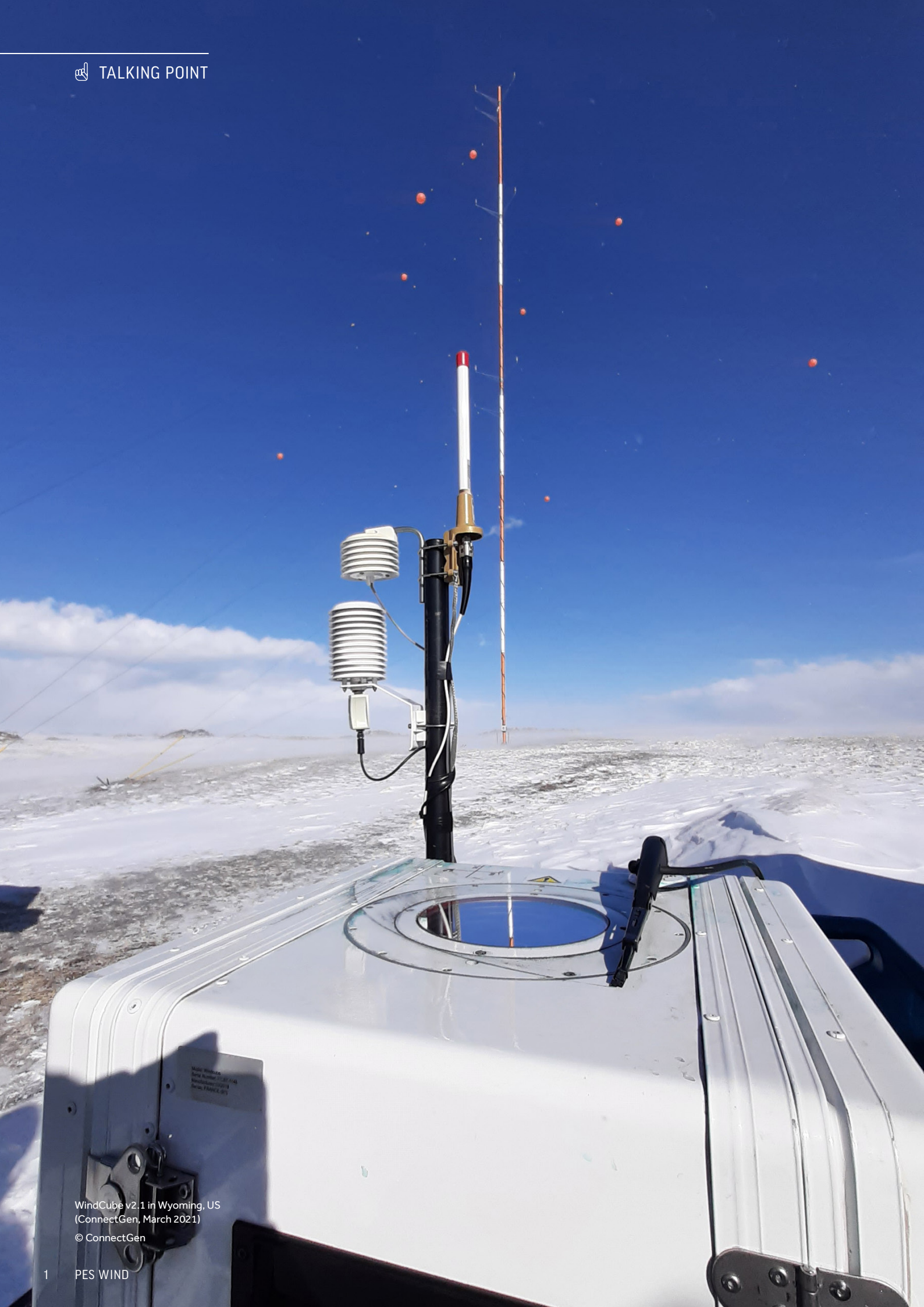

WindCube v2.1 in Wyoming, US (ConnectGen, March 2021)

Leveraging lidar to optimize wind resource assessment

Words: Hugues Portevin, Product Manager at Vaisala

Accurate Wind Resource Assessment (WRA) grows in importance as the industry, and turbines, grow in demand and in size. By understanding how recent wind energy industry innovations have evolved, we can help shape best practices for WRA, so that the wind energy sector can continue to meet demand and make our world a better place.

