

W H I T E P A P E R

Unknown driveline “life” in your portfolio,

here is how to measure it, manage it and price it

Sensing360 GearUp | White Paper for Assets managers

Quantifying gearbox condition through direct measurement replaces assumption-driven valuation with data-backed pricing.

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The Risk currently estimating rather than measuring

Wind asset valuation models contain many assumptions. Most are reasonably well bounded. The planetary gearbox is the exception. It is the component most likely to fail before design life, most expensive to replace when it does, and most opaque in terms of actual remaining life.

Inequality drives wear, and wear feeds inequality, until failure.

This mechanism is not a rare failure mode. It is the fundamental driver of the industry-wide gearbox reliability problem. It runs in your portfolio right now, in assets where no one is measuring it.

The consequence is systematic mispricing, buyers apply blanket discounts to unmonitored assets because condition is unknown. Lenders add margin because the gearbox replacement timeline is uncertain and insurers price against worst-case assumptions. Sellers accept lower valuations, each of these outcomes reflects the same underlying problem: no data.

LumiSens GearUp provides the data.

CDI and LSII: The two metrics that replace assumptions

The CDI (Cumulative Damage Index) answers the question every asset manager needs: how much of this gearbox design life has been consumed, based on what it has actually experienced?

CDI is computed from direct measurements of actual torque and load sharing at the planetary stage, integrated over all operating revolutions per IEC 61400-4 and ANSI/AGMA 6006, using Sensing360's patented extension of Weibull reliability theory. This methodology, validated in collaboration with NREL and Siemens Gamesa, accommodates varying operating conditions through the concept of "used capacity." It is measured from the actual load on the actual components, not SCADA-extrapolated estimates.

CDI replaces conservative engineering opinion with a quantified, auditable figure. A CDI below 100 percent combined with a clean spectral history is the technical basis for a data-backed life extension case. CDI above plan is the early warning that triggers capital provisioning 2-3 years in advance, not as a crisis.

The LSII (Load Sharing Inequality Index) is the leading indicator of vicious cycle progression. When LSII rises above threshold, the smart derate response keeps the turbine generating at around 80 percent of nominal output while buying time for a planned repair. This converts what would be a sudden, total-loss event into a managed, revenue-preserving intervention.

The P-F curve mathematics make the financial stakes concrete. An asset running with undetected LSII of 1.25 is consuming fatigue life at approximately double the design rate, and will harvest only around 50 percent of nominal energy before an unplanned stop. The same asset with LSII detected early and derated to 80 percent returns to the design life consumption rate and harvests around 80 percent of nominal energy in an orderly progression to a planned repair. On a 5 MW turbine over a four-month intervention window, that is EUR 200,000-400,000 in recovered revenue, before counting avoided repair cost differentials.

Three decision moments and how gearUp serves each

Acquisition

Before closing, commission a GearUp pre-acquisition condition assessment. Using available SCADA and maintenance data combined with Sensing360's analytical framework, the assessment produces a CDI estimate, LSII profile, and remaining useful life quantification per planetary stage. Cost: EUR 2,000-4,000 per asset. Turnaround: ten working days. CDI and LSII data gives you the evidence to negotiate price on condition rather than age, or to identify assets with hidden vicious cycle progression before they are on your balance sheet.

Hold

Portfolio monitoring translates GearUp continuous measurements into financial language: CDI trending gives 2-3 years of advance notice of gearbox replacement, turning reactive capex into planned capex. Fault progression rate quantifies AEP exposure per asset in the next twelve months. LSII trend flags which assets are in the active vicious cycle phase. Portfolio dashboard is available at a flat fund-level fee, with API export to your asset management platform and quarterly investor-grade reports.

Exit

A full lifecycle CDI and LSII history in the data room eliminates information asymmetry. Buyers' technical advisors close faster. Per-turbine CDI grading means well-maintained assets are priced at their individual value rather than averaged down by weaker fleet members. Independent certification of remaining useful life, referenced to IEC 61400-4, is accepted by major lenders and increasingly required by certification bodies including DNV and Lloyd. This is the strongest possible evidence base for a life extension premium. Industry data indicates 20 percent or higher transaction value for assets with full monitoring history versus unmonitored comparables. Terminal value at the end of a 20-year PPA is materially higher when the asset has a verified digital birth certificate of its complete operating history.

The impact in numbers

Metric	Impact
NPV	+8-12% from reduced tail risk and higher terminal value
IRR	+1.5-2.5% from smoother cash flows (mid-life unplanned swaps eliminated)
LCOE	-2-5% from monitoring, -10-15% with full lifetime extension
O&M cost	-15-25% from condition-based rather than reactive maintenance
Payback period	Reduced by approximately 1.2 years

The ROI ratio over a ten-year period is approximately 10:1 to 15:1. The sensor investment pays for itself if it prevents a single week of unplanned downtime during high-wind season. On a 5 MW turbine, this generates approximately EUR 25,000 per day.

The CFO framing is straightforward: this is a high-yield insurance policy. You are trading a predictable, low-cost operating expense for an unpredictable, high-cost capital risk. The gearbox swap risk is not eliminated, but it is converted from a black-box uncertainty into a managed, measurable variable. The discount rate your lenders and insurers apply to your assets should reflect this.