FLUKE®

Today's top question in green-energy production:

Where to place the turbines

Application Note

Although computer systems at the National Weather Service rely on data from radar, satellite, images, computer models, weather balloons, and even measurements from commercial jets in flight, today's forecasts "can dazzle us with dead-on precision one day and be completely off the mark the next." That's the assessment of Anastasia Kusterbeck of the ever-enduring Old Farmer's Almanac.

But predicting wind patterns, by comparison, is closer to an exact science, says Robert Powell of Class One Technical Services (CTS), an environmental sciences firm that is helping the state of New Mexico determine the optimum conditions for harnessing power from wind.

Powell's endeavor involves the aid of a small, self-contained mobile unit called Atmospheric Research and Technology (ART) Model VT 1 SODAR (Sonic Detection And Ranging). The SODAR is a self-contained, battery-powered mobile laboratory incorporating 48 integral speakers for sound wave transmission, and sophisticated electronics and modeling software for profiling wind speeds and directions. "We don't have line power and we don't have hard-line communication such as a telephone line," he says. "But in New Mexico we can go virtually anywhere—we have seemingly unending sun to supply the power, and under the right conditions we also have wireless communications." Wireless, he says, allows the team to verify that SODAR is operating within the specified parameters, and also to provide the customer with real-time data if it is needed.

CTS is now in phase two of a state-funded project to specify the ideal locations and exposures for production of wind-based power. In phase one, Powell and his colleagues certified a wind resource site based on storing over a year's worth of data from the site itself and the assistance of wind field maps using advanced computer modeling. In phase two, the team will use the site's resulting "wind regime" to identify other locations with the same wind regime and the same ideal conditions for placing a series of turbines. He explains that the team uses remote sensing with SODAR, along with tower-based modeling, to derive its data and testing of critical electrical units to high levels of accuracy is paramount.

First phase: Testing phase angles

Although voltage and frequency are key signal parameters in success with the SODAR, the first critical component is phase angles. The SODAR emits three pulses in quick succession. The first is transmitted vertically into the air, the second is transmitted east, and third is transmitted north. After each signal is transmitted, the SODAR listens for the return signal. "The signals pointed east and north are phase-angled at 90° to the vertical signal, and they are all phase-angled at 90° to each other. It's critical that we

know that the angles are phased properly—that's our first requirement for the Fluke ScopeMeter® Test Tool."

Powell's team uses commercially available modeling software to aggregate the three return signals and to derive the direction and velocity of the wind. "The software integrates all of those return frequencies, amplitudes, directions, and delay timings resulting from the triggering of the three signals. This is another reason why the ScopeMeter is so important to us—by verifying all of those components of the outgoing signals, we can verify that the return signals are correct."

"We use the ScopeMeter to calibrate each signal," he says. "We use it to measure voltages and validate that the signals are in the proper amplitude, and we look at frequencies to see that the generated frequency expected for a certain set of parameters is the frequency that is actually going out."

Towers and trailers

Every wind measurement the team makes is tied to either a set of tower-based monitoring devices or remote sensing. "We use the SODAR for remote sensing—where siting a 100-meter tower would not be practical—and that's where we rely on ScopeMeter to monitor this comprehensive, high-precision environmental-testing setup that has to move across bumpy terrain in remote locations."

In many cases, he says, the team needs to monitor wind at altitudes inaccessible from a tower. "We often need to know what is going on at 10 meters, but we may also want to know what's going on at 60 or 200 meters." To gather that data reliability and cost-effectively, he says, requires a solution that does not involve constructing a tower and finding a landline power source, both of which are often out of the question. Not to mention that a 200-meter tower would involve a major feat of engineering.

"Anywhere that we can pull a trailer with a truck, within a very short period of time we can be profiling the atmosphere," he says. SODAR is essentially an 8-foot by 14-foot mobile lab with speakers, electronic controls and a laptop computer. The computer sends a pulse out to the speakers, which translate the pulse into a sound wave. The sound pulse is transmitted through the air, and SODAR listens for return signals 'bouncing off' the air.

New directions in monitoring

"When we have fairly high humidity, or if we have turbulence, the air has greater density, allowing sound waves to bounce back," says Powell. SODAR measures the Doppler shift of the echo for each of the three pulse directions. "From that we can get the speed and direction of the wind. The beauty of the setup is that we measure altitudes between 30 meters and 300 meters, with signal capture every 10 meters. We may also attach a temperature sensor and a precipitation gauge to the SODAR data logger, allowing us to get simultaneous readings from those sensors."

As phase two of the research, the team is selecting three locations for potential turbine siting, and at the first site SODAR will be located with a tower. The goal: to collect 500 hours of data, and to see how well the SODAR and tower data correlate with each other. "We would then select two spots, each of them a little farther away from the tower, move SODAR to each new location, and see if we can use our source data to predict what the wind regime will be over a greater distance. In short, our goal is to find two additional locations where we can get the same desirable wind regime that we have found at the location of the tower."

It is not enough to collect data for just a day, says Powell. "We are looking for an annual wind profile. That obviously means monitoring the location for a minimum of one year to verify that the site really pans out. We also use other atmosphere models—with the end goal being that the data we collect is not an aberration, but is actually the norm for that location."

Committing data to memory

According to Powell, step one in using test equipment with SODAR is to verify proper calibration of their wind-monitoring hardware. "I'm not highly conversant with scopes, but what I do know is that the calibration we perform with ScopeMeter has really backed up the validity of the data we record. Of course, as a relative newcomer to testing—I'm an environmental consultant, not an electronics technician—physical setup of our equipment is paramount. It's the very lifeblood of what we do and the reason we can take our data to the state and say 'You can rely on these findings.'"

ScopeMeter setups make the job easier and more repeatable, says Powell. "It's nice because we have to program all of these phase angles, trigger delays, frequencies and amplitudes into flash memory, and ScopeMeter has an intuitive program interface that simplifies matters. At the job site, we pull up the appropriate program, attach the test leads, and we're ready to go. In addition, power outages are not an issue: our setups will still be there, and that makes our entire team more efficient."

The state of New Mexico has funded the SODAR project through grants, and the success of phase one enabled funding for phase two. The ultimate goal, says Powell, is to make the storehouse of collected data available to private developers. "Knowing that our data is both accurate and statistically valid for new sites, we're now equipped to continue our mission," he says. "We'll keep going where the wind goes."

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Fluke Corporation
PO Box 9090, Everett, WA 98206 U.S.A.

Fluke Europe B.V.
PO Box 1186, 5602 BD
Eindhoven, The Netherlands

For more information call:
In the U.S.A. (800) 443-5853 or
Fax (425) 446-5116
In Europe/M-East/Africa +31 (0) 40 2675 200 or
Fax +31 (0) 40 2675 222
In Canada (800)-36-FLUKE or
Fax (905) 890-6866
From other countries +1 (425) 446-5500 or
Fax +1 (425) 446-5116
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