



enXco
A leader in renewable energy

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Reliability Centered Maintenance

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enXco – an EDF Energies Nouvelles Company

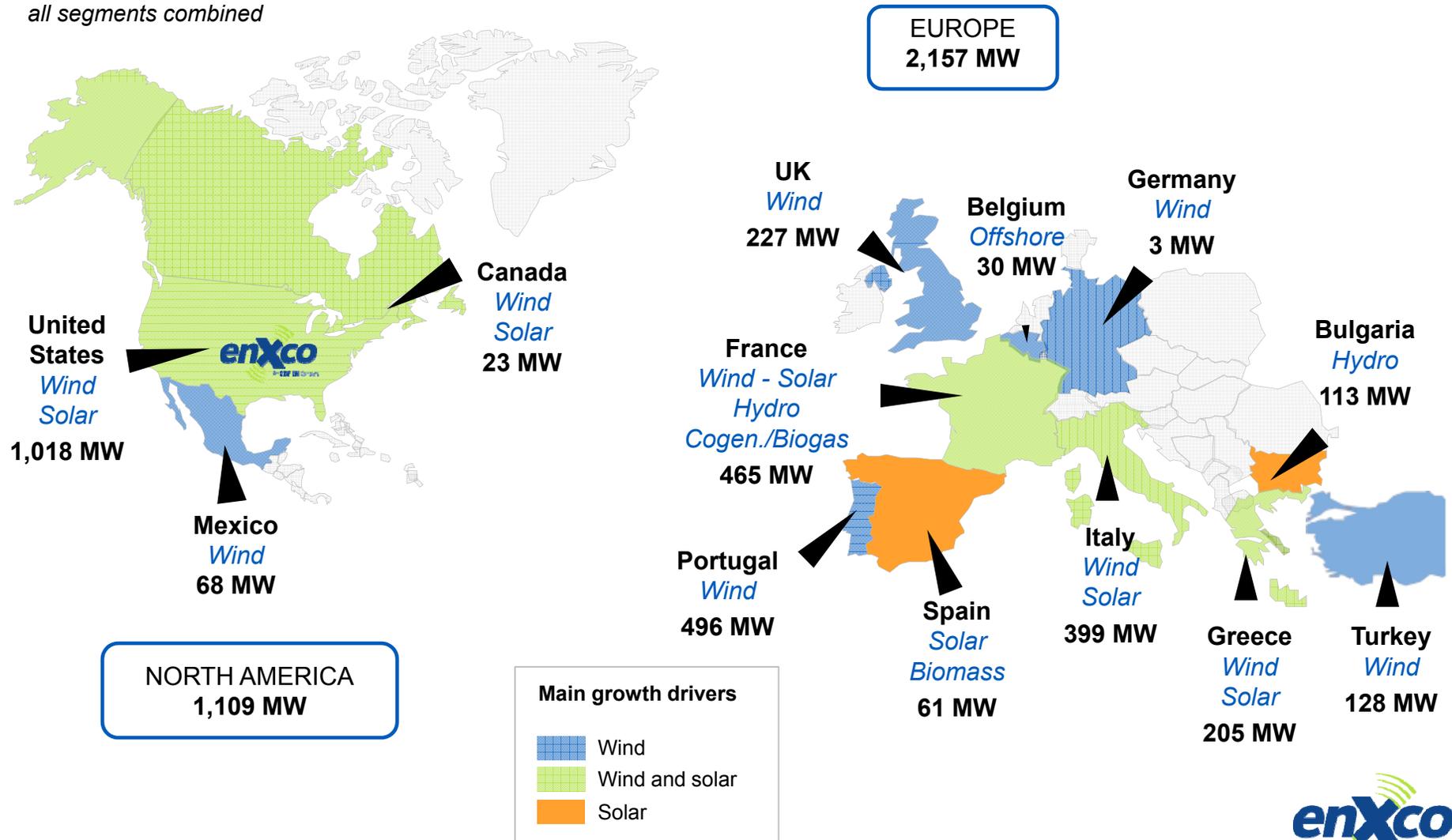
- ▶ The EDF EN group develops, builds and operates power plants in Europe, Canada, Mexico and the United States for its own account and for third parties.
 - ▶ Focus is on large-scale renewable energy projects – wind & solar
 - ▶ recent acquisition of two high BTU landfill gas projects that, on average produce enough gas to generate 50 MW of equivalent electricity (up to 65 MW in the long run with increased gas production) makes third business focus biofuel.
 - ▶ dedicated to helping drive the transition to a sustainable energy economy through our deployment of renewable energy resources
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- ▶ A producer of renewable energy projects and services, that provide extensive services all along the entire value chain.



