# Inspection approaches and machine learning for wind turbine integrity

BINDT Workshop on NDT and SHM requirements for Wind Turbines

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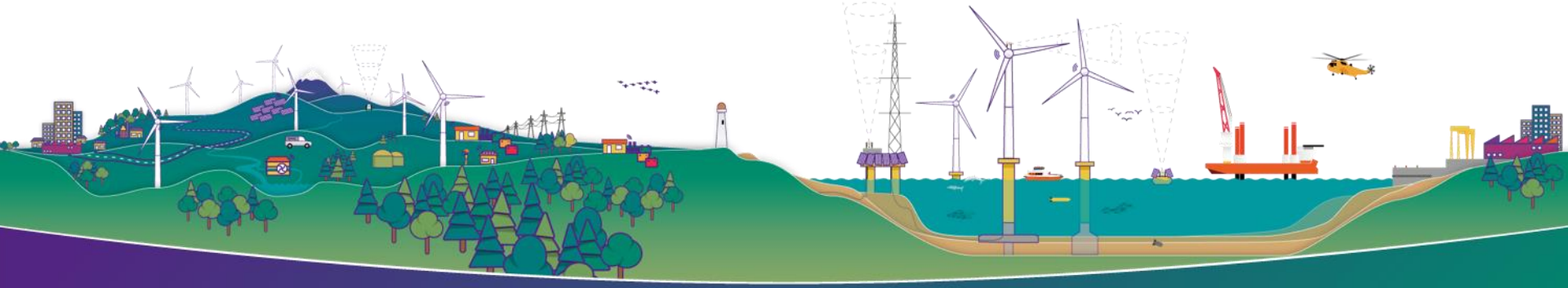
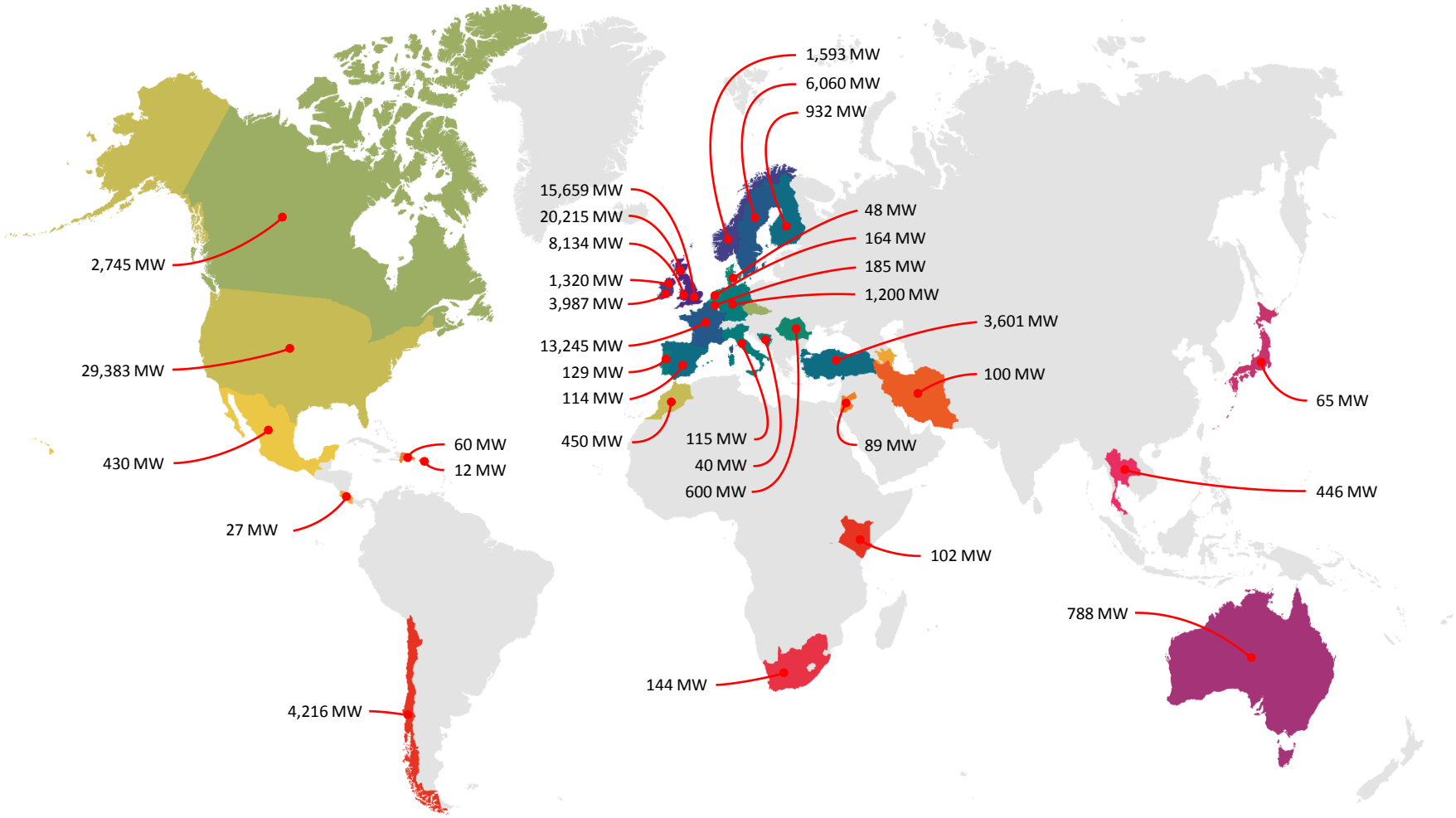
Date: 13th February 2019

