THE SHIFT TOWARD OPTIMIZATION

Advanced technologies help wind farm operators maximize plant potential

By Barry Logue
Vaisala, Inc.

As the wind power industry matures, project developers, owner-operators, and financiers are asking for ever more reliable predictions of power output from both new construction and existing assets. Industry studies analyzing operating wind power plant production data indicate that the accuracy of pre-construction estimates compared to actual performance has greatly improved. However, long-term climate variability (i.e. the 2013-14 "Polar Vortex"), evolving energy markets, repowering contracts, and financial vehicles such as YieldCos are driving a need for continually increased certainty in wind power plant performance. This is required both to better understand portfolio risk and to drive incremental operational improvements for getting the most out of the existing steel in the ground.

Fortunately, today there is a wide range of hardware and software to collect and analyze a steady stream of data for better predicting and enhancing turbine performance. Some of the newest tools available for operational optimization are remote sensing and advanced mesoscale computer models. Both modeling and remote sensing instruments, like traditional anemometry, play three basic roles in the life cycle of a wind project: prospecting, assessment and operations. Here we will focus on the operational applications of remote sensing and advanced computer modeling for continual wind farm optimization. When properly leveraged these technologies offer site-specific data for on-going production and operational assessment.

Remote sensing has been used commercially for decades in the wind industry as a pre-construction measurement tool. However, with the focus in more mature markets switching from rapid development to optimization of existing wind turbine assets, its unique capabilities have been put to use in a variety of operational applications. These areas of operational optimization include: making investment decisions for upgrades and new equipment; analyzing yaw, wake, and other losses factors; developing mitigation strategies to minimize energy losses; and accurately forecasting production for scheduling energy and turbine downtime for maintenance.

Remote sensing systems, such as ground-based SoDAR (sonic detection and ranging) and LiDAR (light detection and ranging), provide developers with the means to measure wind speeds at above hub height to better estimate production for today's large rotor diameter utility-scale wind turbines. With these modern measurement instruments, the industry has developed a greater understanding of how wind characteristics such as atmospheric stability and directional shear (variation of wind direction

vs. height) affect turbine power performance.

Monitoring wind conditions in and around an operating wind farm is traditionally accomplished with wind measurement equipment mounted on the top of the nacelle (or turbine housing) or via permanent meteorological (or met) towers. Turbine mounted equipment is affected by the turbine itself and is not representative of the free-stream wind coming into the turbine array. Met towers are typically used for conducting one-time power performance verification testing on nearby turbines according to the turbine supply agreement and then provide data to regional electrical balancing authority for forecasting purposes. Post-construction comparisons

ALSO IN THIS SECTION:

of production data to pre-construction data are often challenging because many of the wind measurement sites used for wind resource assessment are not used to site the permanent power performance met towers.

As previously mentioned, wind farms often operate with just one or two met towers as reference sources, which were originally used for the contractual power performance test. Once turbines are installed, wind information from the fixed met towers is used to monitor production estimates and as an aid to operations and maintenance. However, the met tower may only represent a subsector of the wind turbine array. The demand for operational assessment analysis is being addressed using a combination of advanced mobile ground-based remote sensing instruments and advanced modeling techniques. An advantage of a mobile remote sensing instrument is that it can be moved around and within an operating wind turbine array to provide the project owner-operators access to specific sector wind data that they can use to assess their operational control strategies and predict specific turbine maintenance needs.

As wind turbine technology improves, existing wind farms must regularly evaluate whether to invest in a manufacturer's new performance enhancement, such as vortex generators, new SCADA (supervisory control and data acquisition) algorithms, and other modifications. By using a remote sensing system as mobile met tower, relative power curves can be developed for pre-upgrade and post-upgrade analysis to better understand the benefits of various improvements under varying wind conditions. Monitoring the free-stream wind flow provides better information for determining whether the upgrade produced an improvement or it was simply a 'better' wind day.

Additionally, wind farm operators are investigating the use of forward-looking nacelle mounted LiDAR systems for improved yaw correction, blade pitch control strategies, and potentially early gust and ramp down detection. Several of these nacelle-mounted LiDARs use the Doppler-shift measurement techniques used by ground-based models. However, new direct LiDAR detection methods are in test and early results are promising with a number of providers offering such systems. Whether it is necessary to install a forward-looking LiDAR on each turbine or only on a few key turbines to provide the necessary guidance is still under investigation since wind direction variation across a project site will likely influence the decision.

Another loss factor and one of the most important steps in wind project valuation is the estimation of wake effects. These occur when upwind turbines create turbulence that detracts from downwind turbine performance. Wind project wake losses make a substantial contribution to understanding wind plant underperformance, and in many cases may be the largest contributor to such underperformance.

Remote sensing systems can play a role in measuring these effects at operating wind farms, but can also calibrate and test various advanced mesoscale models used for wake analysis. Studies conducted by Vaisala's 3TIER Services and WindLogics have shown the WRF (Weather Research and Forecasting) model to be quite skilled in this application.

