# We have the inside information

**Condition monitoring systems can anticipate failures and allow turbine owners to schedule for repairs. Yet, in the US wind industry, most still prefer to rely on a more hands-on approach. Mark Anderson talks to proponents of both options and looks at what is available**

The price of predicting catastrophic turbine breakdowns in the North American wind industry is anywhere from zero to $20,000 or more — and open to lively debate. While some insist rigorous regular maintenance will always be the best answer, others argue that condition monitoring systems (CMS) are the only way to go.

Yet, while CMS is well established in other North American industries and in Europe where insurance firms practically mandate it before offering a policy to a wind farm, estimates suggest that only 10% of the US wind fleet uses CMS to anticipate failures and schedule repairs.

As turbines get bigger, more costly and more expensive to repair, the debate continues with no consensus in sight: Is paying $20,000 per turbine for CMS a no-brainer investment? Or is it better to use common sense and an owner's manual throughout a turbine's 20-year life?

CMS applied to wind turbines usually takes one of two forms. Vibration monitoring is more costly and more widely used. Sensors are attached to gearboxes, generators and drive trains to provide real-time data streams that are transmitted to operators who monitor the results on a computer for changes that highlight a potential problem.

Automated oil-particulate systems count metal pieces floating in lubricating fluid, either displayed as real-time data or stored for later examination. Increasing rates of gear-tooth or bearing particulate indicate trouble.

Beyond those mainstay methods, acoustic monitors are newcomers to a CMS niche market where dozens of competitors have popped up in recent years. Borescopes can take photos inside the gearbox, much like a medical procedure, but are not considered CMS because a complete scan can take eight hours and is largely inefficient unless specific problem areas are already known.

Clipper, Siemens and Gamesa are among the turbine manufacturers that provide CMS as standard equipment in the US. Others offer it as a pricey factory add-on and many don't offer it at all. Insiders say that few firms welcome the intense scrutiny of CMS, preferring that the data remains proprietary. Some dismiss all such technology as unproven.

So, many companies simply send a technician up-tower to collect gearbox oil in a vial and send the sample off to a lab for quarterly particulate counts — at $30 per turbine. A few others stick to the age-old method of rolling down their pickup-truck windows, driving slowly through the wind farm and listening. Those numbers are dwindling.

## **UNCONVINCED** THE COST IS NOT COMMERCIALLY VIABLE

Not everyone is convinced that condition monitoring systems (CMS) are a panacea for the US wind industry. At somewhere around $20,000 per unit, a good vibration system can pick out exactly which bearing is failing and depict it, in real time, on a computer screen thousands of miles away. Considerably less expensive real-time oil-particulate systems can reveal increasing metal fragments that suggest potential problems.

But the key information — time until the turbine breaks down — is something CMS cannot predict, says Harm Toren (pictured), head of US operations services for Spanish-based Iberdrola, the world's largest wind farm operator. The company's US arm, building at a 1GW annual rate, has implemented a pilot CMS programme on around 100 of its 2,500-turbine North American fleet, but it has no plans to add more as it studies the technology.

"The unfortunate nature of it is that the industry is currently in a research and development mode," Toren says of CMS. "I can predict trending. I can see that things are happening. But I'm not quite certain whether they will occur today, tomorrow, ten days from now or a year from now. Or even at all."

Timing is paramount because scheduling repairs during calmer wind periods and coordinating crane call-outs around multiple jobs can save big money. But, since virtually every turbine sees at least one gearbox replacement during a 20-year life, Toren says that Iberdrola would rather replace the entire gearbox when trouble is brewing, committing to spend upwards of $500,000 instead of making an up-tower bearing replacement at $30,000.

"It would be similar to your car," Toren says. "If you didn't change oil, then you had several bearing problems and, rather than replace the engine, you just took the top off and replaced some of the bearings. But you didn't do the pistons, you didn't do the gears, you didn't do the transmission."

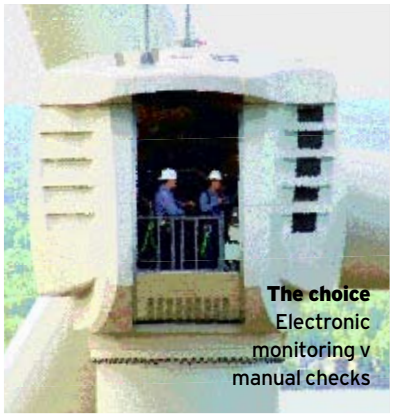
Toren says the philosophy is rooted in Iberdrola's penchant for long-term ownership and operation of the projects it builds — not maintenance to provide suitable balance-sheet value for eventual sale. And as almost any problem will lead to replacement, an up-tower oil sample sent to a lab for results, costing $30, will give enough information.