EDF EN Group: An international footprint

3,266 MW installed in 13 countries

Gross figures by country as of 30 September 2010, all segments combined





enXco History

2011: EDF purchases the other 50% of EDF EN, Therefore EDF EN is now wholly owned by EDF which is the largest electric utility on the planet

2010: Exceed 1GW in ownership – Acquisition of first Biogas projects - Completion of First Mexico project – Continued growth in Canada

2008: Successful increase of capital to roll out Solar as second core business

2006: IPO

2004: SIIF Energies changes its name to EDF Energies Nouvelles and becomes EDF's subsidiary dedicated to renewable energy

2003: enXco contracts the first wind levered tax partnership in the US

2002: SIIF acquires enXco

1992: Acquisition of service assets from Bonus

1987: enXco Inc. formed from Difko Adm. Inc. (US) & FORAS Energy Inc.; Development of techniques, e.g. gasification

1985: Difko Wind Farms in California to provide O&M Services for Wind Projects



Techniques – Overview

1-The more common predictive tools available to maintenance departments without great cost are:

- vibration analysis,
- lubrication analysis,
- Thermography
- Intelligent SCADA patterns

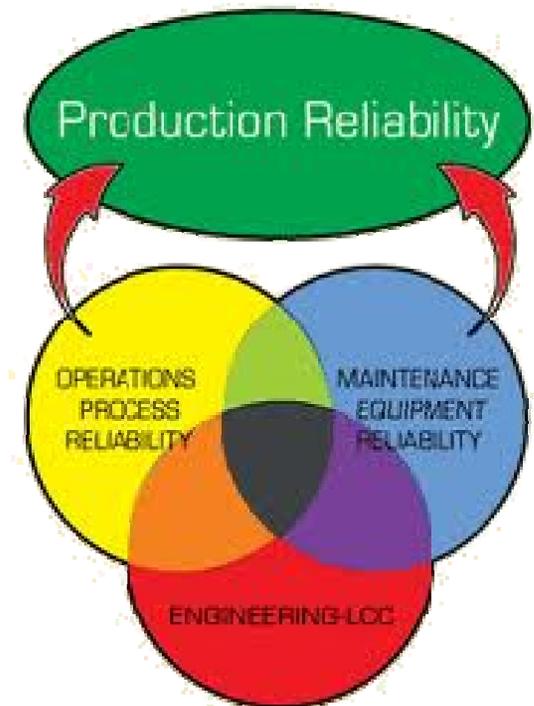
2-Good forecasting tools are essential.

- Weibulls
- Regressions
- Historical

To prolong the useful operational life of the given equipment configuration, proper application of varied predictive maintenance tools are available to determine failure patterns and effectively predict eventual failure with some degree of accuracy over time.

