Lidar takes the lead: wind energy measurement in action

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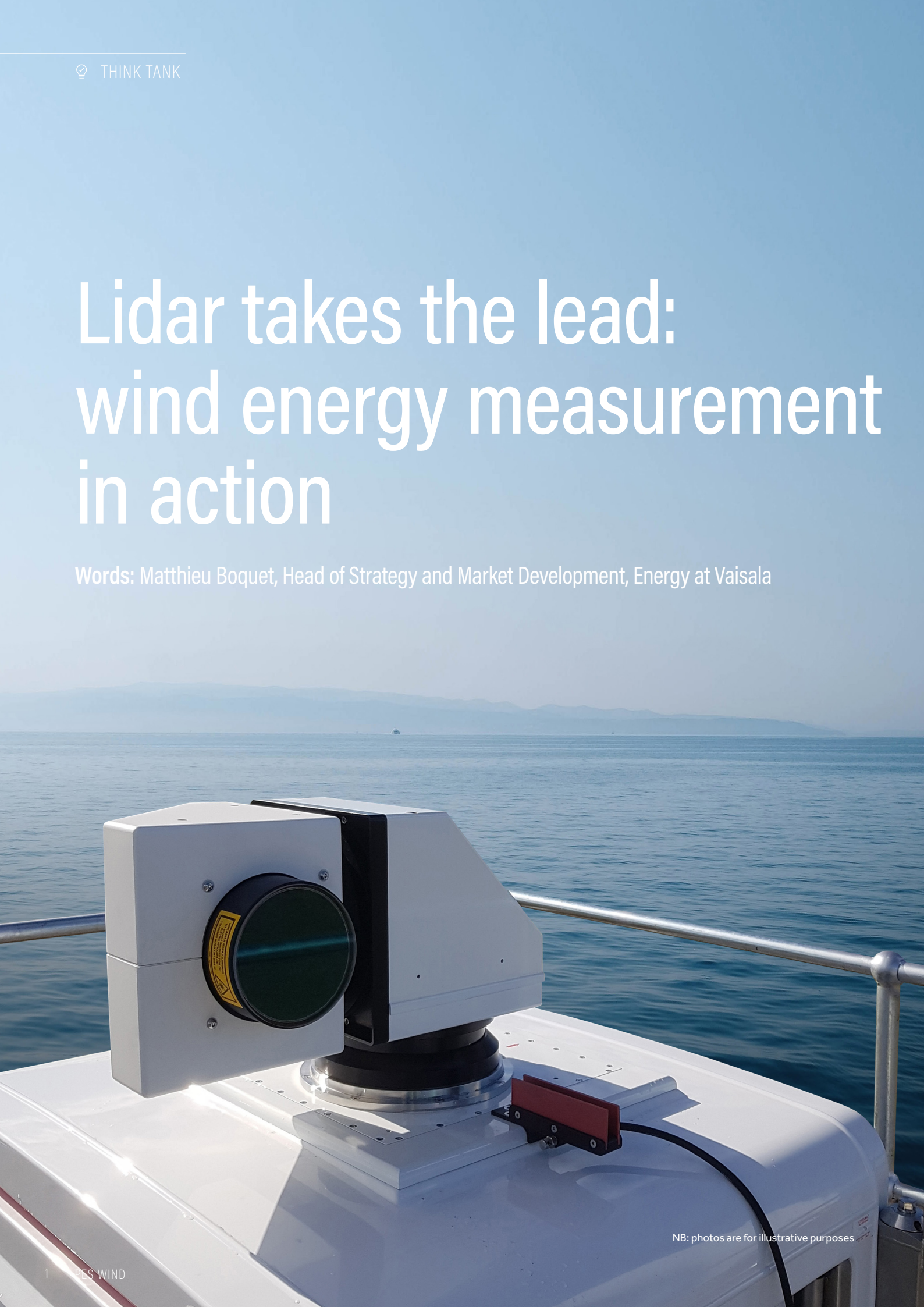


NB: photos are for illustrative purposes

Around the globe, renewable generation capacity is exploding, as more countries seek to reach net zero in the decades ahead. With the world increasingly turning toward renewable sources, wind energy plays an increasingly prominent role in this transition. In the modern world of wind energy, the need for accurate and reliable wind measurement data has never been more pronounced.

Solar and wind continue to dominate new generating capacity, with wind energy capacity increasing by 75 GW or 9% in 2022. As new projects are rapidly constructed, onshore and offshore, the world's installed wind generation capacity will only continue escalating. But with growth comes challenges, and wind energy industry players are not immune to them.