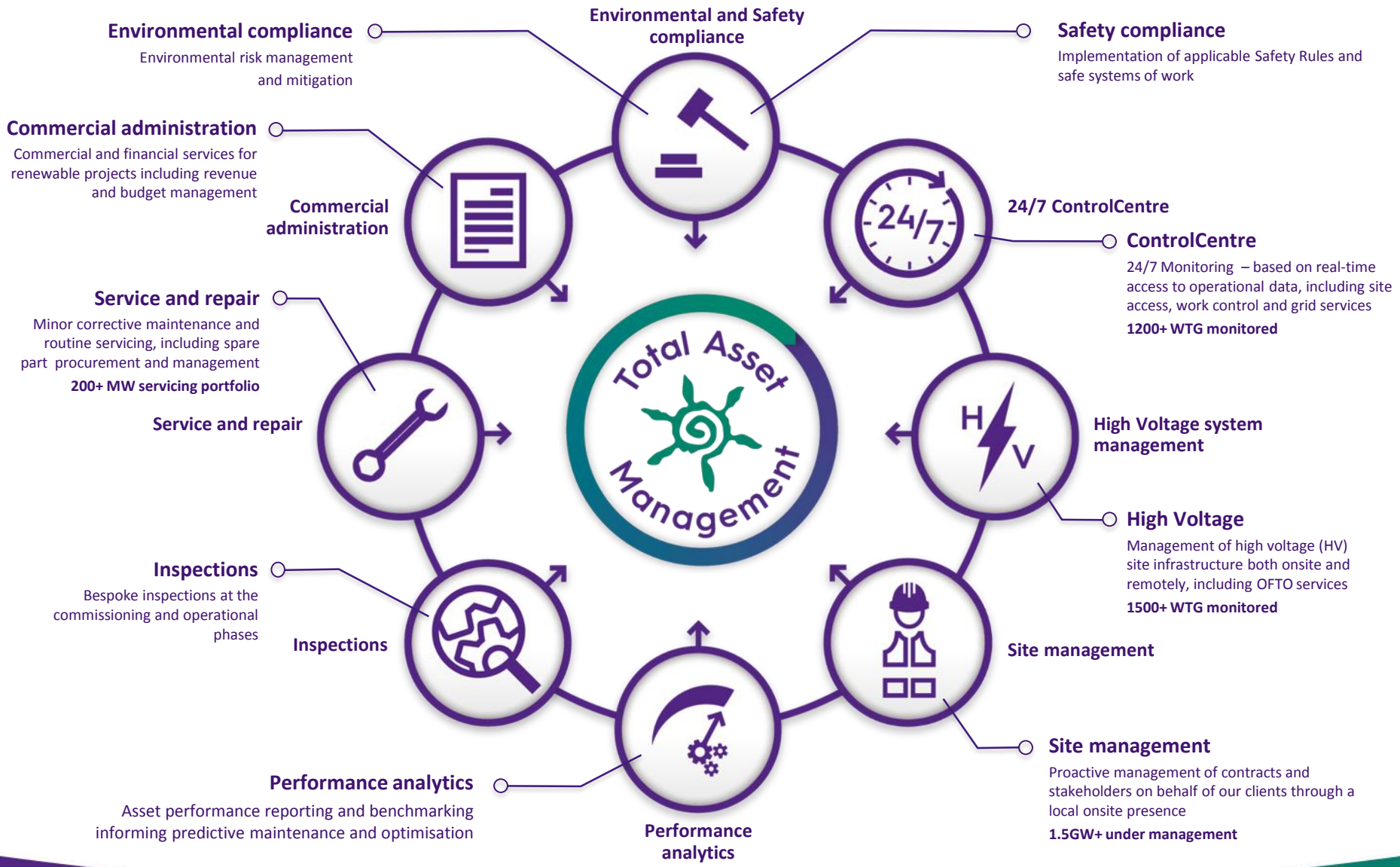


# Global Experience

Total: **116,393 MW**



# Total Asset Management



# Inspection Approach

- Have a variety of options to allow clients wishes be met
- Remain at the forefront of technological advances
- Have inhouse capabilities to ensure quick decision making
- Have a good client based approach to decisions
- Have a solid approach to undertaking a project to its completion
  - Investigate
  - Make Decisions
  - Repair if necessary
  - Continual support
- Continuous process improvement and active innovation R&D
- Schedule work during planned downtimes and low wind periods to reduce losses

External Blade Inspection Technology

Ground-Based

DJI M210 RTK

Autonomy

Internal Blade Inspection Technology

Internal State of the Art Camera

Blade Processing Platform

Internal and External

Airfusion Portal

Artificial Intelligence

# Our aim

Speedier, more flexible and technology agnostic reporting

natural power

Image capture:

Ground based inspections using robust inhouse developed best-in-class technology

Aerial inspections using drone technology

Data quality:

Use specialist software to provide real time data quality checks, allowing immediate remedial action when quality issues are detected

Automation, in particular for drone inspections, to reduce quality issues

Analysis and reporting:

To increase the speed of reporting through Machine Learning capabilities

To present inspections on a single platform, irrespective of the capture methodology