There are several hypotheses to explain why the WRF model provides a more accurate estimate of turbine wakes. Foremost, WRF takes into account the variability of the atmospheric vertical temperature profile, which strongly controls the amount of turbulence available to dissipate turbine wakes, whereas the standard wake models assume neutral atmospheric stability. Neutrally stable flows allow more rapid dissipation of wakes than would occur in the more strongly stable conditions typical of the nocturnal boundary layer. Although WRF is more computationally expensive and may slightly overestimate wake losses, the results of these studies show that using WRF to model wind turbines (and nearby existing or planned wind plants) is the best method to ensure that the total waking effect has been appropriately captured.

Since computer simulations are the only option for evaluating wakes prior to construction, these findings are significant. Advanced mesoscale models also offer flexibility for operational optimization because they can quickly provide a modeled wind profile at each turbine with wake losses incorporated, which can be compared with actual production on an ongoing basis – all without the expense of installing, maintaining, or collecting measured data at each turbine.

Finally, a wind project's generation must be integrated predictably into the power grid both for system reliability and to fulfill its expected financial return. Regional independent system operators (ISOs) thus require wind generation facilities to provide forecasting data, which they use to understand how much power a wind generation facility will be supplying to the grid on a day-ahead and hour-ahead basis.

ISOs also need wind forecasts to predict so-called “ramp events.” A ramp event is a period of rapid change in wind farm production caused by increases or decreases in wind speed over a few hours. Different grid systems operate in their own unique wind regime and therefore, have different definitions of wind ramps. ISOs and wind farm operators must have operating strategies in place to deal with any impact these events have on generation capacity and system reliability. Energy traders also use wind forecasts to determine the amount of power that will be available at any given time, as this will drive prices up or down.

Accurately forecasting wind energy production requires both measurements and advanced computer modeling. First, measurements of the current wind resource at and around the wind farm site are recorded. These data along with data from national and global weather service forecasts are combined with high-resolution Numerical Weather Prediction (NWP) models like WRF. Forecasts are based on these weather models, knowledge of the capacity of the turbines, and their predicted power output in various wind conditions.

NWP models are typically initialized with national weather service gridded data sets that are, by nature, at least one hour old by the time they can be accessed, ingested, and processed by the modeling software. Therefore, in many locations, forecasting in the hour-ahead timeframe can be improved with onsite wind observations. Analysis of the local weather conditions using a network of ground-based remote sensors can assist in tuning forecast models to site conditions. These mobile wind measurement systems offer a new source of data to feed today’s robust micro-climate forecasting models. By combining remote sensing measurement technologies with advanced computer modeling techniques in forecasting, owner-operators can improve the cost competitiveness of wind power generation compared with traditional fossil fuel generators in electrical markets around the world.

The wind industry is deploying more advanced measurement technology, turbine performance enhancements, and forecasting systems to seek optimized wind power generation for better grid integration and, ultimately, to improve the value of wind energy in a utility's generation portfolio. Improvements to both remote sensing and advanced computer modeling enhance operational turbine performance. These advancements include new SoDAR and LiDAR instruments developed for studying active wind farm conditions, such as SCADA integrated permanent SoDARs and nacelle-mounted LiDARs. Used either as a complement to met tower data or as a stand-alone tool, remote sensing systems and advanced modeling software can be used throughout the lifecycle of a wind farm. Through innovation, both in hardware and software, wind farm developers and financiers can reduce the uncertainty of wind power generation and make it a more attractive component of modern energy investment portfolios.

Predictive maintenance methodology streamlines operations

Condition monitoring approach reduces downtime while providing cost savings

By Matthew Whittle and John Coultate
Romax Technology

Operations and maintenance (O&M) of wind turbines is estimated at 21 to 24 percent of the total cost of energy from wind. As turbines are built larger, the capital-expenditure component of the cost of energy from wind drops, but there is still room to reduce the cost of O&M.

Too often maintenance is carried out reactively: the asset fails and it is repaired. This is a good approach when the asset is inexpensive, easy to source, and when the inevitable downtime does not have major cost, or health and safety implications. But operators too often take a reactive approach to major wind-turbine components such as main bearings or gearboxes failures. This results in expensive crane mobilizations at short notice and lost production while the turbine is unavailable. Failures during the high-wind season can be costly.

An alternative is to carry out preventative maintenance, periodic replacement whether the component seems to be failing or not. This approach is useful for expensive mission critical components, particularly where the component condition is difficult to monitor.

