ZX Lidars

Wind speed at light speed

ENOWA Leverages Wind Lidar Technology to Advance Wind Resource Assessments Across Saudi Arabia

ENOWA. NEOM

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Authors

Eleonora Catalano,
Senior Wind Resource Engineer, ENOWA

Matthew Smith, ZX Lidars

Local Office:

ZX Lidars,
Willow End,
Blackmore Park Rd,
Malvern,
WR13 6BD,
UK

Tel: +44 (0) 1531 651 000

Registered Office:

Zephir Limited
The Green House
Forrest Estate, Dalry,
Castle Douglas
Kirkcudbrightshire,
DG7 3XS

Company No. SC317594
VAT No: 2436926 48

Contents

1 Overview

ENOWA, a key subsidiary of NEOM and leader of its energy and water initiatives, is driving the deployment of renewable energy in Saudi Arabia. While using the more traditional method of measuring the wind with met masts, ENOWA is also leveraging cutting-edge wind Lidar technology to overcome the unique wind measurement challenges presented by the Kingdom's vast and complex landscapes. The deployment of the ZX 300 wind Lidars across Saudi Arabia is playing a critical role in enabling accurate, efficient, and cost-effective wind resource assessments as ENOWA develops its portfolio of wind energy projects.

2 Background: Wind Energy Potential in Saudi Arabia

- Saudi Arabia is poised to become a major player in global renewable energy, aiming to diversify its energy mix under Vision 2030.
- The country has ambitious wind energy targets and favorable wind resources, particularly across its western and northern regions.
- ENOWA is responsible for building NEOM’s sustainable energy and water systems, with the goal of achieving 100% renewable electricity supply. It plays a pivotal role in positioning NEOM as a global benchmark for circular economy principles and net-zero energy systems.
- Realising this potential requires overcoming measurement challenges due to:
  - The large scale of proposed wind sites (from less than 100 to more than 2,000 km²).
  - Harsh desert environments with limited accessibility.
  - Complex and unique atmospheric phenomena, including negative wind shear.

3 Overcoming Saudi-Specific Challenges

Saudi Arabia's wind energy ambitions are accompanied by distinct technical and environmental challenges. ENOWA looked to wind Lidar technology to address these obstacles to advance the Kingdom's renewable energy goals.

3.1 Large-Scale Wind Sites

One of the foremost challenges faced in Saudi Arabia is the sheer scale of its planned wind farms. Projects commonly extend over areas ranging from hundreds to thousands of square kilometers. This vastness presents significant complexities in obtaining representative and reliable wind data using conventional methods. Traditional meteorological masts, constrained by their fixed position and limited spatial coverage, fall short of capturing the variability of wind conditions across such expansive terrains. By contrast, wind Lidar provides a decisive advantage. Its portability and ability to be rapidly redeployed enable measurements to be taken at multiple locations throughout the project area. This results in a far more robust and spatially representative dataset, improving the accuracy of wind resource assessments and informing key development decisions such as turbine layout and project yield estimation.

3.2 Complex Wind Regime

In addition to scale, some desertic region of Saudi Arabia can be characterized by a unique and complex wind regime, most notably the occurrence of negative wind shear. This phenomenon, where wind speeds decrease with altitude—contrary to the more common pattern of increasing wind speeds with height—poses significant challenges for accurate modeling and turbine design. Traditional anemometric techniques are often insufficient in fully capturing these atypical conditions. Wind Lidar, with its high-resolution vertical profiling capabilities, is uniquely suited to addressing this challenge. By measuring wind speed and direction at multiple heights, it provides detailed insight into the vertical structure of the wind field. This data is essential for determining optimal turbine hub heights, refining turbine micro-siting, and improving energy yield forecasts, all of which are critical to maximizing the technical and commercial viability of wind projects in the region.

3.3 Remote and Inaccessible Locations

A further obstacle is the geographic remoteness of many prospective wind development sites. Situated in arid desert landscapes, these sites often lack basic infrastructure, making access difficult and the construction of traditional met masts impractical or prohibitively expensive. Wind Lidar's design directly addresses these challenges. Its compact and transportable form factor, combined with autonomous operation, allows it to be deployed without the need for roads, power supplies, or heavy construction. This capability not only reduces logistical complexity and cost but also enables wind resource assessments to be carried out even in the most isolated areas of the Kingdom. As a result, ENOWA could confidently progress its wind development pipeline without the limitations imposed by traditional measurement techniques.

4 Solution: Deployment of ZX 300 Wind Lidars

ENOWA turned to ZX Lidars' ZX 300 ground-based wind Lidar, a proven and leading wind Lidar technology, to address these challenges and embrace the opportunities offered by wind Lidar technology.

