Datenanalyse, Methoden und Prozesse für Ertragsmaximierung

Spreewind 2014

UPTIME ENGINEERING®

Overview

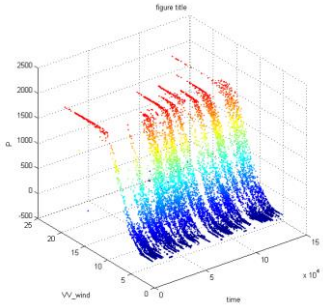
- History, motivation
- Infrastructure, software, processes
- Diagnostics, prognostics and CBM
- Summary

What‘s So Great About SCADA?

Advantages and opportunities provided by available data

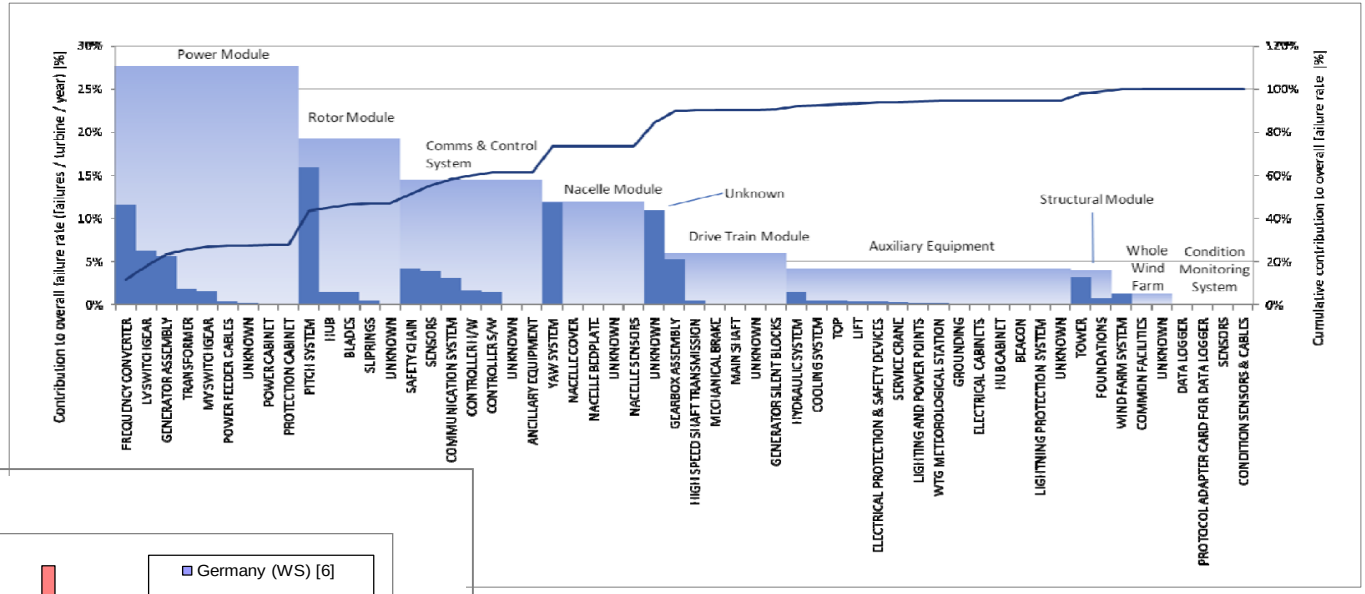
How Did I Get Here?