# External Blade Inspections

# External Blade Inspection Technology

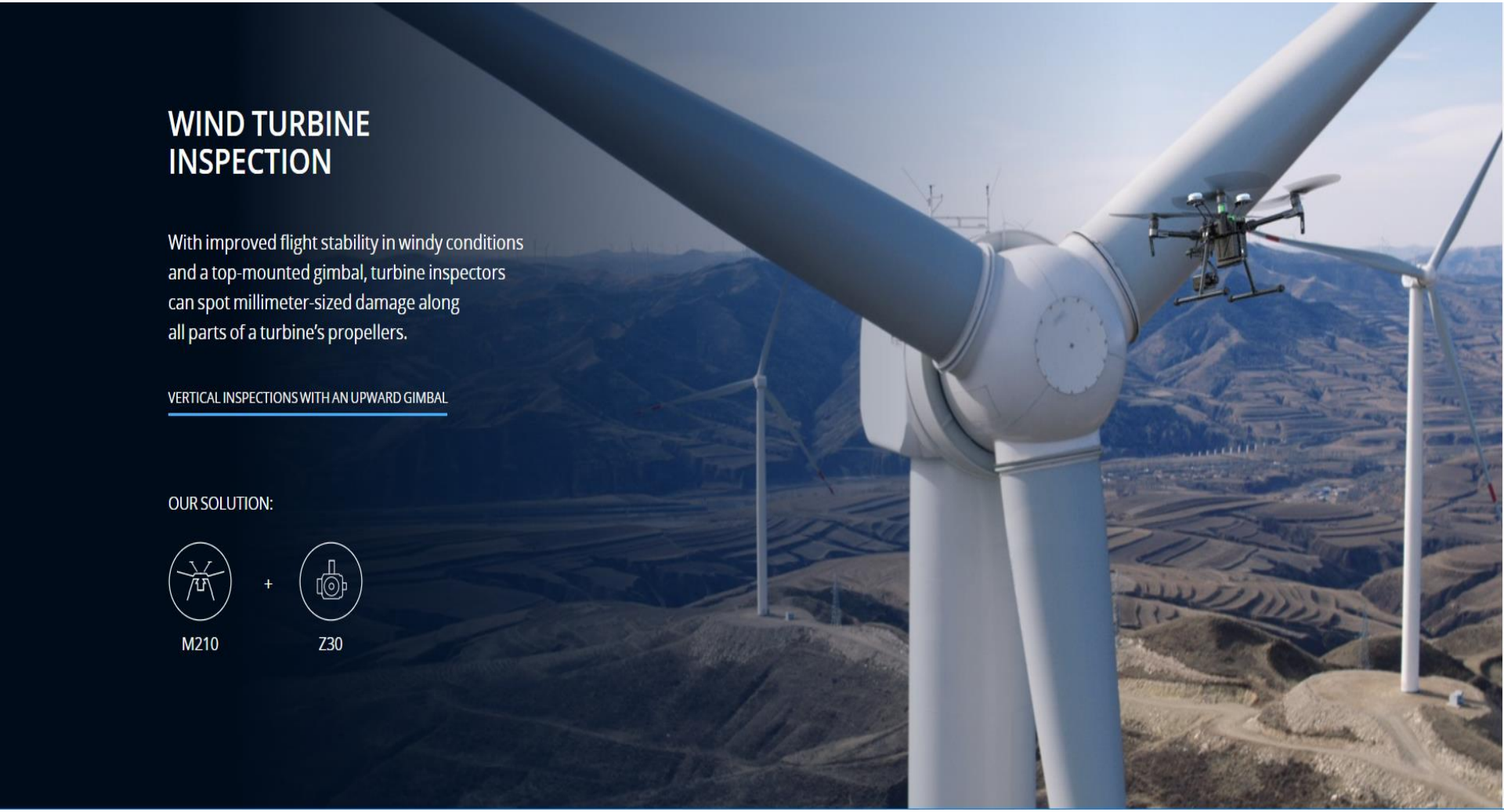
Motorised head solution for GBI

## ➜ Ground based solution for blade inspections

- A robust solution
- Pan and Tilt technology advancements combine electronic triggering and panoramic motion to maximise efficiency and reduce inspection time
- Remote control operation via LAN or WLAN connection
- Local storage
- No computer link necessary, no laptop required onsite reducing components needed for operation
- Advance software ensures a seamless workflow and perfectly stitched panoramic images
- Ability to review the data live and immediately after acquisition to ensure quality parameters have been achieved
- Mobile connection available to check imagery
- Increased battery life, 5200 mAh provides seven hours of usage per battery

# Our Drones

## DJI Matrice 210 RTK



DJI M210 RTK

## Drone Technology

- DJI M210 RTK Drone
- Designed for commercial use in harsh environments
- Dual batteries for longevity, redundancy and safety
- Multiple sensors onboard for obstacle avoidance ensuring protection to both inspection objects and the drone
- Used across a wide variety of applications including power line inspections and search and rescue
- Can accomodate Zenmuse X4S, Zenmuse X5S, Zenmuse XT and Zenmuse Z30 cameras onboard with dual gimbals for expert precision imagery and excellent resolution
- Second sensor mount for dual recording, thermal camera etc.
- Autonomous solution to turbine blade inspections