Figure 1: ZX 300 deployed with ENOWA in the Kingdom of Saudi Arabia

Key Advantages of ZX 300 for Saudi Arabian Wind Projects:

- **Spatial Coverage:** The ZX 300 provides accurate wind measurements across large and remote sites where traditional met masts are not feasible.
- **Mobility & Flexibility:** The portable design allows for rapid deployment and easy relocation across multiple positions, providing comprehensive site characterization.
- **High-Resolution Vertical Profiling:** Capable of measuring wind speed and direction from ground level up to 300 meters, enabling full coverage of modern turbine rotor heights.
- **Resilience to Harsh Conditions:** Suited to operate in Saudi Arabia's extreme desert climate without the need for heavy civil infrastructure or additional equipment.

Figure 2: ZX 300 is profiling the wind resource from ground level up to 300m

Meaningful Impact

ENOWA's wind resource engineer, Eleonora Catalano, emphasizes the impact of the technology:

"Wind Lidar technology from ZX Lidars has proven to be an invaluable tool in overcoming the logistical and climatic challenges associated with wind resource assessment in Saudi Arabia. By providing detailed and reliable data, it plays a crucial role in advancing the development of renewable energy projects in the Kingdom."

5 Results & Benefits

The use of the ZX 300 wind Lidar has enabled ENOWA to conduct accurate wind measurements across both remote and large-scale sites in Saudi Arabia. The ability to gather reliable data over such expansive and often inaccessible areas has strengthened the foundation for ongoing wind resource assessments. In particular, the flexibility of the technology has allowed ENOWA to adapt its measurement campaigns to the spatial variability of wind conditions, improving the overall understanding of site characteristics.

By obtaining high-quality wind data, ENOWA has been able to reduce uncertainty associated with resource assessment and energy yield predictions. This has contributed to improved decision-making regarding turbine layout, hub heights, and project design. The availability of detailed wind profiles has also helped to better account for specific regional characteristics, such as negative wind shear and complex terrain, which are prevalent across many of the planned development sites.

More broadly, the use of portable Lidar systems such as the ZX 300 has supported the practical implementation of ENOWA's wind measurement programme. In a region where traditional measurement methods face logistical and environmental constraints, the adoption of Lidar has allowed for more efficient and effective data collection, contributing to the progress of ENOWA's renewable energy activities in Saudi Arabia.

About Us

In 2003 we released the first commercial wind lidar, pooling decades of fibre laser research from the science, security and energy industries. Designed specifically for the wind industry our Lidar has paved the way for many of the remote sensing devices seen in the market today. Our original lidar technology continues to innovate with world firsts such as taking measurements from a wind turbine spinner and being the first to deploy an offshore wind lidar, both fixed and floating. Our Lidars have also now amassed millions of hours of operation across 15,000+ deployments globally spanning two decades of commercial experience. Some of our proudest achievements are listed below; these are the earliest reported examples that we are aware of from open publications.

2003 - The first wind lidar to make upwind measurements from a turbine nacelle
2004 - The first and original commercially available lidar for the wind industry
2004 - The first wind lidar to investigate the behaviour of turbine wakes
2005 - The first wind lidar to be deployed offshore on a fixed platform
2007 - The first wind lidar to take measurements from a turbine spinner
2008 - The first wind lidar to be signed off against an industry-accepted validation process
2009 - The first wind lidar to be deployed offshore on a floating platform
2010 - The first wind lidar to re-finance and re-power a wind farm
2011 - The first wind lidar to be proven in a wind tunnel
2012 - The first wind lidar to be used with very short masts and secure project financing
2012 - The first wind lidar to be accredited for use with no or limited on-site anemometry for project financing by DNV GL
2014 - The largest batch of single-type lidar verifications against an IEC met mast
2015 - The first lidar designed specifically for offshore use, with the longest warranty available - 3 years as standard
2016 - The first wind lidar to support safe lifting on a jack-up vessel
2016 - The first wind lidar SCADA integrated on operational wind farms in replacement of site met masts
2017 - The first wind Lidar to be installed across a wind farm on a Lidar-per-turbine basis, uniquely mapping wakes across a wind farm
2018 - The first wind Lidar to satisfy all criteria for IEC Classification
2019 - The first wind Lidar to take wind measurements from a drone
2020 - The first wind Lidar to be accepted for bankable energy assessments in complex terrain standalone (without a met mast)
2021 - The first wind Lidar to attract more than £150bn+ of investment into wind energy projects
2022 - The first wind Lidar to be fully integrated into a retrofit wind turbine controller for Lidar Assisted Control
2023 - ZX Lidars moves to Willow End!
2024 - The first wind Lidar with a 5 year warranty and 5 year planned service interval as standard

Our Products & Services

ZX300
Onshore vertical profiling wind Lidar

ZX300M
Floating & platform-mounted vertical profiling wind Lidar

ZXTM
Turbine-mounted horizontal profiling wind Lidar

ZX Measurement Services
Wind Data as a Service