The third approach is predictive condition-based maintenance. This is suitable for a component when its condition can be monitored and a failing component can be detected sufficiently far in advance of a date of failure. To be useful, how far in advance must this warning be received? That depends on many factors, but the period must be sufficient to allow at least some of the following benefits:

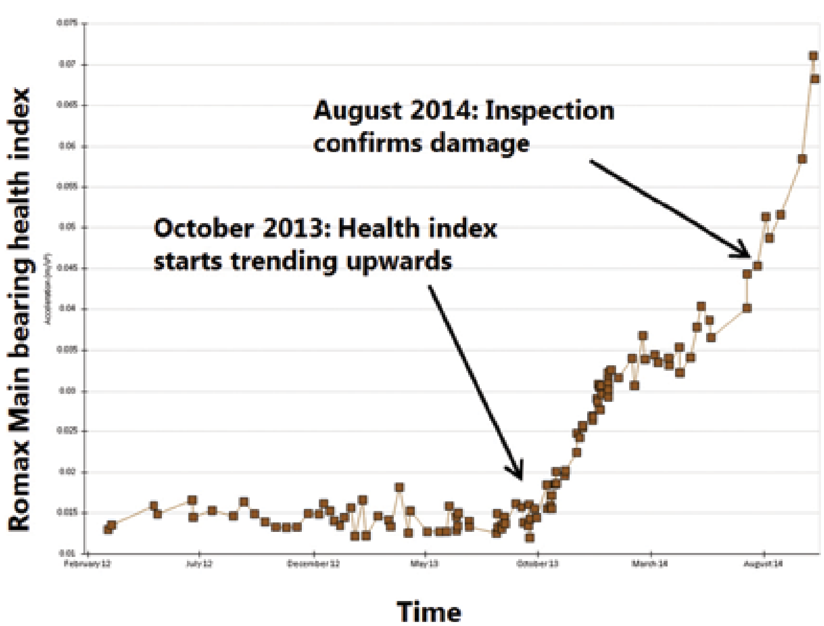

Figure 1: Fleet Monitor main bearing health index trending upwards.

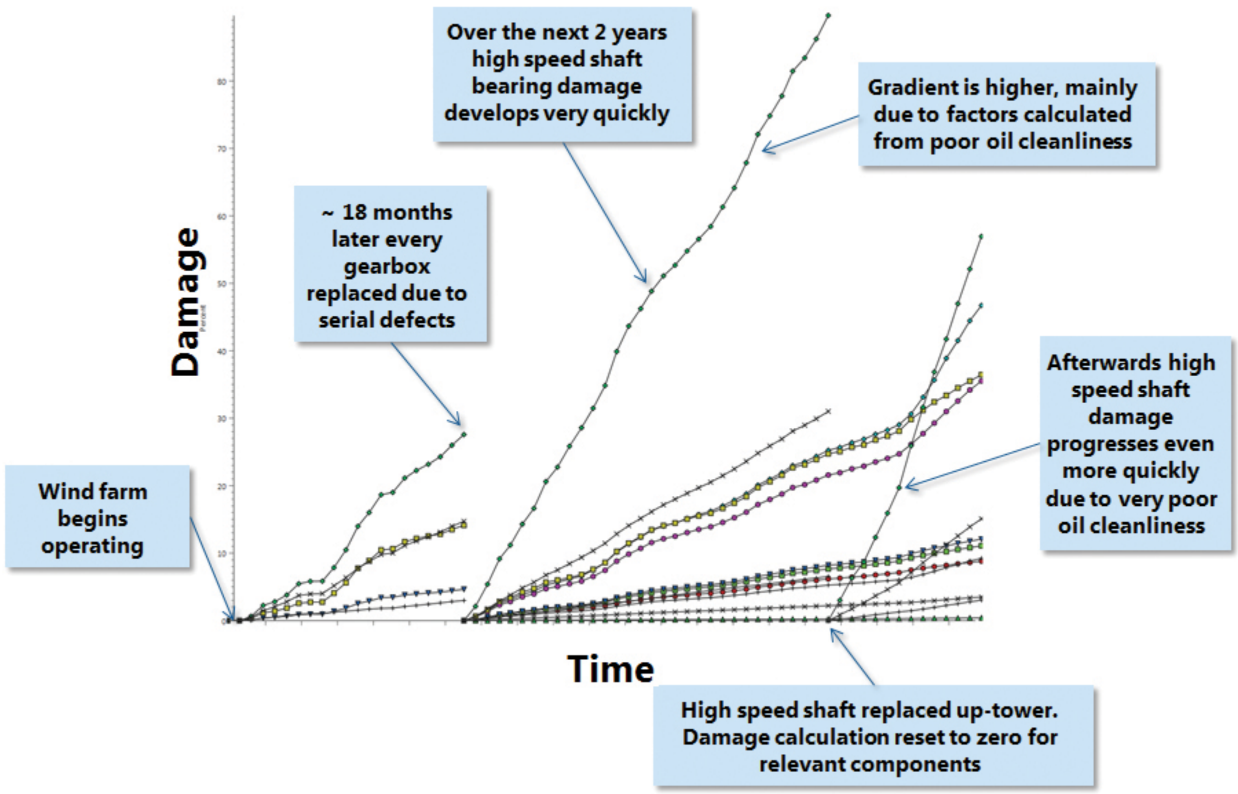

Figure 2: Romax approach to remaining useful life models.