For centuries, people around the world have harnessed the wind for countless applications. Continuing this tradition, wind energy is now one of the fastest-growing renewable energy segments and a critical component of building a healthier, greener, more innovative future. Around the globe, an increasing number of countries are boosting their wind-generation capacity, both onshore and offshore, to produce the electricity that powers our daily lives.

Key components of this innovation have been to understand how to optimize turbines to extract more energy from wind, as well as the ability to accurately define, measure and forecast the world's land-based and offshore wind resources. Both are critical to projects of all sizes and have highlighted the importance of accurate Wind Resource Assessment (WRA).

Wind resource assessment basics

The most critical step in any wind farm project, WRA is the foundation for determining feasibility and securing financing. Since each wind farm is unique and presents its own distinct challenges, accurately quantifying the wind resources at a given site is critical to determining its financial and practical viability. Initial site prospecting data informs site selection, while a full resource assessment forms the basis for annual energy production (AEP) estimates that investors require.

Complicating the issue, the average hub height of onshore and offshore wind turbines

WindCube v2.1 in complex terrain

is increasing, as manufacturers design turbines with greater generating capacities. Meteorological masts, the traditional standard of wind measurement, are costly and struggling to keep up with this growth trend. Onshore or on land, most met masts fail to cover the entire operating region or the full rotor sweep of modern turbines, and shorter met masts require a greater reliance on data extrapolation techniques that typically introduce error and uncertainty.

Despite the shortcomings of met masts, the bank engineers who judge a wind farm project's viability still rely on met mast measurements. Consequently, there are plenty of situations where met masts and remote sensing lidar technology are natural partners.

As lidar technology advances, wind farm site assessment can be undertaken more swiftly and accurately. The mobility and ease of deployment of vertical profiling and scanning lidar devices ensure the technology can be used across many types of terrain and in all climates to better account for sitewide spatial variation and reduce wind flow modeling uncertainty.

Consider the case of Mainstream Renewable Power, a global wind and solar developer, as an example. Mainstream develops sites in complex remote territories that face wind resource risks related to dramatic changes in wind climate or unusual vertical wind speed patterns.

Like many developers, one of Mainstream's key technical challenges is obtaining high-quality data beyond that which is offered by traditional met masts to demonstrate that a given site will generate predictable and dependable revenue.

Deploying Vaisala's WindCube lidars, to supplement existing met masts, across multiple sites allowed Mainstream to collect wind data at greater heights. The resulting data sets removed the need to rely on vertical met mast data extrapolation, enabling energy yield estimation accuracy improvements.

Let's take a look at a few cases studying several recent wind energy industry innovations to discover how these advancements ultimately enable wind industry decision-makers to embrace not just new turbines, terrains and tactics but entirely new ways of harnessing data and making critical decisions.

WRA in complex terrain

Often, installing a met mast is impractical, too expensive or even impossible given the terrain. However, with an increasing number of developers turning to challenging wind farm locations, a bankable alternative to more traditional measurement technology is necessary. Enter lidar's mobility, reliability, data accuracy and ease of deployment.

About 30 kilometers inland from the Croatian coast lies a developing 400 megawatt wind farm on a site with unique landscape features. The hilly, forested area sees a 500 meter difference between the lowest and highest point and is subject to powerful seasonal Bora winds. While wind energy consultancy Green Trust had one met mast installed at the site for WRA, it decided to add a wind lidar to reduce measurement uncertainty and measure where met masts cannot.