3-These inputs span across all departments

- Finance
- Generation/AM
- O&M
- Development
- Engineering





Vibration System Applications

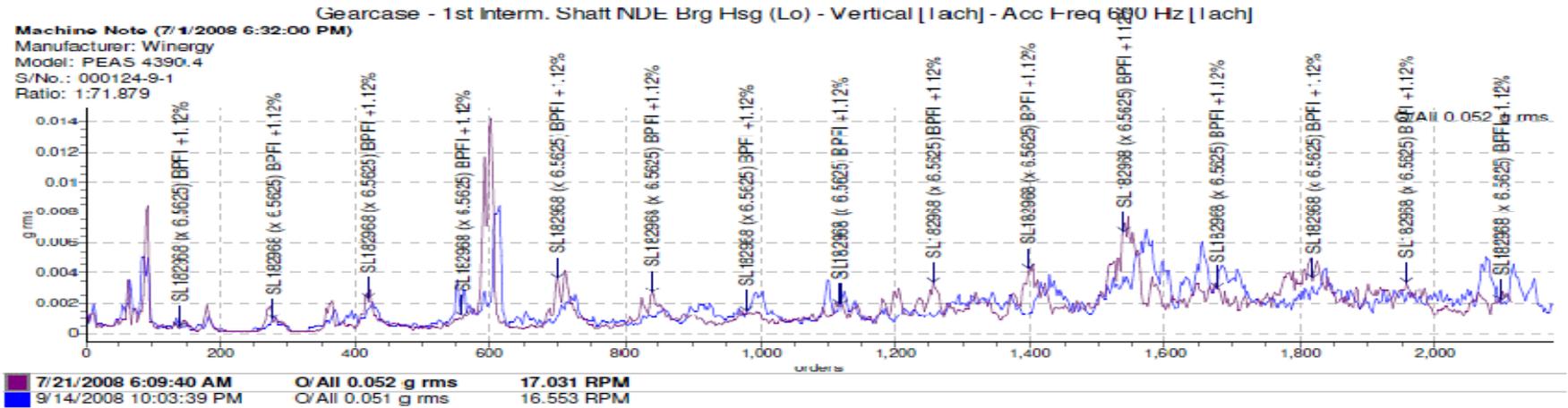
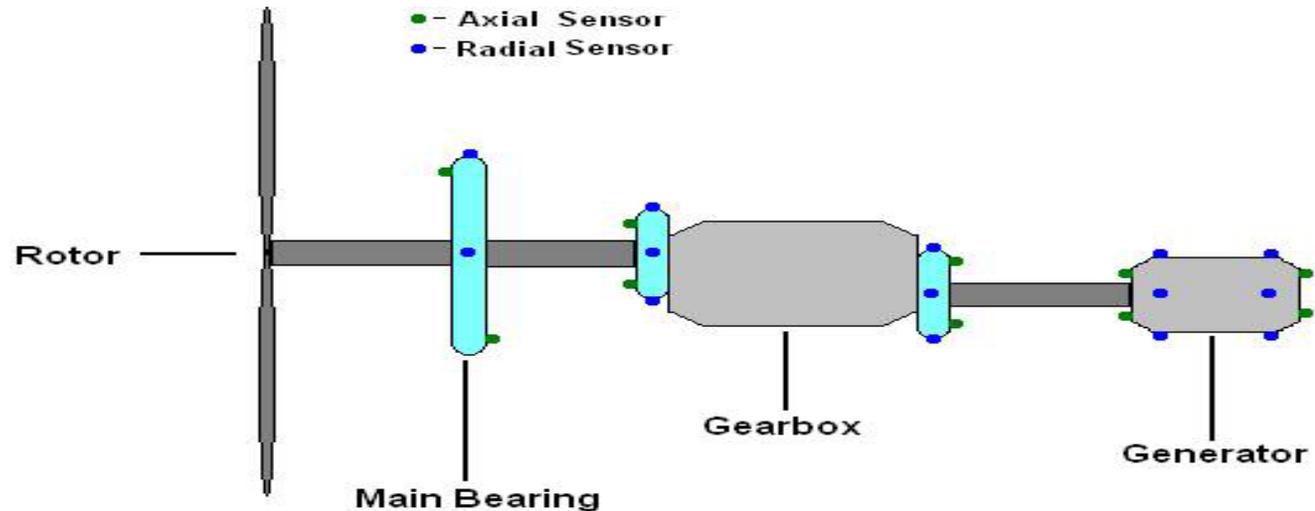


Figure No.1

ABOVE- Broadband spectrum

SIDE-group of sensors to monitor the rolling elements





Techniques – Lubrication Analysis

- ▶ The most common of the predictive tools used in Predictive Maintenance (PdM) is lubrication analysis.
- ▶ Oil samples can tell you more:
 - ▶ Additive breakdown
 - ▶ condition of the equipment and the oil.



schedule preventative activity before a breakdown occurs.

▪Equipment:

- The presence of certain wear materials can tell of normal and abnormal wear to the internal components.

- Particle counters are a great TOOL!**

▪Oil:

