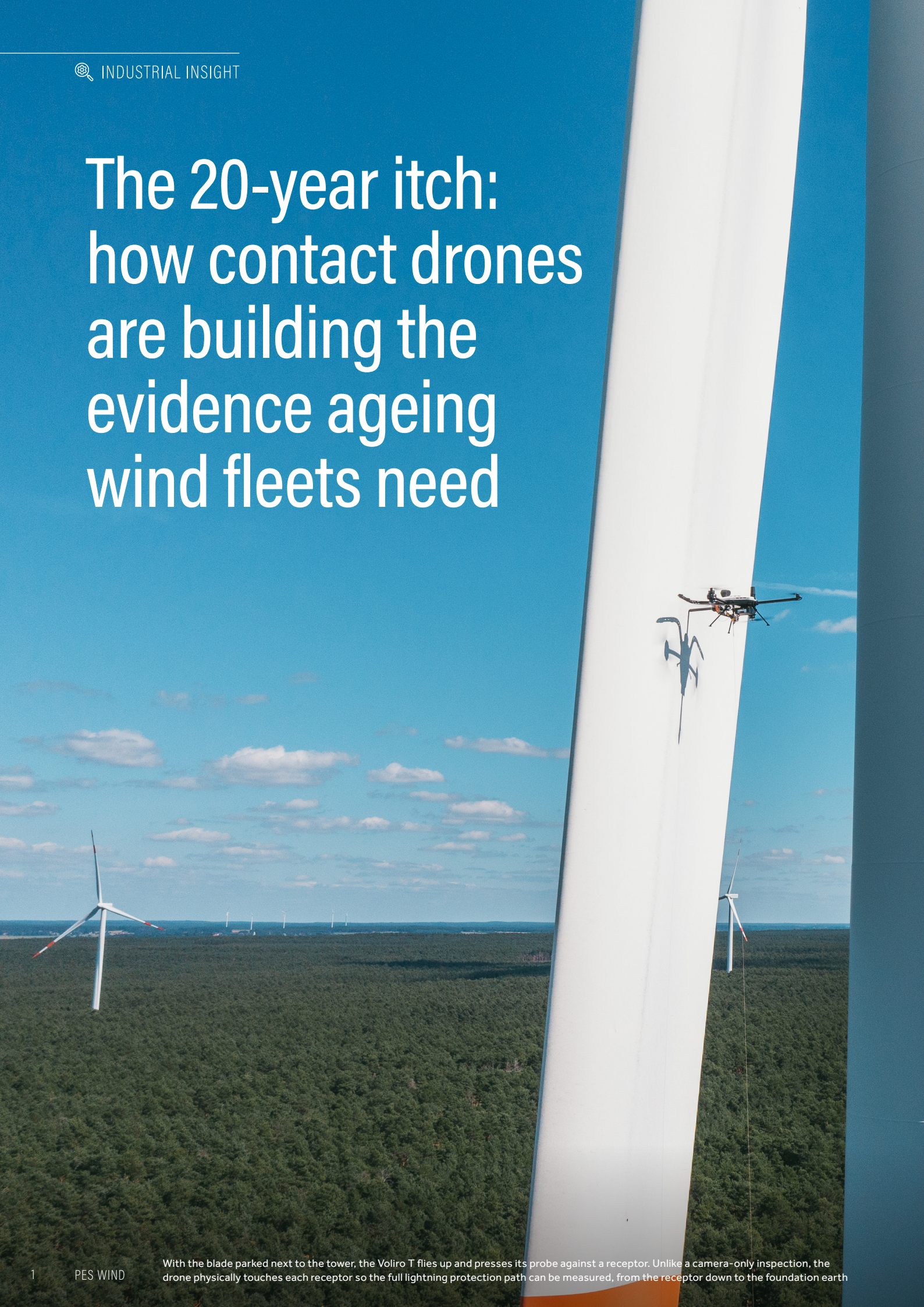
The 20-year itch: how contact drones are building the evidence ageing wind fleets need



With the blade parked next to the tower, the Voliro T flies up and presses its probe against a receptor. Unlike a camera-only inspection, the drone physically touches each receptor so the full lightning protection path can be measured, from the receptor down to the foundation earth



Routine inspections are often bought as a box to tick at the lowest possible price. As wind fleets age and owners face life extension, repowering and budget decisions, the condition data those inspections produce is becoming one of the most valuable and least used assets in the business.

