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New approach for the Condition Monitoring System within Life Extension Strategies

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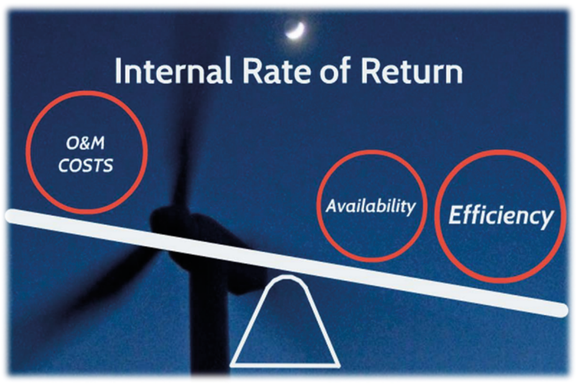
Abstract

The energy output from wind turbines has increased over the past thirty years from 50 kW to 8 MW.
The ROI (return of investment) for Condition Monitoring Systems (CMS) including installation, maintenance and licensing is between 3 and 5 years. Nowadays these figures are only interesting, from of investment point of view, for turbines bigger than 1 – 1.5 MW of power.
Most turbine manufacturers build their machines with 20-year operational life but in practice around 90% of turbines can potentially carry on working for up to a decade beyond their original operational life. Life extension programs of turbines offer European operators a competitive alternative to repowering.

These turbines are generally powers lower than 1 MW and it was an unreachable market for installing CMS so far. Life-extension programs involve the installation of new or additional condition monitoring equipment, so it brings the opening of a new scenario for the CMS:

- Need to install new CMS.
- Need to adapt the actual CMS with more capabilities for the hardware as the adaptability and configurability.
- Need to have one unique software to integrate the different CMS technologies that they are already installed in the wind turbines.

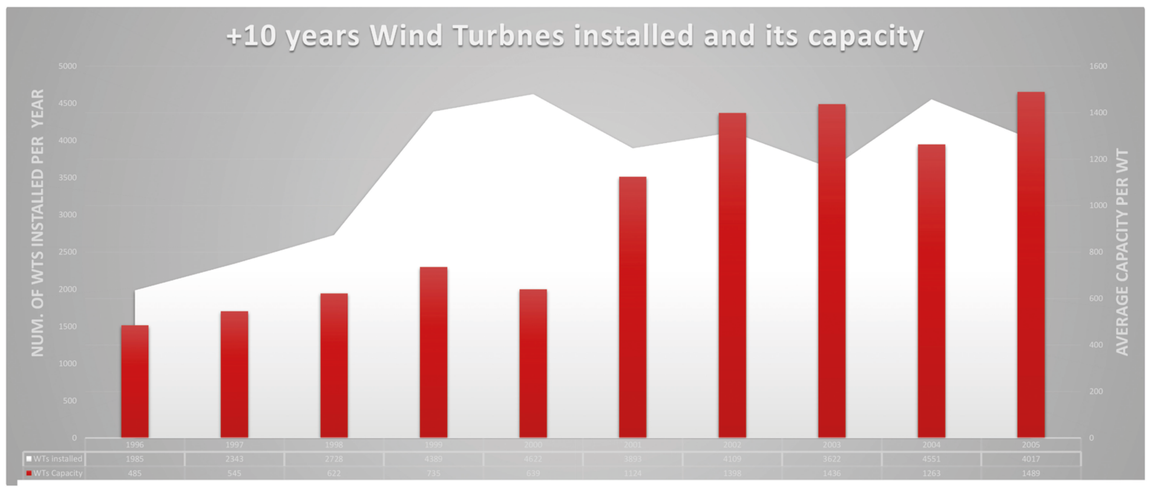
Objectives



The end of a Wind Turbine Life is only determined by its “financial death”. Extending the operative life of a wind turbine means increasing revenue form energy sales. On the other hand, it would also mean higher Operation and Maintenance (O&M) costs and growing risks of structural faults, which usually imply expensive interventions. In conclusion, the improvement of the Internal Rate of Return (IRR) of a particular wind farm will lean on three main aspects: (i) Availability, (ii) Efficiency and (iii) O&M Costs. [1]. This means that a wind turbine could remain operational, while the required operation and maintenance expenditures remain profitable (whenever the environmental and safety requirements are accomplished). The objectives of this work are:

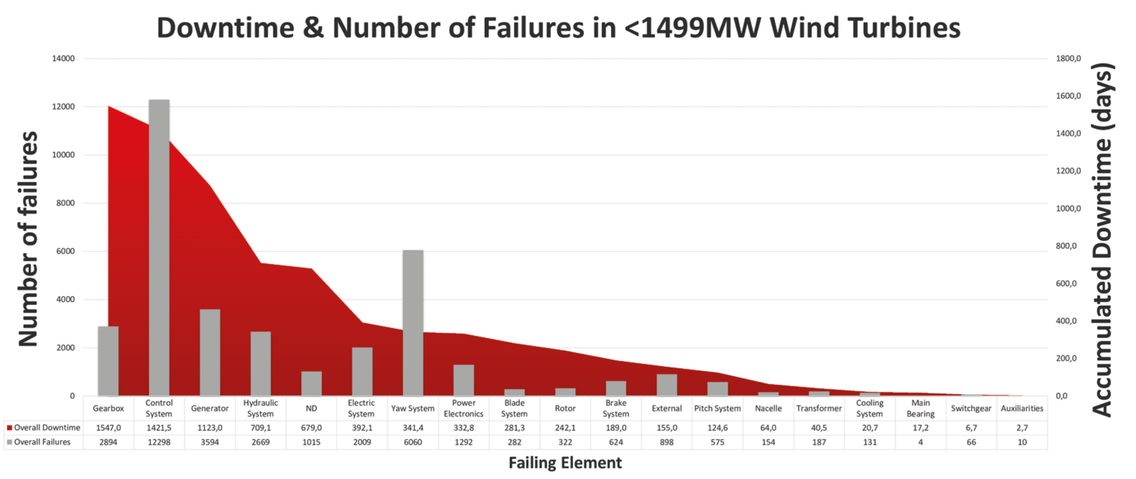
- To seize the potential market in Europe.
- To highlight the convenience of extending the life of a wind turbine, and how to perform it..
- To locate the most critical components and subsystems (in terms of reliability and availability).
- To propose a solution to optimize the afore mentioned the Key Performance Indicators (KPIs) involved in the Internal Rate of Return of a wind farm.

Methods



Potential Market

There are more than 30.000 installed Wind Turbines (WT) in Europe between 10 and 20 years and below 1.5 MW [2]. This means up to 10 GW only considering Germany, Denmark and Spain. In some of those countries, like in Germany, legislation stimulates repowering while in others like Spain the restrictive laws makes Life Time Extension (LTE) the most simple and most profitable solution . Note that those wind farms built in the late 90’s and early 2000’s are usually placed on sites with the best wind resource. A local community used to them, also offers higher social acceptance [3].

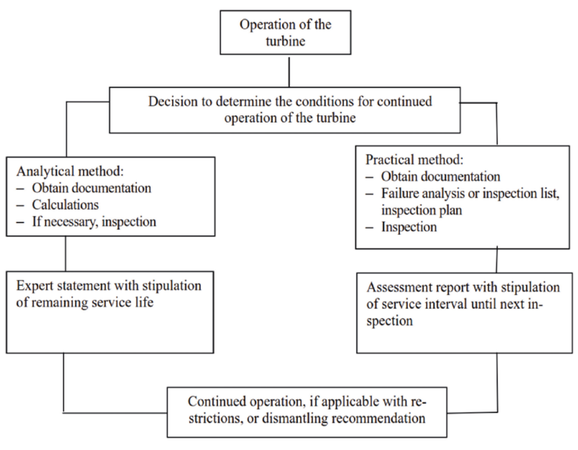


Most Critical Components

In terms of number of failures and downtime caused, the components of the drivetrain (Gearbox, Generator and Main Shaft/Bearing) are identified as the most critical ones. It is not negligible the number of failures involving the control system (sensors, false alarms…) but they are usually solved much quicker than the mechanical ones. Yaw System faults, in number, are also remarkable and significantly higher than in more powerful machines. [*Data by Ingeteam Service for the EU founded FP7 OPTIMUS Project*].

