VENN Design SOLUTIONS

Tower Sway Sensor Implementation Case Study

Venn Design Solutions and Lillie Systems collaborate to develop cost-effective tower-sway sensor for Orenda Energy's 50kW Skye Wind Turbine fleet.

> "As to the project, I also really enjoyed working on it […]. It is not so often we get the chance to collaborate on projects in this way and seeing some of the results, so hopefully there will be more of this to come in the future."

Jacob Lillie,
FOUNDER AND CEO, LILLIE SYSTEMS.

Orenda Energy Solutions are manufacturers of the Skye™ Wind Turbine, an innovative 50kW wind turbine which employs a powerful 4th generation SCADA system for remote monitoring, control and preventative maintenance. They wanted to add tower-sway measurement to the nacelle sensor array, further enhancing the Skye™ Wind Turbine's reputation as a safe and reliable system. COTS solutions were identified as expensive and difficult to retrofit into existing sites. Venn Design Solutions agreed to investigate ways of designing a cost-effective solution that would easily integrate with the existing control system.

Wind turbine monitoring systems typically rely on vibration measurement utilising multi-axis accelerometers as a means of detecting abnormal operation but monitoring vibration levels can be complex, often requiring high speed data-capture and sophisticated post-capture analysis. Correlating fault sensor outputs with turbine measurement signals such as wind or rotor speed in real-time to correctly identify an abnormal condition is a challenging task, but necessary to reduce false-positives resulting in lost revenue opportunities due to unnecessary wind turbine stoppage.

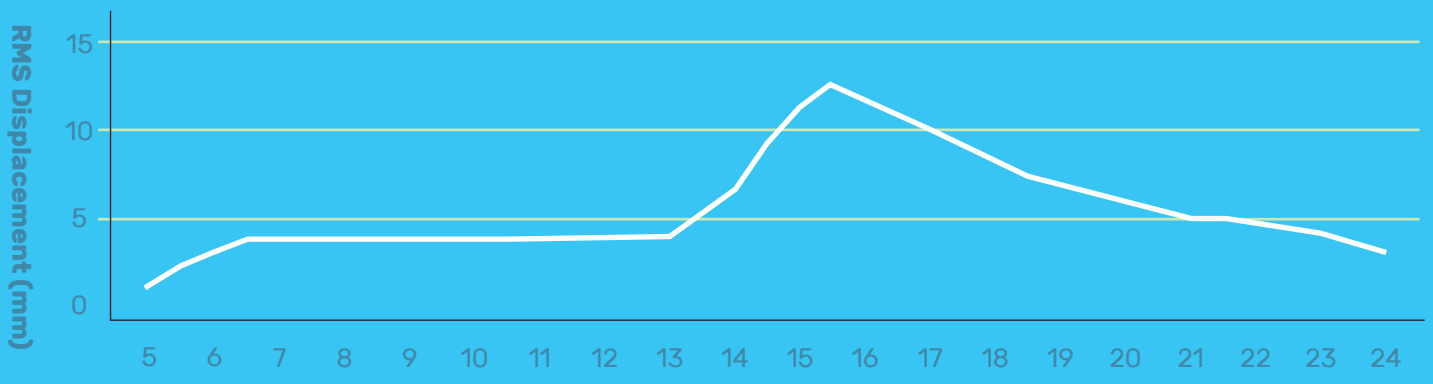
Orenda Energy needed a cost-effective solution to measure low-frequency (1Hz) tower-top displacement to positively identify if the turbines were operating within predicted limits, that could be installed in their fleet with minimal effort. Commercially available displacement sensors either could not operate at this low frequency or were too costly/complex for implementation into the Skye™ Wind Turbine architecture.

Lillie Systems offers a 3-Axis ±2g Intelligent Accelerometer / Tilt sensor with CAN bus and logic output that was identified as having the required measurement accuracy and internal processing power to be customised for the tower sway application. Founder and CEO Jacob Lillie agreed to collaborate with Venn Design Solutions on the development and testing of a tower-sway algorithm for integration into the A2C-TRI-M12 sensor. This algorithm had to be compact enough to be able to compute real-time tower-top displacement with a sub-second response time and 1 mm resolution to permit immediate detection and shut down in the event of abnormal operation.

> "The staff in Venn Design Solutions were great to work with — they understood our requirements, and worked to meet them in the most cost-effective manner without making concessions."

Gerry Lalonde,
CEO, ORENDA ENERGY

To accomplish this, an A2C-TRI sensor and CAN bus datalogger were first installed into one of Orenda Energy's wind turbines to capture tower acceleration data for post-acquisition analysis. Utilising this high-speed data, Venn Design was able to derive a reduced set of equations that once implemented into the A2C-TRI sensor microcontroller code enabled it to convert acceleration measurements to tower-top displacement in real-time.



Once programmed with the new measurement capabilities, the A2C-TRI sensor was connected into the existing Skye™ SCADA sensor array, permitting data collection over a period of several months. This data was then used to easily identify a strong correlation between wind speed and tower-sway under normal power production. Analyses such as this will permit Orenda Energy to easily optimise fault detection limits of tower sway conditions, minimising the reporting of false-positives and subsequent loss of power production due to unnecessary wind turbine shutdown.

This new sway sensor can easily be added to any Skye™ Wind Turbine's SCADA sensor array, permitting remote monitoring and data collection of tower-top displacement to analyse long term changes in characteristic performance, as well as real-time fault detection and safe shutdown of the wind turbine in the event of any abnormal tower motion.

VENN Design SOLUTIONS

For further information, or to discuss your design requirements, please contact Venn Design Solutions at **info@venndesign.ca**