- Prevent secondary damage to other components
- Secure necessary resources in advance at reduced cost
- Carry out multiple maintenance activities at once, thereby reducing the cost (e.g. replace multiple main bearings and gearboxes with one crane mobilization)
- Minimize downtime, thereby increasing production
- Schedule downtime at a low impact time (i.e. during the low-wind season)
- Use cost effective life extension methods to mitigate damage

Predictive condition-based maintenance can be online or offline. Many newer wind turbine models come with factory-fitted vibration based condition monitoring system (CMS) for online monitoring. Alternatively, CMS can be retrofitted. Effective offline techniques include lubrication analysis and vibration sweeps using portable vibration hardware.

For example, Romax's InSight Fleet Monitor web-based Software-as-a-Service uses data from existing CMS and SCADA systems together — with lubrication analyses and O&M records — to provide decision makers with a clear picture of the health of their fleet. The software has a range of detection and prediction methods to enable condition-based maintenance of wind turbines. The following case study is a typical example of a main bearing fault detection.

CASE STUDY: MAIN BEARING FAULT

An upward trend of a fleet monitor health index from October 2013 indicated a main bearing fault. Figure 1 plots this trend. The trend continued upwards and in August 2014 the bearing was inspected and the damage confirmed (spalling and rollover marks). While the main bearing replacement was scheduled, the turbine continued running but with close monitoring. By detecting this fault 12 months before repair was required it is possible to minimize downtime and schedule multiple main bearing change-outs together. Production was increased and crane mobilization costs were reduced.

Condition monitoring of wind-turbine drivetrains has proven to be effective, but it must be part of an integrated predictive maintenance strategy to yield significant financial rewards. Merely identifying that a component is damaged does not increase the profitability of a turbine or farm. It is necessary to act on the information to optimise the O&M activity. Condition monitoring centers must not be isolated from site managers and asset-management teams. Integrated condition monitoring tools, such as Romax's InSight Fleet Monitor, help condition monitoring engineers diagnose turbine faults early and efficiently. In addition, they aid collaboration with other key departments. Designed with global access and collaboration in mind, Fleet Monitor lets site managers, asset management teams, and condition-monitoring centers communicate and collaborate more effectively.

But key questions remain for wind farm operators:

1. How does management weigh the trade-offs inherent in decisions regarding component life extension?
2. How can a team optimize the timing of component replacements?
3. How can an owner budget O&M expenditures over the next three years?

REMAINING USEFUL LIFE MODELS

While vibration based condition monitoring detects developing faults, it cannot give an indication of the remaining useful life of a component which has not yet started to fail. This creates a challenge for operators wishing to implement a condition-based maintenance strategy, namely one posed by the question: How to budget O&M expenditure over the next three-plus years?

Each bearing and gear in the drivetrain of a wind turbine has a design life. This life is consumed as the turbine operates, but one hour at rated power does not consume damage at the same rate as one hour at 50 percent rated power. Also the turbine undergoes transient loading, during gusts, or when the turbine starts and stops, for example. All of these events consume a portion of the design life of each component. The remaining useful life model calculates how much component life is used by the different operational regimes and events, and deducts this from the design life.

The approach is to use all available historical data from the CMS (if installed), SCADA, lubrication analysis, inspection and maintenance records, combined with measured loads and then calibrate the remaining useful life models for each bearing and gear in the turbine. This hybrid approach, using computer models and empirical

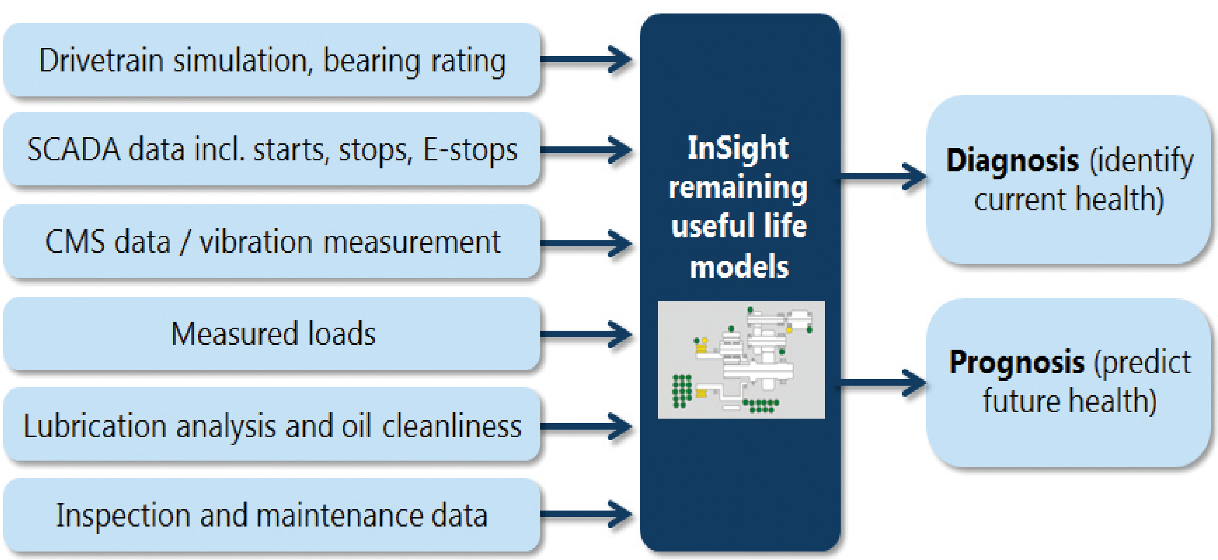

Figure 3: Remaining Useful Life case study.

data, has been developed based on extensive domain experience. Failures in turbines are complicated and unexpected things can happen.

