ZX Measurement Services

The easier way to measure in renewables

Lidar Deployments

A Best Practice Guide

17/11/2025

PUBLIC RELEASE

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Issue	Date	Revision details
1	01/12/2025	First release

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1 Introduction

Wind Lidar systems such as the ZX 300 are proven, bankable alternatives to met masts, widely accepted for energy assessments and project financing. Their ability to provide high-resolution wind profiles up to hub height and above - with minimal infrastructure - makes them ideal for both greenfield and repowering campaigns.

This document presents an industry-aligned, field-tested guide to best practice across the full lifecycle: from site selection and system setup through to maintenance, monitoring, and pre- and post-campaign validation. It includes practical tools, sample checklists (see Annex), and is underpinned by IEC, MEASNET, DNV, and IEA guidance. By adhering to these practices, project developers and measurement professionals can significantly reduce uncertainty, improve data representativeness, and ensure successful wind measurement campaigns.

2 Why deployment matters

Lidar systems operate in the uncontrolled, real-world environment. Their data output is only as reliable as the deployment strategy that supports them.

Success in siting, power provision, or communications can lead to:

- High data availability
- Data representativeness with respect to flow distortion and wind conditions
- Demonstrable and expected performance during third-party validation or audits

Without following best practice, consequences can include delayed project development timelines, increased measurement uncertainty, and additional campaign costs.

International guidance such as IEC, MEASNET's evaluation framework, and IEA RP16 emphasise that deployment procedures - not just device specifications - are central to data quality. Comprehensive pre-installation planning, structured commissioning, and ongoing operational verification are essential for minimising these risks.

This best practice guideline document aims to be thorough but can never be exhaustive. We will continue to update and share new versions as the industry continues to utilise wind Lidar in new and novel ways. Our focus here however does cover the following areas:

- Installation site selection
- System preparation and setup
- Power and communications
- Operational monitoring and maintenance
- Verification and validation
- Future-proofing the deployment
- Working with expert partners

3 Installation site selection

Installation site selection is one of the most consequential decisions in a Lidar deployment campaign. A well-sited system reduces uncertainty, enhances data availability, and supports comparability with long-term references or modelled wind resources. This section outlines the technical and logistical criteria used to evaluate, select, and secure a suitable deployment location that ensures measurement integrity and operational practicality.

Objectives:

- Maximise data integrity by avoiding unexpected flow distortion, ground clutter (i.e. objects that may cause significant Lidar beam blockage), and electrical interference.
- Ensure safe, secure, and logistically practical access for installation and maintenance.
- Mitigate environmental and technical risks over the full deployment period.

Best Practice Checklist:

- Conduct terrain classification using CFD models, mesoscale overlays, or similarly accepted approaches to identify flow complexity; this is to be performed by the wind engineer consultant. IEC and MEASNET recommend using appropriate complex terrain conversion methods.
- Maintain an agreed distance of clear, unobstructed fetch in prevailing wind directions. Sites with significant sheltering effects (e.g. forestry, buildings) should be excluded unless mitigation is feasible and consideration should be given to the effects on both the intended power supply (e.g. solar) and the Lidar. Consider constraints and requirements in relation to mast-based correlations and siting (i.e. bird flag diverters or guy wires etc). This is performed by the wind engineer consultant with input from the service provider at the site survey stage.
- Working with a wind engineering consultancy, validate long-term siting suitability using wind roses, site constraints maps, and seasonal accessibility assessments.
- Ensure required site access for re-fuelling, servicing, and winter resilience. Include snow clearance and flood risk in the planning matrix; to be performed by the service provider.
- The service provider is to develop a deployment Risk Register including security concerns, weather constraints, and local hazards including vermin and dangerous animals. Include escalation protocols for each risk class. This will form part of the RAMS (Risk Assessment Method Statement) for each visit to site.

4 System preparation and setup

Proper preparation and setup ensure that the Lidar and ancillary equipment operates safely and consistently from the moment it is powered on. This phase includes equipment operational verification, software configuration, mechanical security, and traceability documentation. The goal is to eliminate preventable failures and to standardise deployment quality across sites and teams.