The traditional method of using meteorological masts for wind measurements is fraught with risks and limitations, as turbines reach taller heights than ever before and farms are constructed in increasingly challenging terrain or harsh, difficult-to-access offshore environments.

When high costs and uncertainty are untenable, significant players across the industry demand safe and accurate wind measurement solutions to accelerate wind energy globally. Enter lidar, a remote sensing technology that has rapidly become the industry's new standard for wind measurement. Positively impacting every stage of wind energy projects, lidar technology is helping three major players in the wind energy industry overcome challenges and create new opportunities for success.

This article will discuss different lidar use cases and acceptance trends in the wind energy space, exploring challenges faced by RES, Green Power Investment and General Electric, and how lidar empowered these companies to overcome their concerns.

RES: standalone lidar campaign

RES is a global renewable energy company. Working across a variety of technologies, wind, solar, storage, transmission and distribution, green hydrogen, etc., RES has delivered more than 23 gigawatts of renewable energy projects globally and supports an operational asset portfolio exceeding 12 GW.

Over the past three decades, the company has conducted about 2,000 measurement campaigns using met masts and remote sensing devices. As lidar technology advances, there is a growing acceptance within the technical community of the industry and more widely across all aspects of the industry, most importantly among financing partners. But bankability takes a backseat to employee health and safety.

Given the industry's priority around safety, RES' approach involves taking the least risk to obtain the data necessary for measurement campaigns to ultimately finance projects. Beyond long lead times, planning permission and the time-consuming permitting process, met masts can pose risks during installation, operation or decommissioning, whether due to environmental factors, engineering defects, mechanical failures or accidents.

To mitigate these risks, a recent RES development project revealed that appropriately sited lidars combined with accurate modeling can replace met masts.

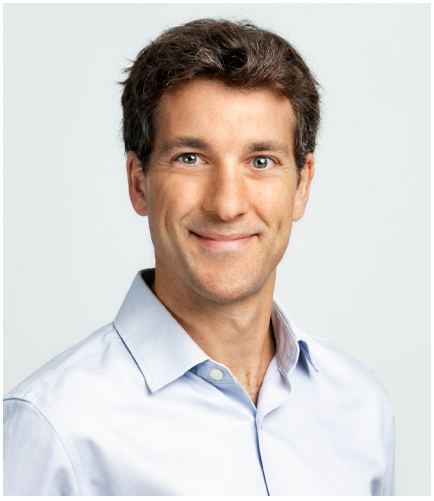
Leveraging a single verified Vaisala WindCube v2 lidar to conduct measurements, RES completed a measurement campaign at the Corlacky Hill Wind Farm in Northern Ireland. All turbines were within two kilometers of the measurement location, with a non-complex wind flow.

The campaign was completed in 12 months, and an energy production assessment was received within one month of completion. The campaign represented a 40% saving over the conventional measurement campaign for such a site, and the measured data helped RES optimize its wind farm layout and maximize energy yield. With no lifts, no climbing and zero safety incidents during the 12-month measurement campaign, RES' 11-turbine project achieved market standard uncertainty levels using standalone lidar.

Green Power investment: dual scanning lidar for offshore wind resource assessment

Green Power Investment, also known as GPI, develops, constructs, owns and operates a chain of power plants intended to generate electricity from renewable energy sources. Based in Japan, GPI wields extensive experience in offshore wind farms and, with the Japanese government aiming to eliminate greenhouse gas emissions by 2050, GPI is actively expanding its offshore wind farm operations.

Modern offshore projects are evolving to include larger turbines, increased heights and denser installations, and traditional measurement methods need to catch up. Consequently, GPI demands the best wind measurements possible to get started.



