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Lidars for offshore applications

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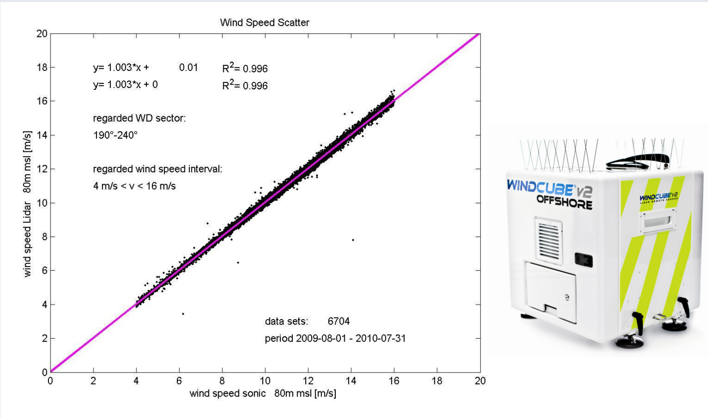
Abstract

Lidar technology has proven performance in onshore applications and now a growing track record for offshore wind measurement. The rapid increase of offshore wind farm projects has given rise to the need for accurate, easy to use equipment to measure the wind on locations several kilometers from the coast.
If installed offshore, the traditional mast equipped with anemometers requires a large and heavy platform to sustain the weight and the size of the structure. Lidar technology allows for the development of innovative and cheaper solutions, while achieving similar measurement accuracy to cup anemometers. In terms of logistics, installations of met towers offshore are dependant of the availability of large vessels, involve several days of work by highly trained engineers and specific calm sea conditions. Meanwhile, the installation of a Lidar on any type of structure takes less than a day. Taking into account all these considerations, the use of Lidars allows for the saving of thousands of dollars in construction costs, installation and maintenance.
This poster focuses on the different types of Lidars available to realize such measurements during the different phases of any offshore project, from site assessment to power curve measurements.

Ground based Lidar

The first measurement campaigns offshore were realized using existing oil & gas platforms or platforms already equipped with masts, such as FINO 1, the first German off-shore research platform. DEWI has performed an analysis of the Lidar data on this platform and has proved the excellent availability of Lidar data over one year of measurement as well as the good reliability of the equipment. Lidars are also widely used in the framework of the NORSEWInD project, with Lidars operating for more than four years. For wind measurement from a fixed platform for site assessment, ground based Lidar is becoming the equipment of choice.



Excellent correlation between sonic anem. measured wind speed (80m) and Lidar measured wind speed, one year measurement on FINO 1 (Courtesy of DEWI GmbH)

Scanning Lidar

Although scanning Lidars are not widely used yet in the wind energy market, there are proofs of interest, especially offshore. While the wind resource tends to vary less spatially in offshore wind fields, there is interest in using such devices for site assessment in comparison to ground based devices.

There is also interest in using scanning Lidars after the construction of the wind farm thanks to their capability to measure the wind away from the device and on large surfaces (several km²).

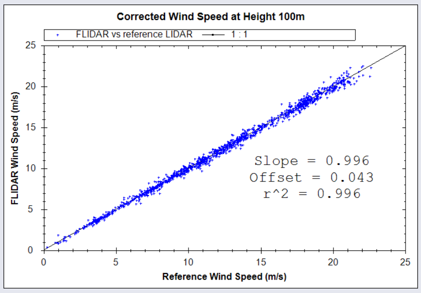
Scanning Lidars can be used for wake analysis, as the phenomena is not perfectly understood and the existing models are showing their limitations. Another field of application is the realization of power curve by placing the device on the available platform at the base of the wind turbine and by scanning at the rotor level at the distance suggested by the standards.

Lidar on buoy

Even though the price to erect a platform with a Lidar is cheaper than with a mast, it is usually not the least expensive solution. The adaptation of the Lidar technology to a buoy solution is an even more cost-effective option.

The usage of Lidar on a buoy requires specific adaptations. For ground based Lidar, the device is located a few tens of meters above the sea level whereas buoy-mounted Lidars are at the sea level where they suffer from the sea state and also the assault of waves. Specific adaptations must be developed to make sure that the high tech device can operate properly for long periods without being compromised. The second challenge is the measurement. Buoys are is in constant motion and this movement needs to be taken into account to reach the same level of wind measurement accuracy as on fixed platforms or onshore. Below, you can find the solution developed by 3E in partnership with Leosphere and OWA.

FLIDAR (Courtesy of 3E)



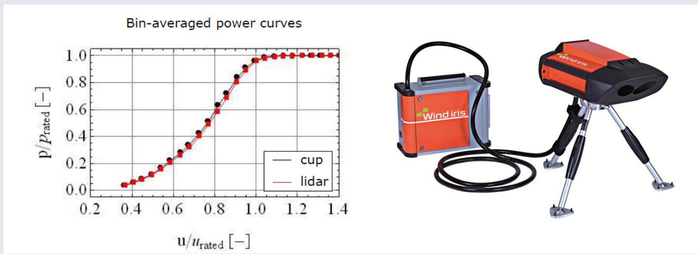
Wind speed correlation between the Lidar on buoy and a reference Lidar located on a platform (Courtesy of 3E)

Nacelle mounted Lidar

Turbine mounted Lidars offer a cost efficient and very accurate mean to measure power curves and to improve wind farm economical performance.

DTU Wind, DONG Energy, Siemens Wind and Avent Lidar Technology have developed nacelle Lidar power curve measurement procedures compliant to the IEC 61400-12-1 standard. Agreement to within 1% of Class One cup anemometry was achieved, thereby establishing nacelle Lidar as a valid alternative for power curve verification.

Thanks to its flexible installation, permanent upwind alignment and low maintenance requirements, nacelle Lidar allows for verification of any turbine. Monitoring inflow wind conditions to every turbine (turbulence, wakes, wind speed losses) allows for the optimization of wind sector management, with improved power output and reduced loads.



Power curve given by nacelle Lidar vs. met. mast mounted cup (Wagner et al.)

Conclusion

Lidar technology has proven its accuracy and dependability for onshore applications. Hundreds of deployments and onshore independent validations have permitted the acceptance of the technology by the market. This history, as well as the cost advantage of using Lidars instead of offshore masts, allow for the fast deployment of Lidars for any offshore application, at any stage of wind farm projects.

References

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