Key Principles:

- Apply consistent and traceable mechanical and software setup routines across all deployments.
- Perform full bench testing and operational verification before field mobilisation.

Required Actions:

- Securely level the Lidar base using the in-built bubble/spirit levels. Confirm directional alignment using the in-built alignment guide on the top face of the Lidar.
- Secure the Lidar met station, ensuring vertical and directional alignment.
- Document all firmware versions, configuration files and serial numbers. Maintain traceability throughout deployment lifecycle.
- Assign a unique Deployment ID linked to all logs, service reports, and metadata.
- Implement logging intervals and scan heights appropriate to campaign objectives, validated through pre-test comparisons with legacy or modelled data as part of any wind engineering consultancy scope.
- Ensure all connectors and ancillary equipment have been checked prior to deployment and comply with manufacturers recommendations.
- Pre-label all cables and hardware with identification labels. Package all equipment for secure transportation and include packing list.

Commissioning Outputs:

- Signed RAMS document including environmental, H&S, and electrical protocols
- Full photographic log of system configuration and cabling
- Site map with access routes, cable trenching (if any), and PSU location
- Pre-operational checklist verified by technical supervisor and logged with central registry

5 Power and communications

Stable power and resilient communications are prerequisites for high-availability wind measurement campaigns. This section outlines how to design, test, and maintain robust systems for powering the Lidar and ensuring uninterrupted data flow from field to data centre. Recommendations are based on field experience and aligned with industry norms such as DNV-RP-0432.

Power System Best Practices:

- Design systems for appropriate autonomy without generation. Use hybrid solar plus auxiliary generator or fuel cell configurations for redundancy.
- Install Class II surge protection (where applicable), inline circuit breakers, and thermal control systems matched to site climate zone. Include battery heaters or cooling fans as appropriate.
- Monitor voltage, charge rate, and battery health within the PSU remotely to minimise risk of Lidar downtime and extend operational run time under degraded conditions. Compare with manufacturer thresholds for proactive maintenance planning.

Communications Recommendations:

- Use multi-network SIMs with automated failover scripting. Log downtime and cause analysis in persistent local storage.
- Configure modem watchdog timers and auto-reset parameters. Integrate local logging of ping responses and throughput tests to central portal. Log downtime and cause analysis in persistent local storage.
- Apply encrypted data transfer protocols (e.g., FTPS, VPN) to ensure data integrity and confidentiality.
- Maintain active alerting system with mobile notifications for offline alerts >30 minutes. Escalation should follow a predefined response plan with contact details, spares availability, and access protocols.

6 Operational monitoring and maintenance

Even the most well-installed Lidar systems require effective oversight. This section provides field-tested routines and decision-making frameworks for monitoring data quality, responding to alerts, and planning periodic maintenance. The goal is to proactively address issues before they impact campaign integrity.

Monitoring Procedures:

- Perform weekly remote inspections checking for data completeness, hardware diagnostics, and environmental warnings. Use automated flagging systems for signal loss, internal temperature anomalies, and power drift.
- Analyse 10-min data availability trends and environmental log statistics to detect emerging faults before they impact data quality.
- Weekly fuel level reporting to understand power supply consumption and forecast/plan future refuel visits.

Maintenance Actions:

- Any planned visits should include window cleaning, replenishing screen wash, PSU diagnostics, cable integrity checks, and physical security assessments. Replenishing fuel if required.
- Perform functional verification using built-in test sequences or portable diagnostic tools. Validate system alignment.
- Maintain a rotating spare stock policy with validation schedule. Replace ageing PSU components proactively.
- All maintenance actions should be recorded in the Deployment Service Log, signed by technician, and appended to the central project file.

7 Verification and validation

Verification and validations confirm that a Lidar system is performing as expected under operational conditions and helps to ensure that measurement data can be trusted, audited, and used in critical assessments such as energy yield calculations. This section combines the latest IEC, MEASNET, and IEA guidance with structured routines and documentation expectations.

