THINKING ABOUT TOMORROW

How full data access helps predict future failures and reduce operational expenditure

Data access in wind energy
Report 2

ONYX INSIGHT
FOREWORD

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HEAD OF CONSULTANCY,
ONYX INSIGHT
Digital hardware, big data, artificial intelligence and machine learning are four technologies that together are helping to revolutionise how the wind energy sector works. Using data collected from wind turbines, they are able to anticipate the operational performance of a turbine in the medium term and predict wear, tear and breakdown. While these technologies are powerful, the benefits they provide to their users are, in the end, set by the types of data they are fed and the quality of that data.

Provided with access to all the operational data created by a fleet of wind turbines, these technologies can improve the way inspections and maintenance are conducted and reduce operational expenditure across an entire wind portfolio. The effect of lower costs of maintenance, repairs and replacements can be seen by asset owners directly in better profitability for their wind farms.

Without full access to data the results the technology can deliver will be limited. A basic level of data access is essential for running a well-maintained wind farm. Our recent whitepaper, *Standing in the Way of Control*, looked at which operational data streams wind farm operators need to access, what level of access would be ideal, and challenged owners to understand how much data from their own machines they could access.

*Standing in the Way of Control* encouraged owners to secure full access to the data their wind turbines produce, to help them optimise the performance of their portfolio. *Thinking About Tomorrow* calls on owners and operators to recognise that digital technology, often seen as a threat to operational teams, actually promises to improve data collection and monitoring and deliver more powerful analysis that will increase the value engineering teams bring to turbine management, as well as improving overall profitability for owners.

In this whitepaper, we outline some of the benefits that owners and operators stand to gain from a better understanding of their machinery. The benefits are not only about reducing the cost of unplanned maintenance and repair. Predictive maintenance practices, underpinned by full access to data, will improve owner and operator understanding of turbine performance and unlock greater value across turbine fleets.

Access to data provides turbine owners with a freedom to change operational strategy in the future. Contracts that set limits on data access may be acceptable to operator teams in the short term. However, they will limit the ability of operators to adopt more effective strategies in future and choose between hybrid inspection and maintenance strategies or move towards self-performance. With an improved understanding of their own machinery, owners can also put themselves in a stronger position when renegotiating contracts.

Over the next decade the wind energy industry will see assets become increasingly exposed to merchant risk. In those markets where subsidies will be withdrawn in coming years, owners need to develop the resilience of their projects. This will involve not only the deployment of advanced digital technologies that have already revolutionised many industries, but will also need owners to demand greater access to the data produced by their turbines, so that machinery performance can be properly managed and optimised.

I hope you find *Thinking About Tomorrow* useful and thought provoking, and I look forward to being able to discuss its implications with you in the future.

Evgenia Golyshева,
Head of Consultancy
Operational benefits for wind farm owners and operators
Most owners do not have full access to the data produced by their wind turbines. Data can be restricted in a number of ways that limits how useful it can be for owners that want to optimise the performance and profitability of their machines. Whether these barriers are written into a supply contract, come about because access is gated by a subscription, or occur because owners only receive partial data in their reports, the result is an obscured view of the true performance of the wind turbine.

Importantly, the data generated by wind turbines during their operation is not intellectual property data and shouldn’t be restricted on that basis. The difference is clear, IP data is created during the design, development and manufacturing of equipment; operational data records turbine performance and health, and is captured by various monitoring and inspection systems. Owners have a right to full access to the performance data generated by their turbines.

The operational benefits of having access to more data can translate directly into improved profitability for a wind farm owner. Data captured by inspection and maintenance teams during site visits and recorded continuously by sensors installed on the wind turbine can be combined with real-world engineering principles to model behaviour and predict performance. This predictive power helps operational teams to forecast maintenance needs better and reduce the resources that might be needed for unplanned maintenance.

Typical maintenance budgets may account for 60% of wind farm owners’ operational expenditure. While industry data shows that up to two-thirds of this budget is spent dealing with unforeseen and unplanned maintenance and repairs. By adopting planning and maintenance strategies driven by greater data access, owners can eliminate most expensive unplanned repairs and cut maintenance budgets by 30%.

A wider view of turbine and fleet performance provides asset managers with more clarity and control over their turbines, and helps extend the useful life of wind assets. Accurate data on the reliability of individual components helps asset teams make small adjustments in performance to manage the condition of components, by, for example, defining different control scenarios or adjusting lubrication strategies.

Most major failures associated with wind turbine drive trains can be detected 3-6 months before they need to be repaired. Knowing when parts fail and being able to manage their performance, improves maintenance planning, avoids surprises and helps managers optimise the use of resources. Increasing the useful life of a component by up to 25% means repairs and replacements can be planned several weeks in advance.