Life Time Extension

Wind Turbines and their structures are designed with a 20 years lifespan. The design conditions are very conservative, so in real conditions the fatigue life is rarely consumed. However, site-specific conditions are crucial for the accumulated fatigue damage. Life-consuming causes are multivariable, simultaneous and coupled what makes fatigue damage calculation quite challenging [4]. This remaining life time will be function not only of WT’s model or site-specific wind conditions but also O&M strategies previously applied.

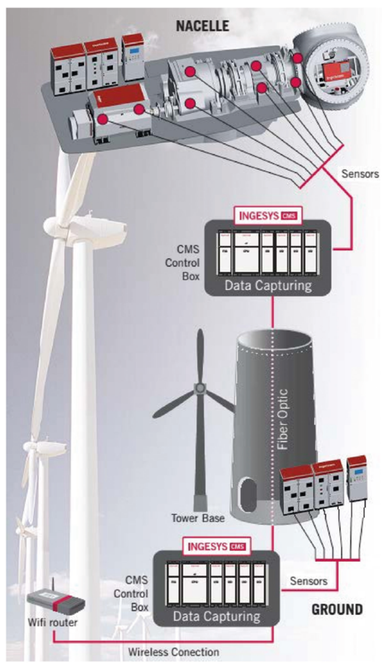


According to DNV GL Guidelines [5], to certify the Life Time Extension of a specific wind turbine, an Analytical or Practical method is required (see flowchart on the left).

The **Analytical method** implies complicated re-calculations to define a new “end of life” date. The detailed models needed in those studies demand a big amount of data, leading to an **expensive monitoring**.

The **Practical method** will also need previous studies like Failure Mode Effects and Criticality Analysis (FMECA) but the instrumentation used is significantly reduced. This method requires **periodic inspections** to validate the condition. The follow-up of the turbine health is based on audits, inspections, and on-line Key Performance Analysis of the variables monitored.

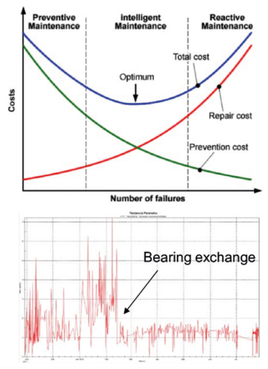
Use of Condition Monitoring Systems in Life-Extended Wind Turbines



The use of a Condition Monitoring System (CMS) allows the operators to assess on-line the actual health of the most critical sub-systems from a wind turbine. This is a must to obtain the External Certification required for the wind turbine to continue in operation.

As it is based on fault prediction analyzing the key variables, it brings the operators the opportunity to stablish and adapt their O&M strategy. This results not only into a **reduced investment** method for Life Extension but also a powerful tool to **optimize O&M costs, availability and efficiency**, the three factors identified as the main levers to improve the Internal Rate of Return.

The solution proposed by Ingeteam is to install the modular, versatile, fully-configurable and cost-effective INGESYS CMS for an on-line key variable analysis which in combination with the proper maintenance planning results in an intelligent O&M strategy: a Condition Based Maintenance.



Conclusions

A Condition Monitoring System not only shows up as a unique tool to warrant the Wind Turbine’s good health, as required by the Certification Bodies to continue in operation: the use of a modular, versatile, fully-configurable and cost-effective **Condition Monitoring System, as Ingeteam’s INGESYS CMS,** is essential to lead to a proactive maintenance strategy. This kind of strategy will ensure **a significant O&M costs reduction, justifying the extension of the service life** of an old and low-powered wind turbine. In this way, it will still offer good profit for its operator.