For instance:
- Bolts back out
- Rollers wear on the end face generating damaging debris
- Oil degrades
- Bearings are ground with incorrect micro-geometry
- Gears have inclusion related early failure
- Bearings spin in their journals
- Damage starts due to poor assembly

This practical knowledge has been combined with sophisticated computer models to create an effective remaining useful life tool, which has been subject to validation campaigns with major operators over many years.

CASE STUDY: REMAINING USEFUL LIFE MODELS

The plots in Figure 3 illustrate a case study in which the high speed, upwind bearing in a gearbox rapidly accumulated damage during its first year of operation. The gearbox was replaced due to serial defects. The same bearing in the replacement gearbox accumulated damage rapidly and after two years was replaced up tower. Unfortunately the new bearing consumed life even more quickly due to poor oil cleanliness. Debris introduced during the up-tower repair was a key factor in the reduced life.

Remaining useful life models are powerful because they enable early action to be taken to mitigate damage. Different what-if scenarios can be run to see the impact on the remaining useful life of different approaches, and the cost-benefit weighed. Also, the advanced warning gained from predictive models make possible more accurate O&M budgeting.

WHAT WE HAVE LEARNED ?

The powerful tool of condition monitoring enables detection of faults before they progress to failure. After detecting a fault, wind farm operators must make important decisions. These decisions will affect whether or not the value of the condition monitoring is realised, and tools are required to assist decision makers. Prognostic models which estimate damage accumulation give a longer term forecast which can be used for budgetary planning. The cost of wind energy must be reduced. To achieve that cost reduction, predictive condition-based maintenance will play an increasingly important role.

RENEW Energy Maintenance

'One-stop' service provider forging success on quality and innovation

By Stephen Sisk

Always finish what you start. Take pride in your work. Do what has to be done. Antiquated life lessons from a bygone generation or a solid business model?

Today, advances in technology and communication have ushered in an information age that renders the old way of life obsolete, inefficient, and slow.

Those who fail to adopt that modern train of thought are often labeled as out-of-touch, old-fashioned, or irrelevant.

Bucking that trend is five-year-old wind energy independent service provider RENEW Energy Maintenance.

Disillusioned with the typical service provider business model, energy industry veterans Jim Mikel and Gary Fish founded the group in 2009.

The pair shared a unique vision for their company. Instead of specialization, they sought to offer a comprehensive suite of services, with an emphasis on quality and innovation. The result was an imaginative wind service provider that would employ modern methods and the latest technology, while never straying from its solid, "old-fashioned" ethical foundation.

Shaping the core of that foundation is a set of principles drawn from the code of the working cowboy and outlined by author and former Wall Street financier Jim Owen in his book "Cowboy Ethics: What Wall Street Can Learn from the Code of the West."

"What Owen said was that Wall Street would be better if they would abide by the Code of the West in their decision making," said Fish, who serves as Chief Financial Officer for Sioux Falls, South Dakota-based RENEW. "When I read the book and saw the Code, I thought: 'This fits Jim and I. This fits the kind of company that we would like to build.'"

While the rural, open landscape may be the most noticeable parallel between the cowboy lifestyle and the wind industry, RENEW's intent in operating under the Code lies in its dealings with others — its customers, employees, and shareholders.

"It goes back to how cowboys would treat each other in the West. We just took the ten principles and applied them to this industry," Fish said. "It just gives us some guidance — not only in our daily operations, but in our strategic thinking of where we want to take the company, and how we want to treat customers and employees."

Following those principles, RENEW has grown steadily since its inception. Since the company started, its workforce expanded to 113 — 90 of whom are technicians. RENEW's sales in its first full year totaled $3 million and grew at a consistent pace for the next three years. In 2014, sales jumped to $25 million — up significantly from $14 million at the end of 2013. The company's client base includes 18 of the top 25 U.S. wind asset owners, as well as four of the top 10 OEMs.

RENEW attributes that growth and success to its ability to meet a customer's many different needs through its broad range of services spanning multiple functions in the wind energy O&M segment. While in the past, owners had to deal with hiring and coordinating the efforts of multiple service providers, one call to RENEW could now handle the majority — if not all — of their needs.

"There probably isn't any other third-party service provider that offers the same range of services we offer today," said Mikel, RENEW's Chief Executive Officer. "A lot of them specialize in the O&M side or end-of-warranty inspections. We're a one-stop shop. We can manage cranes, perform end-of-warranty inspections and construction services. If something needs to be done, we'll figure out a way to get it done."

