Extending turbine lifespan with robotic leading edge repair

The wind energy industry is growing rapidly due to the urgent need to combat climate change and the global shift toward renewable energy, leading to new challenges that demand innovative solutions. One of the most pressing issues is leading edge erosion (LEE) on wind turbine blades, which can significantly reduce efficiency and increase maintenance costs. Addressing this challenge, Aerones has developed robotic technology that revolutionizes turbine maintenance by offering safer, more efficient, and cost effective repairs. This article explores how its solutions, combined with preventive maintenance and data driven insights, are setting new standards for the industry's future.

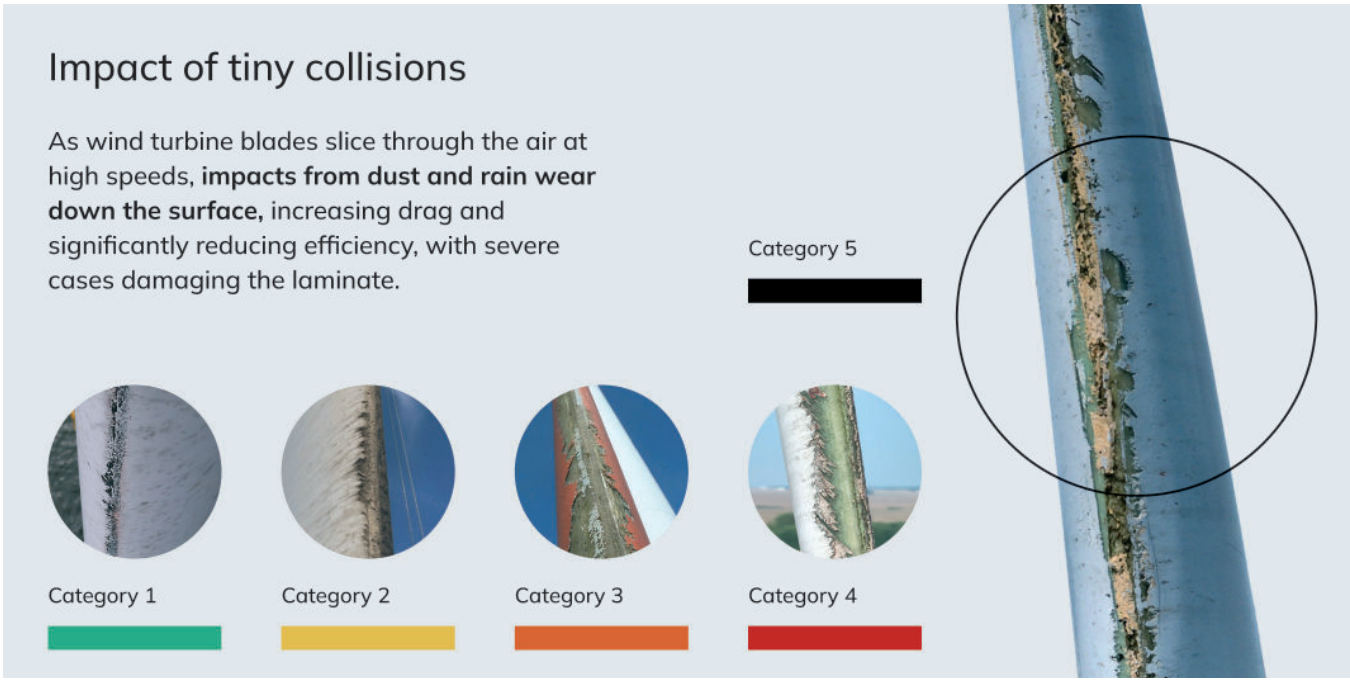
The wind energy industry is experiencing unprecedented growth, driven by the urgent need to address climate change and the global shift towards renewable energy sources. In 2023, the industry saw a record 117 GW of new capacity installed globally, a 50% increase from the previous year. This surge is fueled by increased political ambition, corporate sustainability commitments, and advancements in wind turbine technology.