'With lidar, you can measure up to higher altitudes. For me, it means I can never measure higher than that with a mast, so I need something additional to understand what's going on up there. And of course, lidar is the best solution for that,' commented Jorn Goldenbeld, Senior Wind Specialist, Green Trust.

Leveraging the WindCube vertical profiling lidar enabled Green Trust to take measurements in more than one location for a complete picture of wind conditions throughout the three-year measurement project. By using the resulting flow correction map within the search area of the lidar location, Green Trust ultimately found the best position with the smallest correction and the lowest uncertainty.

Dual lidar to improve WRA

Today, progressive companies, especially

Windcube 200S Offshore wind farm, University of Oldenburg

Mainstream Offshore on Platform Vietnam

offshore developers, utilize scanning lidar for a fuller, 3D understanding of the wind environment. One such organization is Green Power Investment (GPI), the owner of Japan's largest wind farm.

By measuring across 360˚ using several scanning patterns, scanning lidars provide 3D spatial wind awareness and allow operators to assess several turbines at once, increasing wind assessment certainty.

During the wind farm certification process of their proposed offshore wind farm project, GPI leveraged WindCube Scan Dual Lidar to execute its WRA campaign in an offshore-from-the-shore configuration. With each lidar placed in a strategic location to observe an offshore location from several positions, this unique configuration provides a comprehensive picture of the wind resource profiles.

WindCube Scan Dual Lidar provides the accurate wind measurements (at several heights) needed to reduce measurement uncertainty and create a competitive bid for the upcoming wind farm development auction.

Lidar enhancements to conduct WRA

In an effort to increase data accuracy, operational continuity and bankability, Vaisala has recently enhanced its WindCube vertical profiling lidar with increased measurement capabilities, premium services and turnkey options.

By increasing the suite of lidar instruments' measurement range to 300 meters, enabling 20 simultaneous measurement heights, leveraging a unique, patented hybrid wind reconstruction algorithm, and garnering industry-leading classification and validation, WindCube enables its customers to better harness wind energy.

Empowering the future

Fortunately, recent wind industry innovations have provided developers, operators and manufacturers with better, bankable data with increased agility and simplicity. As lidar technology advances, the industry now has the necessary guidelines and standards that create global confidence, knowledge sharing and standardization of lidar as an important and expected part of most standard wind energy processes.

Lidar's quality and quantity of data have redefined wind energy, and its benefits include reduced uncertainty, improving financing and protecting profitability, from onshore complex terrain to remote offshore. Other advantages include minimized third-party, on-site validation time and the simplification of burdensome processes, such as power performance testing (PPT) and WRA.

It also leads to more accurate yield assessments and informed, data-driven decision-making related to turbine selection and wind farm layout and increased human safety.

By reducing the risks in wind energy output and the global cost of energy for wind farms both onshore and offshore, wind energy innovations are empowering decision-makers to supply clean, renewable power to businesses and homeowners at lower costs.

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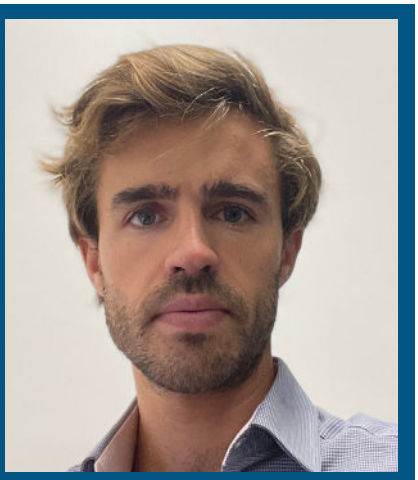

Hugues Portevin is the Product Manager for both WindCube and WindCube Offshore vertical profiler lidars. Within Vaisala's market & offering team he is responsible for developing the acceptance and use of WindCube lidars as standalone measurement devices for Energy Yield Assessment.

Hugues graduated from CentraleSupelec and HEC Paris, he has strong experience in product and marketing management acquired mainly through several years in the Aerospace industry.