Predictive Maintenance Management Workshop

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Hosted by NREL/DOE at the NWTC
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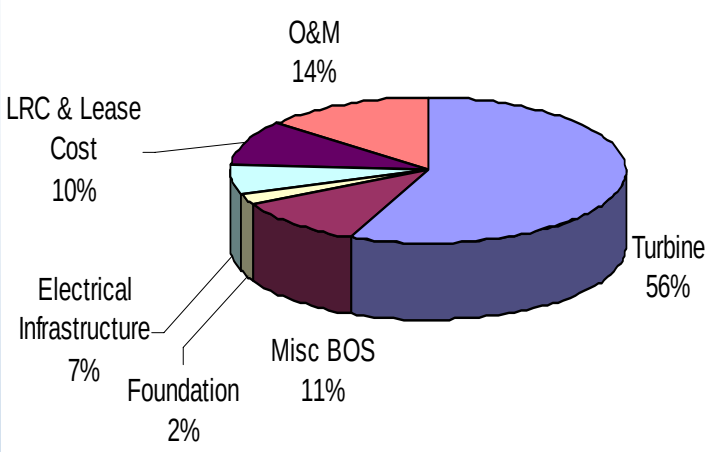
Workshop Description

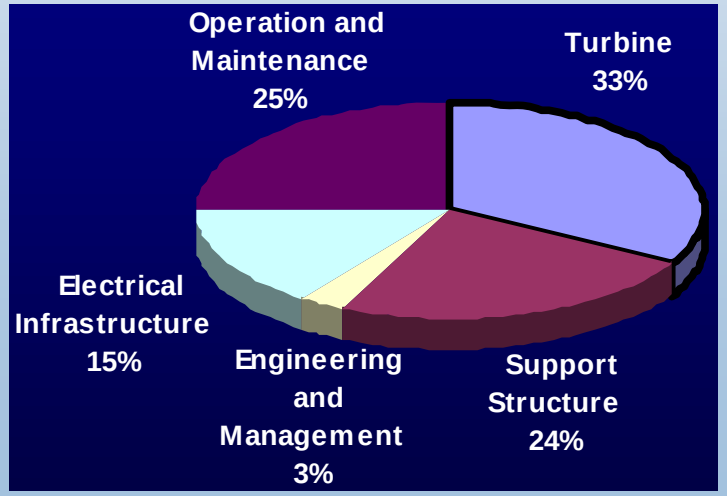
- 1 ½ days at the National Wind Technology Center, Boulder, Colorado
- Representatives from:
  - wind plant O&M,
  - Gearing & bearing industry
  - Predictive maintenance service providers
  - Condition monitoring equipment suppliers
  - SCADA design experts
  - Due diligence consultants
  - Researchers
  - One manufacturer
- Goal
  - Assess the value of various condition monitoring technologies
  - Understand how it is used in other industries
  - Understand the applicability to wind energy

Why did we organize the workshop?

- Understand current O&M practices
- Reduce cost of O&M
- Increase fidelity of knowledge base (more complete knowledge of full operating condition of turbines and wind plant)
- Automate data interpretation and detection of abnormal operation
- Anticipate maintenance
- Optimize wind plant operation for site specific lowest COE
- Close the loop on the design process.
- Expand the concept and exploitation of predictive maintenance management

