Fraunhofer IWES

Data and facts

Fraunhofer IWES Wind Lidar Buoy – Offshore Wind and Ocean Measurements

Measuring offshore wind conditions

Traditional met masts for wind measurements are simply too costly and inflexible for offshore sites. Nowadays, »Floating Lidar Systems« (FLS) are commonly used. FLS are platforms equipped with a lidar device, which uses laser beams to measure the wind speed and direction at heights of up to 300 m. Due to the remote location and harsh environment, the survivability and reliability of the buoy hull, the autonomous power supply, and the adequate compensation of the wind measurement for buoy motions are of high importance.

Fraunhofer IWES' Floating Lidar solution

As one of the leading wind energy research institutes, Fraunhofer IWES has been working on floating lidar systems since 2009 and deployed its first prototype in 2013. Fraunhofer IWES operates its Wind Lidar Buoys in scientific projects and, since 2017, in commercial projects, delivering wind and metocean resource measurements and analysis.

Our competences at a glance

- Development, production, and operation of FLS
- Data monitoring, analysis, and quality control
- Proven, in-house motion compensation algorithm for even more accurate measurement data
- Continuously high quality of research, technical improvement, and flexibility

The hull of the Wind Lidar Buoy is based on a German navigation buoy with a track record of 40 years, which was modified to accommodate a higher-grade power supply and specialized sensor payload. The lidar device is integrated in a fully encapsulating housing to protect it from the wave impact and briny environment. The compact, steel design of the FLS enables it to withstand severe sea states during storms and typhoons.

The power supply is redundant and intermeshed to ensure reliability from the micro wind turbines, the photovoltaic modules, and the backup generator. The energy storage is duplicated over three battery banks. All the power system elements are connected to a data communication system (BUS), which enables automated management based on real-time information. The FLS runs renewable energy sources; in case of exceptionally low input, the backup generator starts automatically. The generator has the capacity to run the buoy for 12 weeks on its own with eco-friendly GTL diesel fuel.

The Fraunhofer IWES Wind Lidar Buoy is typically equipped with either a ZX Lidars ZX300M or a Vaisala WindCube v2.1 lidar. Redundant meteorological sensors are fitted to the superstructure and oceanographic data is recorded with underwater-mounted sensors. The IWES engineering team can accommodate custom sensors flexibly to suit specific requirements.

The FLS is monitored 365 days a year via web-based surveillance tools to ensure uninterrupted operation. All key statuses are frequently received and the data from the sensors – including compensated wind data – are transferred daily.

Validation and acceptance

Fraunhofer IWES verifies lidar devices against 200 m met masts (IEC 61400-50-2). The assembled FLS is then typically deployed offshore for calibration against a met mast and fixed lidar. The North Sea FINO3 research platform is often used for this.

Both Fraunhofer IWES FLS types achieved Stage 2 maturity of the Carbon Trust OWA Roadmap in 2016 (ZX300M) and 2017 (WindCube).

Stage 2 type verifications against North Sea met masts

@100 m MSL with WS > 2 m/s	Best practice	ZX300M FLS type	WindCube FLS type
Overall system availability	> 97%	98.5%	99.6%
Overall processed data availability	> 90%	97.9%	98.1%
Wind speed slope	0.98-1.02	1.006	1.006
Wind speed R^2	> 0.98	0.992	0.997
Wind direction slope	0.97-1.03	0.996	0.992
Wind direction offset	< 5°	1.66°	-2.93°
Wind direction R^2	> 0.97	0.991	0.991

ZX300M FLS type: Stage 3 maturity body of evidence is currently under third-party expert review.

Technical specifications (default configuration)

Buoy specifications
- Height: 9.2 m; diameter: 2.5 m; weight 5.6 t
- Material: DIN 1.0036 steel hull, aluminum lidar housing
- Moorings for 100 m, 250 m, and 1,000 m water depths

Lidar options
- ZX Lidars ZX300M up to 300 m
- Vaisala WindCube V2.1 up to 300 m

Data communication
- Data transfer: WiFi, mobile network, satellite
- Data storage: redundant system with over 2 years of raw data capacity

Power system
- Primary input: 3 micro wind turbines and 6 PV panels
- Storage: AGM batteries (up to one week of autonomy)
- Backup power: 5 kW GTL diesel generator

Additional sensors
- 3 motion sensors: recording position and 3D motion
- 2 weather stations: atmospheric pressure, temperature, wind speed and direction, relative humidity, precipitation
- Surface water temperature and CTD sensor
- Seabed water pressure and temperature
- Optional: ADCP, oxygen, others on request

FLS operation and data analysis

Fraunhofer IWES offers not only customizable measurement campaign delivery but also cutting-edge data analysis, measurement concepts incl. multiple lidar devices of different types, and the possibility to include data modeling.

Further information

Fraunhofer IWES secures investments in technological developments through validation, shortens innovation cycles, accelerates certification procedures, and increases planning accuracy by means of innovative measurement methods in the wind energy and hydrogen technology sectors. At present, there are more than 300 scientists and employees as well as more than 100 students employed at the nine sites: Bochum, Bremen, Bremerhaven, Leer, Görlitz, Hamburg, Hannover, Leuna, and Oldenburg.

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Contact

Erik Patschke
Head of Department
Wind Measurement and Characterization
Phone: +49 471 14290-315
erik.patschke@iwes.fraunhofer.de

Sarah Zwick
Group Manager
Wind Measurement Campaign Operations
Phone: +49 471 14290-360
sarah.zwick@iwes.fraunhofer.de

Fraunhofer Institute for Wind Energy Systems IWES
Am Seedeich 45, 27572 Bremerhaven, Germany
www.iwes.fraunhofer.de