# DJI M210 RTK

DJI Matrice 210 RTK

# Basic Process

**Navigation**

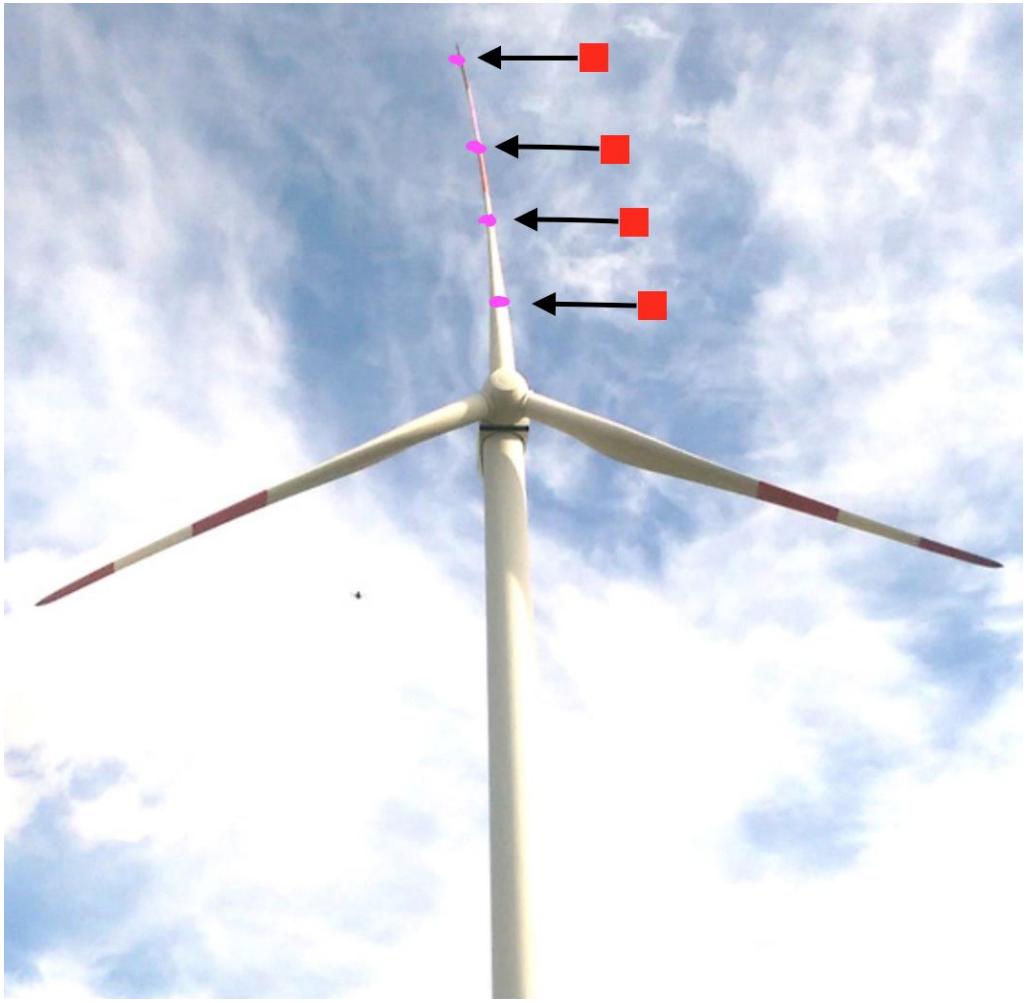
- The MTK210 uses onboard laser rangefinders to ensure resolute proximity to the object before taking a series of pictures to build a panoramic image
- From there, the onboard computer, makes adjustments to the waypoint mission in real time.

**Positioning**

- Uses world class D-RTK system.
- Onboard GPS to ensure location information

**Advantages**

- Faster, Cheaper
- The technology ensures that its operation is easy to adapt to by trained persons



# Quality Images and Metadata

- The goal

# Internal Blade Inspection

A new approach

# Internal Blade Inspection Technology

➔ Internal blade inspections are driven by:

- ***The desire***
  - To establish and build a data base over the life span of a wind turbine blade
- ***The need to***
  - Identify manufacturing defects, design flaws and structural damage and the propagation thereof across different models and batches of wind turbine blades
- ***The result***
  - Early proactive detection of defects allow preventative maintenance plans to be put in place and minimize asset downtime.

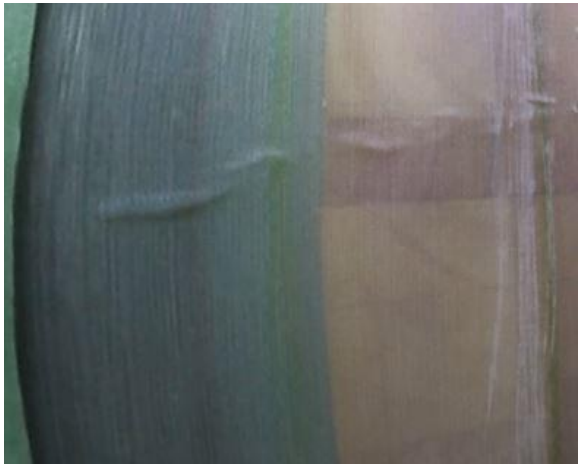
# Internal Blade Inspection Technology

- Reduced risk as no personnel are required to enter the blade
- Reduced asset downtime with inspections taking approximately 1 hour per blade
- Upto 5.7k video footage of the entire inspection
- Live 360 pan & tilt function allows defects to be viewed from different angles making for more accurate classification
- Low profile of the equipment allows access to the extremities of the blade not possible by alternative methods.

