FRANCE ENERGIES MARINES

TwinDAR©

An innovative solution for assessing TI using lidar profilers

The calculation of turbulence intensity: a key issue for the wind energy sector

Turbulence intensity (TI) makes it possible to characterise atmospheric turbulence.
The importance of this parameter is widely recognised in both onshore and offshore wind energy and affects:

- **The estimation of the loads applied to the wind turbine (blades, rotor–nacelle and tower)** for fatigue design purposes, particularly to assess the cyclic stresses induced by atmospheric turbulence.
- **The modelling of wake effects within the wind farm,** which can lead to a reduction in energy yield by locally altering the wind profile and TI downstream of the turbines.

An overestimation or underestimation of TI can lead to a misjudgement of requirements, resulting in higher CAPEX and, consequently, an increase in LCOE.

Our expertise to support you

- **Seven years of experience in developing a unique methodology** dedicated to calculating TI from lidar measurements for both onshore and offshore wind energy.
- **An innovative approach developed through major national and international projects.**
- **An operational and validated TI reconstruction algorithm** enabling a significant reduction in calculation errors.

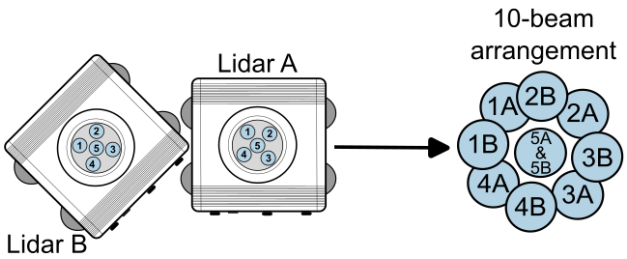
Our services

Our experts support you at every stage in defining and deploying a methodology for calculating turbulence from lidar measurements.

- Configuration of lidar positioning
- Data acquisition
- Data analysis using our TI reconstruction algorithm

The variance method

Lidar profilers have three inherent sources of error when measuring turbulence intensity. These errors limit the reliability of the conventional TI calculation method used in the industry.
To overcome these limitations, **France Energies Marines has developed the variance method,** a major advancement that corrects two of these errors: the inter-beam effect and instrumental noise.
To be applicable in all wind directions, this method requires at least six beams, obtained either from two Vaisala WindCube v2.1 lidars positioned at 45° (10 beams in total) or from a Lumibird lidar with six beams.



Option 1: Two Vaisala WindCube v2.1 lidars

Option 2: Six-beam Lumibird lidar

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TwinDAR© for floating lidar systems

Under offshore conditions, a fourth source of error arises: buoy motion. To address this, France Energies Marines has developed a spectral motion correction method, applied as a preliminary step to the variance method, to ensure reliable turbulence measurements at sea.

The benefits of our support

Access to recognised expertise

Improved TI calculation

A 35% reduction in MRBE* and a 40% reduction in RRMSE** for TI measurement compared with the conventional method used in the industry.

Improved component sizing

Performance optimisation, cost reduction, and increased system reliability.

A reduction in CAPEX and LCOE

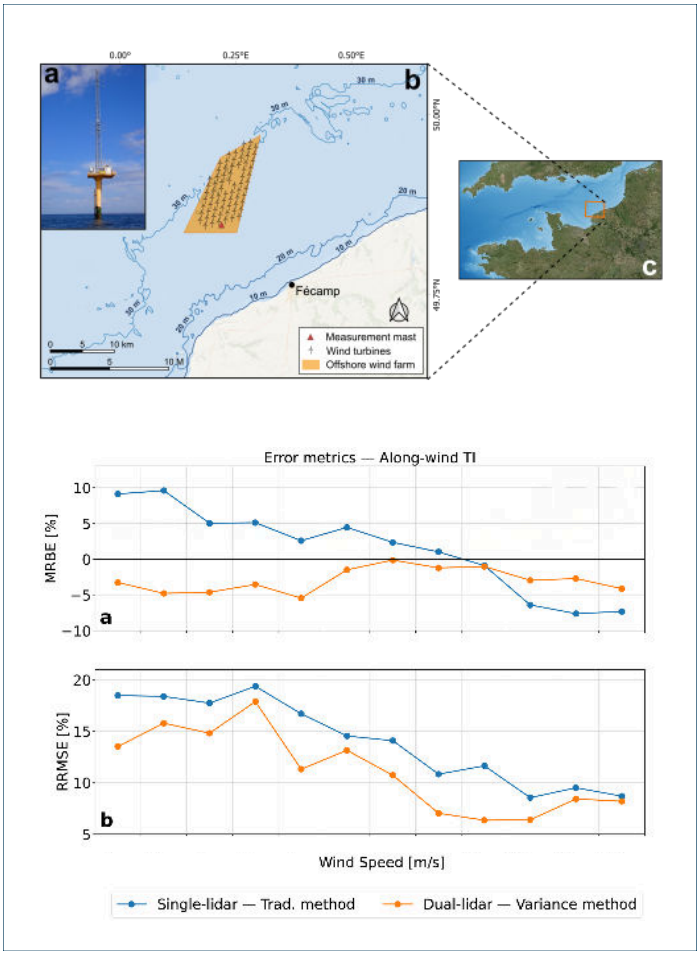
Reducing CAPEX and LCOE improves project profitability and enhances their competitiveness in the market.

A tested and approved methodology

The reduction of TI measurement errors

Our new 'variance method', which has only one source of error for TI reconstruction, was applied to measurements acquired using a dual Vaisala WindCube v2.1 lidar configuration on the Fécamp mast.
It was compared with the conventional method, which has three sources of error. The evaluation, conducted over thirty days of data, relied on reference measurements from a sonic anemometer to calculate MRBE and RRMSE, in accordance with DNV recommendations.

The variance method thus reduced MRBE* by 35% and RRMSE by 40% compared with the conventional method, providing greater reliability and a more robust basis for project design.**



*MRBE : Mean Relative Bias Error
**RRMSE : Relative Root Mean Squared Error

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