Is it broken or is it frozen
and other wind sensor questions.

January, Western New York

It is 6:45, the sun is not up yet and I'm standing in a field in desolate Western New York. It is sleeting. Ice is flaking off my hard hat like gold leaf. The gravel underfoot is covered with ice. I feel like I'm walking on ball bearings. Above us is a skinny communication tower. On the ground we've laid out six booms - the longest booms I've ever seen. 24 feet. They will hold our anemometers and vanes so far from the tower that they could be blessed by the IEC power curve testing gurus. So far from the tower that you need binoculars to see them. OK, they're not that long. Our crew is ready to haul the booms up to 300 feet. Or not. The crew chief reports ice on the tower. As it falls it could break your shoulder. The crew says not today. Maybe they will finish tomorrow. I hear the sound as another thousand dollars runs out of WindPole's bank account.

Later I tell the story to a client, Mike Frerker VP at Invenergy. Deadpan he says, *"Welcome to the glamorous world of renewable energy. Send a photo to the White House."*

The sun never shines that day, so we spend the gray morning laying out the cables, unpacking the PV panels and sensors, testing the communications gear that will deliver data every five minutes. The crew comes back later that week when the ice has melted. The tower gets instrumented. Data flows. One tower done. One down, 579 to go.

This story is not about installing sensors, it is about selecting them. So we have to talk about ice and cables.

Cables & Ice

Cables cost over $1,000 for each site we instrument. So we are very interested in wireless sensors. And we are interested in non-mechanical sensors because ice is hard on sensors. Ice compromises WindPole's mission: meeting developers AND operators need for hub height wind speed data.

Developers are OK with occasional gaps in wind resource data from iced up sensors. Our other customers, ISOs, power traders and wind farm operators are NOT satisfied by missing data. If wind farms are going to compete with dispatchable fossil, nuke and hydro generation, the ISOs and power traders will need dependable hub height data…in real time. All the time. Gaps from frozen sensors are not acceptable. Sleet freezes sensors. Chunks of ice break them. If we had started installing cup anemometers in April, we would not worry about ice. Fortunately we started in January!

We have a sensor test bed on an eighty foot high tower on the roof of our offices. We use it to torture sensors before they go to the field. Right now we have a wireless sensor, an ultrasonic sensor, and a set of vanes and cup anemometers from Second Wind and NRG.

Wireless Sensors

The wireless sensor failed in the first week. Rain got into the internal workings of the device. Flooded it. We're protecting the name of the wireless sensor because we hope the vendor will survive, and we really want to see the next version. We think the water leak can be fixed. Cables are expensive to buy, over $1,000 per site, and expensive to install. And they fail too. Another problem with the wireless sensor is the cut in speed. Because cup rotation needs to power the tiny transmitter in the sensor, the sensor's moving parts have more mass. More mass means a higher cut in speed, one that is more than one MPH *above* the cut in speed for a GE 1.5 MW turbine for example. We'll keep testing the wireless sensor. Call us if you want to get a copy of the results.

Cautious Investors

Two years ago, investors would only finance projects where the analysis was underpinned with cup anemometers. Investors drive the market, so every developer used low end cup anemometers from Second Wind and NRG. No LIDAR, no SODAR, no ultrasonic sensors. They remain too expensive and problematic for long term monitoring anyway. We're looking at $65,000 and almost $200,000 respectively for SODAR and LIDAR. We see some loosening of investor opinions on cup alternatives. But not much. Data loss from icing and broken sensors from falling ice make it worth pushing the envelope and looking at options.

Half way solutions like aluminum cups that are tougher than plastic ones might help. And coated cups designed to shed ice (the R. M. Young Alpine) might have less freezing and higher uptime, but as with the aluminum cups, the improvement seems likely to be modest.

Ultrasonic Sensors

We're testing a Lufft ultrasonic unit which promises to address the problem of damage and lost data from ice. The xxx unit is heated, armored and affordable. Ultrasonic sensors are expensive: $1,000 to $1,500. But we look at a life cycle costs over five years. A cup anemometer with a calibration certificate may cost just $350. But if it fails just once Remember the Western New York site that opened this report? Two of the cups failed due to ice damage in the first month. It costs roughly $1,000 every time we have to climb a tower, so a $350 sensor becomes a $1,350 sensor as soon as it fails and has to be replaced. And that does not include the replacement sensor. Now each sensor costs $1,700. And that makes ultrasonics look like a smart buy. Further, regardless of cost, sensor failure undermines WindPole's mission: dependable, real time hub height wind resource data. So, frequent cup sensor failure is not an option. Incidentally, the ultrasonic sensors need line power if the heater is activated, but can operate with an immense battery and a large PV panel (2' by 3') if not heated. WindPole's standard sensor package uses a small PV panel (1' by 2') and is NOT line powered. Most of this power is eaten up in communications as we poll our systems every five minutes to meet customers' real time demands. So again the ultrasonics raise our costs but not materially.

The ultrasonics boast a 29 year (calculated) mean time between failures. Since they are heated we expect nearly 100% uptime in cold climates. Most important, the ultrasonics are armored. Some ultrasonics in non hostile environments (no tower ice above them)

look like three fingers pointed skyward. But the Lufft device looks like two cereal bowls suspended horizontally with a gap between them. Four sensors on the inside of the lower bowl measure speed and direction. And Lufft claims that the device can measure temperature as well. We don't understand that. So the upper plate may protect the sensor against falling ice. In our field test we are comparing cups with ultrasonics. Both are mounted on the same immense boom that stretches 24 feet from our skinny towers. Results should be available in a few months. Call or email us if you want to see the results of the test. One of the top five wind analyst firms has agreed to analyze data at three of our sites where we're installing conventional cups and vanes AND the Lufft ultrasonic sensor.

Stay posted as we continue our field research on sensors.

ABOUT WINDPOLE

WindPole has a portfolio of almost 6,000 towers over 80 meters from which we are instrumenting roughly 10%, or 580 to be exact. We have sensors at 40, 60 and 80 meters high, with redundant sensors on separate booms at each level. If you are a developers, a wind farm operator, a power traders or grid manager, WindPole has a tower where you want it!

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