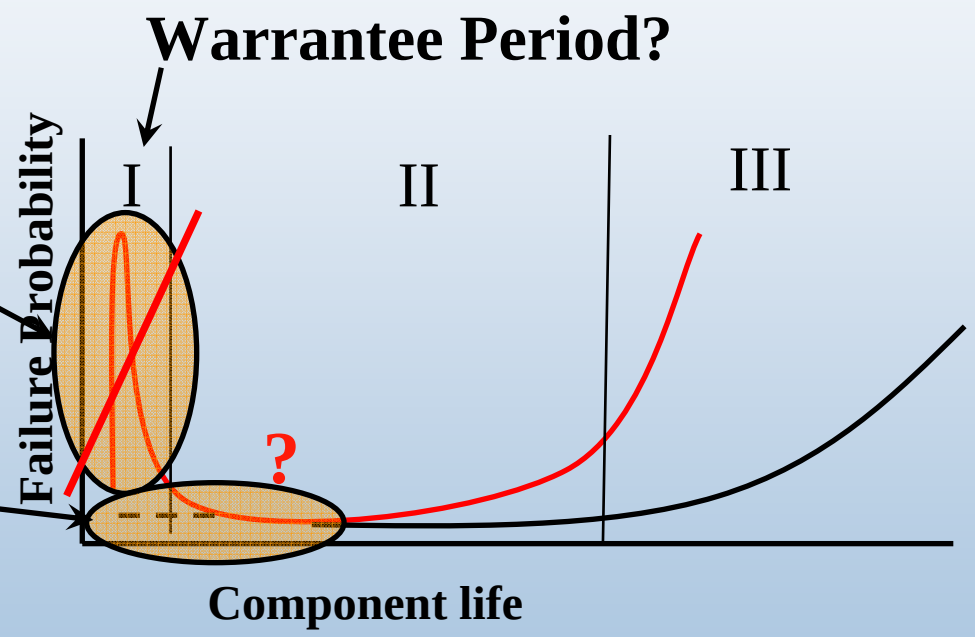


Onshore (top) **Offshore (bottom)**



Typical Component Failure Statistics

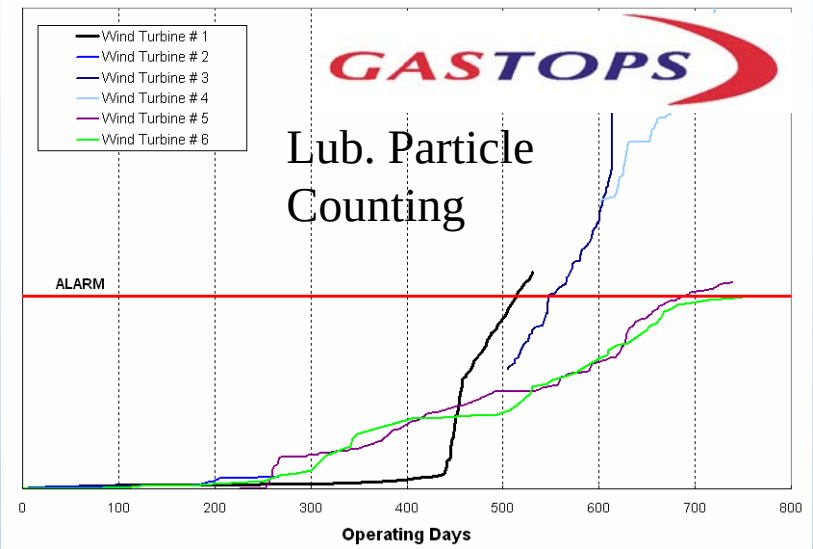
- Reliability curve
  - **I** Infant failures (unscheduled O&M)
  - **II** "normal" failure rates
  - **III** end of life failures
- Solutions to infant failure peak
  - Testing (prototype, assembly)
  - QA (suppliers, manufacturing, onsite acceptance)
  - Commissioning (also helps set baseline)
- Value of bathtub baseline phase
  - Establishes baseline characteristics
  - Establishes expected life
  - Establishes basis for trend models
- Value of prediction ability
  - Anticipate O&M
  - ability to plan cost
  - Life extension strategies (preventative maint.)
  - Plan for design improvement

