The challenges of legacy CMS hardware in ageing turbines

As wind operators look to ensure their fleets are running as economically as possible, the use of data to improve asset management and predictive maintenance strategies is becoming increasingly vital. In the wind industry today, the benefits of Condition Monitoring Systems (CMS) are widely accepted to help achieve optimal wind turbine performance. More data from more turbines means the industry is better equipped to rise to any emerging O&M challenges and will enable further reductions in the Levelised Cost of Energy (LCoE).

Drivetrain CMS systems accurately determine early signs of damage in subcomponents, such as gears, bearings, couplings, etc. This enables predictive maintenance (PdM) and estimates of remaining useful component life to be made. The knowledge of a fault developing with a long lead time before a critical failure occurs leads to major operational economic gains, by facilitating the sourcing of cheaper replacement parts well in advance, shutting down turbines before catastrophic failure, reducing downtime, scheduling repairs out of the windy season, and consolidating multiple turbine repairs into lower cost campaigns. This has led to all major owners and operators being able to justify the investment of the CMS hardware and data monitoring.

However, historically CMS systems were not always installed in wind turbines. Many wind turbines left the OEMs with no CMS well into the early 2010s. Turbines without CMS are subject to significantly higher O&M costs, particularly as they age, and component failure rates accelerate.

Historically, many operators and owners found that retrofitting a quality CMS solution onto an ageing asset was prohibitively expensive and was seldom carried out. That was until 2017, when ONYX launched ecoCMS, a cost-effective CMS system underpinned by cutting edge MEMS vibration sensor technology.

The product was designed specifically for the unaddressed retrofit market and has since been installed in over 9,000 wind turbines across more than 80 different turbine models. Its rapid adoption was driven by its ease of install, price, exceptional fault detection capability, and outstanding software and analytics.

The challenges of ageing turbines

Not all CMS systems are born equal and deliver optimal predictive maintenance outcomes. Likewise, a once functional CMS can experience problems and failures over time. These systems are known as Legacy CMS systems.

In ageing turbines, when a CMS needs to be delivering its most value, operators are commonly met with poor CMS performance when it matters most.

A major issue with legacy CMS is poor fault detection, which can have a variety of root causes. For example, some legacy CMS have no shaft speed sensor. This is vitally important for accurate tracking of fault frequencies in variable speed machines, which wind turbines are. Fault frequencies for a drivetrain often occur in narrow bands, and key vibration signals can be obscured completely without sufficient order tracking. This can lead to a reduction in fault detection lead time or worse, missing faults entirely.

Worse still, some legacy CMS were not commissioned with sufficient numbers of vibration sensors. Often sensors are missing in key locations such as the main bearings. Typically, a drivetrain requires seven or eight vibration sensors for complete component coverage, but some legacy systems were commissioned with as low as 5 accelerometers.

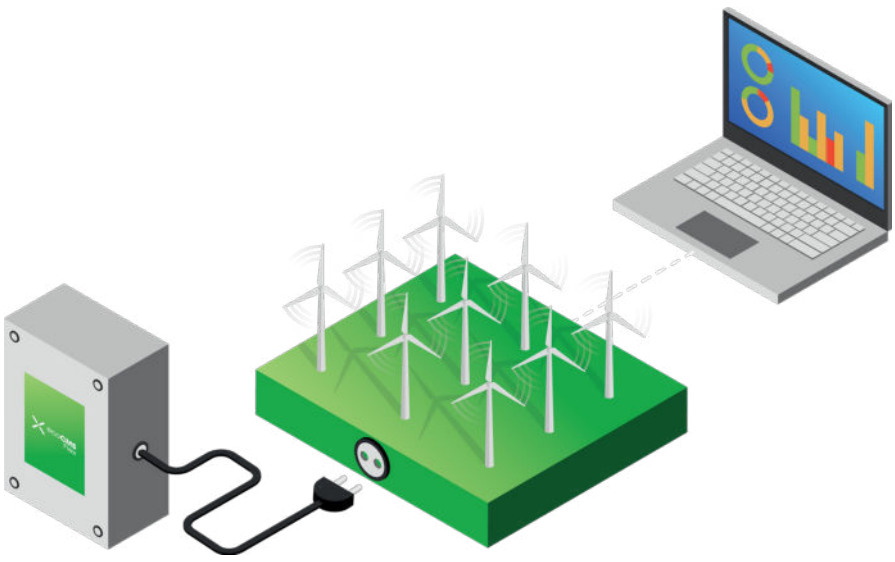
Another issue with legacy CMS which can lead to poor fault detection is inadequate vibration data resolution. The data sampling regime should be optimised for each stage of a drivetrain, but often the sampling rates or sampling durations configured when the legacy CMS was commissioned are insufficient. This can lead to poorly resolved signals in the frequency domain and can severely compromise fault detection for certain failure modes. For many legacy CMS systems operators are stuck with these poor sampling configurations as there is no way of updating the CMS software.

Problems do not end there. Legacy CMS systems can also suffer from poor IT performance leading to unreliable data flow from a fleet. Legacy CMS IT systems are notoriously difficult to debug and maintain. It is not uncommon to see some turbines in a fleet not send data for months at a time. Whole fleet data outages can also be common.