Standards Alignment:

Any operational verifications should follow appropriate guidelines such as IEC, MEASNET, and IEA RP16 guidance as provided by the wind engineering consultancy. Verification is both a technical validation and a project de-risking measure. This includes confirming the Lidar system is performing according to specification and that site conditions have not introduced unmanageable uncertainty.

Factory Acceptance Testing (FAT):

- Conducted for every Lidar unit prior to deployment to ensure functionality, stability, and data integrity. FAT confirms device-level compliance with manufacturer specification in a controlled setting.
- FAT ensures that field validation outcomes reflect environmental/site influences only—not device performance issues.
- FAT includes power supply test, environmental tolerance simulation, optical alignment check, and data output verification across all heights.
- FAT certificates should be included in the deployment file and referenced in data quality statements.

Field Verification Routines (may involve wind engineering consultancy):

- Co-locate with reference mast or validated system to confirm directional accuracy, wind speed correlation ($R^2 > 0.98$ typical), and turbulence behaviour.
- Apply suitable filtering using Lidar OEM’s recommended guidelines. Retain all exclusions and document methodology.

Uncertainty Management:

- Use traceability matrix to link all setup activities, test routines, and QA procedures to final dataset.
- Validate that system passes minimum acceptance criteria even if best practice is exceeded. Record results as part of commissioning validation pack.

8 Future-proofing the deployment

As projects scale or new technologies emerge, Lidar deployments must remain adaptable. Future-proofing includes both hardware flexibility and data integrity over time. This section details how to build deployments that are resilient, upgradable, and compatible with future analytical and operational needs.

Environmental changes

- Plan for what the deployment site may look like at the next planned visit but also any exceptional visit.
- Implement necessary equipment such as fauna matting to limit changes to site during the planned campaign.

Scalable design considerations:

- Use modular and serviceable power systems with interchangeable parts and future-compatible interfaces. Avoid bespoke or non-standard components.
- Set output formats to integrate with SCADA, IoT gateways, or external data management systems. Include CSV export as well as direct database integration.
- Enable firmware updates and configuration changes remotely, where possible.

Data continuity:

- Archive all data in dual locations: on-board and via remote server. Schedule regular backups and test recovery procedures.
- Log metadata including installation settings, firmware versions, all intervention history, and any power/communication fault durations.
- Align metadata structure with MEASNET documentation requirements, or similar, to support future audits or re-analysis.

9 Working with expert partners

While in-house teams may handle day-to-day deployment logistics, involving independent experts brings additional assurance to the measurement campaign. This section highlights the value of peer review, independent audits, and formalised documentation in establishing credible, bankable data sets.

Independent Oversight:

- Invite qualified independent engineers to assess site layout, siting, installation documents, and service history prior to campaign go-live.
- Use peer-review of commissioning and FAT documentation to ensure data acceptance by stakeholders, regulators, and financiers.

Best Practice Documentation:

- Collate all material in a Deployment File: site risk register, RAMS, commissioning reports, verification data, uncertainty budget as part of a wind engineering consultancy scope, and service logs.
- Format all documents according to standard naming and version control protocols. Use indexed references and structured metadata.
- Define clear escalation routes for system outages, including contact lists, response times, and available spare systems.

10 Conclusion

A correctly deployed Lidar is not just a data source - it is a strategic asset within a wind farm development project. High-quality wind measurements underpin everything from turbine selection to financing, and even grid integration.

This document sets out best practices built from real-world field experience, international standards, and robust QA/QC processes. By implementing structured deployment workflows and maintaining a traceable audit trail of procedures, wind project stakeholders can significantly de-risk their campaigns.

Use this guide - alongside the Annex of sample checklists - to operationalise best practice and standardise excellence across your measurement activities.

11 Sharing and Evolving Best Practices: An Invitation for Feedback

The wind energy industry thrives on collaboration and continuous improvement, and this best practice guide is no exception. At ZX, we recognise the importance of collaborating and collecting expertise to address the evolving challenges of wind resource assessment. This guide represents a culmination of industry knowledge and best practices, but it is only as strong as the contributions and insights from the wider wind energy community.

