Floating LiDAR technology

Words: Graham Howe, Director of Sales, Europe for AXYS Technologies

Using tried and tested technology it is possible to save the cost and time of installing offshore met masts by using floating LiDAR systems

Offshore wind resource assessment: floating LiDAR replacing met masts

Initial wind resource assessment is a critical first step to offshore wind development, and the single most important characteristic of a site is its wind speed. The performance of a wind farm is very sensitive to uncertainties and errors in the basic wind speed estimate, therefore the assessment must be extremely accurate in order to secure funding and for the economic development of a wind farm. The traditional solution to measuring local wind conditions is to construct a meteorological mast (met mast) equipped with anemometers and extrapolate those measurements across the length of the wind farm.

Around 7 years ago, floating LiDAR devices emerged as a response to a specific market need. The rising offshore wind industry needed a way to easily gather wind resource data to support the rapid growth in the sector. The traditional met mast method used onshore did not translate well to the marine environment. Onshore, a mast can be erected rapidly at a cost of approximately US$50,000. Offshore, a mast typically takes up to a year to get a permit, around 3 to 6 months to build and incurs a cost of up to US$15 million. In addition, there are significant costs to operate, maintain and decommission met masts. As a result, 25% of UK wind farms have been commissioned or are under construction with less than 1 year of on-site wind measurements.[1]

Floating LiDAR devices were designed as a faster and less expensive alternative to met masts. Putting it simply, a floating LiDAR device substitutes an anemometer on a fixed mast structure with a LiDAR sensor on a floating platform, typically a buoy. A LiDAR is a laser-based sensor that measures the wind speed and direction by tracking the motion of air particles and has been accepted as a reliable and accurate technology for onshore wind resource assessment. A floating LiDAR typically costs in the region of US$1 million to US$1.5 million, permits take less than 30 days, deployed in a day and recovered (decommissioned) in a day.

The advantages a floating LiDAR system has over traditional meteorological masts include significant reductions in cost and time, coupled with the flexibility to move and gather additional meteorological and oceanographic data in the surrounding environment across multiple locations which all result in the indisputable value of this technology. The ability to buy accurate wind data at specific locations for the standard 12-24 month campaign periods from a fleet of available floating LiDAR buoys is appealing to developers who once had to wait over a year before acquiring the first permit to begin constructing an offshore met mast.

The following timeline shows the development of both the market and the introduction of the floating LiDAR solution:

1991 | First offshore wind farm, Vindeby, was constructed off the coast of Denmark by DONG Energy

1991-2009 | Offshore met masts constructed in Europe, including the construction of the three FINO platforms in Germany (2003-2009) and 24 met masts around the UK. From 2007 it became more common to not install a met mast until after construction starts

2009 | First buoy to be outfitted with a LiDAR for wind assessment by AXYS Technologies is tested against a LiDAR stationed on an island off the coast of Victoria, BC Canada

2013 | Carbon Trust Offshore Wind Accelerator group recognizes value in floating LiDAR technology and develops the Roadmap for the Commercial Acceptance of Floating LiDAR Technology to help give developers trust in the available options and drive the technology to commercialization

2013 | Floating LiDAR (FLiDAR) is first validated against an offshore met mast

2014 | First developer to reach financial close for a new offshore wind farm based entirely on wind data acquired by a floating LiDAR system (FLiDAR) (Burbo Bank Extension, DONG Energy)

2014 | First floating LiDAR system (FLiDAR) equipped with dual (redundant) LiDARs is validated against an offshore met mast

2015 | First floating LiDAR system (FLiDAR) with dual LiDAR system completes extended Carbon Trust Stage 2 validation trial against offshore met mast with no required maintenance and achieves >99% data availability, >98% data accuracy

2016 | First floating LiDAR system (FLiDAR) equipped with dual LiDARs completes full 12 month commercial wind assessment campaign with no maintenance outages

As can be seen from this timeline, floating LiDAR technology has progressed rapidly over a few short years to market acceptance and made a significant impact on offshore wind to help lower costs for accelerated development.