Optimising maintenance regimes cuts down time for a turbine fleet and increases the availability of turbines. This allows owners to generate more power and more revenue.

Better data collection, monitoring and analysis by operations and management teams improves turbine performance by making them healthier. As well as improving profitability, better data access can increase overall asset value by up to 12%. Having access to a digital representation of the wind turbines in their fleets will help owners better manage portfolio costs and improve resilience ahead of the transition to a merchant market.
For wind farm owners digitalised collection tools make it easier to manage information and compare performance of turbines in their portfolio. The monitoring software used for analysing data should be hardware agnostic to remove barriers to data access and analysis across multi-brand fleets. In a single dashboard, monitoring software can show alarms and trends on all turbines in a multi-brand fleet, regardless of type.

Using monitoring software with AI and machine learning technology allows turbine owners to explore performance data and understand trends that may indicate future failure. Digital tools significantly increase the amount of data that can be analysed and understood, dramatically improving owners’ understanding of their portfolios. However, in practice these technologies need to be underpinned by thorough engineering expertise and principles.

Machine learning brings improved pattern recognition and swifter decision making to a predictive maintenance solution, but on its own cannot evaluate the urgency of an anomaly, or suggest a solution. Human decision makers, with engineering expertise are needed to harness the power of machine learning and prevent owners from acting on a string of alarms that turn out to be false and instead end up increasing unnecessary maintenance expenditure.
Processing data to optimise savings and profitability

Operators have traditionally relied on a combination of SCADA system data and vibration and lubrication routine manual sampling to track turbine performance, identify anomalies in behaviour and understand the overall health of turbine components.

Collecting and managing this data so that turbines can be effectively monitored has always been an intensive process that reduced resources available for operations and asset management teams to understand their turbines fully. A move towards computerised maintenance management systems (CMMS) and the digitalisation of monitoring and analysis by the industry is improving understanding of wind turbines.

Two pieces of technology are involved to digitalise data for improved reporting and processing:

• **Cloud-based inspection and servicing tools** accessible on mobile and tablet computers. By turning data previously recorded by pen and paper into digital data, these tools support data-driven O&M decision making. Inspection teams can use the tools to ensure best practice in sampling and data collection, provide instant visibility of inspection results and produce field reports faster.

• **Condition monitoring systems (CMS)** installed as factory fitted or after-market option use microelectromechanical systems (MEMs) sensors similar to those found in a mobile phone. The low-cost technology accurately records drive train vibration and the temperature and particle content of oil in a turbine, reporting the data to a remote monitoring system via the cloud. Digitally recording these data makes them easier to analyse than notes from a paper report.
Calculating the financial benefits of access for owners and operators

It is important to reiterate the data used in the following examples is exclusively operational data, and does not rely on proprietary design information.

However, with restrictions applied to operational data in a number of ways, as outlined in *Standing in the Way of Control*, the benefits accrued can vary correspondingly.

The extent of the benefits owners can extract depend on the characteristics of the wind farm, and will vary by location, turbine technology, contracts type, as well as past O&M practices. Fundamentally, unrestricted access to their operational data allows owners to reduce operational costs and stay competitive with alternative sources of power generation.

The following information is indicative of the benefits and savings that can be achieved with unrestricted access to operational data and has been modelled on a typical UK onshore wind farm with a 100 MW capacity and 50 turbines.

As the tables show, savings are possible even with only partial data access, but savings are optimised with access to all data types. Having full access to data is important. As the circumstances of each site are unique, being able to access all operational data increases the accuracy of forecasting failures, and improves maintenance planning.

Data is listed in order of simplicity of access.
## Performance and curtailment assessment

<table>
<thead>
<tr>
<th>DATA TYPE</th>
<th>BENEFITS</th>
<th>SAVING WHEN CONSIDERED SEPARATELY</th>
<th>SAVING IF ALL DATA TYPES AVAILABLE</th>
</tr>
</thead>
<tbody>
<tr>
<td>SCADA data</td>
<td>Improve production on underperforming turbines</td>
<td>1.5% increase in power production</td>
<td>3.5% of power production</td>
</tr>
<tr>
<td>SCADA alarms</td>
<td>Accurately assess liquidated damages from downtime &amp; curtailment</td>
<td>Equal to 2% of power production</td>
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</table>

Illustration for UK onshore wind farm, with a 100 MW capacity and 50 turbines. Savings could be much larger on offshore projects.