An Open Dialogue for Progress

We acknowledge that there is always room for refinement and further progress. As the industry grows and technology advances, so too must the frameworks and practices that support them. By sharing your experiences, insights, and questions, you can help shape the next iteration of this guide, ensuring it continues to reflect the very best practices.

We see this guide not as a static publication but as a living document. Future versions could include:

- Expanded case studies demonstrating real-world applications of Lidar and ancillary equipment.
- Updates to incorporate emerging standards or innovative technologies.
- Tools like checklists or decision matrices to make the methodologies even more actionable.

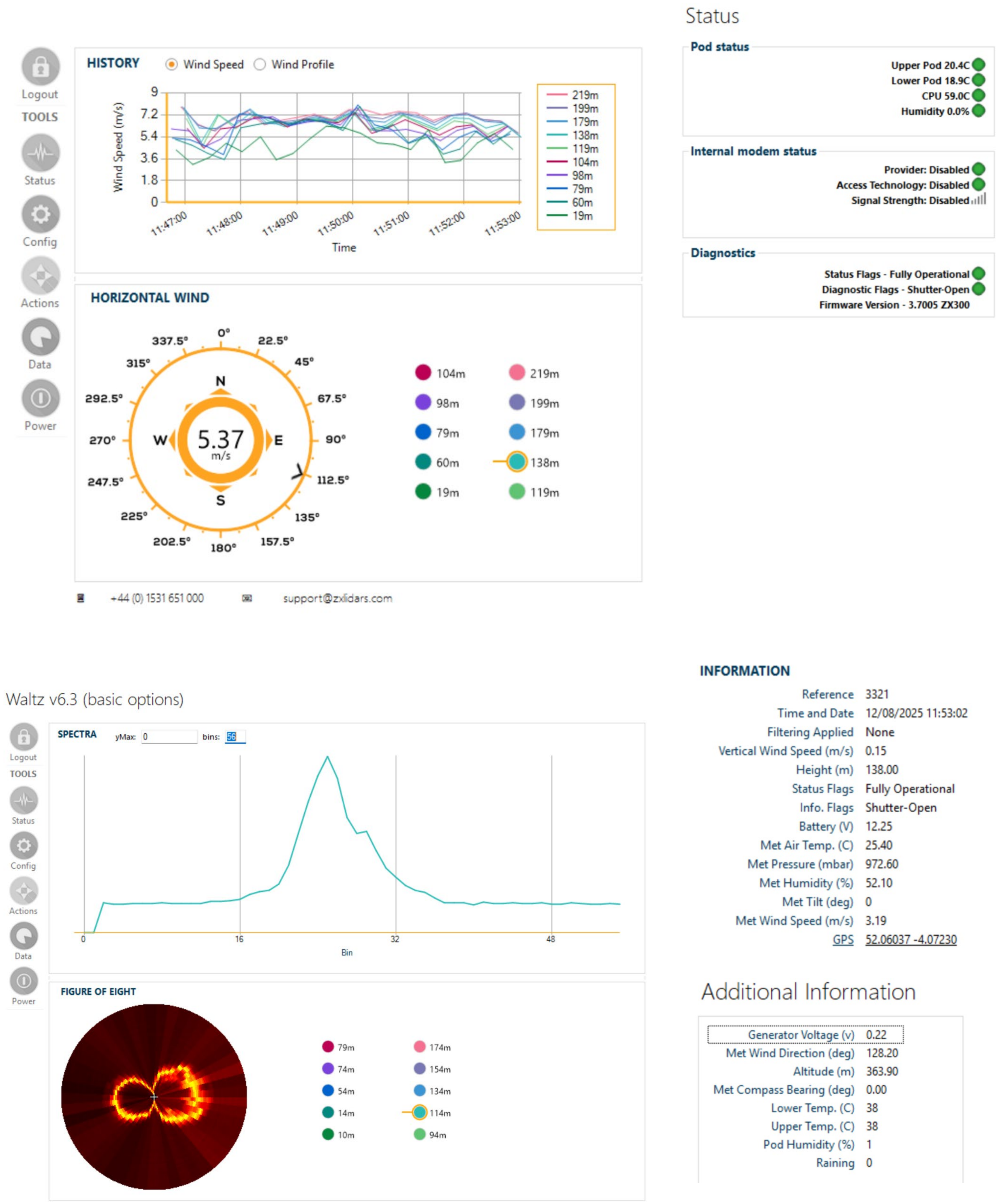
How to Contribute

We invite feedback from consultants, developers, financiers, and other stakeholders to ensure this guide remains relevant and impactful. Whether it's a suggestion for improvement, an observation from your own project, or a question about the methodologies described here, your input is invaluable. Together, we can continue to build a resource that supports transparency, collaboration, and excellence across the industry.

Thank you for being part of this shared journey. Let's advance wind energy assessments together.

12 Annex

Typical Lidar deployment with remote power supply unit and renewable resource



Functional verification using built-in test sequences and portable diagnostic tools

13 Sample Checklists for Lidar Deployment

13.1 Checklist: Pre-Deployment Site Survey

- Record GPS coordinates in WGS84 and elevation (m ASL)
- Visually inspect for line-of-sight clearance >100 m in all directions
- Measure terrain slope at Lidar location using clinometer or GNSS profile
- Confirm year-round vehicular access and evaluate risk of isolation (mud, snow, landslip)
- Test signal strength across all major network providers
- Photograph site from each quadrant (N/E/S/W), noting obstacles, fencing, animals, etc.
- Identify nearby infrastructure (powerlines, substations, towers, roads)
- Assess solar window: log sunrise-to-sunset shadows using pathfinder
- Engage landowner for access agreements and livestock control
- Evaluate long-term use plans (forestation, development, excavation)
- Rate multiple alternative sites using a scoring matrix

13.2 Checklist: System Preparation and Setup