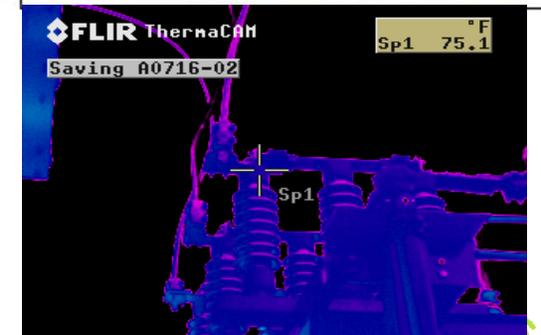
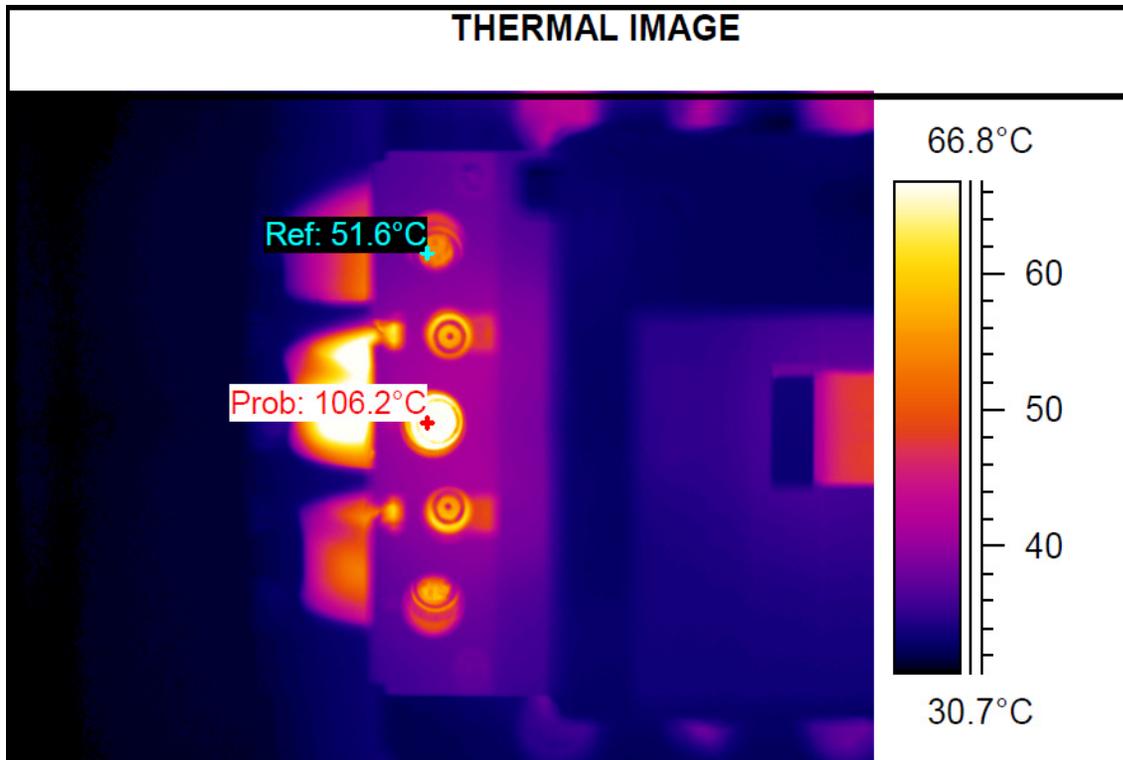
- Viscosity, Additive package and the Total Acid Number (TAN) tell of the oil condition, good or bad.





Techniques – Thermography

- Images can then be compared over time to identify changing conditions and point out trouble areas immediately

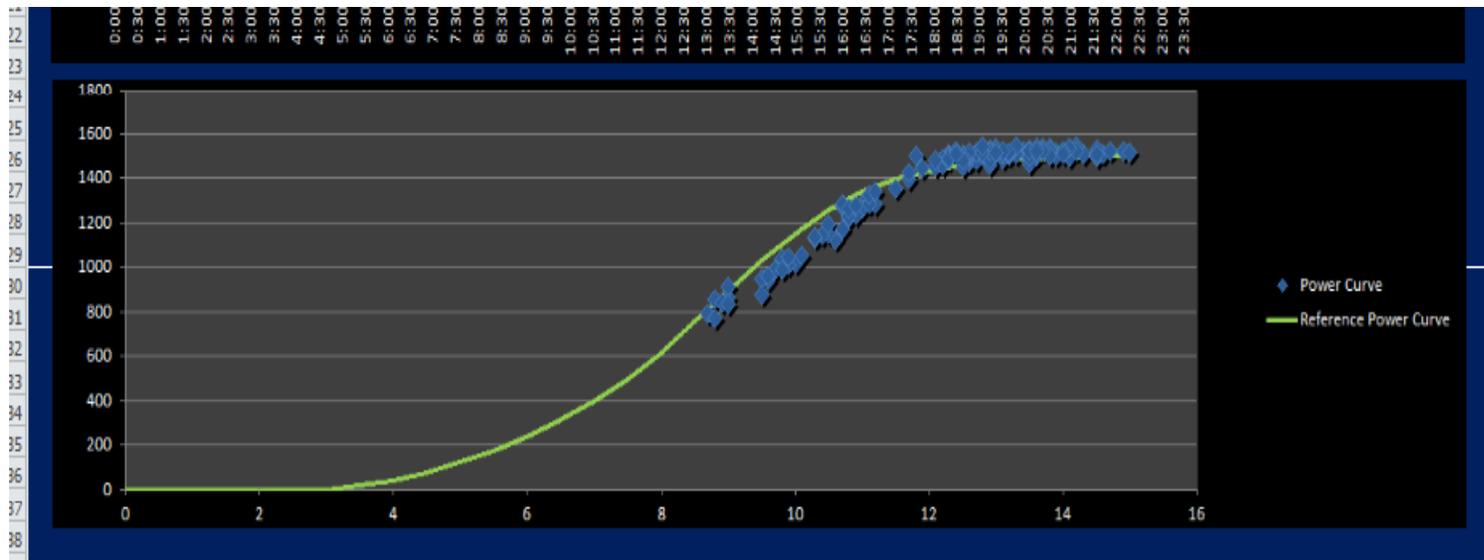




Making SCADA useful

Evaluating SCADA data is the first step to deciphering outliers

- ▶ Creating models for performance
- ▶ Understanding triggers for faults
- ▶ Creating patterns pre-failure



