Driving Down Offshore Wind Substation O&M Costs: CMS and SCADA

Every dollar spent on a wind farm once it has been built and commissioned affects the bottom line, and therefore, efficient low operation and maintenance (O&M) costs are crucial to the profitability of wind energy. This is especially evident in light of the fact that the UK government has recently introduced regulations that require operational and maintenance costs to fall by 25 percent by 2020 in order to make offshore wind more financially sustainable for businesses and more affordable to consumers.[i]

Further, up to 90 percent of all offshore wind farm insurance claims are related to medium voltage and high voltage cable faults. Many experts, including those from HVPD Ltd in the UK, estimate that these types of faults are preventable, and that some of the most significant savings the offshore wind industry can achieve will come from a holistic approach to condition monitoring using technology to predict when preventative maintenance interventions will be required to avoid costly faults on the network.


Image via Flickr: Jedimentat44

One method to ensure operation and maintenance costs remain manageable and don't bite into the bottom line is to use a condition monitoring system (CMS) for critical networks. By alerting operators of potential problems by providing a comprehensive overview of current function and condition, this type of technology allows operators to stay ahead of the game. Likewise, SCADA (supervisory control and data acquisition) systems are used for both high voltage and medium voltage substations to remotely monitor and acquire information about the substation's function and performance, but to an even greater depth than conventional CMS options.

Boosting Wind Farm Reliability and Performance with a CMS

Condition monitoring systems are another method of improving the performance of a wind farm. Using accelerometers, oil particle counters, and many other points of data collection, a CMS offers several significant cost benefits, not least of which is providing early warning signs of pending problems.

In one case study offered by Wind Systems Magazine, three wind farm scenarios were compared, with data drawn from many real-life US wind farms. In the scenario with a CMS installed, early warning of a bearing failure was detected by the CMS. Had the bearing failure not been detected, high costs of crane mobilization and repair and replacement costs would have significantly cut into the bottom line.

In this example, the initial savings offered by having a CMS were $40k where bearings were readily available, but could have been as high as $300k if the maximum downtime was prevented. Additional savings were estimated in the range of $150k to $400k by mobilizing the crane only once and saving significant downtime. Over three to four years, the CMS offers even more savings by providing information about retrofit requirements as well as minimizing wear on the gearbox and generator.[ii] Similar savings, no doubt, would be achieved for offshore substations.

In another case study, this one presented by HVPD, holistic condition monitoring technology was applied to subsea MV and HV cable networks for offshore wind projects. Infant mortality of cable failures was studied to determine the potential for a CMS to provide early warnings against incipient cable insulation faults to direct preventive maintenance to avert unplanned outages.

They found that only with cross-correlation of all condition and state parameters could there be an adequate level of diagnostic data for cost-effective implementation of preventative maintenance schemes. In other words, a holistic system is required including the integration of power quality, partial discharge, cable sheath current, weather/tidal data, power flow, and overvoltage/overcurrent events. Given the fact that, when compared to onshore wind farms, offshore wind farms incur costs that are 10 to 50 times higher for outages due to cable failures, the need for holistic monitoring is substantially more important. Conversely, the potential for O&M savings with a holistic CMS are significant.[iii]

Introducing SCADA Systems for Greater Predictive Ability

Similar to a CMS, the core functionality of a SCADA system is communication. Though the first versions of SCADA systems relied on wiring to transmit data to a point where it could be bundled together for analysis, today's more advanced SCADA systems use fiber optic connections for extremely fast, reliable connections. The information is displayed on sophisticated user interfaces graphically to illustrate the real-time state of all elements monitored by the system. Issues such as electrical faults can be quickly pinpointed within a few seconds, allowing maintenance teams to be deployed quickly to avoid downtime as much as possible.

Using SCADA allows wind farm operators to remotely monitor the systems from a central location, including multiple substations on one plant though some wind farms require more than one SCADA system. Today's SCADA suppliers have all agreed on a standard communication protocol known as IEC 61850 which has vastly improved the results across the industry.

One of the most recent big projects to be announced for offshore wind substation installation is that of the Van Oord Luchterduinen offshore wind farm in The Netherlands. The project, which will include 43 turbines for generating enough electricity for 150,000 homes, will include a SCADA control system designed by CG.[iv]

Alstom's SCADA System

WindAccess is Alstom's SCADA system. It's designed to work on open communication protocols to provide easy integration with other renewable assets. Collecting information such as substation operation, meteorlogical mast data, and so on, WindAccess analyses information to help system operators improve the performance of their farms. It also integrates with CMSs and can incorporate information from across an entire wind farm including substations to make it possible to operate the wind farm like a conventional power plant at the grid connection point.[v]

SCADA systems are extremely useful when it comes to interpreting sets of parameters to compare hundreds of channels of information to find related problems. For instance, "a high yaw misalignment will reduce performance, but also effect the health of the turbine longer term, as the rotor bending moments are increased and accelerate structural fatigue for all major components in the load path: pitch bearing, rotor hub, main bearing, main shaft, main frame, yaw bearing and depending on the drivetrain architecture also the gearbox."[vi]

For example, a European offshore wind farm was analyzed after a high speed shaft bearing was replaced. Using a Romax InSight SCADA system after the failure, researchers were able to determine that temperatures had been rising, though this was not detected at the time, resulting in a gearbox failure within 12 months. Since the gearbox could not be replaced for 7 months after failure due to the offshore location of the turbine, the downtime costs were more than $1 million.[vii]

Further, SCADA may become increasingly important as smart meters are used more extensively in the electricity market. In fact, by synchronizing SCADA with smart meters, and combining them with other technologies such as GIS systems, distribution networks could be optimized to reduce network losses by improving system load factors, combining capacitor bank control, allowing for demand response applications for asset management, and balancing system voltage.[viii]

Lessons Learned for SCADA Systems

Despite all of the benefits of SCADA systems, they do present some challenges that the industry will need to address in order to instill confidence. Security risks are of particular concern. One of the main security risks with high-tech systems such as a SCADA is the opportunity for well-organized hackers to take control over energy systems remotely, even from outside a business's security zone.

This is a vulnerability about which some companies have already become aware the hard way. Two recent examples illustrate the dangers involved when SCADA systems are not properly protected. The first relates to Telvent (owned by Schneider Electric), a smart technology vendor that supplies projects in the US, Canada, and Spain. On September 10, 2012, the company reported to its customers that hackers had breached their firewall and accessed OASyS SCADA system project files. The perpetrators, believed to be a Chinese hacker group known as Comment Group, also left malicious software in their wake. Project files may contain information on a customer's network and operations as well as architecture.[ix]

Similarly, researchers in Finland recently evaluated Internet-facing SCADA systems and found that there were thousands of unsecured systems – 2915 in all for systems ranging from building automation to transport to water supply. Researchers expect that there are even more vulnerable systems since their survey included an estimated 30 percent of all Finnish IP address space.[x]

Nevertheless, risks are being addressed by new innovations in security and data protection. Vigilance in this area requires companies to assess the IT architecture and equipment of current systems against existing vulnerabilities in light of government legislations and regulations for privacy and data protection.[xi]

Leaping Over Challenges to Achieve Lower O&M Costs Through Better Communication

If offshore wind farm operators hope to meet new standards such as those being introduced in the UK for lower O&M costs, they will need to address the issue with better communication. And for that they will inevitably have to rely on advanced technologies such as CMS and SCADA systems. No doubt the industry will continue to lurch forward, learning as it goes how to supply the best, most comprehensive information without putting critical energy supply systems at risk of being controlled by those with malicious intent.

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