Matthieu Boquet

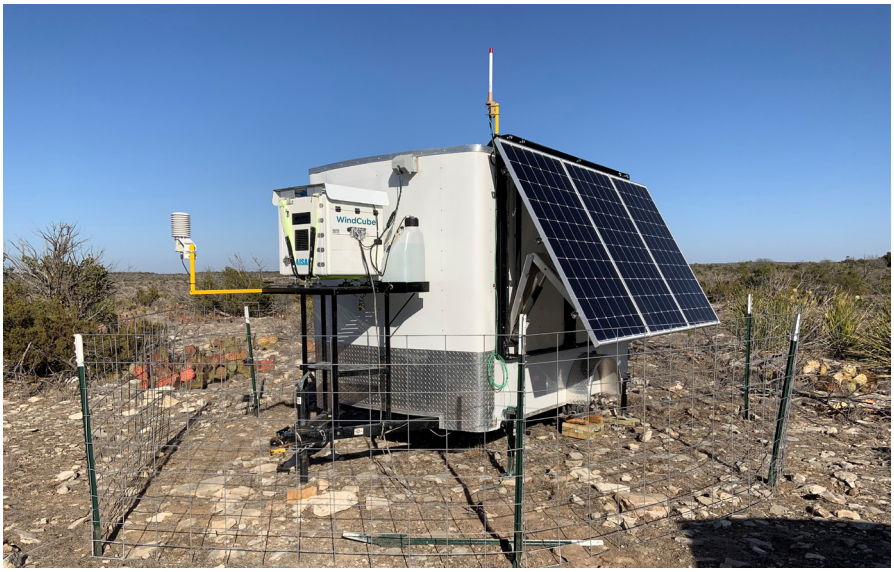
Recognizing that single scanning lidars can simultaneously capture the wind trend at different heights across a large area, about 10 kilometers from the coastline, GPI employs a dual scanning lidar approach for Wind Resource Assessment (WRA). Multiple offshore virtual met masts can be set up with dual scanning lidar, allowing for more precise design mapping and reduced uncertainty in horizontal wind modeling.

Compared to traditional measurement methods, dual scanning lidar can collect data more consistently and reliably, reducing the likelihood of errors or inaccuracies. Plus, dual scanning lidar also allows for more efficient data collection, covering a larger area in a shorter amount of time to deliver cost savings for developers.

GPI conducted a campaign comparing the use of one met mast to a dual scanning lidar setup, finding a 6% error in the single met mast case. With dual scanning lidar, GPI found that better wind assessment can be achieved, and more virtual met masts can be 'installed' to reduce uncertainty in offshore WRA.

General Electric: the acceptance of nacelle-mounted lidar for power performance testing (PPT)

General Electric (GE) is a multinational conglomerate corporation that operates in several industries, including renewable energy. In recent years, the company has focused



heavily on expanding its presence in wind power, manufacturing wind turbines and parts and developing various wind energy technologies and services to help optimize wind power plant operations and maintenance.

Demanding quality performance testing metrics for its wind turbines, GE turned to nacelle-mounted lidar for its performance warranty testing. Nacelle lidars provide reliable and accurate wind measurements without installing a separate measurement mast, which can be costly and time-consuming. This means data can be collected more frequently and easily, allowing for a better understanding of how the turbine performs and how to optimize its operation.

When IEC 61400-50-3, allowing the use of nacelle-mounted lidars for Power Performance Testing, was released last year, GE began working with companies like Vaisala, some of its customers and third-party consultants to gain the same level of confidence in the use of nacelle-mounted lidars as in ground-based lidars.

The company conducted a series of field tests in the U.S. and Europe to evaluate the accuracy, reliability and robustness of nacelle lidar. The GE-led campaign focused on data such as wind speed measurements and performance type A uncertainty, especially against the met mast, and environmental factors like shear and turbulence intensity.

In field tests, the WindCube Nacelle lidar provided accurate wind speed and direction measurements, enabling GE to optimize turbine performance and improve energy output. GE's findings showed that nacelle lidar measurements are comparatively close for wind speed compared to a met mast.

Across the board, GE witnessed lower type A scatter, good overall shear characterization and quality TI measurements from the nacelle lidar. The results illustrate that GE has a solid level of trust in nacelle lidars for measuring hub-height wind speeds and is close to gaining that same level of comfort regarding wind shear and TI.

Based on these successful tests, GE has accepted WindCube Nacelle lidar as a valid method for its performance warranty tests.

Final thoughts: embracing lidar for a more sustainable future

As the world moves toward a greener, more sustainable future for the next generation, lidar technology transforms wind energy, providing a safer, faster and less expensive solution for wind measurement.

Standalone lidar campaigns are progressively becoming the reality of wind farm development, delivering accurate and bankable data at much lower costs. In offshore WRA, dual scanning lidar shows reduced measurement uncertainties and accurately measures the wind's behavior at different heights for offshore wind farm development.

Finally, nacelle-mounted lidars are gaining acceptance among significant wind industry players for wind turbine performance testing, providing accurate measurements and reducing the need for more expensive met masts.

By improving the accuracy of wind measurement, reducing uncertainty in WRA and enhancing PPT, lidar technology empowers RES, GPI and GE to optimize wind farm layouts, maximize energy yield and increase trust in measurement quality, resulting in increased safety, speed and cost savings. As the demand for renewable energy continues growing, lidar will undoubtedly play a critical role in ensuring the safety, accuracy and cost-effectiveness of wind energy production.

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