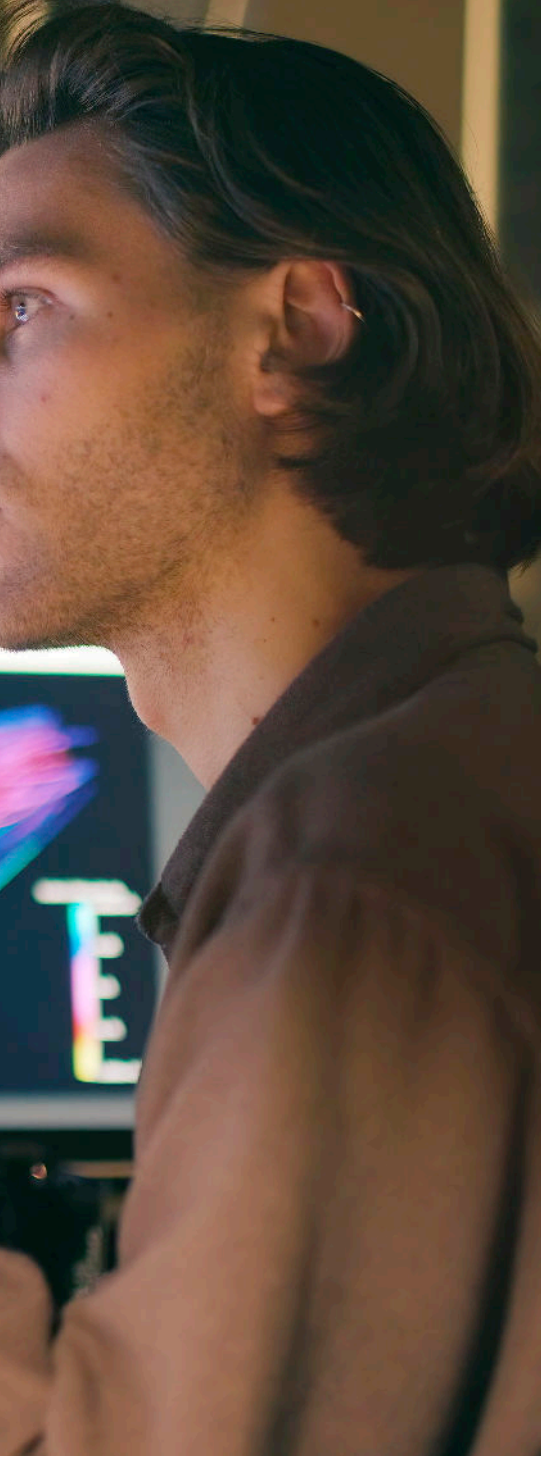
Minimising asset downtime with predictive inspections

Hands-on predictive wind turbine inspections provide the most inclusive overview of the condition of a wind asset, highlighting issues and key degradation factors, providing asset owners with actionable insights.

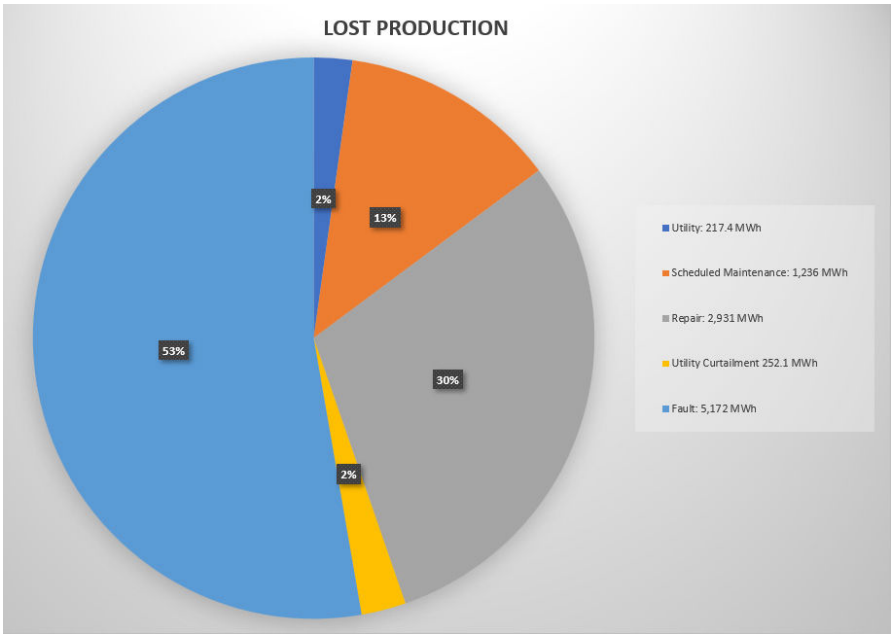
The increasing demand for renewable energy within the past few years has led to asset owners and operators placing an increased focus on reducing revenue losses on wind assets due to avoidable issues.



