Wind speed site tests come under scrutiny

Wind-farm locations are chosen and projects financed partly on the basis of wind-speed site tests. However, the gap between test results and actual performance in some markets is making investors nervous and causing a rethink in measuring methodology. Paul Garrett reports

Concerns about the possible underperformance of wind farms began to surface in the early 2000s in North America, where analysts at risk-management firm Det Norske Veritas (DNV) saw operational data from projects they were monitoring for investors and found that third-party wind-speed assessments at potential wind-farm sites tended to overestimate annual electricity generation.

Similar problems emerged in Germany and Italy a few years later. Actual wind performance once wind farms were built was not even translating into 50% of the levels predicted from the wind speed and energy. This began to hit investor confidence in the viability of wind projects and the suitability of their siting.

Tom Murley, head of renewables at UK investment house HG Capital, sees a pattern emerging. "Wind forecasting in the project-planning stage has been seen to be inaccurate," he says. "There are examples of persistent overestimates in Germany and Italy and as a result some investors are becoming less willing to invest in wind which isn't there."

Paul Stangroom, general manager of energy resource services at global consultancy Wind Prospect, believes it is vital to persuade investors that wind-resource figures are accurately compiled, reliable and properly interpreted. "Investors need to know they can trust the consultants and the processes that have been undertaken to get the energy-yield estimates," he says. "They need to believe the occurrences of particular low or high wind years are included in the uncertainties — such as low wind in Europe in 2010 — and trust the validity of technology used in assessments."

Several factors

DNV found that a major reason for the frequent over prediction of energy production at wind farms was a misunderstanding of the effects of topography, such as hills or valleys and other physical obstructions. This has often been made worse by the incorrect positioning of meteorological masts (metmasts) — the devices used to measure wind speeds — or simply not deploying enough of them across a site.

There are many reasons for overestimates. Sometimes projects experience higher-than-modelled wake losses. These occur in the space behind a wind turbine, where the wind speed is much lower because the turbine itself has used some of the energy in turning the blades. The weather also plays a big role. On a day-to-day basis, the wind does not always blow as fast as it was forecast. And turbines may generate less energy than expected if the weather conditions are different from those used to calculate the original turbine's power rating. According to DNV, the icing of turbines in very cold weather, which causes slower blade rotation and lower energy production as a result, is another significant factor that is often neglected in the modelling phase.

Measuring wind A potential wind-farm site is tested in Kilkenny, Ireland

Mark Young, head of cleaner energy UK at DNV, says: "Historically we have found a 9% overestimate of performance across the industry." That is, energy outputs based on wind estimates are 9% more than have actually been delivered. Much of that seems to be down to over-optimistic wind estimates rather than underperformance of equipment. He suggests that energy estimates are more often reliant on consultants' past experience than on fact-based on-site observations.

"We have not seen intentionally misleading figures,

{CONTINUED}

but some decisions may have inadvertently led to positive bias in long-term predicted production figures," Young explains. He has found that individual factors such as positioning the measuring equipment in the windier positions may lead to predictions of future wind-farm output that will not be matched by reality.

The accuracy battle

For Kell Oehlenschlaeger, head of global siting at Siemens Wind Power, wind measurement and site selection has become more difficult and will now take more effort. "Ten years ago there were plenty of suitable onshore sites for wind farms with good wind. Today we are looking at less optimum sites in places such as forests, which will require taller turbine towers." He also anticipates the growing use of taller metmasts to match the increasing hub heights, and the need to be open to new technologies such as light detection and ranging (Lidar), which uses lasers to measure wind speed and capture the data, and sonic detection and ranging (Sodar), which uses sound waves. These technologies could improve the understanding of site wind conditions.

"Higher accuracy can be obtained by measuring wind at sites for as long as possible, as close to hub height as is practicable and at locations that are representative of the whole site," says Holly Hughes, a senior engineer at DNV. She also believes that accurate wake modelling is particularly important for large projects. An early screening process is vital to identify signs that a site is unsuitable for wind development. Several elements unrelated to wind speed might make a project difficult to develop, including radar activity, the presence of nearby airports, transmission availability, environmental or scenic concerns and logistics constraints such as gradients that would make it difficult to build access roads. Hughes describes these as "fatal flaws" that will make development very expensive at best.