However, the industry faces several significant challenges. Labor shortages are particularly acute, with high demand for skilled technicians to build, operate, and maintain wind farms. The wind turbine technician role is one of the fastest growing job categories, necessitating a rapid upskilling of the workforce. Additionally, the rising height and complexity of modern turbines add to the operational challenges. Taller turbines require more specialized maintenance, often in harsh and inaccessible environments, which increases the risk and overall costs. Rising labor expenses add to the challenge as turbines become more complex and maintenance tasks more demanding, the cost of hiring skilled technicians increases. This is compounded by logistical challenges, such as the need to transport technicians to remote wind farm locations and the difficulty of performing maintenance at great heights and in adverse weather conditions.

The problem of leading edge erosion

LEE is a critical issue affecting wind turbines worldwide. It occurs when the leading edge of turbine blades is worn down by environmental factors like rain, hail, and sand particles, which significantly reduces aerodynamic efficiency and energy output. The erosion is caused by the constant bombardment of rain droplets and airborne particles, which are more impactful for taller turbines with higher blade tip speeds. This not only impacts the turbine's performance but also increases the risk of more severe damage if not addressed promptly.

Conventional methods for repairing LEE involve manual inspections and repairs, which are both costly and time consuming. Technicians typically must scale the turbines to apply protective coatings or replace damaged sections of the blades. This process is labor intensive and poses significant safety risks, especially given the increasing height of modern turbines. Additionally, the downtime required for these repairs can be substantial, further impacting the economic viability of wind farms.



The Aerones solution

Aerones has developed an innovative solution to address the challenges of LEE through robotic wind turbine leading edge repairs. This technology offers several benefits over traditional methods, primarily by reducing the need for human technicians to perform high risk maintenance tasks.

The robotic system is capable of performing detailed inspections and applying protective coatings or repairs. The robots can operate in various weather conditions and at heights that would be challenging for human technicians. This not only enhances safety but also improves the efficiency and speed of maintenance operations.

The process starts with a visual drone inspection to assess blade erosion. The robot then removes any protective tape, sands, and cleans the blade, applies filler to smooth imperfections, and finally applies a protective coating, ensuring consistent repair quality. Robots can work with a wide variety of LEP materials that can be either sprayed or applied by spatula.

This automated approach ensures consistent quality and reduces the downtime associated with turbine maintenance. Aerones' robots can repair Category 3 erosion on up to one turbine per day.

This solution includes real time data collection and analysis, enabling operators to make informed decisions about maintenance schedules and priorities. The integration of sensors, AI and machine learning technologies allows for predictive maintenance, where potential issues can be identified and addressed before they escalate into major problems. This proactive approach significantly reduces the long term costs and operational risks associated with turbine maintenance.

The importance of preventive maintenance

Shifting from corrective repairs to preventive maintenance is crucial for the wind industry. This focuses on regular inspections and early damage detection, which can prevent severe damage and reduce the overall cost of repairs.

Preventive maintenance programs involve scheduled inspections and minor repairs that ensure turbines operate at peak efficiency. By identifying and addressing minor issues early, operators can prevent the escalation of these problems into major faults that require costly and time consuming repairs. This proactive approach not only extends the lifespan of the turbines but also ensures optimal performance and energy output.

This approach also aligns with the industry's broader goals of reducing operational costs and improving efficiency. By minimizing the need for emergency repairs and reducing turbine downtime, operators can achieve significant cost savings and enhance the reliability of their wind farms. Additionally, regular maintenance helps maintain the structural integrity of the turbines, ensuring they can withstand harsh environmental conditions and continue to generate power effectively.

Data analysis and added value from inspections

Aerones' detailed inspections, combined with data from various sources, provide valuable insights that help wind farm operators make informed, data-driven decisions. By analyzing this data, operators can make informed, data driven decisions to optimize maintenance schedules and improve turbine performance.

Data analysis allows for predictive maintenance, where potential issues can be identified before they occur. This approach uses historical data and advanced analytics to forecast when and where maintenance will be needed, enabling operators to plan more effectively and reduce unexpected downtime.

Aerones' inspections provide detailed, real time data on the condition of each turbine. This information can be integrated with other data sources, such as weather patterns and operational performance metrics and wind turbine model technical specifications, to create a comprehensive view of the wind farm's health. This holistic approach enables operators to optimize their maintenance strategies and ensure the long term success of their operations.