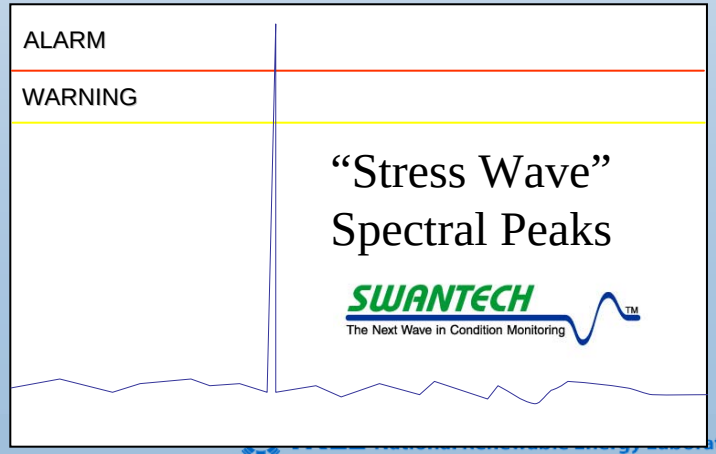


Examples from Established Predictive Maintenance Management (PdM) Companies

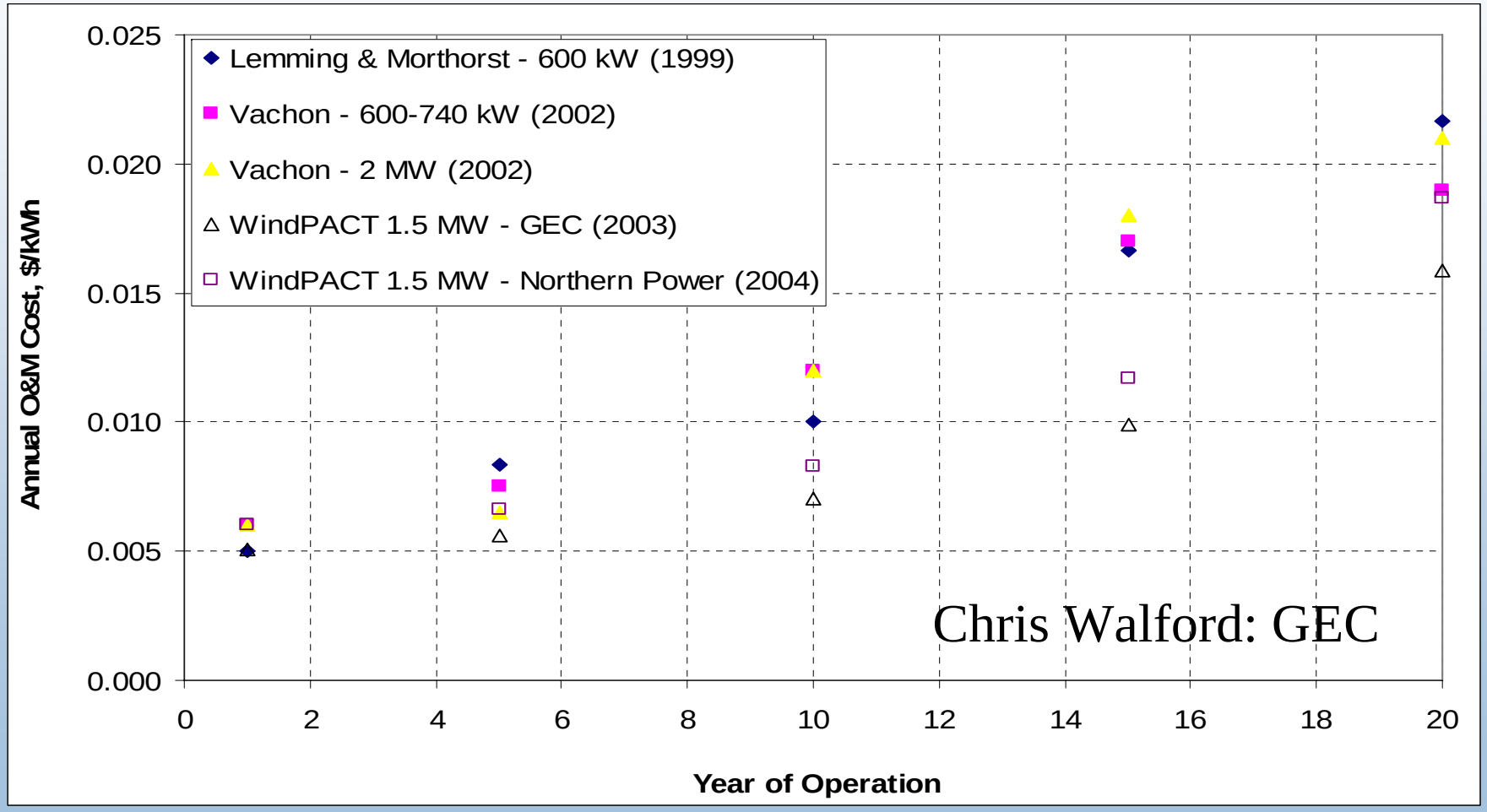
Early damage detection by baselining and trending:

- Gearbox
  - Bearing vibration
  - Lubrication
  - temperatures
- Structural components
  - Crack detection
  - Changes in dynamic behavior
- Other components
  - Increased power requirements
  - Increased noise