But Toren also believes there is potential value in CMS and that vibration and oil-particulate systems work especially well in concert. "It's important that we have the capabilities to monitor particles and vibration levels," Toren says. "Unfortunately, the cost to do that isn't currently commercially viable. You can imagine if I spent $20,000 times 2,500 units, how much I would spend."

One solution, Toren says, is for turbine makers to add factory-installed CMS. Manufacturers could differentiate themselves by integrating reliable and easy-to-use CMS directly into the Supervisory Control And Data Acquisition (Scada) systems that come standard with all modern turbines.

"Red light, yellow light, green light," Toren says. "If it's red, stop the turbine and fix it. If it's yellow, give me a counter to say when this component is going to break. If it's green, we're good to go."

Turningpoint: Clipper



**The choice** Electronic monitoring v manual checks

## THE CASE FOR CMS IT PICKS OUT A MYRIAD OF PROBLEMS

One passionate proponent of condition monitoring systems (CMS) for the wind industry is David Clark, sales director for Turningpoint, a New Zealand-based maker of vibration-based CMS that sells more systems in North America than all its competitors combined.

Clark is convinced that vibration CMS are the best answer to an industry that has long struggled with catastrophic gearbox failures and expensive repairs. Finding such problems – and finding them early – can provide months of lead time for up-tower part replacements that might cost $30,000, versus full-blown repairs that require removing a gearbox and cost hundreds of thousands of dollars.

"It can pick out bad bearings, bad gears, misalignment and balance, mechanical looseness – there's a myriad of things that it can pick out," Clark says of vibration monitoring. "There are things that it finds that no other method does." And that, he adds, sets vibration CMS apart from methods that involve examining oil for increasing numbers of metal particles.

Overall, Clark believes that North Americans have been slow to embrace CMS because, in its early years, the US wind industry was given tax credits for merely planting turbines, not for actually producing 20 years of power. It is only recently that the US wind industry has become increasingly populated with executives from industries, such as oil and gas or heavy manufacturing, where CMS has long been accepted as essential.

Clark believes CMS is especially important on new turbines. "I just talked to somebody who had nine out of 20 gearboxes that failed in the first three months," he says, "and that all falls under the manufacturer's warranty." But predicting failure near the end of warranty periods, as well as around the end of a turbine's 20-year life cycle, is also vital. "Nothing runs better in year 18, 19, 20 or even seven, for that matter, than it did in the first two years," Clark says. "CMS benefits both the manufacturer and the owner, but it's just that point of who's going to pay for it is where people usually have a hang-up."

Although Clark's company provides factory-installed vibration systems for American-made Clipper 2.5MW machines, Clark doesn't believe turbine makers adding CMS as standard equipment is a likely overall solution. "It doesn't behoove manufacturers to tell you what's wrong with their product," he says, adding that turbine makers fear such statistics could lead to extensive recalls.

Clark concurs with estimates that suggest only 10% of domestic turbines use CMS. But he believes the tide is turning, especially as turbines get larger and the cost of repairs goes up. Using CMS and knowing what needs to be fixed before it fails lets the industry perform maintenance on its own terms, he insists. That means expensive crane call-outs can be coordinated around multiple repairs and, significantly, it also means repairs can be targeted to low-wind seasons.

"You wait until the turbine breaks and react to the maintenance that way," Clark says, "or else you predict maintenance. That's what we do. And virtually every other industry, save for wind turbines, uses that same technology."

## CMS OPTIONS

### Vibration sampling

**What it monitors:** gearboxes, generators, drive trains
**How it works:** sensors applied near moving parts detect changes in vibration patterns, sending real-time data to off-site computer
**Installation:** usually added after construction but can be factory installed
**For:** can pinpoint problems to a specific bearing or other component; widely used in European market
**Against:** expensive; can supply overabundant information that can be easily misinterpreted

### In-line oil sampling

**What it monitors:** approximately 150 gallons of wind turbine's gearbox oil
**How it works:** counts metal particles in oil to detect frequency changes; real-time data is stored or sent to off-site computer
**Installation:** added after construction
**For:** inexpensive relative to vibration-based systems
**Against:** cannot pinpoint problems; accuracy can be compromised by conditions such as temperature fluctuations or particles settling after turbines have sat idle; only monitors gearboxes

### Periodic up-tower oil sampling

**What it monitors:** small gearbox oil sample
**How it works:** technician manually draws oil sample then sends vial to lab for examination
**For:** very inexpensive
**Against:** same as for in-line sampling; also, results are periodic and can vary greatly depending on conditions at time of sample

### Supervisory control and data acquisition (Scada)

**What it monitors:** although technically not condition monitoring, Scada is the computerised controlling system on all modern wind turbines and can enhance CMS results when used in concert with vibration and/or oil-based system
**How it works:** tying Scada together with CMS can help technicians understand if data anomalies are connected to a wind gust or other temporary conditions; Scada can also detect slight discrepancies in turbine power output that can indicate problems WW