Moving to predictive blade maintenance

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Tracking blade damage progression to enable predictive maintenance can generate huge savings and increase annual energy production.

It's no secret that wind energy is experiencing enormous, and fast, growth. Irena's Renewable Capacity[1] Statistics 2022 shows that 93 GW of new wind energy generation capacity was added last year alone and the annual installation is anticipated to exceed 120 GW by 2027[2]. The numbers speak for themselves.

While this is positive news for the sector, such growth does make the challenge of cost-effective wind turbine maintenance more crucial than ever. As demand increases, and fleets age, repair requirements and their related costs also grow. A recent report[3] shows that the number of wind turbines reaching 20 years of operation annually, for instance, in Spain and Germany will be around 800 per year in the next decade. With an annual average of 3,800 blade-related failures globally and an increase in unplanned repairs, it's no surprise that repair budgets surge, sometimes doubling from year to year. In fact, onshore wind farm operators spent around $15 billion on operations and maintenance services in 2019[3], a cost that has a huge bearing on the energy price and overall competitiveness of renewable energy.

Finding the balance between repair cost and performance

Not unexpectedly, there is huge pressure to optimise blade O&M and reduce cost. A key element of this is for OEMs, owners and operators to have a good understanding of the blade health of their entire fleets. This includes knowing which damages are present, the effect these damages have on turbine performance, how they develop over time, as well as identifying the failure

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mechanisms of wind turbines. Only then can we predict failure events and find the optimal timing for repairs. With aging turbines, extending the lifetime of blades becomes increasingly important and is one of the best strategies for their continued use after 25 years of service.

Take leading-edge erosion as an example, this type of surface damage increases the drag coefficient, which in turn can lead to a reduction in AEP of up to 5%[4]. Despite this, these damages are often marked with a lower severity, with no immediate action planned. However, sometimes repairing these damages before they reach a high level of severity means that we not only lower the cost of repairs, but we can also

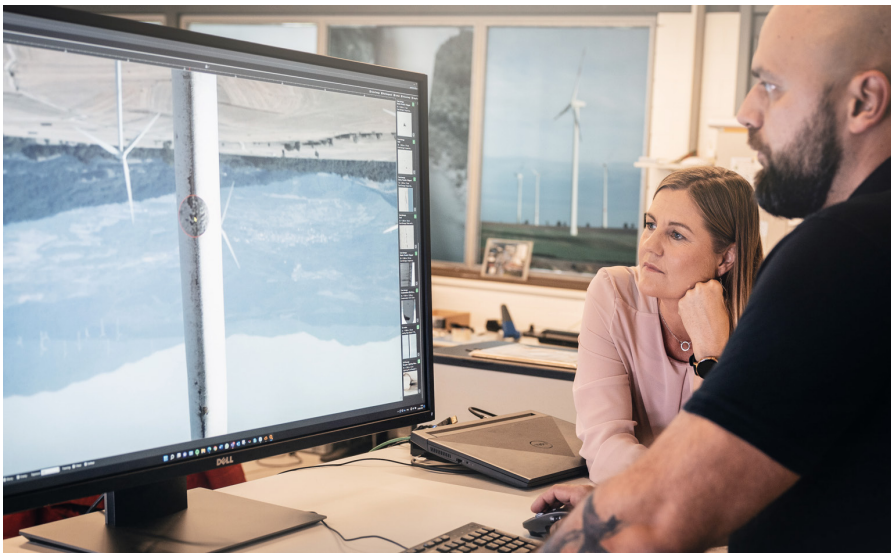
High-quality rotor blade data is obtained with digital inspection methods

restore the turbine AEP and prevent a certain number of rotor blade failures. Conversely, it might be better to wait because history has shown a slow progression.

With costs of $200,000 and more to replace a turbine blade and damage inflicted downtime leading to a daily loss of income up to $1,600 per turbine[4] it's easy to see that finding the right balance between repair costs and aerodynamic performance of your blades is crucial to guarantee the efficiency of your wind farm. But how can this be achieved?

Driven by data

First of all, you have to regularly monitor the condition of your blades. Severe cracks and surface damages, for example, are among the most common reasons for wind turbine failures, both of which can be identified at an early stage with a simple visual inspection.



Leading edge erosion can reduce AEP by up to 5%

The Sulzer Schmid 3DX™ Blade Platform marks the start of a digital journey, providing an overview of the condition of assets. Our end-to-end process employs autonomous drones and incorporates cutting-edge image analysis tools within a browser-based interface, but the platform is open and compatible with many kinds of inspection data. With a flexible, modular, and scalable design, the system can be customised to work seamlessly with a customer's existing processes, facilitating both historical and current data as well as a smooth annotation workflow.