# Internal Blade Inspection Technology

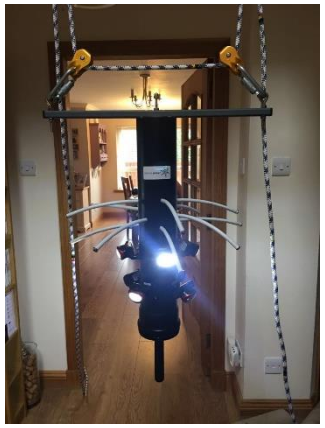
Case Study

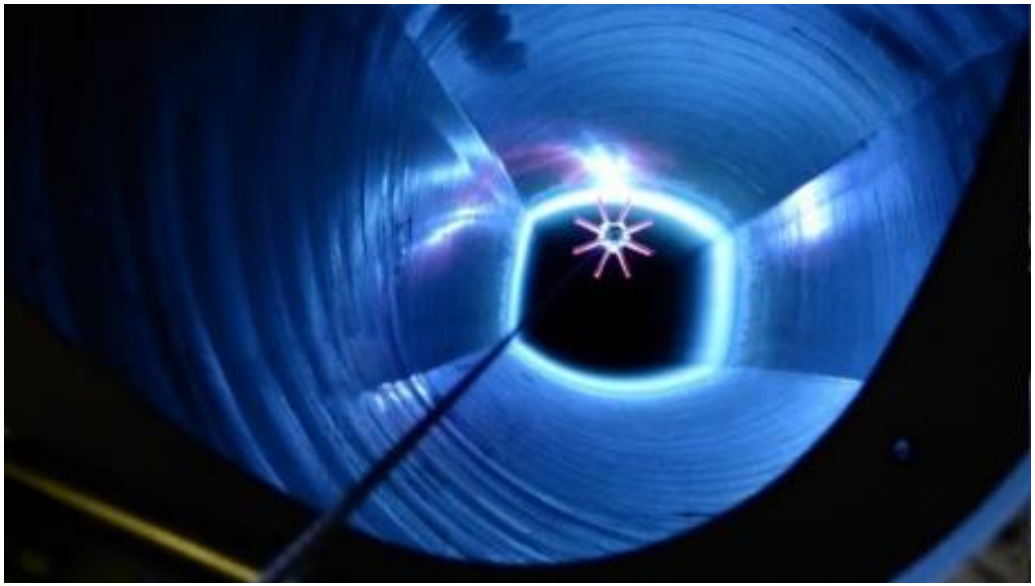
- Natural Power were asked to investigate a potential blade bearing issue
  - A noise was apparent from the blade during rotation, at the frequency of blade rotation
  - No issue was found with the bearing
  - No loose blade bearing bolts were uncovered
  - Missing/loose epoxy from the internal structure was discovered



- Turbine downtime could have been prevented if this epoxy issue was known beforehand
  - This is a common issue within the industry
  - Epoxy can be removed as part of maintenance
  - Not all issues are potentially catastrophic failures
  - Issues can be detected closer to the tip than alternative methods due to small diameter of camera equipment used