Beyond reducing time, effort, and scheduling, that philosophy translates into cost savings for the owner. "It's that type of quality and innovation that our customers are looking for — that we can do uptower repairs and minimize that crane cost. In the past, a lot of these gearboxes were just coming down-tower, getting sent to a shop and rebuilt, and just put back in," Mikel said. "Our philosophy — not only in the gearbox, but with the generator or any other type of major component — is to do what we can to minimize that cost to the customer."

"It's a little bit of a different business model from that standpoint," Fish added. "We provide a broad level of services to the wind industry. That is a little unusual for a company of our size, but it has worked out very well."

RENEW's services segments include: construction and field services; remanufacturing; specialty field services; operations & maintenance; supply chain services; and asset management. Recently, RENEW has added composite/blade services and mobile oil changes to its services portfolio. (Comprehensive services listing located adjacent to this article.)

Regarding the level of services and type of services that we provide, we started out really with construction support," Fish said. "We also have our specialty field services, which

comprises of major corrective work, end-of-warranty inspections, some mobile oil changes, and a variety of uptower field services — primarily focused on the gearbox."

The company's 32,000-square-foot facility in Sioux Falls is also home to its gearbox remanufacturing facility. There, customer gearboxes undergo a complete remanufacturing process—from teardown to assessment and engineering to rebuild.

"With our remote locations, we have about 100 turbines that are under long-term O&M contracts on various terms of three to ten years. Recently, we've also added supply chain services and support.

"Late in 2014, we also added field blade services. We acquired a small field blade service that was based here in Sioux Falls — Logical Energy Solutions. That acquisition further broadened our service offering to the industry."

Performing those services requires a lot of skilled manpower — often in situations and environments that can be dangerous.

RENEW considers employees its primary asset, and has built a strong safety culture into the fabric of the company. In October of 2014, the company was recognized by the South Dakota Safety Council with a Meritorious Achievement Award for its workplace safety program. At the time of this writing, RENEW had celebrated its 661st day without incident.

"We have a very strong safety track record, and we continue to emphasize a strong safety program," Fish said. "Even though we've gone through a fairly steep growth pattern, we've been able to really embed a safe culture within our organization. We believe that safety is not only good business for our customers, but obviously it's good for our employees, and for the company."

Further illustrating its commitment both to its employees and to the Code of the West, RENEW in December 2014 began an employee stock ownership program. "We are in the process of becoming an employee-owned company also," Fish said. "We believe that's a very good business model for us, and that it will align our customer-shareholder (which will include our employees) interests on a long-term basis.

Regarding the employees' roles in living and communicating the Code, Mikel said: "Employees are the face of RENEW. When they're out in the field and they're living by these ten principles, our customers see it, and that's why we get a lot of return calls. It's our employees, our technicians that live by this every day and customers understand that."

And for what's next for the growing service provider, the company is optimistic about its future in the wind industry.

"We think that the industry — services for the installed base — is going to grow long-term at about a six percent clip," Fish said. "Maybe six percent isn't all that impressive a number, but when the general economy grows at about two percent, that's a pretty attractive metric. The installed base is aging also. The installed base creates the opportunity. We're obviously not an OEM, but we also see that the OEMs have less interest in the older projects. Once they get to be over five years old, we're very competitive."

"That's why we're in this business." Mikel added. "We're looking long-term. How can we keep these turbines running through their 20-25 year life cycle."

For more information on RENEW Energy Maintenance's portfolio of wind energy maintenance, repair, and asset management services, call (605) 275-9666, or visit them online at renewenergy.com.

RENEW Energy Maintenance Services Portfolio

O&M Services

- Fixed-price preventative maintenance schedule compliance
- Operations staffing
- Labor support
- Parts tracking/sourcing
- Site supervision, production reports, safety compliance
- 24-hour response, shift scheduling

Construction & Field Services

- Project management
- Turbine assembly
- Quality assurance / quality control
- Commissioning
- EPC and BOP roles

Specialty Field Services

- In-field repairs
- Unscheduled events
- Engineering
- Diagnostics
- End-of-Warranty inspections

Remanufacturing

- "Dirty Room" (receiving, staging, teardown)
- "Clean Room" temperature-controlled, clean environment
- Test stand capable of 300 hp load test
- Oil conditioning system (ISO 4406 standard)
- Condition monitoring equipment
- 13,000-square-foot warehouse w/storage

Component Supply

- New/refurbished gearboxes
- New/refurbished main shafts
- Gears and Bearings (complete sets or single-source)
- Gearbox accessories
- Pitch and Yaw drives
- Fastener Kits
- Consumables

Asset Management

- Production monitoring and reporting,
- Safety compliance
- Preventative maintenance scheduling
- Quality control
- Component monitoring
- Collection system and interconnect management
- Accounting services

Composites/Blade Services

- Blade inspections
- Blade repairs
- Cleaning
- Manufacturing Services
- Special Services