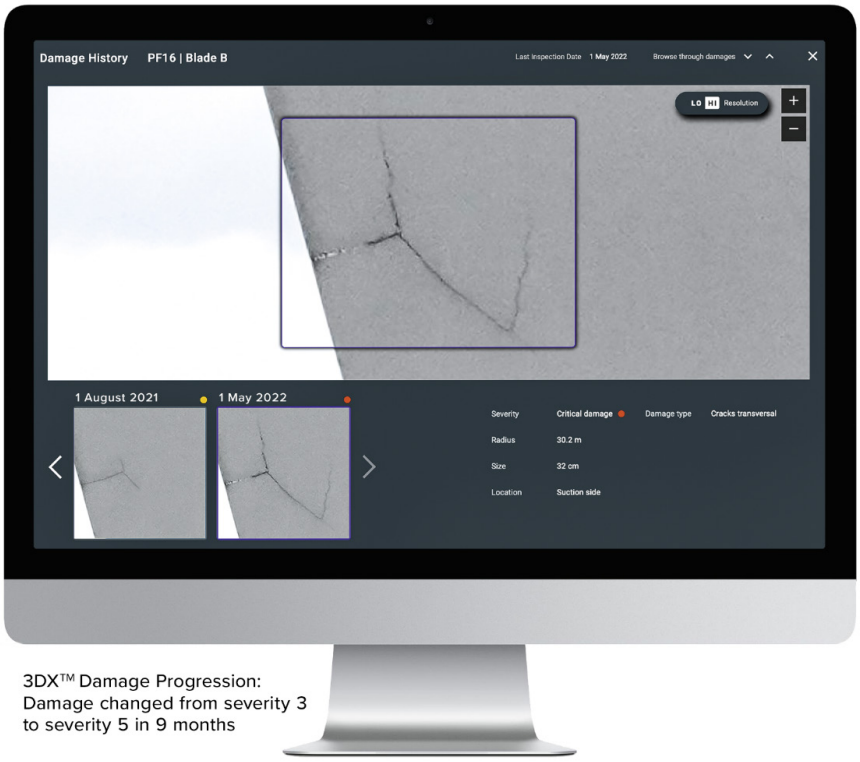
By means of the 3DX™ Data Analytics capability, the inspection data can be 'sliced and diced' in different ways. Dynamic dashboards allow for a quick overview and are a highly effective tool for communicating with customers or own management. Drilldowns enable operational staff to quickly pin-point conditions where action must be taken. For instance, filters can consolidate certain damage types or severities across an entire wind asset portfolio or specific wind farms.

Monitor damage progression

But that's not all. With a new unique damage progression module you can also compare damage data from previous inspections with new data of the same damage in an intuitive way. Thanks to a user-friendly interface, the progression of a damage is displayed in a time series of recorded inspections and can be easily evaluated. OEMs, owners and operators now have the information to optimize repair campaigns and take a significant step closer to predictive maintenance.

The new Damage Progression module has a unique damage ID component. The rich inspection data is used to accurately identify, localise, measure, and classify damages. This means that for each subsequent inspection it is always possible to find the exact location and history of any damage, review, and evaluate its evolution in a so called 'damage chain'.

Knowing how damage develops over time allows blade experts and service planners to better determine which damage needs to be repaired, and when. Having this information at their fingertips, makes the planning of repair campaigns significantly more efficient, saving downtime and optimising blade repair budgets. Being able to compare current inspection data with historical data also facilitates the quality assessment of repairs.



3DX™ Damage Progression: Damage changed from severity 3 to severity 5 in 9 months

Damage is displayed in a time series of recorded inspections and can be easily evaluated more accurately

Laying the foundation for predictive maintenance

The 3DX™ Blade Platform is a powerful asset management platform that enables OEMs, owners and operators to make informed decisions about their assets in a way that fits with their processes, strategy and ambitions.

The platform provides transparency, which allows customers to work more efficiently both within their organization and with partners. The deep link function means that information relating to specific damages can easily be shared, enabling repair companies to provide reliable quotes, and facilitating discussions with customers, certification bodies or any other parties.

Sulzer Schmid is constantly innovating to increase the degree of automation for rotor blade inspections and that's what makes our new Damage Progression module possible in the first place. When inspections are carried out in a routine and automated fashion, the data generated becomes a veritable treasure. As more and more data are collected, we learn how problems develop over time and lay the foundation for predictive maintenance.

Data is captured in a routine and automated fashion, allowing for comprehensive trend analysis and benchmarking over time and across an entire fleet

A future-proof O&M strategy

Finding the optimal balance between repair costs and aerodynamic performance of rotor blades plays crucial role in any O&M strategy and the benefits of investing in a powerful asset management platform are clear. The system provides detailed information on rotor blade condition, delivering lifetime records of rotor blades across entire fleets that allows for comprehensive trend analysis and benchmarking over time. With this information to hand, OEMs can more easily define blade repair work and schedule preventative measures, leading to O&M cost savings and, ultimately, energy production gains.

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1. IRENA (2022), Renewable Energy Statistics 2022, The International Renewable Energy Agency, Abu Dhabi
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3. Root Causes and Mechanisms of Failure of Wind Turbine Blades: Overview, by Leon Mishnaevsky, Jr, 2022
4. A Comprehensive Analysis of Wind Turbine Blade Damage, Dimitris Al. Katsaprakakis, Nikos Papadakis and Ioannis Ntintakis Energies, 2021