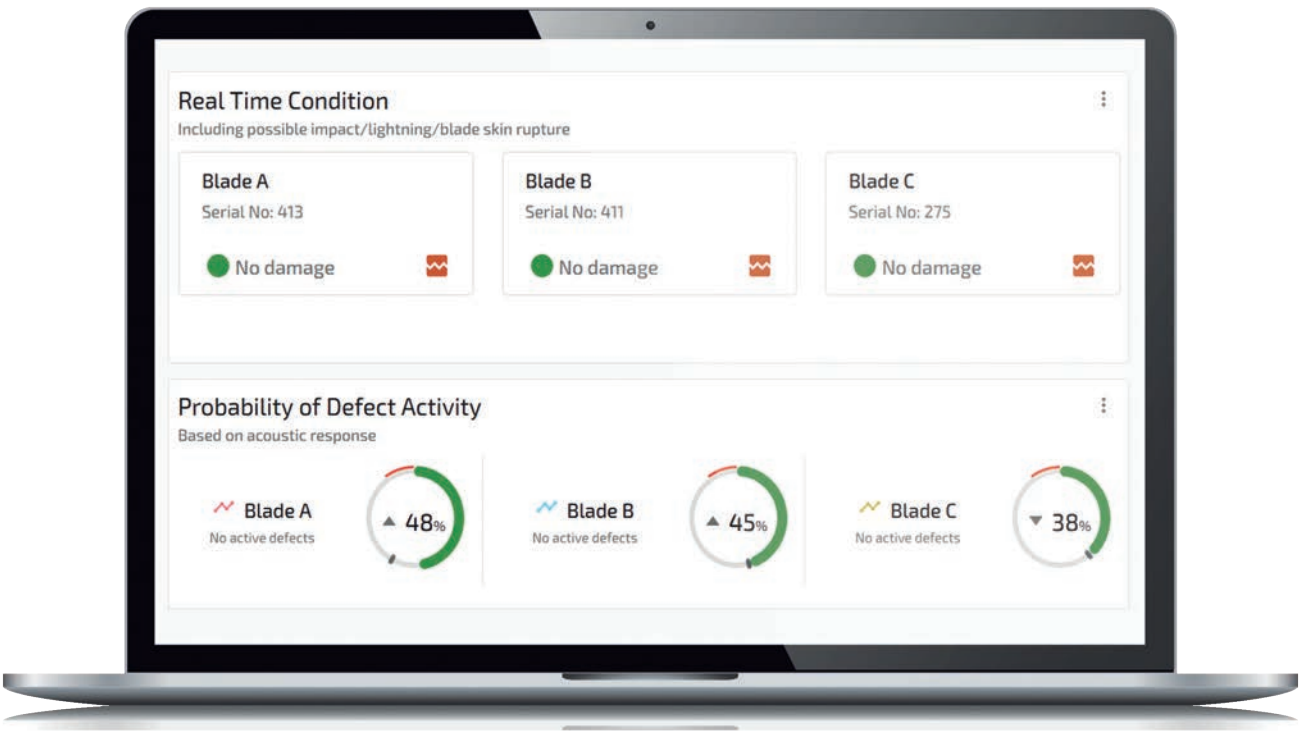
PES: Having to take a turbine out of action for unplanned maintenance must cost money, as well as affect the overall energy capacity?

OL: Taking a turbine out of operation for unplanned maintenance is a costly interruption that negatively affects the Annual Energy Production (AEP). Being able to avoid unplanned outages is a huge benefit for operators that need to meet certain quotas and goals in their operations.

