Catching the wind with laser technology

The wind industry could soon be using a new type of innovative technology that has more to do with lasers than ecology. A new laser system that can be mounted on wind turbines allows them to prepare for the wind rushing toward their blades. These lasers act like sonar for the wind, bouncing off microscopically small particulates and back to a fiber optic detector. PES investigates…

With its headquarters just down the road from Washington DC, Catch the Wind Inc. (CTW), is a high-tech company based in Manassas, Virginia. The company was founded in 2008 to develop and manufacture laser-based wind sensor systems with a primary focus on developing technology to serve the wind power generation industry. CTW is actually a spin-off corporation of Optical Air Data Systems, LLC (OADS), an R&D firm supporting the US defense industry. OADS has been developing next generation laser sensors since 1990 for use in commercial avionics and military applications such as the LandSafe Aircraft Survivability System.

OADS has since become a leader in pulsed fiber optic laser sensor research and development.

Created as a separate company, CTW serves the commercial market sector for laser-based wind sensor systems – recognized as the 'gold standard' in wind measurement. Because of the impact this first-ever, portable laser wind sensor will have on wind power generation efficiencies, the company is focused on becoming a major contributor in providing clean, renewable energy. CTW recently deployed a laser-based wind unit on a Nebraska Public Power District turbine. This increased the production of the unit by more than 10 per cent, according to a white paper issued by the company. If those numbers held across the nation's 35 GW of installed wind capacity, the LIDAR (Light Detection and Ranging) sensors could add more than 3.5 GW of wind capacity without adding a single additional turbine.

The Vindicator fiber optic laser wind sensing system measures real-time horizontal and vertical wind speed and direction at varying ranges out to 300 meters ahead of the sensor. When mounted on a wind turbine nacelle, this forward-looking information facilitates smarter turbine control for

increased power output and reduced turbine stress. The sensor design is based on state-of-the-art fiber optic laser technology developed and patented at Optical Air Data Systems LLC.

Using concepts of Doppler radar, with light as the medium of detection, the Vindicator system quickly senses air particle movement. The system processor analyzes the air particle movement, producing speed and direction data for wind field determination. The first production variant of the Vindicator system will sense the wind at ranges out to 300 meters; as industry learns how to utilize and integrate this new technology into various control and forecasting applications, longer ranges can be incorporated.

A CTW spokesman said: "The system works by integrating with a wind turbine's control system, or electronic brain. The Vindicator LWS's fiber optic lasers sense the wind that is approaching the wind turbine at various ranges and reports this information to the control system in sufficient time to adjust and orient the turbine. Utilizing control algorithms, the control system will decide how and when to best exploit the wind that is approaching the turbine and command internal systems to either change blade pitch and/or reorient the entire nacelle in an effort to maintain efficiency, reduce the stressing effects of wind shear and gusts, or maintain a constant blade speed. Without the Vindicator laser wind sensor, wind turbines will continue measuring the wind after it passes the blades and will be out of phase with changes in the prevailing wind."

"This is what they call disruptive technology," added William Fetzer, Vice President of Business Development at the company. "There are roughly 80,000 to 90,000 wind turbines out in the world, and they don't have this technology." In many cases, cup anemometers, which took their current form in the 1930s, are still used. They work well enough, but have to be positioned behind the blades, which subjects them to turbulence. And, importantly, they can only tell you how fast the wind was blowing after it has passed. That doesn't help you with a freak gust of wind or any of the odd behavior that renewable energy developers have caught the wind exhibiting.

CTW's Fetzer is optimistic about the company's chances of success. "When you do disruptive technologies, it takes time," he said. "People don't believe that things are as bad as they are until they can see what we can do." It probably helps that they don't need the wind turbine manufacturers to incorporate their technology to jump-start their business. They've got a bolt-on solution, meaning it can be attached to existing turbines. They don't need manufacturers to incorporate their product to sell it to wind farms. Still, some wind farmers may worry that the warranties they have on their turbines would be voided by adding a LIDAR system. Fetzer said CTW was currently working out these potentially complex warranty issues.

General Electric, which is the largest wind turbine manufacturer in the US, is not using or developing LIDAR specifically, either. CTW did recently sell one of their machines to a large, unnamed turbine manufacturer. Though CTW is not yet discussing pricing for its products, Fetzer maintains that their customers will make their money back in the three to five-year range that he says wind developers are looking for. The 2005 NREL report calculated a preliminary cost for a generic LIDAR system of less than $95,000, once production was up and running. The development of controls for capturing most energy from the wind has been a constant theme in wind energy research. However, it's not always the company that develops the technology that reaps the rewards from its commercialization. Wind turbines in the 1980s struggled hugely to convert the wind's gusty capriciousness into reliable rotary power.

At the time, the turbine's rotor had to turn at a constant rate. Researchers realized that their machines could operate over a larger range of speeds if the rotor could speed up or slow down in response to the wind, but they would need power electronics to translate the power into electricity suitable for the grid. A multimillion dollar R&D program launched by US Windpower and the Electric Power Research Institute to commercialize a variable-speed rotor resulted in a mostly defective turbine design that helped push US Windpower out of business. The variable-speed rotor went on to become a standard part of wind turbine designs. CTW is patently hoping not to suffer the same fate. The company is exploring a variety of business models including sharing the revenue from the extra power it says the systems can generate. If they don't generate any more electricity, the wind turbine owner doesn't pay anything. If they do, Catch the Wind gets half the take. "It's a good value proposition," Fetzer said.

"Consistent with our strategy, our focus in our first full year of operations centered on validating the effectiveness of our laser wind sensing technology," said Phil Rogers, CTO's President and CEO. "As evidenced by our trial programs with Nebraska Power, the Wind Energy Institute of Canada and others, we successfully demonstrated that our technology enables wind farm operators to increase energy output while reducing operational costs. These results, coupled with our ongoing evaluation programs with TransAlta and Gamesa, will help to pave the way for commercialization of our wind sensor products in 2010." ■