Mobile Oil Change Services

- Two fully enclosed trailers with heaters.
- On-board 4-7 micron absolute filters
- Individual tank filtration (new, flush, and rinse)
- Oil temperature control
- Online particle counter for new oil
- Three separate lines, and four separate tanks (used, new, flush, and rinse)
- In-ine magnets on used and flush lines
- Advanced Donaldson filtration down to ISO 4406 standards

Safety considerations for the offshore wind site

Proper planning for lifting and transport yields safety and cost benefits

By Alexander Heitmann and Björn Kramer
TÜV SÜD Industrie Service

Man and materials must regularly overcome around 90 meters in height to access the nacelles of offshore wind turbines for installation, maintenance and servicing activities. Lifting equipment, service lifts and ladders assist in carrying workers, equipment and heavy components. But what about occupational health and safety?

Lifting and material-handling equipment are used not only onshore for heavy-duty work. They also play a significant part in the installation, servicing, and maintenance of offshore wind turbines far out to sea. To cope with these tasks, all wind turbines nowadays come with cutting-edge lifting and material-handling equipment. However, the environmental, ambient and operating conditions involve specific risks, thus imposing very special requirements on components and occupational health and safety. Workers must be able to get safely from the service boats to the nacelle while safely moving loads that are often very heavy.

In concrete terms this means that workers at sea must be able to safely transport, say, a hydraulic cylinder with a weight of around 600 kg, even with the boat rocking in high waves, the entire tower oscillating in the wind and the loads swinging from the suspension hook. These conditions involve increased danger of impact and crush hazards because even the firm footing required by accident prevention regulations for manual lifting of even lighter loads of up to 25 kilograms cannot be guaranteed.

Challenges in operation

The main dangers are not caused by the installed lifting equipment, service lifts and ladders themselves, which are all state-of-the-art. Rather, practical experience has shown that more attention should be paid at the planning stage to the different conditions for offshore wind turbines compared to the onshore sector, with a view to optimizing transport processes and improving safety levels.

One example concerns a lift's long trailing cables and power lines. In an offshore wind turbine these cables do not simply hang vertically, but follow the oscillations of the tower. During operations, these cables may become entangled around ladders or get caught on components, causing hazards for the lift. The trolleys of the lifting equipment are a further example; unless they are restrained by braking and locking mechanisms, acceleration forces will cause them to move unexpectedly in their guide rails

Safe passage from service boat to nacelle

A further safety-relevant aspect has emerged during the operating life of the first offshore wind farms: there is also room for improvement in the systematic interaction between individual lifting devices and components, which should become a focus as early as the planning stage. Ideally, there should be a continuous transport chain for lifting heavy parts and components from the boat to the nacelle. Often, however, the transport chain is already interrupted at the entry to the tower, because the crane boom is too short to bridge the entire distance at the base and there are no robust and suitably marked anchorage points to transfer the load. The workers, who must find a solution under constant time and cost pressure, are forced to rely on their resourcefulness and talent for improvisation and sometimes resort to very risky and dangerous maneuvers to move the loads manually. The same phenomenon can be observed during many activities in the nacelle, where the narrow confines and the strong oscillations of the tower expose workers to even higher risks.

In recent years the industry has taken a greater interest in these issues and incorporated many aspects in current planning and design as lessons learned – not least because improved health and safety also offers potential to reduce operating costs. After all, well thought-out and smooth transport processes not only reduce the accident risk, but also considerably speed up work at the turbine; the risk-fraught scenarios described above are generally unnecessarily time-consuming or may even require temporary shutdowns. The cost-intensive mooring times of service boats are reduced significantly and the teams can complete more work more safely in the same period. Ultimately, then, optimization of transport processes at the turbine is a key factor in continuing the improvement of competitiveness of offshore technology and reducing the costs of power generation.

Optimized transport processes cut operating costs

In other areas too, pioneering work is being performed by those involved. The wind energy industry only moved into offshore operations around a decade ago; for this reason, the standards involved in this new industry sector must undergo continuous advancement and are regularly reviewed for this purpose. Recent years have shown that the mature technology generally installed in offshore operations, while eminently suitable for onshore service, required improvements before it could be used at sea. One such improvement is anti-corrosion coating to provide protection against the aggressive weathering of the salt-laden sea air. This also impacts significantly on transport processes, because adequate corrosion protection can ensure that lifting equipment and its components, such as brakes and gears, permanently function correctly and reliably — and thus guarantee their safety.

The shipbuilding and oil and gas industries apply stricter standards based on decades of experience with offshore conditions. However, their implementation would involve significantly increased costs. While these standards apply to far harsher conditions and it is unnecessary to adopt them unchanged, in many cases they can serve as a useful basis for alignment with the requirements of the offshore wind power industry, which are not reflected by their onshore counterparts

Conclusion and outlook

In recent years the offshore wind energy industry has made enormous technological strides in solving the challenges posed by operations at sea. Practical experience has shown that the design and structural integrity of the turbines, the transport and installation of large-size components and turbine technology can all be mastered – but it also reveals that transport processes involved in the installation, maintenance and repair of the turbines can be optimized and improved from the perspective of safety.