Across Europe and North America, a growing share of the wind fleet is moving into the second half of its design life. According to WindEurope, 34 GW of Europe's wind capacity has already been operating for more than 20 years, and that figure will reach 65 GW by 2030[4]. Germany and Spain alone each have more than 20 GW of capacity older than 15 years[4].

In the United States, a 2026 study by Lawrence Berkeley National Laboratory and the US Geological Survey counted more than 76,000 installed wind turbines, roughly 7,500 of them 20 or more years old[3].

For asset owners, that brings a new set of decisions. Should a turbine be run for longer, repowered or retired? Which components need investment, and which can be left alone? How much should the maintenance budget grow as the fleet ages?

The scale of those decisions is considerable. WindEurope expects 74 GW of European wind farms to need a decision on whether to repower, extend their life or decommission over the next five years. Of the 42 GW reaching 20 years of age by 2030, it expects only 2.5 GW to be repowered and 1.7 GW to be retired.

The remaining 38 GW will continue to operate and will probably be assessed for lifetime extension. Most of Europe's ageing turbines are not going away, and owners will need to know what condition they are in[4].

Each of these decisions depends on knowing the true condition of the asset. Yet much of the information that could support them is collected in a way that treats it as an obligation rather than an asset.

Lightning protection inspection is a clear example. It is required under many safety regimes and carried out routinely across the fleet. It is also, in many organisations, bought largely on price, scheduled to minimise disruption and filed once the report arrives.

The compliance trap

Matthias Pauli, Founder and Managing Director of Deutsche Drohneninspektion, a German inspection specialist that has carried out several hundred lightning protection inspections this year, sees the consequences of that approach first-hand.

'We inspect a lot of turbines and we often find defects,' he says. 'They are not always so serious that a strike would cause major damage, but they are such that damage is possible.'

The inspection itself does not fix anything. Inspectors measure the current condition and make recommendations; the repair decision belongs to the owner. 'We only give recommendations,' says Pauli. 'The actual repair then has to be ensured by the turbine operator.'

This is where the value of an inspection is won or lost. A report that confirms compliance and is then archived has cost money and delivered little. A report that locates faults precisely, can be compared with previous years and feeds directly into maintenance planning is something else: evidence that supports better decisions about the asset.

Why condition evidence matters more as turbines age

The lightning protection system (LPS) shows why evidence quality matters. Most of the system sits inside the blade, out of sight. Receptors capture a strike, down conductors carry the current through the blade, hub, nacelle and tower, and the energy is discharged into the foundation earth. Over time, receptors corrode, connections loosen, conductors break and current transfer elements wear. Little of this is visible from the outside.

The stakes are high. According to DNV, lightning damage is the single largest cause of unplanned downtime in wind turbines and the most common insurance claim filed by wind farm owners[1].

'Current always takes the path of least resistance,' says Pauli. 'We want the lightning to be guided through the turbine and into the foundation, so that no damage occurs.'

For an ageing turbine, the question is not only whether the system once passed, but how it is changing. That depends on what is measured. A partial measurement, or one where sections of the path are bridged, may satisfy a checklist without showing how the complete system would behave during a real strike.

IEC 61400-24, the international standard for lightning protection of wind turbines[1], provides the reference point here. Contact-based inspection drones, such as those developed by Voliro, physically touch each receptor with a probe rather than only capturing images. They



Matthias Pauli

now make it possible to measure the full path from receptor to foundation earth without a technician on the blade.

Some systems use a four-pole measurement, which separates the current and voltage leads so that the resistance of the test leads does not distort the reading.

'We don't manipulate the systems in any way,' says Pauli. 'We don't bridge anything. We can do the complete measurement from the blade tip to the foundation earth, in line with the standard.'

For an owner building a case for life extension, that difference matters. A complete, standards-based measurement is far easier to defend in a technical due diligence review than a partial one.

Data that can be compared

Evidence only becomes intelligence when it can be compared: across turbines, across sites and across years. That requires consistency in how measurements are taken.

Pauli sees repeatability as the foundation of useful data. 'The secret, in the end, is repeatability,' he says. 'When you repeat the same work every day, you get better every day.'

A method applied the same way every time produces results that can be trended. A value that drifts over three inspections tells an owner far more than a single pass or fail.