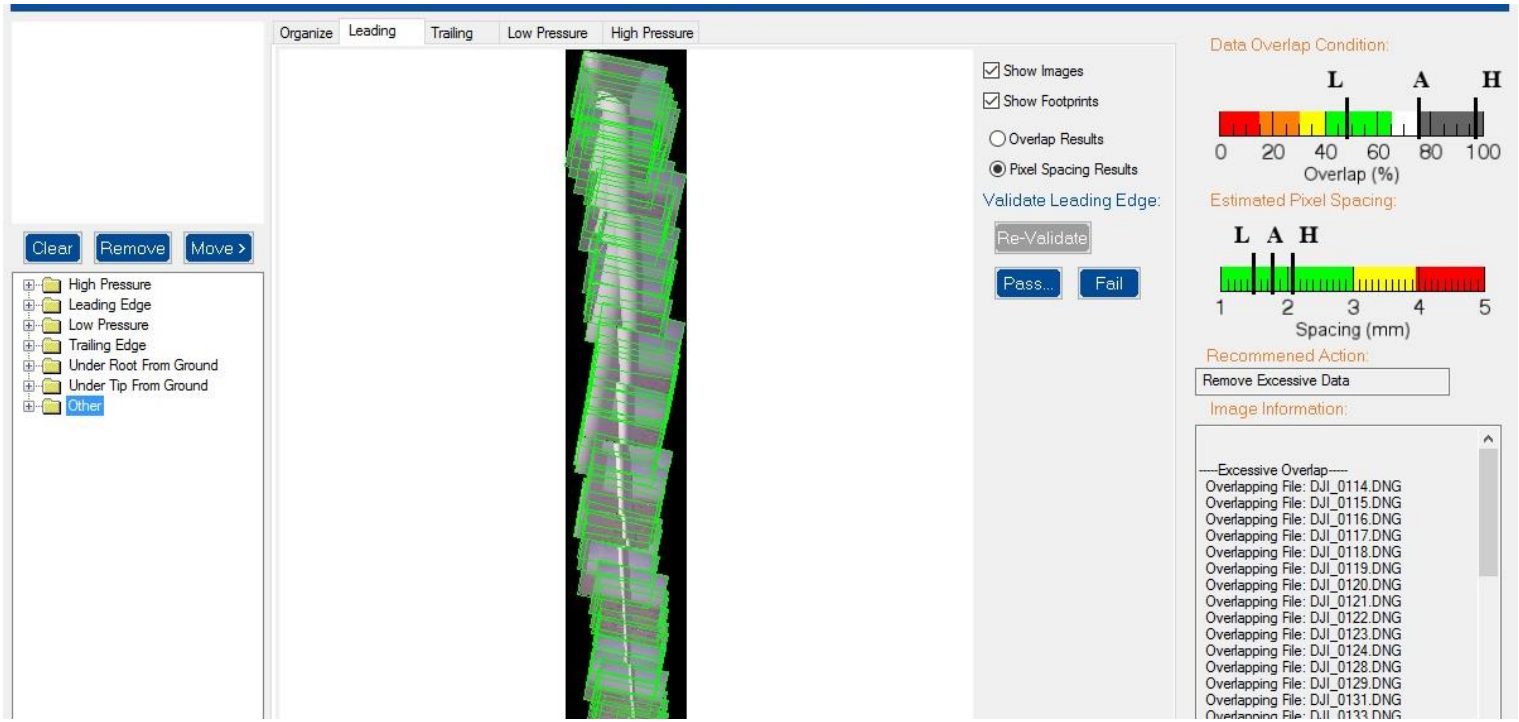
- Each blade is individually inspected in the 6 o’clock position.
- High resolution camera equipment is lowered from the root to the tip of the blade.
- Full coverage of the blade is captured for analysis.
- The kit is retracted from the blade and removed to prepare for the next inspection





# Data Processing

# Software Capture Assurance

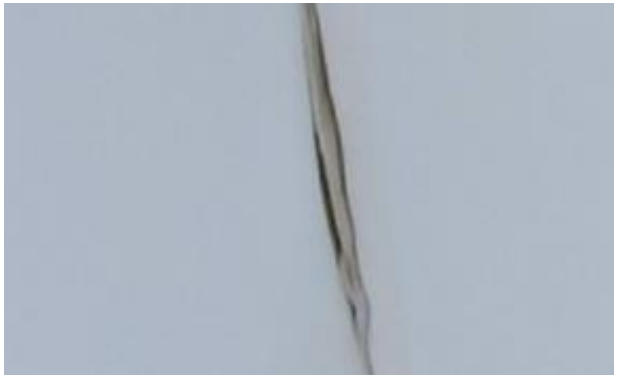



- The software provides assurance that all images have been captured and are focussed

# Data Processing

Natural Power & Air Fusion Solution

- A new approach to data processing and image handling has been adopted by Natural Power
- The system uses state of the art Machine Learning to detect and characterise damage on internal and external blade damage.
  - The software utilises computer handling of the three primary colours in imagery. Red, Green and Blue
  - It subsequently learns to adopt to changes in colours and assesses the colour accordingly whilst updating itself per image
- Natural Power are moving forward with industry advancements to ensure we are at the forefront of technology driven by the desire to provide market leading services
  - Time taken per inspection is critical
  - Excellence in the analysis is key
- The software is able to detect and categorise for internal and external
  - All results are analysed by Natural Power engineers and blade technicians for review and approval prior to client release



# Summary

- Importance of having multiple solutions
  - Dutch Water usage of Drones
- Important to be able to cover all angles
  - Internal Remote
  - External
  - Rope Access
- Important to be able to assist after an inspection
  - Consultation on next steps
  - Deliver repair strategies

- Conference Aim:
  - Consider the application of emerging inspection tools and technologies

Hopefully covered some of these