Many of these safety-relevant aspects have only become apparent during operation of the wind turbines. Given this, the time has come to address occupational health and safety and transport-process optimization in this context with more intensity. For example, hazard assessments performed during the planning phase can help to ensure that the components chosen are designed for safe offshore operation with respect to both ambient conditions and to potential situations arising during work on an offshore site.

— Source: TÜV SÜD Industrie Service

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Sage Oil Vac has been serving the wind industry for a number of years. Can you tell our readers a little about the company's product offerings?

In addition to our Gear Oil Exchange Systems (GOEX), Sage Oil Vac manufactures mobile lube equipment for fluid handling and transportation in a variety of industries. Those industries include everything from oil and gas, agriculture, and construction to specialized military systems. We strive to give our customers choices, and in 2015, we plan on launching several new products for our wind industry customers that will include a truck-mounted system and a tote system among others. We will also introduce several improvements to our flagship system that will make it lighter, faster, and more user friendly.

How does using the exchange system for gearbox oil changes differ from the traditional method?

Traditionally, the oil was exchanged using five::-::gallon buckets that were hoisted up and down the towers. Most wind turbine gearboxes hold 80 gallons of oil or more, so countless man hours and resources were wasted. Not to mention, this practice was very unsafe and highly inefficient. The traditional method also never offered a flush and rinse of the gearbox, which is vitally important when it comes to gear oil particle counts.

In some parts of the world, the oil is never changed until a gearbox failure occurs. In China for example, the conditions inside some of their gearboxes is shocking. I recently traveled to Beijing to train customers on our system and to educate them about the physical and financial benefits of gear oil exchanges. Since then, our systems have grown in popularity and they have quickly adopted our O&M best practices.

What are the practical, physical benefits of using the GOEX to perform turbine gearbox oil changes?

The two greatest physical benefits to utilizing our system are clean oil and extending the life span of the gearbox. New oil is typically dirty, and our system uses a 3-micron filtration system to filter new oil to required ISO levels before it touches the gearbox. Oil samples taken from the gearbox after the use of our system have consistently shown a drastic reduction in the amount of contaminants such as dirt, iron, and wear particles. If your gearbox fails, the cost associated with replacing it can be upwards of half a million dollars. Owning or renting an asset like our Gear Oil Exchange System coupled with a pro-active approach to maintenance equates to improved reliability and a higher ROI.

How does that translate into operational benefits, as far as maintenance schedules, downtime and labor savings, extending equipment lifespan, etc.?

Sage Oil Vac strives to provide our customers with most efficient, cost effective tools on the market today. Oil changes, joined with on-site repairs, used to require larger crews, longer downtimes, and more money. When used properly, our systems can transform a messy, cumbersome 8-hour oil change job into a productive, multifaceted success. A preventative maintenance schedule is imperative when it comes to reducing wind turbine downtime. That's why our customers make effective use of their time, and operate our system while performing other required routine maintenance.

Do operators see a cost savings as a result of using your equipment to streamline those processes?

Simply put, most O&M service providers in the market today are multitaskers, and any piece of equipment that can maximize time and increase efficiency and profitability is vital to their success. Our goal is to create and construct tools that do just that. Time is money, and our pioneering GOEX systems cut oil change procedure time by more than half. Our dynamic line of products offers our customers the opportunity to optimize their business processes and customer services. Oil changes can be performed year round through the use of our enclosed and insulated GOEX systems. The Sage Oil Vac GOEX Offshore system can create new prospects for companies looking to expand out to sea. The possibilities are boundless.

What are the overall long-term benefits that justify the use of the system?

The Sage Oil Vac GOEX System has been used on basically every major wind turbine OEM across the globe. Gearboxes are generally the single largest issue when it comes to operations and maintenance cost. Addressing the long term issues such as oil contamination control, abrasive wear, and corrosion can result in an increase in energy production and gearbox reliability. The use of our system, joined with oil change procedures written by the top gear oil manufactures of the world, has helped to reduce the amount of common maintenance problems previously seen in the wind industry.

Is the GOEX only available for purchase, or do customers have the option of an equipment lease program?

Yes, we currently offer a rental program to US based customers through our headquarters in Amarillo, Texas. SOO Foundry & Machine is our authorized dealership in Sault Ste. Marie, Ontario, and they offer rentals to Canadian based customers. If anyone is interested in our rental program, please feel free to contact us at any time.

Every wind farm and maintenance protocol is different. How do you address situations where customers may need a custom set-up?

Sage Oil Vac takes pride in the fact that our company was built on innovation and the development of solutions. We are contacted by clients on a daily basis who need our assistance with unique circumstances. We thrive on the opportunity to tackle new challenges head on, and we do so by identifying the voice of our customers. If any current or prospective customer has ideas on improving processes that will maximize the impact on their oil exchange method, we would love to hear from you.