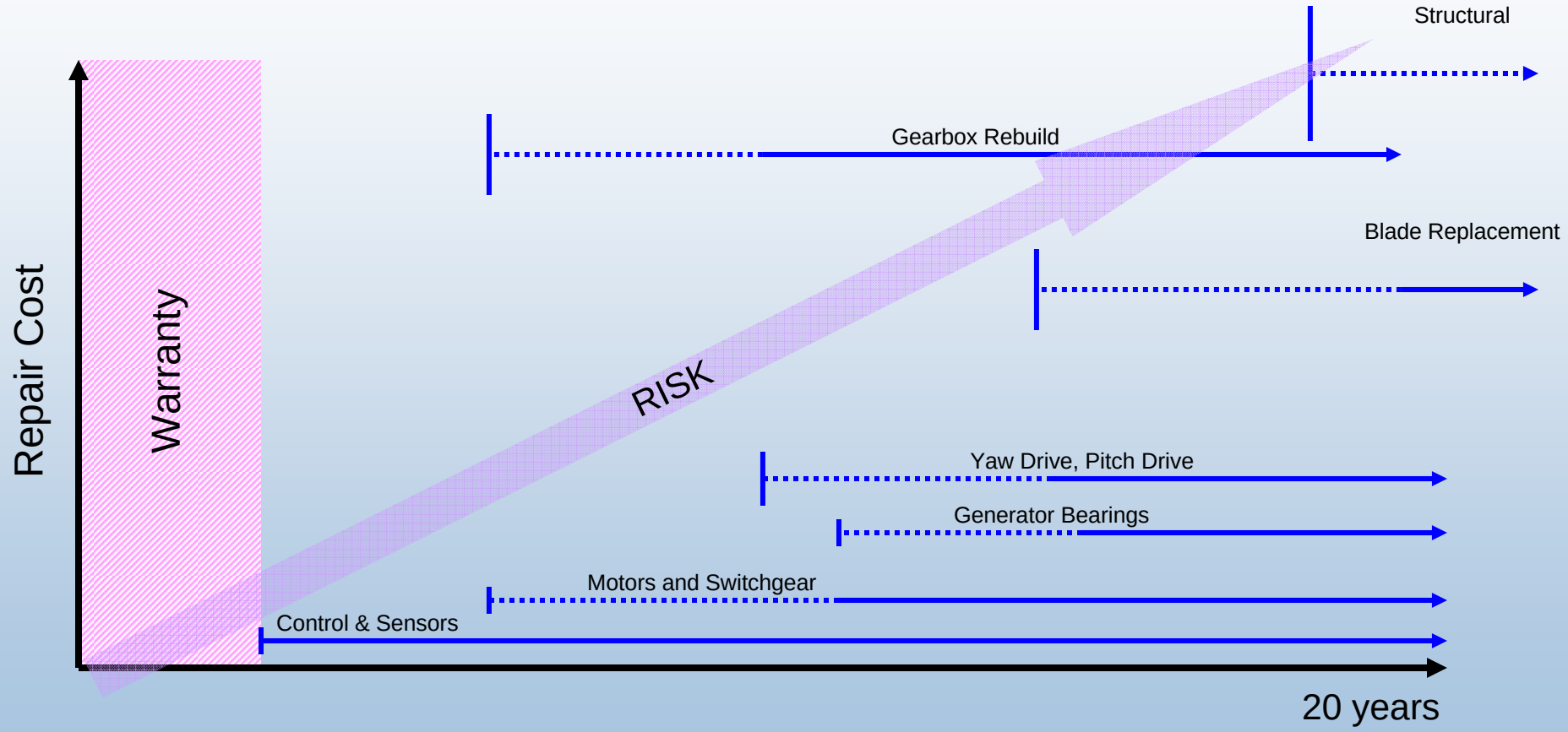




Land Based O&M Cost Estimations



Failure Risk



Chris Walford: GEC

Major Conclusions

- O&M could benefit significantly from low cost condition monitoring with automated interpretation tools.
- Benefits of PdM well established for other industries
- Requires intimate knowledge of components
- Must justify cost for highly distributed wind farm application
- Required for German insurance
- CM critical for offshore turbines
- Integrate PdM with existing SCADA for cost efficiency
- Access to controller information restricted
- Existing SCADA data not exploited efficiently

Next Steps

- ✓ Develop webpage resource for wind plant condition monitoring
- Form industry partnerships to understand O&M costs
- Form a Reliability and Test program at NREL/SNL
  - O&M data analysis
  - Root cause analysis and laboratory testing
  - Automated diagnostics
  - Reliability (design, evaluation and testing)
  - Condition monitoring technology
- Follow-on condition monitoring workshop

Thank You for Your Interest