- Integrate automatic logging scripts and auto-start protocols
- Firmware updates for all hardware
- Apply anti-theft tags or GPS tracking
- Verify screen wash fluid is freeze-resistant
- Anchor system to resist local wind gust design (e.g., 120 km/h)
- Use armored cable trunking for protection

13.3 Checklist: Maintenance Inspection

- Inspect PSU casing for degradation or damage
- Check cabling for damage
- Verify Lidar and MET station alignment and stability
- Test vent fans and battery case temperatures
- Check solar array alignment and stability
- Verify time sync across all data systems
- Download power logs and confirm data availability
- Replenish fuel and screen wash as appropriate

ZX Measurement Services

About Us

At ZX Measurement Services, our primary focus is the acquisition of the highest quality data with the lowest measurement uncertainty. Our team has over 80 years combined experience in the design, installation and management of measurement systems, ensuring all measurement campaigns are designed and delivered to exactly meet our customers' needs whilst optimising new and existing technologies to provide comprehensive data sets.

Combining ZX Lidars' position as industry leaders in the development and supply of Lidars globally with our experience in the design, application and management of turnkey measurement campaigns offers the unique opportunity for Project Developers, Asset Managers and Owner / Operators to maximise data quality and availability whilst minimising measurement uncertainty and cost.

2018 - First ZX 300 installed for wind resource assessment
2018 - First wind farm permanent ZX 300 installed
2018 - First nacelle-based ZX TM installed
2018 - First ZX 300 installed outside UK
2018 - Design, construction and deployment of first ZX Power
2019 - First met mast installation including design and construction of power supply and measurement system
2022 - First non-renewables industry measurement system design and supply
2022 - First Sodar deployment
2022 - ISO 9001:2015 certification achieved
2023 - ISO 45001:2018 certification achieved
2023 - Achilles accreditation achieved
2024 - ISO 14001:2015 certification achieved
2025 - Installation of first ZX300e

Our Services

- Lidar Rental – Onshore & Turbine Mounted
- ZX Data Portal
- ZX Power
- Field Services
- Fleet Management
- Met Mast Installation Services
- Noise Monitoring Support Services
- Solar Resource Assessment & Monitoring