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An Innovative TLP platform for combined reliable and bankable offshore Cup Anemometer - Lidar wind measurements

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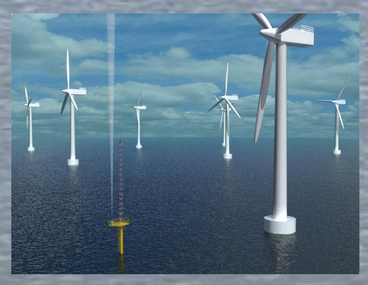
Abstract

Reliable and Bankable Wind Resource Assessment in offshore wind farms, presents a huge challenge, as only fixed met-masts are, at the moment, IEC/MEASNET compliant measuring devices. With the stable TLP FloatMast platform IEC/MEASNET compliant data can be acquired at a much lower cost at any depth and distance from the shore. As a result, a wider range of capabilities for wind resource assessment is available and consequently the level of data credibility and availability are increased and become bankable at a much lower cost. Finally, the structure can be redeployed in another location and provide these capabilities for another adjacent site.

Objectives

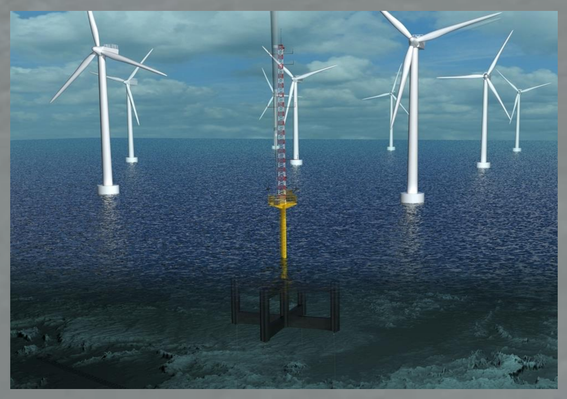
As offshore wind parks are getting into deeper waters, further from the shore and bigger in size, the costs are scaling rapidly. Therefore, high-quality wind resource assessment is needed to mitigate and drive down the costs per kWh. This leads the financiers to the need of IEC/MEASNET compliant wind resource assessment which requires offshore met masts. At present, these structures are expensive, as they are fixed in the sea bed and cannot be redeployed in another location, if the initial site does not comply with the Developer's expectations. FloatMast overcomes these issues, being a redeployable met mast platform, with the ability to be installed in any sea depth at a lower cost. Moreover, it complies with the technical requirements of the Developers' engineers and the Financiers IEC/MEASNET standards of wind resource assessment.



Methods

The solution to the above issues can be provided by the FloatMast innovative combination of three industries: Onshore Wind, Naval and Oil & Gas. On the deck of a small Tension Leg Platform (TLP), which is a standard and proven technology in the Oil & Gas Industry, a met mast and a Lidar are fixed.

The accuracy of the provided wind speed measurements is assured by the use of three different state-of-the-art devices (cup anemometers, ultrasonics and a lidar) at the height of 40m asl, which is inside the today's offshore WT's rotor. Cup anemometers assure the highest data availability (no matter the weather conditions) and the conformity to the today's IEC/MEASNET standards. A 3D-ultrasonic anemometer provides fast measurements for turbulence and other meteorological quantities (Reynolds stresses, etc). Finally, the lidar provides the wind shear by measuring the wind speed at several heights within the WT's rotor.



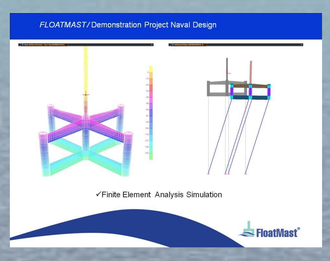
The verification of cup-lidar data is performed according to the IEA Recommended Practices RP15 for two 2 heights (40m and a lower one), by an accredited organization for such measurements and member of the MEASNET network. The verification will comprise also turbulence intensity and wind gust speed correlations, two quantities that play an important role in the classification and the design of the wind turbines.

Naval engineering practices secure the floating structure integrity by design and construction approval from classification societies.

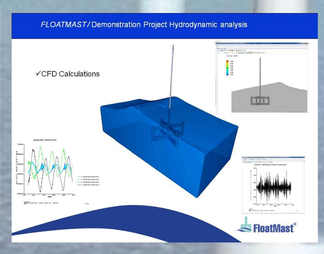
Results

The small (unavoidable) motions of the TLP platform are monitored by high-precision marine motion and orientation sensors. CFD simulations and model tank tests of a 1:25 prototype showed practically no heave motion, very low translations (<0.1Hz) and tilt angles below 3deg, even in storm conditions.

Naval Design Calculations



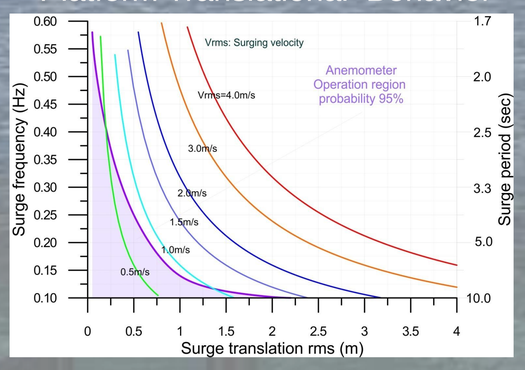
CFD Simulations



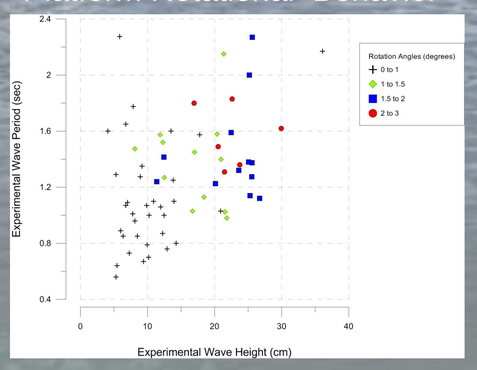
Model Tank Tests

Preliminary results show that motion compensation is not required and this is continuously verified by the concurrent fast 3D ultrasonic measurements combined with data from inertial motion units (IMUs).

Platform Translational Behavior



Platform Rotational Behavior



A full scale prototype under construction will serve as demonstration project off the coast of Makronisos island, at 65 m of sea depth, in the Aegean sea, known also for its severe sea state conditions and with an annual average wind speed of 9m/s. Third party evaluation of the results will be conducted by an Institute member of the MEASNET network.

Conclusions

The project demonstrates that TLP platforms are very well suited to wind energy applications and practically no motion compensation is required for the wind speed measuring devices.

Lidars are known to have lower data availabilities than cup anemometers, mainly due to atmospheric conditions, but also because they are sophisticated opticoelectronic devices, requiring also power autonomy. With the FloatMast platform, lidar unavoidable data losses are recovered from cup anemometers, with much lower uncertainties than correlating with faraway met masts. The high data availability assured by the high reliability of cup anemometers, lowers the uncertainties of the results, as well as, the investment cost of the offshore wind farm, increasing thus the bankability of the project.

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