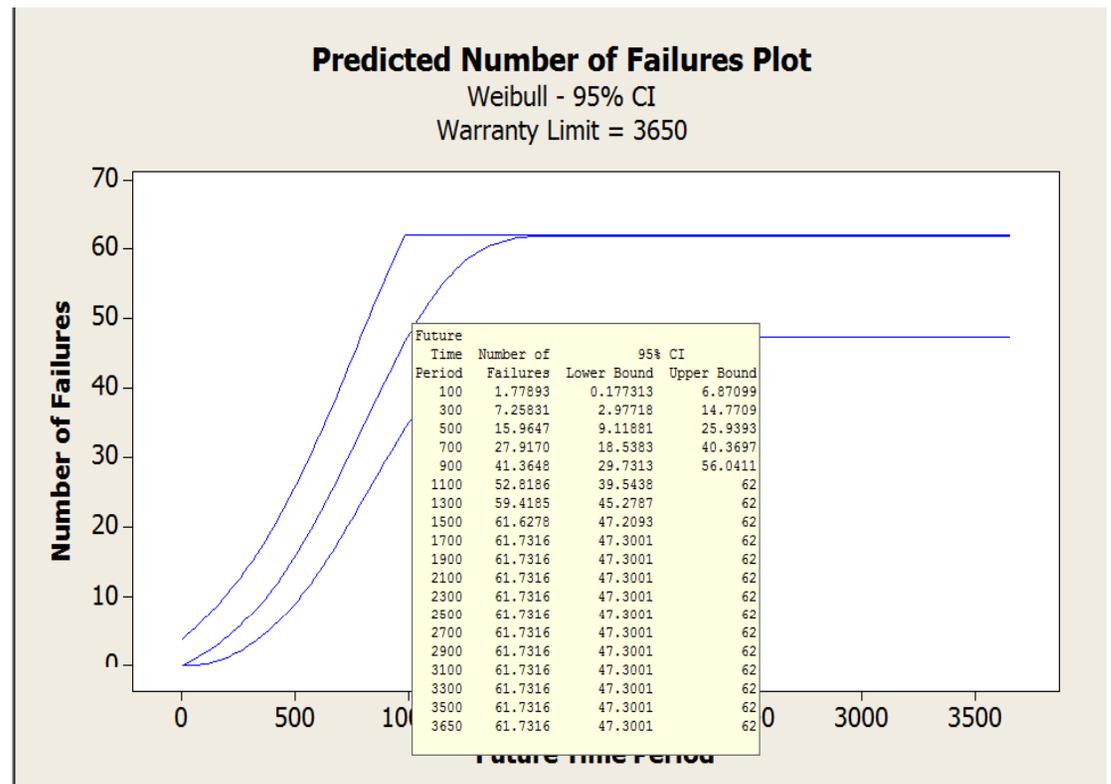


Forecasting Tools

► Weibulls & Regression Models

- Statistical tool that frames future failure potential but inputting one type of failure mode
- It requires understanding of the problem via RCA
- Confidence intervals are crucial to determine validity of data

Using other industries experience on large equipment is relevant to predict failure





Knowledge is Key

- ▶ Knowledge garnered will aim to better designs and products = RELIABILITY
- ▶ Provide improved maintenance processes which further reduce expected failures occurring in the wind industry
 - Choices in oil & Better filtration (dehydrators & oil)
 - Mitigating RISK
 - Cost benefit balance between running to failure and preventive repair program to address impending catastrophic failure





Conclusion

- There are other industries that are light years ahead that have created predictive maintenance techniques that have proven themselves can be injected into the wind industry to move towards the maturity of coal and gas
- The correct application and early uses of those predictive tools will greatly aid in the identification of impending problems before they become catastrophic.
- Effective use of failure trending will not improve reliability immediately- it set the stage for what you need to do next for better positioning
- The larger the data set the accurate the predictive capabilities, aka :

THE NEED FOR MORE PILOT MEMBERS IS NECESSARY TO GAIN A
LEAD IN THE WIND INDUSTRY AND FEED THE ORAP DATABASE