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What is openWind? Can you give us an idea of its primary purpose and functions?

openWind is a GIS-based wind farm layout and wind resource assessment software that has been designed primarily with the goal of empowering the user. It is an advanced and complete software solution as well as a toolbox to allow users total control over how best to tackle their wind farm design challenges. It makes extensive use of multi-threading and is built on an open-source code-base that can run on Linux, Unix, or Windows.

What is the difference between the "Basic" and the "Enterprise" versions of openWind?

Our typical users are the biggest names in the industry, so we target the Enterprise edition to address their needs. Rather than selling modules, we provide a supporting relationship in which we improve the software on an ongoing basis and incorporate user requests into the software in a timely fashion. We found that there was a market for a low-cost, off-the-shelf version, which could allow environmental consultancies and small developers access to the core features of the openWind platform including multi-threaded wind-flow model and shadow-flicker analysis.

openWind has recently undergone a significant upgrade. What enhancements and additions have been made?

First, we have incorporated the latest IEC recommendations regarding turbine performance under non-ideal conditions, specifically:

(1) Modeling the effects of non-standard shear across the rotor disk using the rotor equivalent wind speed, and
(2) Adjustment for turbulence intensity

We have also added the capability to read time series of sodar and lidar profiles and multi-level tall tower data into openWind. For the first time, users can really make the most of their remote sensing data in estimating power production. We do this using the rotor equivalent wind speed concept.

We have responded to user requests to include time-series modelling of mitigating effects of wind distribution (which way the turbine was facing at any given day and time and whether the blades were turning) and cloud cover on the amount of shadow flicker encountered at a residence in any given year.

Another significant change is improved GIS capabilities such as integer and floating point value conversion. These tools allow users to easily convert land-cover data to roughness length or vegetation height; or to convert bathymetric data to turbine foundation costs.

We have also added openWind model outputs as shape file attributes so, for example, turbine layers can be exported to GIS including net energy, mean wind speed, cost of energy and so on.

If you were in the client's position, which of these changes would you most look forward to implementing in your operations?

The ability to model the effects of turbulence intensity on energy production will have the biggest effect just now on reducing uncertainty. Users who have lots of remote sensing data (from sodars and lidars), or who observe really unusual shear profiles at their tall towers, will appreciate being able to model the impacts on output. From a practical usability standpoint, improved data conversion and GIS output will be a great benefit.

openWind is targeted toward developers, owners/operators, investors, utilities, governments, and manufacturers. How do these clients benefit from its use?

openWind offers industry standard wind resource assessment methods and energy capture routines along with some of the best performing wake models currently available, which benefit all the groups above. For developers in particular, the ability to optimize the turbine layout taking into account the trade-

offs between energy production and constructibility and cost is hugely helpful. Energy optimization is really only helpful as a proxy for financial viability when working with very small simple projects. Dollars per MWh is the driving metric for energy projects, and openWind allows this to be optimized taking account of BOP design. For investors, improvements in the modeling of turbine performance mean lower uncertainty which should benefit everyone in the industry.

How does the software enhance the combined efforts of those clients in wind energy development in the short and long term?

Our business is based on the idea that our clients are most successful when we empower them both with tools that let them to do the job themselves if they want to, and with expertise to support them where they need it. One of the ways we do this is by sharing openWind workbooks between ourselves and our clients. We have found this has led to improved collaboration and efficiency.

What influences decision making about feature upgrades? How does AWS Truepower work with the industry in developing and upgrading openWind?

Although we like to provide useful and time-saving tools to our users, getting the energy numbers right takes precedence over everything else we do and so, where possible, we want to modify the software to be able to take account of significant effects on energy capture. Right now, the effects of non-standard shear and turbulence intensity are the focus of much discussion in the industry, and the subject of a draft IEC standard, so it makes sense for us to incorporate these proposed methods as openWind makes a good platform to test against real world performance.

In general a large part of our product development is driven by user requests and a big part of this is making ourselves readily available by email, phone, and Skype. We work through problems with our users using shared desktops or by uploading workbooks to a shared, secure FTP space, so any deficiencies in the software become obvious pretty quickly.

We try to respond equally to both internal and external requests for functionality, and in general we see a large overlap, as you might expect, between what our internal consultants and what our Enterprise users want to see as the next development priority for the software.

New systems often come with a learning curve. How does AWS Truepower support the current user's transition to the upgrade? Also, what training and support resources are available to first-time users?

We offer on-site as well as online training to clients. We find that clients generally prefer the online training, as this is less expensive and provides more flexibility in that it allows clients to split a day or two of training into several half-day sessions over the course of several weeks. This tends to be easier to fit into people's schedules and also allows the client to practice what they learn in one session before moving on to the next. We host a blog at blog.awsopenwind.com, which we use to communicate the enhancements in each update and as well as tips and videos to help users become acquainted with new features. We also have a growing number of instructional videos on YouTube, and the trusty user manual and tutorial materials. However, we find in general that people would rather watch a video than work through a tutorial.

As technology advances exponentially, so does the emphasis on taking the technology to the next level. How does openWind fit into the research and academic world?

We find that more and more top-tier institutions are coming to us to get access to openWind Enterprise for research projects. A recent collaboration with MIT CSAIL resulted in them imparting to us the algorithm that optimizes our automated collector system design as part of the optimizer for cost of energy. We are currently providing tools to various industry and research institutions to further research in optimization using the cloud and to improve the tools we already have.

What's next for openWind? Is development of the software a perpetual process?

We are currently working with industry and academia to further improve our optimization for cost of energy and hope to have an enhanced version out sometime in Q2.

We will be adding functionality to allow for combining multiple wind resource grids, query-able by time of year and time of day, in order to allow for ongoing improvements in wind resource modeling.

We are also continuing to engage with the industry to address those factors affecting turbine performance.