Location is just as important. When readings are taken across each of the three blades and their receptors, the pattern of results helps narrow down where a fault sits. Sometimes imagery shows directly that a receptor is damaged; in other cases, the readings point to connection points or current collectors.

Turning a measurement into a work order that a repair team can act on depends on inspectors who interpret these patterns consistently.

Changing the cost of knowing

One reason inspections have been kept to a minimum is that they are disruptive. Rope access campaigns are slow, depend heavily on the weather and keep turbines stopped for long periods while technicians work at height. The people needed for that work are also scarce: WindEurope lists blade technicians among the roles with the largest projected skills shortages in the industry to 2030[4].

The challenge is growing with the turbines themselves. The average power rating of new onshore turbines in Europe has doubled since 2016, reaching 5.2 MW in 2025, and turbines ordered last year averaged a record 6.1 MW[4]. Larger machines mean longer blades, more receptors and more work for every inspection.

Remote, contact-based drone methods are changing that equation. Field experience from inspection providers using drone-based LPS measurement shows downtime falling to minutes rather than hours.

On a mid-sized onshore turbine such as the Enercon E-82, a measurement can be completed in under 20 minutes; on larger models such as the E-126, it typically takes 30 to 45 minutes, depending on site access conditions.

When the cost of knowing falls, owners can afford to know more. Inspections can be scheduled more often or across more of the fleet without a significant penalty in availability. Fewer people work at height. More turbines can be covered in a single weather window. The useful comparison for a finance team is no longer the price per inspection, but the total cost of a verified turbine, including lost production, repeat visits and safety exposure.

A growing inspection market

The inspection market is adjusting to this demand. Specialist providers are expanding quickly; Deutsche Drohneninspektion, founded in 2024, expects to complete between 1,000 and 2,000 drone-based LPS inspections in 2027 and plans to expand across Europe.



The Voliro T presses its probe against each lightning receptor on the blade with stable force. Because most of the lightning protection system is enclosed within the blade, an electrical measurement is the only reliable way to verify its condition



A DDI operator monitors the inspection from the ground station. When the same method is used on every turbine, every year, the results can be compared over time and show trends

Contact drone-based operations depend on weather and operator judgement, and both human and technical errors can occur. Pauli says incidents in his own operations have been rare, with no injuries and no damage to turbines, and that carrying redundant equipment avoids repeat site visits. Nor is the equipment inexpensive. Advanced inspection robots require significant investment, which favours providers with the volume to keep them working.

For asset owners, that points to a market likely to consolidate around specialists with deep experience of a single task, rather than generalists offering many services.

Questions for asset owners

For executives reviewing how their fleet is inspected, a few questions help separate compliance from intelligence:

Is the complete path from receptor to foundation earth measured, without bridging?

Is the same method used every year, so that results can be compared over time?

How long is each turbine stopped, and how many turbines can be covered per visit?

Do reports locate faults precisely enough to plan repairs?

Who in the organisation acts on the findings, and how quickly?

A changing industry perspective

The wind industry is moving from reactive maintenance towards proactive asset management. WindEurope notes that most wind farms reaching the end of their support schemes currently opt for some form of lifetime extension rather than repowering[4]. For the 38 GW in Europe expected to keep running beyond 20 years, that means owners will be asked to justify each additional year of operation with evidence.

Insurers are already looking more closely. An analysis of offshore wind insurance claims by NIORD found that blades are a significant and growing share of claims costs, with lightning the largest single cause at 25%, and expects lightning-related damage to accelerate as turbines grow taller and carbon fibre blades become more common[2].

Lightning protection is therefore a good test of whether that evidence exists. It is checked regularly, it is required in many safety regimes, and most of it sits inside the blade, where only a measurement can show its condition.

An owner who has complete, comparable readings for every turbine over several years can make a confident decision on life extension, plan targeted repairs, budget for them and answer an insurer's questions. An owner with a stack of pass certificates cannot.

The time needed to collect that evidence has fallen to minutes per turbine. What remains is the decision to treat it as more than a compliance task.

'Owners extending the life of their turbines are making a bet on what they can't see. Reactive maintenance means waiting for a lightning strike to show you where the system has failed. Proactive maintenance means measuring it every year, the same way every time, so that you know before the strike.

'For an ageing fleet, that is the difference between running a turbine for another ten years with confidence and running it on hope,' says Matthias Pauli, Founder and Managing Director of Deutsche Drohneninspektion.

voliro.com

drohneninspektion.de

Sources

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