Component failure is currently the leading cause of asset downtime on wind turbines. A turbine constantly operates to produce power day and night, so the power electronics and electrical equipment within are in constant operation during these periods. This increases the rate of component degradation compared to most other forms of power generation. Combined with the increasing age of the components within a wind turbine, this is leading to higher levels of asset downtime associated with component failure.

We recently carried out analysis of lost production on a wind farm comprising 16 2MW wind turbines over a 12-month period. As seen within the lost production pie chart pictured, 5,172 MWh have been lost due to faults, and 2,931 MWh have been lost due to repair time associated with these faults.

This is a total loss of 8,103MWh. Based on an average energy price of this site of £513 per MWh, this is a total loss of £4,156,839. An estimated 85% of these faults were observed to be associated with component failure, amounting to £3,533,313 worth of revenue loss due to component failure.



Hands-on inspections with PredictRF

The RFM Services team has been working behind the scenes to develop PredictRF, a combination of hands-on inspection techniques utilising a variety of technologies. With 3D imaging of a wind asset and virtual data tagging, an immersive digital twin is created, ensuring that our clients have a clear picture of the condition of their assets.

PredictRF promotes reliability centered maintenance by utilising the data from an individual asset to better meet their maintenance requirements. Using a range of technologies at turbine level aids in highlighting key degradation factors and rates of component degradation. Successful implementation of PredictRF will lead to an improvement in cost effectiveness, less asset downtime, and a higher production forecast.

Data compiled from a PredictRF inspection is interpreted by a team of in-house experts, by comparing the condition of the component against our internal database and other components on the turbine.

To use a Yaw motor as an example, traditionally a turbine will have a number of Yaw motors. By carrying out thermal imaging, motor circuit analysis and insulation resistance testing on a motor we can ascertain the current condition of the motor and rates of degradation. This data can then be pulled into the 3DI digital twin, allowing for comparison between components on the same turbine. It also enables year to year comparisons between annual PredictRF inspections, giving asset owners an inclusive overview of the condition of their assets.

The technologies and their applications

3D imaging

3D imaging allows us to create an immersive copy of a wind turbine, ensuring the most inclusive overview on the market today. The data tag function allows for clear and effortless defect localisation and identification, ensuring that issues are adequately raised and addressed.

Thermal imaging

The most evident indicator of component breakdown within a wind asset is heat radiation, or infrared. As a component breaks down, over time the resistance within a circuit increases, leading to heat being dissipated. Heat dissipation will often go unobserved within a wind asset, as the human eye cannot detect it, allowing the component to degrade to the point of asset downtime.

Utilising thermal imaging for wind turbine inspections can highlight gearbox and bearing issues, as well as electrical component degradation, such as loose connections and imbalanced loads and areas of increased friction.

Ultrasonic and vibration measurement

We use a cloud connected condition monitoring solution, which combines both ultrasonic and vibration analysis. This is particularly useful when identifying the condition of bearings such as blade bearings.