In addition to improving maintenance practices, data analysis can also enhance the overall management of wind farms. By understanding the patterns and trends in turbine performance and degradation, operators can optimize the deployment of resources and make strategic decisions about the expansion and upgrading of their facilities. This data driven approach not only improves the efficiency of existing operations but also supports the sustainable growth of the wind energy sector.

The company offers various reports, analytics and tools for cost/benefit analysis free of charge on its customer platform. Each customer can see wind asset stats, project reports, as well as approve services and review project scope changes. Tools have been developed for calculating AEP losses caused by leading edge erosion, as well as for optimizing service planning.

Summary

The wind energy industry is poised for continued growth, driven by technological advancements and increased political and corporate commitments to clean energy.

Leading edge repair process

1

3M tape removal

2

Sanding

Preparing blade surface for further work by sanding.

3

Cleaning

Surface decontamination after sanding. Removing all excess dust from blade surface for best results.

4

Filler application

Filling in all the surface imperfections and damaged areas.

5

Repeated sanding and cleaning

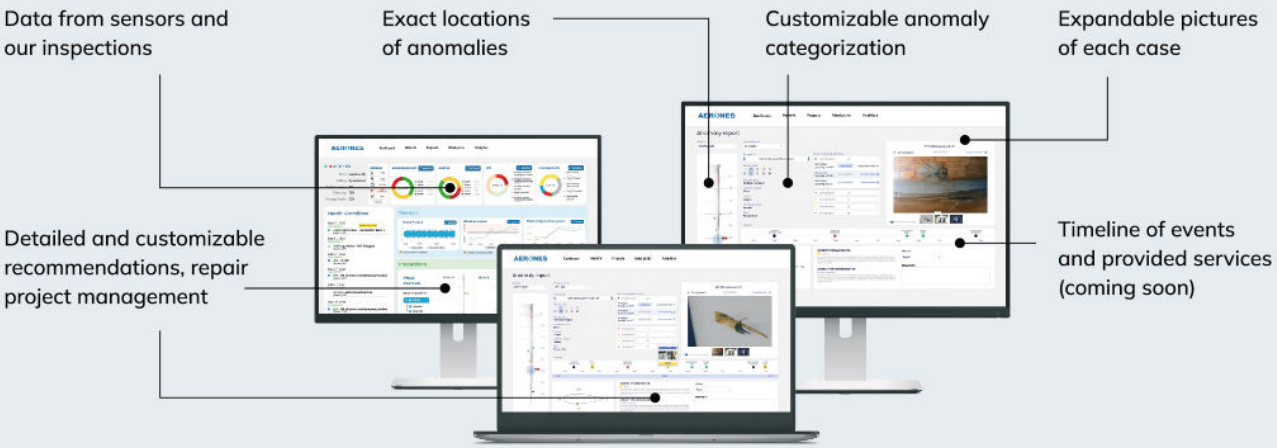
Sanding to remove any surface imperfections and cleaning afterwards to remove all dust.

6

Coating application

Finishing it all off with a fresh new layer of coating.

Aerones customer platform



Explore data on Aerones customer platform. Inspection services for intelligent reporting with damage categorization.

Analyze results from wind turbine visual inspections, lightning protection system tests, ultrasonic scanning, and sensor readings.

Approach maintenance operations smarter with a built-in budgeting tool, calculator, service planning, and tracking.

However, challenges such as labor shortages and rising costs necessitate innovative solutions like Aerones' robotic wind turbine repairs.

Shifting from corrective to preventive maintenance, supported by data analysis, enhances the efficiency, safety, and reliability of wind farms. This proactive approach reduces costs and supports the global growth of sustainable wind energy.

'The Aerones R&D team prioritizes the effectiveness and simplicity of our robots to deliver exceptional solutions to industry challenges, ensuring satisfaction for both our customers and team members,' concludes Dainis Kruze, CEO and Co-founder of Aerones.

Addressing the issue of leading edge erosion through innovative solutions like robotic systems is essential for the future of the wind energy industry. By adopting preventive maintenance strategies and utilizing data driven decision making, operators can ensure the long term success and sustainability of wind farms. As the industry continues to evolve, these advancements will play a crucial role in meeting the growing global demand for clean, renewable energy.

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