Fraunhofer
IWES

FRAUNHOFER INSTITUTE FOR WIND ENERGY AND ENERGY SYSTEM TECHNOLOGY IWES

LIDAR BUOY FOR FLEXIBLE SITE ASSESS-MENT

»Validated in Carbon Trust trial«

Contact

Dr. rer. nat. Bernhard Lange
Division Director
Tel. +49 471 14290-350
bernhard.lange@iwes.fraunhofer.de

Dipl.-Met. Claudia Rudolph
Group Manager
Tel. +49 471 14290-351
claudia.rudolph@iwes.fraunhofer.de

Fraunhofer IWES supports developers and operators of offshore wind energy power plants by providing new and innovative methods, tools and services for resource assessment, determination of design conditions and wind characterization. The overall target is to reduce risks in the planning and operational phase and lower the costs of offshore wind generation.

Wind conditions are of paramount importance for any wind power project – they determine the expected yield at a certain site and set the design parameters of wind turbines. LiDAR is a game changing new wind measurement technology which will replace conventional met masts in many applications due to its flexibility and its highly competitive price.

WE HAVE COMBINED OUR KNOWLEDGE FROM LONG-TERM RESEARCH IN ONSHORE LIDAR APPLICATION WITH SEVERAL YEARS OF OFFSHORE EXPERIENCE

gained from coordinating the RAVE (Research at alpha ventus) initiative to take the advantages of LiDAR technology offshore. The Fraunhofer IWES wind LiDAR buoy allows measurement heights of up to 200 meters at a cost 5 to 10 times less than an offshore met mast measuring just 100 meters. Moreover, the permission and installation process for the LiDAR buoy is by far shorter, allowing flexible use of the system.

The main challenges associated with the use of LiDAR on a buoy is to design and build a system which is robust and which works reliably in rough offshore conditions, but which, at the same time, delivers data accuracy comparable to met mast measurement results. Fraunhofer IWES has added a precise in-house motion correction algorithm to neutralize the wave motion of the buoy.

The Fraunhofer IWES wind LiDAR buoy has reached the pre-commercial status according to the Carbon Trust Offshore Wind Accelerator Roadmap in an independent validation campaign initiated by Carbon Trust within the Offshore Wind Accelerator program.
Our experts perform the measurements at your chosen site and deliver valuable results for your project planning. This accelerates the planning process significantly and helps you to keep to your challenging schedule while simultaneously guaranteeing maximum planning security.

The performance of Fraunhofer IWES´ Wind LiDAR buoy in terms of data reliability and accuracy has been validated in several trials, most recently in a continuous validation campaign lasting six months and supervised by ORE Catapult within the Carbon Trust Offshore Wind Accelerator (OWA) program. It reported that: "The Fraunhofer IWES Floating Lidar Buoy was found to meet the highest "Best Practice" criteria within the "OWA Roadmap for Floating Lidar Systems" and the "OWA Recommended Practices for Floating Lidar Systems" for all wind speed and direction metrics." (ORE Catapult)
This extremely high data accuracy, which greatly exceeds the requirements of the OWA Roadmap and OWA Recommended Practices, was achieved using Fraunhofer IWES' motion correction algorithm for compensation of the wave motion of the buoy.

EXCELLENT AVAILABILITY

The confirmed high post-processed **data availability of 97.9%** for the Fraunhofer IWES Wind LiDAR buoy is the result of a design which is systematically focused on robustness and redundancy:

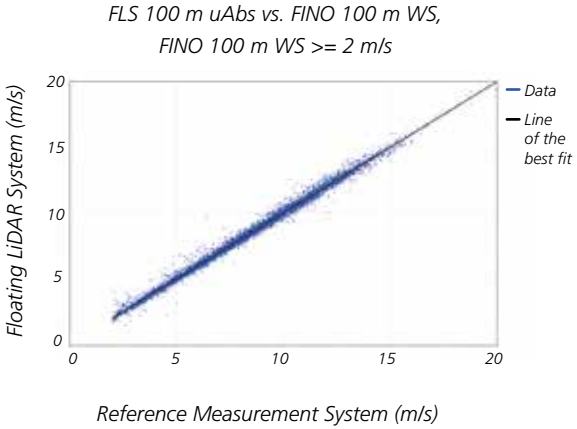
- *Proven hull design with a track record as a navigation light buoy spanning over 30 years.*
- *The LiDAR measuring unit is fully encapsulated and therefore protected from harsh environmental conditions.*
- *Two independent power supply systems ensure the very high availability of the measurements:*
  The primary system is an autonomous solar power- and wind-based system with a battery reserve for one week of operation. A marine diesel generator is used as a secondary backup system.
- *Large and redundant control and data storage systems combined with multiple data transfer capabilities communicate the data safely to your office.*

The Wind LiDAR buoy can be used for a complete offshore wind resource assessment, for site characterization, and for specialized measurement campaigns or monitoring.