In ball bearings, as the metal in the raceway, roller or ball elements begin to fatigue, a subtle deformation begins to occur. This deforming of the metal will produce irregular surfaces, which will cause an increase in the

emission of ultrasonic sound waves, and a change in amplitude from the original reading is an indication of bearing failure.

Motor circuit analysis

Motor circuit analysis is particularly useful when assessing the condition of a motor. It provides an accurate overview of the condition of the component and can identify both motor winding degradation and earth leakage, allowing us to forecast when a motor will reach the end of its working life.

Insulation Resistance (IR) and Polarisation Index (PI) testing

IR and PI testing is essential for assessing the condition of the generator within a wind turbine, generator failure on a gearbox or direct drive wind turbine can lead to extensive asset downtime but can be easily avoided.

Oscillation measurement

Structural health monitoring (SHM) is pivotal for safe and economic operation of the wind turbine. Vertical tower oscillation measurement allows changes within the structure to be identified at the earliest stage of degradation, mitigating the risk of high-level structural failure.

Vertical oscillation measurement can support damage detection on turbine towers and document progression of fatigue, allowing asset owners to react before high-level failure can occur.

Reducing revenue loss with actionable insights

Unfortunately, we can't stop components from degrading over time, but by making use of the methods that our engineering team have set out, we can accurately identify future root causes of downtime on our client's assets, mitigating the risk of asset downtime occurring saving our clients a proportional amount of revenue.

Typically, this allows parts to be stored on site, to be replaced as soon as component failure occurs or replaced during routine maintenance, cutting unforeseen asset downtime to a minimal amount.

Promoting reliability centered maintenance leading to an improved maintenance program

Traditionally, a maintenance program designed by a wind turbine manufacturer is not designed to account for the specific changes that occur on an individual asset throughout its operating period leading to areas of increased degradation. This may be influenced by factors such as moisture content within the air leading to a higher rate of power electronic failure.

PredictRF can be used to create a more effective maintenance strategy, addressing the main causes of equipment failure within an individual asset. It is a more innovative approach to defining a routine maintenance program specifically tailored to the requirements of a specific asset composed of more cost-effective tasks to preserve important functions.

This can also be used to create a maintenance program that focuses on better utilisation of scarce resources on items that would cause the most disruption if they were to fail. It can also increase asset performance and lead to a decrease in asset downtime.

The benefits of PredictRF during end of warranty inspections

The end of the warranty handover process is an important time for any asset owner, with the failure rate increasing as the asset moves towards the end-of-life wear period. It is essential that areas of increased degradation are identified, and then adequately addressed by the manufacturer within the warranty period, mitigating the risk of asset downtime and the associated repair costs becoming the responsibility of the asset owner.

PredictRF helps asset owners to reduce the risk present during this period by detecting key degradation factors and rates of component degradation which will lead to failure of critical components, as early as possible allowing a warranty claim to be established.

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Aiding in defect identification

PredictRF can also aid asset owners and operators identify potential causes of asset downtime before a maintenance team attends the turbine. This can reduce the time that it takes to identify and rectify the current failure, and minimise production losses.

To provide an example of this, during a PredictRF inspection a data tag can be raised highlighting levels of degradation on a particular Yaw motor, with the turbine then faulting further down the line with a yaw error fault code.

The asset owner or operator is then able to refer back to the 3D digital twin, informing the maintenance team that is a likely cause of the failure and further requesting that they bring a replacement motor, leading to a reduction in asset downtime.

Training capabilities of PredictRF

Due to the immersive nature of a PredictRF inspection the 3D digital twin can be used to teach trainees about the different inherent systems within individual makes and models of turbines, as well as the continuity between components, including functions and expected operating conditions of inherent systems.

Through further ongoing development and integration, training scenarios can also be created simulating specific fault conditions allowing trainees to gain fault finding experience in a controlled environment, made fully immersive by using the current VR headset connectivity function.

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