<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td>SCADA data</td>
<td>£228,636</td>
<td>£533,484</td>
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<tr>
<td>SCADA alarms</td>
<td>£304,848</td>
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# Unscheduled maintenance

<table>
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<tr>
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</tr>
</thead>
<tbody>
<tr>
<td><strong>SCADA data</strong></td>
<td>Reduce unscheduled maintenance and downtime</td>
<td>Reduce unscheduled maintenance by 4%</td>
<td></td>
</tr>
<tr>
<td><strong>Vibration data</strong></td>
<td>Reduce unscheduled maintenance and downtime</td>
<td>Reduce unscheduled maintenance by 40%</td>
<td></td>
</tr>
<tr>
<td><strong>Lubrication analysis</strong></td>
<td>Improved servicing, oil replacement and life extension + Reduce unscheduled maintenance and downtime</td>
<td>Reduce unscheduled maintenance by 15%</td>
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</tr>
<tr>
<td><strong>Inspections</strong></td>
<td>Early diagnosis of defects and asset condition</td>
<td>Reduce unscheduled maintenance by 10%</td>
<td>30% of OPEX</td>
</tr>
<tr>
<td><strong>Maintenance records</strong></td>
<td>Reduce downtime, Optimise spares stocking</td>
<td>15% of OPEX</td>
<td></td>
</tr>
<tr>
<td><strong>Documentation for refurbished components</strong></td>
<td>Reduced downtime, life extension</td>
<td>Reduce unscheduled maintenance by 15%</td>
<td></td>
</tr>
<tr>
<td><strong>RCA reports</strong></td>
<td>Improved risk mitigation for downtime, failures and defects, better maintenance</td>
<td>Significant, depending on defect</td>
<td></td>
</tr>
</tbody>
</table>
Illustration for UK onshore wind farm, with a 100 MW capacity and 50 turbines.

Savings could be much larger on offshore projects.

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<tr>
<td>SCADA data</td>
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<tr>
<td>Vibration data</td>
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<td>Lubrication analysis</td>
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<td>Inspections</td>
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<td>Maintenance records</td>
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Case study: US onshore wind farm

In this case study of a US onshore wind farm, the operator was struggling to foresee major failures due to limits on their access to condition monitoring system (CMS) data.

Unable to anticipate failures, the operator was seeing a significant increase in operational expenditure.

Free access to CMS data improved the operator’s ability to predict major failures and delivered material net benefits across 114 operational wind turbines.

→ A net benefit of $1.2m for 114 turbines

RESTRICTED ACCESS TO CMS DATA

→ Unexpected major failures increase O&M costs up to 10 times

FREE ACCESS TO CMS DATA

→ Predictive maintenance up to 24 months ahead of major failures
Operational savings

Savings by operational benefit

- 58% Combining Replacements
- 18% Avoiding Catastrophic Failures
- 10% Optimise Spares
- 7% Reducing Downtime
- 7% Advanced Planning

$1.2M Saving

OPEX

LIMITED DATA ACCESS

FULL DATA ACCESS

0 $1M $2M $3M $4M $5M $6M
The wider benefit for the wind energy sector

Greater access to performance data will certainly deliver better managed wind farms across the sector. The right technology will help wind farm owners collect more data and understand better the health of their turbines. This will include full oil analysis reports, accurate maintenance records and digitised reporting and imagery from physical inspections.

When negotiating with suppliers of original equipment and O&M services, turbine owners will need to keep in mind the significant benefits of better access to the data created by the wind turbines they own. Supply agreements that open up access to raw CMS data, second-by-second SCADA data and a full rundown of alarms, as well as parts lists and work instructions will benefit not only the owners, but the industry as a whole.

Greater understanding of wind asset performance will also create a more attractive secondary market among institutions and investors that are less knowledgeable about the sector. As owners and operators thinking about tomorrow develop well-managed wind turbine fleets capable of providing returns in a future merchant market, investors looking for reliable returns will be reassured. Unrestricted data access has the potential to broaden the appeal of wind energy as an asset class and create more opportunities for the sector.

Improved understanding of machine performance will also create opportunities for owners and their OEM partners. Continuous data collected from a range of sources will feed into coordinated research and development programmes and underpin the sector’s ongoing process of turbine development and innovation.
Immediate returns

The results from wind farms operated by teams with full access to their data are clear. These wind farms achieve better profitability and financial performance than their peers. Full access to operational data supported by a thorough grounding in real-world engineering delivers long-term value to owners.

The technology to achieve this exists. Hardware technologies digitise turbine performance data and manual inspection reports; big data, AI and machine learning technology improve analysis and modelling to allow owners to optimise operational and maintenance planning, performance and expenditure.

Fleet owners can ensure unrestricted access to turbine performance data becomes the norm in the sector when they negotiate with their suppliers. Only with unrestricted access to performance data will they realise the full value of their investments in turbine technology and monitoring technology.

ONYX InSight will continue to research and understand how restricted access to data is hampering the industry, and what can be done to mitigate it. If you would like to keep up to date with this process you can join the Data Access Working Group by contacting your ONYX InSight team or following this link.

Join our DATA ACCESS WORKING GROUP
onyxinsight.com/data-access/#register