Wind-resource screening may reveal some immediate deterrents or physical impediments to optimum wind

Offshore option
A BMO Offshore flexible metmast

"There are examples of persistent overestimates in Germany and Italy, and as a result some investors are becoming less willing to invest"

Tom Hurley, head of renewables, HG Capital

yield. These could be sharp land features, sheltered areas and close proximity of buildings. Geographical knowledge on a macro level also helps eliminate unsuitable sites from the outset. The south-eastern United States, for example, is not generally a windy place.

Cranfield University in England has undertaken extensive work on wind resources and site selection. Professor Feargal Brennan, head of offshore process and energy engineering at the university's school of engineering, says that accurately predicting onshore wind resources meets many obstacles. Not only do a number of local conditions, including thermal currents, the effect of built-up areas and forests have an impact on estimates, he points out, but whenever a specialised contractor is hired to monitor and assess the wind resource at a site, this will typically be done over a limited period.

In the end, developers will always end up with a less-than-perfect estimate. "Wind as a resource is statistically stable only after many years of study," Brennan says. "So I don't believe there is a pressing need

HOW WIND FARM SITES ARE ASSESSED THE METEOROLOGICAL MAST AND ANEMOMETRY

The workhorse of wind-resource measurement is the anemometer – the device that measures wind speed.

A typical meteorological mast will have a number of anemometers installed at different heights and one or two wind vanes, which measure wind direction. These will be connected to a data logger at the base of the mast via screened cables.

It is unusual for there to be a power supply at a prospective wind-farm site, so the whole anemometry system is usually battery operated, sometimes charged by solar panels or a small wind turbine. For some systems in cold climates, temperature measurement is needed to detect icing, with heated ice-free anemometers.

Most sites also measure atmospheric pressure. Typical ten-minute monitoring signals pick up mean wind speed, maximum three-second-gust wind speed, true standard-deviation wind speed, mean wind direction, mean temperature and logger battery voltage.

Before building a wind farm it is important to assess the amount of wind available over a prolonged period and information must be gathered to calculate how much wind will be available all the year round. Errors in this prediction can have an enormous effect on the amount of electricity produced and the viability of the investment.

Large towers are erected with a number of anemometers mounted at various heights to collect data, along with wind vanes. It is important that the correct anemometers are selected at this time, as data produced by the survey must be accurate and comprehensive.

The anemometers are connected to a data logger at the base of the mast via screened cables, and because it is unusual for a prospective wind-farm site to have a power supply, the whole system is usually battery operated, often charged by solar panels or a small wind turbine.

For some systems in cold climates temperature measurement is needed to detect icing, so heated ice-free anemometers are deployed.

for more accurate measuring equipment. It's all about the time over which the local wind characteristics can be monitored."

Mast data is the industry standard for measuring wind quality at a given site. But DNV recommends using remote sensing too. It has developed recommendations on how to position the instruments, what type of documentation to complete, how to check that the equipment is working correctly and how to plan location and duration of the measurements to ensure they are as useful as they can be.

Multiple technologies

Wind Prospect's Stangroom suggests that the usual approach of a single metmast in the middle of a site may not be enough to convince investors that a site has a consistent wind resource across the whole planned project area — although just one mast per site remains common practice. He recommends first-class anemometers to measure wind resource and the use of Lidar and Sodar technologies, which allow for readings to be taken at greater height. These technologies have the added benefit that they do not require planning permission to be installed on site.

"But at least one metmast must still be part of the solution," says Stangroom. "Without lots of data from the site itself there is a limited amount that can be done with models and assumptions."

"We have not seen intentionally misleading figures, but some decisions may have inadvertently led to positive bias in long-term predicted production figures"

Mark Young, head of cleaner energy UK, Det Norske Veritas

Cranfield's Brennan believes that future wind-power developers need to look not just at the veracity of a site's wind performance but the different behaviours within it. Wind variance within a single site must be recognised. "Array technology is in its infancy, but on land and offshore we will start to see a mixture of heights and types of turbine within one wind farm as projects get bigger," he says. On large sites, he predicts that different designs for wind farms will emerge to maximise wind yields and get the most out of a given location.

Uniformity of turbine size and design could give way to diversity reflecting topographical and meteorological variations. For too long, analysis of wind resources at a proposed site has been partly based on optimism, a desire for a project to go ahead and a minimalist approach to equipment deployment.

Now is the time for wind measurement to move quickly towards data-driven prediction based on rigorous data collection over as long a period of time as possible with a more generous deployment of high-quality measuring equipment. That way, the right location can be chosen leading to energy-generation performances that match pre-construction predictions — and keep the investors happy. W