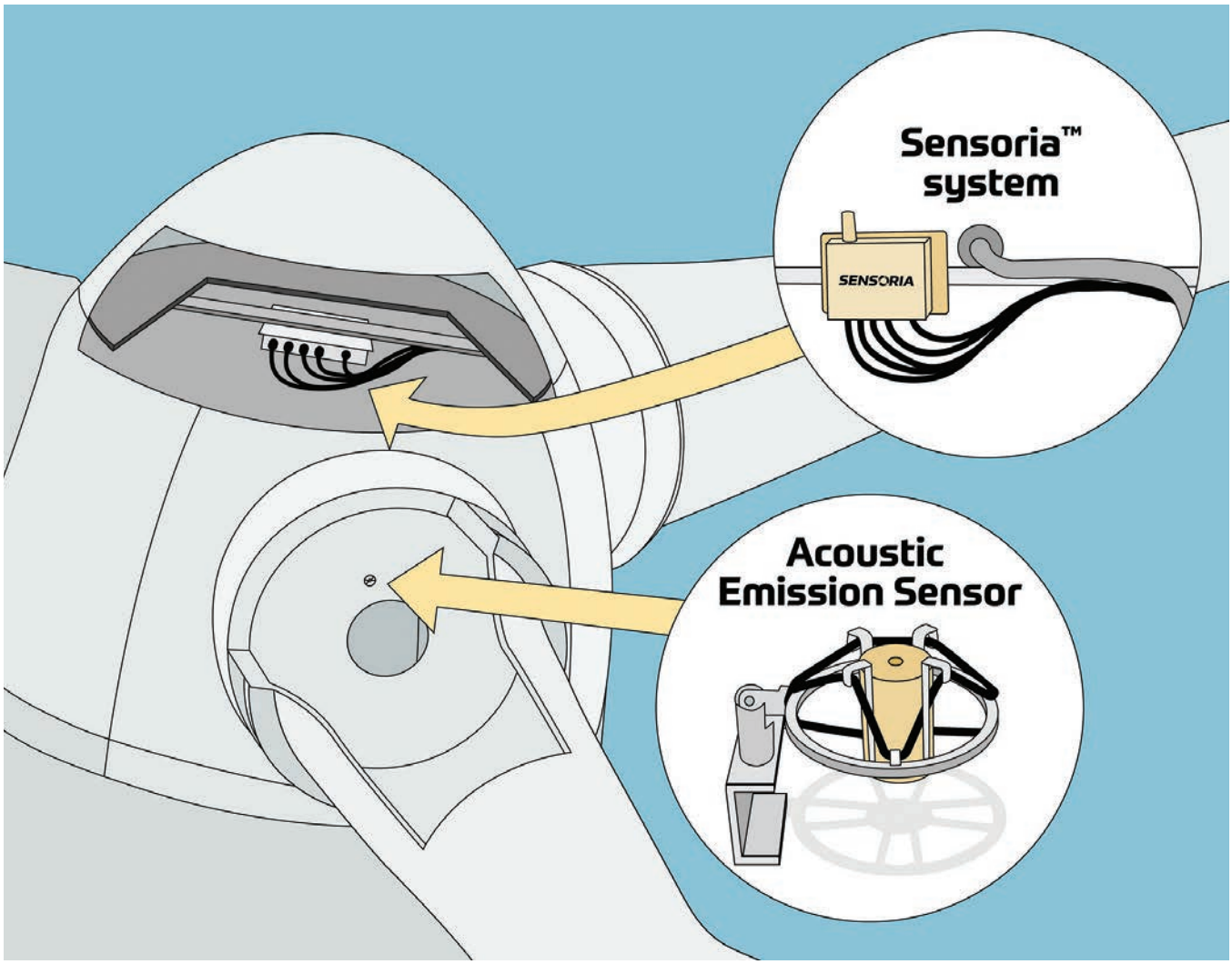
The objective and end goal of monitoring systems like this one is to help asset owners or maintenance providers to better prioritize and get information of damage severity progression between planned inspections. This is very useful if budget constraints limit the extent of the work that can be performed in a season, or planned work cannot be completed during a repair campaign due to weather, for instance.

PES: Do you see this as a way of perhaps replacing the need for in-person inspections entirely, or as back-up to these?

OL: Wind blade monitoring technology is a crucial supplement to manned or drone inspections, not necessarily a replacement. Once the monitor detects potential integrity issues, inspections can be delayed, prioritized, or minimized based on the data visualized. The solution is intended to help reduce expenses, stretch budgets, and



The Sensoria Insights data portal enables operators to prioritize blades for inspection by visualizing blade integrity data and alerting personnel to potential concerns



Permanently-installed sensors in blades reduce the need for in-person inspections by detecting defect activity in real time

ensure the safe operation of turbines through the supplemental monitoring between inspections.

PES: Regarding gathering, analysing and sharing the data, is this a straightforward enough process for turbine operators and fleet engineers?

OL: It is a straightforward process that turbine operators and fleet engineers quickly adapt to and find value in. The reporting process utilizes a data-driven web application where designated personnel can view visualized data on any turbines with sensors installed. This portal allows views of individual turbines or even visualizations across sites and entire fleets. Operators and engineers are also able to look at the same data in real-time.

When blade integrity conditions cross pre-determined damage thresholds, turbine operators and engineers are alerted in real time to access the web-based portal for a closer look on the specific blade and probability of the damage. Though data visualizations can be printed, the portal allows data visualization and analysis to be a seamless, paperless process.

PES: Remote technology such as this is increasingly being used in the industry, but somehow it feels like this is really just the beginning of its capabilities. Would you agree?

OL: We see examples of industries and companies moving towards more digitalized solutions all the time to use data-driven insights to inform their decision-making. A monitoring system like Sensoria that allows the asset owner to see, or in this case, hear, what is happening to asset integrity in an unattended, remote fashion provides big opportunities for wind blade operators to transform their wind blade integrity management processes for the better.

Outside of blades, there are many other wind farm assets that acoustic technology can monitor, such as transformers, offshore monopiles, and turbine hubs, potentially paving the way for even more centralized and integrated integrity management.

PES: How might such technology be developed further and used in the future do you think?

OL: The sky is the limit. Through the creation of a large blade database, we see opportunities to automate processes, reduce costs, and develop predictive analytics that can help evolve and improve the planning aspect of the information that the system is able to provide.

No matter what changes are implemented or the ways in which technology is developed, all advancements for Sensoria and other MISTRAS monitoring systems are founded on maximizing safety and uptime for our customers' critical assets.

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