Hardware reliability can be an issue as well, especially as the CMS unit itself ages. Failure rates can be high after the five-year mark, especially in extreme climates. Typical components that fail are motherboards, cooling fans, and flash storage after high numbers of read/write cycles. Repairs are often expensive and difficult, especially in legacy CMS products as they are well out of warranty, components are obsolete, and many systems lack any support from the OEM entirely.

Last but not least, another major issue with legacy CMS systems is the accompanying analytics software which is used by monitoring engineers to analyse data and feed into operation and maintenance plans. In some cases, even relatively basic analytics methods are missing, such as customisable envelopes, cepstrums, trends, and alarm thresholds. Fundamental parameters such as drivetrain kinematics can be incorrectly configured during commissioning, and impossible to update, often an issue if you replace a gearbox with a different model or from a different vendor compared to the original.

Legacy analytics software is also typically un-user friendly, lacks automation and requires manual and error prone interaction from a user to review data and alarms. This can make it difficult to scale up monitoring operations as an operator's asset portfolio grows and diversifies. In short, legacy CMS analytics software can obstruct the adoption of optimal and efficient PdM strategies that scale.



What options do owners of legacy CMS systems have?

The financial consequences of operating a wind farm with legacy CMS systems can be significant. However, operators and owners have few attractive options available to them to improve the situation.

A common path is to just continue limping along with the legacy CMS systems and swallow the consequences of poor CMS performance. Unfortunately, this strategy results in operating ageing turbines in later life with an underperforming PdM strategy. For ageing turbines this is typically when CMS should be delivering its most value to an operator as component failure rates are increasing.

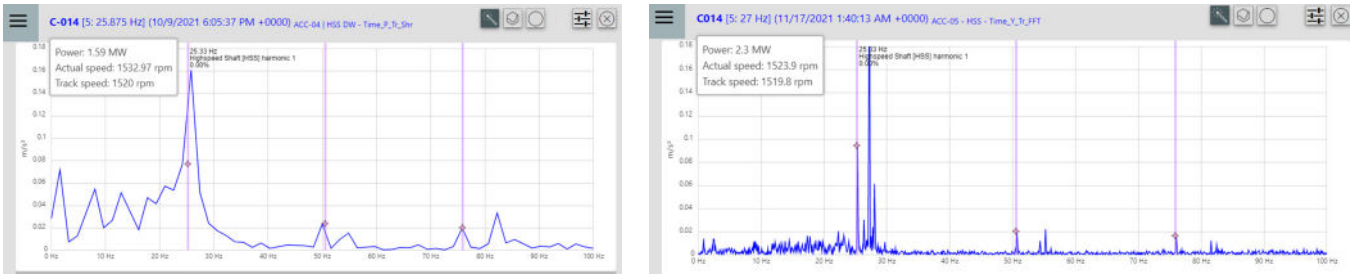


Figure 1 demonstrates how ecoCMS Flex can improve fault detection. The FFT on the left has been taken from a legacy Bently Nevada CMS with a sampling duration of 0.6 seconds, which cannot be updated. In the right hand figure a new ecoCMS system has been installed and the vibration sampling duration has been increased to a more optimal 15 seconds. The fully resolved peaks in the FFT reveals an underlying shaft misalignment fault

One option might be to replace the legacy CMS system with a completely new system. However, this typically incurs a high cost of upgrade due to expensive hardware and install time. Typically operators feel they have already invested in a CMS system and are reluctant to invest again, especially if the legacy CMS systems are still partially working.

In addition, a full CMS replacement doesn't always alleviate the fundamental problems with the legacy CMS. The CMS industry is a slow-moving beast, and the difference between legacy models and the later ones are often marginal from some OEMs. If the legacy system from the OEM was unreliable then the new system may also be unreliable. If the legacy system was plagued by IT problems, then the new system often will too.

The best solution is to seek out a specifically designed upgrade to bring your CMS units up to the highest standards, with minimal install costs and disruption to the operation of your wind farm.

Surprisingly, not all CMS components need upgrading. Often, the existing sensors and cables can be reused. Most, but not all, legacy CMS units utilise piezoelectric (IEPE) sensors which are highly standardised across the industry. For example, most sensors will have a 2- or 3- pin output and will be of standardised sensitivity, typically 100 mV/g or 500 mV/g. These sensors and cables are also relatively reliable, with a long lifetime.

The cost-optimal approach to upgrading legacy CMS is to keep the existing sensors and cables and to replace only the CMS unit itself, i.e. replace the 'brains', but keep the commodity components. The added advantage here is that technicians do not need to re-route new cables and install new sensors, therefore making the installation process fast and efficient. Depending on the turbine type and model of legacy CMS, existing cables may need to be adapted to the new CMS unit with basic adaptors or new connectors, but this is a straightforward part of the installation.

ONYX has developed a new solution, ecoCMS Flex, to specifically address the pain points of legacy CMS in a cost-effective way. ecoCMS Flex allows you to keep your existing accelerometers and cables and carry out a rapid 'plug and play' installation thus cutting install costs. ecoCMS Flex brings your CMS up to the quality of ecoCMS and integrates seamlessly with the market leading analytics platform fleetMONITOR. Installation is also quick and enables a CMS upgrade during a turbine's regular scheduled maintenance.

www.onyxinsight.com

About the author

Henry Tanner is the Product Manager for Advanced Sensing, at ONYX Insight, a leading global predictive analytics solution provider, with a combination of software, hardware, consultancy and engineering services exclusively for the wind industry. ONYX monitors 14,000 wind turbines in 30 countries across the world.