Offshore verification has demonstrated that Fraunhofer IWES´ system delivers excellent results when compared to a traditional tall met mast. The system satisfies the accuracy criteria stipulated by the Carbon Trust Offshore Wind Accelerator Roadmap, which is a guideline for the commercial acceptance of floating LiDAR technology.

THIRD-PARTY VALIDATED

The graph shows a comparison of the wind speeds measured by the LiDAR buoy with those of the FINO1 met mast positioned 100 meters offshore (graph taken from verification report by ORE Catapult). The measured wind speed data are shown on the x and y axes and a 1-parameter linear regression is calculated. The slope of 1.006 proves an extremely low systematic difference between the buoy and mast.
The correlation coefficient of 0.992 underlines the very low uncertainty of the individual 10-min data.



Results of the Carbon Trust validation campaign (taken from ORE Catapult report):

	Wind speed at 100 m (WS>2)		Wind direction at 100 m (WS>2)		
	Slope	R^2	Slope	Offset	R^2
OWA Roadmap Minimum Requirement	*0.97-1.03*	*>0.97*	*0.95-1.05*	*<10°*	*>0.95*
OWA Roadmap Best Practice Requirement	*0.98-1.02*	*>0.98*	*0.97-1.03*	*<5°*	*>0.97*
Fraunhofer IWES Wind LiDAR Buoy Result	*1.006*	*0.992*	*0.996*	*1.7°*	*0.991*

TECHNICAL SPECIFICATIONS

Buoy Specifications

- *Dimensions: overall height 8.1 m, diameter 2.5 m*
- *Weight: 5.4 t*
- *Operational water depth: min. 10-15 m*
- *Material: steel hull (DIN 1.0036), anodized aluminium for LiDAR housing*
- *Mooring: DIN 5683-II mooring chain, 3 t concrete anchor (mooring may be adapted to site conditions)*

LiDAR Specifications

- *Type: ZephIR 300 or Windcube v2*
- *Measurement height range: 10 m – approx. 200 m (dependent on atmospheric conditions and LiDAR device)*
- *Number of measurement heights: 10 (dependent on LiDAR device)*
- *Data sampling rate: 1 s (dependent on LiDAR device)*
- *Laser Eye Safety: Class 1M IEC/EN 60825-1*

Power System

- *Autonomous renewable energy-based power system consisting of PV panels and micro-wind turbines*
- *Energy storage: AGM batteries ensuring a power supply for one week without further generation*
- *Independent secondary power system: Diesel generator of 3.8 kW*

Data Storage and Communication

- *Data transfer protocol: wireless connection – up to 300 m for complete data transfer, GSM – onshore / nearshore, Iridium SBD – for selected status data and alarm, Iridium data transfer*
- *Data storage: capacity for storing 10-min average and complete high-frequency data from all sensors for more than two years of operation*

Additional Sensors

- *ADHR and satellite compass record buoy's positions and motions*
- *Weather station for measurement of barometric pressure, air temperature, horizontal wind speed and direction (at low height), relative humidity, precipitation*
- *AWAC current meter (as autonomous and independent system) for measurement of waves and currents*


Fraunhofer

Publishing notes

Fraunhofer Institute for Wind Energy and Energy System Technology (IWES)

Am Seedeich 45
27572 Bremerhaven

www.windenergie.iwes.fraunhofer.de

Publisher
The Fraunhofer Institute for Wind Energy and Energy System Technology IWES is a constituent entity of the Fraunhofer-Gesellschaft zur Förderung der angewandten Forschung e.V., Hansastr. 22c, 80686 München; and as such has no separate legal status.

Editorial team
Claudia Rudolph, Bernhard Lange, Britta Rollert

Layout
www.designagl.de

Print
müllerditzen AG, Druckmanufaktur am Meer
Bilderdruck FSC Mix Credit (mattgestrichen, holzfrei, weiß) / Umschlag: 300 g/m², Inhalt: 170 g/m²

Photos
Fraunhofer IWES

Acknowledgement

Federal Ministry for Economic Affairs and Energy

EUROPEAN UNION:
"Investing in your future"
European Regional Development Fund

Bremen Bremerhaven

QUALITY SYSTEM CERTIFICATION DNV·GL ISO 9001

Fraunhofer IWES is DIN EN ISO9001-certified in the areas of "product development up to the prototype stage, technology development and optimization, technology assessments and studies" as well as "trials in demonstration centers".