Estimating uncertainty: re-evaluating with more data

When floating LiDAR technology was first developed, original assumptions surrounding their data uncertainty was somewhat arbitrarily set at 4% to 7% uncertainty compared to the data from a compliant met tower at 2.5%. The reasoning behind this was conservative assumptions by wind resource engineers who took the proven met mast data uncertainty of 2% and added an assumption of uncertainty since it was expected that a LiDAR on a buoy would be less reliable and accurate due to the impact of a combination of hostile marine conditions and error induced by the motion of the buoy. Since that estimated standard was set in 2012, there have been a number of validation studies across multiple system types in wide variety of weather and sea states. Using this assembled data it is now possible to re-evaluate the original uncertainty assumptions. For example, there have been twenty-four offshore wind resource assessment campaigns in seven countries totalling over 12 years of collective data on just one of the floating LiDAR systems currently available on the market (AXYS FLiDAR 6M). These specific studies have revealed the following key findings:

1. Dynamic ocean conditions have little or no effect on the quality of the wind data collected from a FLiDAR 6M buoy.[2] This means that the data quality is essentially equal between a LiDAR onshore and a LiDAR offshore on the FLiDAR 6M NOMAD hull.
2. Data availability from a FLiDAR 6M matches that of an offshore met tower. Recent validation studies show FLiDAR 6M buoys deployed for periods of 6-12 months have required minimal maintenance and demonstrated system data availability of nearly 100%, greatly exceeding published best practices of 90-95%.[3]

Graham Howe is Director of Sales, Europe and Middle East for AXYS Technologies. Having worked in North America, the Middle East and Europe he is currently accountable for the sale of all of AXYS product lines from the AXYS European office in Brussels. He has a special accountability for the market development of the AXYS FLiDAR floating LiDAR solutions and is active in the introduction of international standards for these systems.

FLiDAR 6M buoys have performed throughout some very harsh marine conditions over the last few years, and their continual hardening and redundant design for sensors, autonomous power, and telemetry systems have made them exceptionally robust. The FLiDAR 6M have experienced and survived extreme weather, including 10m waves and winds exceeding 57 knots, from hurricanes, typhoons, and winter conditions in the North Sea and elsewhere off three continents worldwide.

It can be argued that this body of evidence, acquired over several years of deployments, can be used to reduce the initial uncertainty assumptions for the FLiDAR 6M from 7% to the more typical 4% given to data acquired by onshore LiDAR systems.

Learning from experience while embracing new technology

Although offshore wind has been a significant power source for areas of Western Europe since the first offshore wind farm was constructed in 1991, it is only now beginning to gear up in North America and other parts of the world. The United States has begun construction of its first offshore wind farm off the coast of Massachusetts after overcoming many political and bureaucratic hurdles that continue to cause delays. Despite the fact that offshore wind farms haven't yet provided power to American homes, floating LiDARs (FLiDAR 6M) have been used extensively there for research and assessment purposes. Likewise other countries are beginning to evaluate their offshore wind potential and construct demonstration projects to help this process. The National Cheng Kung University was also an early adopter of FLiDAR technology in 2013 helping them to begin evaluating the offshore wind potential in the Taiwan Strait.

While there are many offshore wind development lessons to be learned from the pioneers in Europe through their years of experience, there is also now the opportunity to reliably bypass the expensive burden of offshore met masts that was not possible in the early days. According to some wind experts, floating LiDAR systems will be essential for the development of offshore wind to help with resource maps, forecasting tools, weather models, measurement stations and technical reports documenting physical design basis.[4] It can therefore be concluded that this accepted and continually improved floating LiDAR technology enables all new offshore wind developments to shorten the path to cost effective offshore wind power by removing the need for expensive and somewhat outdated met mast equipment. ■

About AXYS Technologies

With over 40 years of experience, AXYS is an expert at collecting, managing and disseminating remote sensing data from harsh environments. AXYS is committed to continual investment in R&D to innovate new products and services that solve complex business problems and add value to clients. The FLiDAR solution developed by AXYS in 2009 is a wind resource assessment buoy capable of accurately gathering data on wind speed and wind direction offshore at turbine hub-height and across the blade span. Since its inception the FLiDAR has been used on 24 offshore wind resource assessment and validation campaigns worldwide.

www.axystechnologies.com

[1] "Do we need offshore met masts for offshore wind farm developments?" Author: Peter Flower, DNV, February 2013

[2] "On the Sensitivity of Floating Lidar Systems to External Conditions," Author: Andrew Clifton, National Renewable Energy Laboratory, February 2016

[3] "Assessment of a Pre-Deployment Validation of the AXYS FLiDAR-6M-ZephIR Floating Lidar Device, S/N F080 at West of Duddon Sands, UK," Author: Detlef Stein, March 2016

[4] "Floating Lidar Systems: the US Perspective," Author: Andrew Clifton, National Renewable Energy Laboratory, February 2016