AN OFFSHORE 40M HIGH TLP MET. MAST AT 65M DEEP WATERS IN THE AEGEAN SEA

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INTRODUCTION

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 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 become available to developers (from wind resource assessment to environmental -marine and atmospheric- data monitoring), increasing thus the project value, the data credibility and bankability.

At the end of a campaign, the platform can be redeployed at another site. The adaptation consists mainly in modifying the anchorage to adapt at the new water depth and sea tide.

DESIGN PARAMETERS

- Comply with the IEC / MEASNET Guidelines
- Conform with the proven methodology applied for onshore complex topographies (low met mast+Lidar)
- Adopt existing mature solutions from the mature Oil & Gas Industry
- Re-deployable platform
- Optimize the ratio `P90/Cost´ for offshore wind resource assessment

	Cost	Wind Speed uncertainty 1	
Fixed HH Mast	~ 8.0M€	~ 2.2%	
Fixed HH Mast + Lidar	~ 8.5M€	~ 2.1%	
Floating Lidar	~ 1.2M€	~ 4.0%	
FloatMast	~ 3.0M€	~ 2.4%	(expected)

KEY ADVANTAGES VS FIXED MASTS AND FLOATING LIDARS

Extremely low mean wind speed deviation compared to a Fixed Met Mast
Analysis of real offshore 10min-wind data2 using a 5MW HAWT shows that, using the measured wind shear, the deviation between the annual average wind speed at hub-height (100m asl) and the extrapolated one from a lower anemometer is only 0.4%. Similarly, the deviation of the WT's annual energy yield is 1.3% and capacity factor deviation result is 0.7%.

Superior data availability based on cup anemometer.
Contrary to LIDARs, cup anemometers are expected to approach 100% data availability. For an annual availability of 80%3, then the above mentioned offshore dataset, run for 14 different scenarios, yields average deviations for the annual wind speed of 1.4% and for the annual energy yield of 1.7%.

Avoid wind speed uncertainties due to wave motions
Results from recent publications with wind speed comparisons between stable and wave-influenced platforms, for various types of LIDARs, converge to similar deviations: 1.6%[4] 1.5%[5] 1.4% 1.0%[6] 1.4%[7]
Although no energy yield deviations are given, the above result is an additional uncertainty to be accounted, further decreasing the bankability of an offshore project.

MODEL TANK TESTS

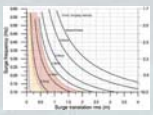
The small (unavoidable) motions of the TLP platform are monitored by high-precision marine motion and orientation sensors. Naval Design calculations, together with CFD simulations and model tank tests of a 1:25 prototype, showed practically no heave motion, very low translations (<0.1Hz) and tilt angles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

Naval Design Calculations

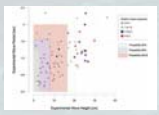
CFD Simulations

Model Tank Tests

Platform Translation Behavior



Platform Rotation Behavior



DEPLOYMENT PHASE STARTED

The prototype is ready for deployment off the coast of Makronisos island at a sea depth of 65m, in the Aegean sea, known for its severe sea state conditions and its high wind potential (9m/s annual average wind speed).

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 reliable cup anemometers, lowers the results uncertainties, the investment cost of the offshore wind farm and increases bankability.

SPONSORS

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1. John Slater , Charles Pearce "The benefits and uncertainties of floating lidar", RWE Innogy UK, EWEA 2015
2. CRES Technical note: "Sensitivity analysis of 5-year wind data from the FINO1 offshore platform", EERA-DTOC project, 2014.
3. Latest revision of the German TR6 guideline for Wind Resource Assessment, requiring for LIDAR standalone operation, 12 consecutive months of measurement, with a minimum data availability of 80%.
4. CMR publication: "Effect of wave motion on wind lidar measurements – Comparison testing with controlled motion applied", DeepWind 2013 Conference, Norway
5. DNV publication: "Remote Sensing on Moving Offshore Platforms", Tony Rogers, Katy Briggs, Gordon Randall, Holly Hughes, EWEA 2011
6. ZephIR Lidar publication: "The effect of motion on continuous wave lidar wind measurements", A. Rutherford, M. Pitter, C Slinger, etc. WINDPOWER 2013, Chicago
7. GL-GH publication: "Investigating the Efficacy of Floating LIDAR Motion Compensation Algorithms for Offshore Wind Resource Assessment Applications", Daniel W. Jaynes, EWEA 2011.

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