Optimisation of Engine Reliability

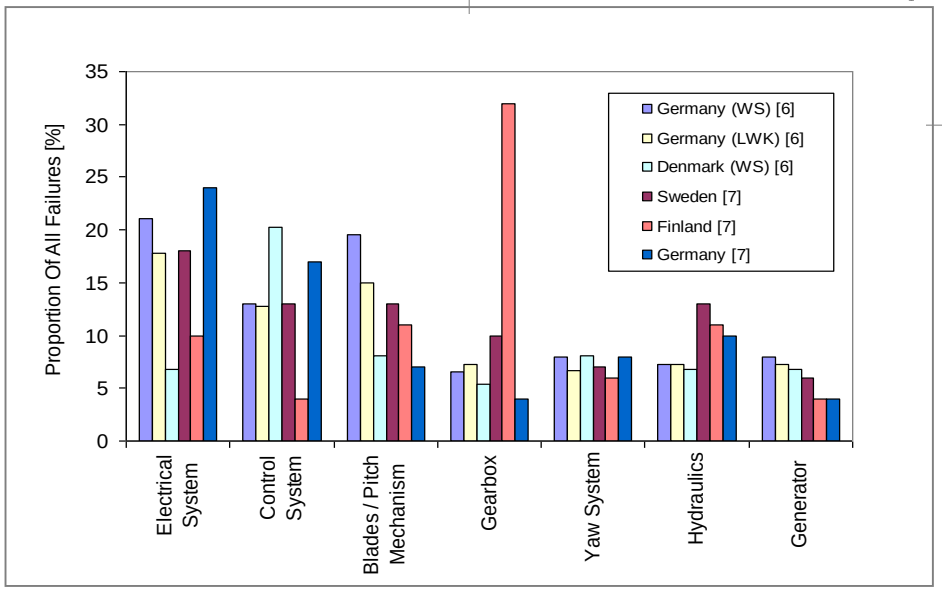


Optimisation of Wind O&M

Multiple Failure Modes



Ref: Reliawind 2010



Ref: Gray & Watson, Wind Energy 2009

Wind turbine reliability affected by a high volume and frequency of failure modes

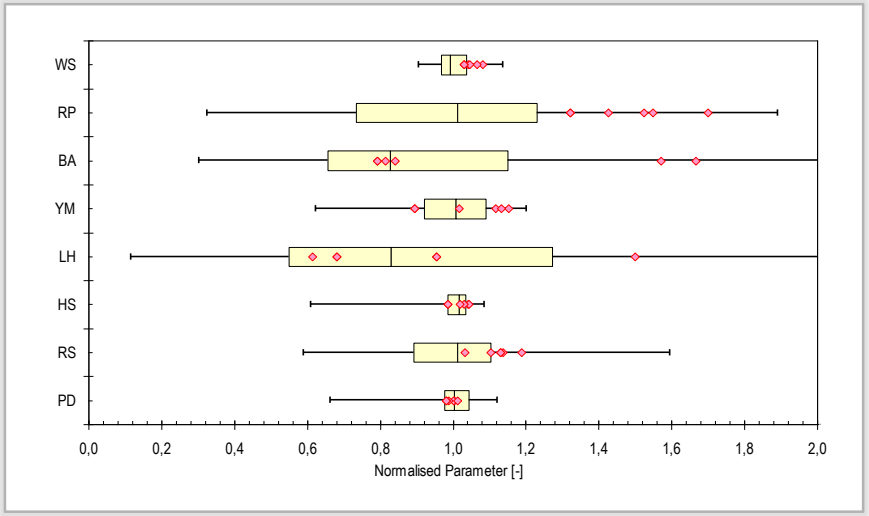
Wealth of Information

- *Monthly performance reports*
- *Power performance test reports*
- *Alarm records*
- *Vibration CMS*
- *Bill of Materials*
- *Sensor calibration certificates*
- *SCADA 10-Minute Logs*
- *Service history*
- *Resource assessment*
- *Control software versions & parameters*
- *Power curtailment*
- *Sensor specification*

Large volumes of information available to support analysis tasks

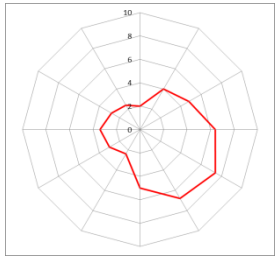
Multiple Applications of SCADA Analytics

Production forecasting

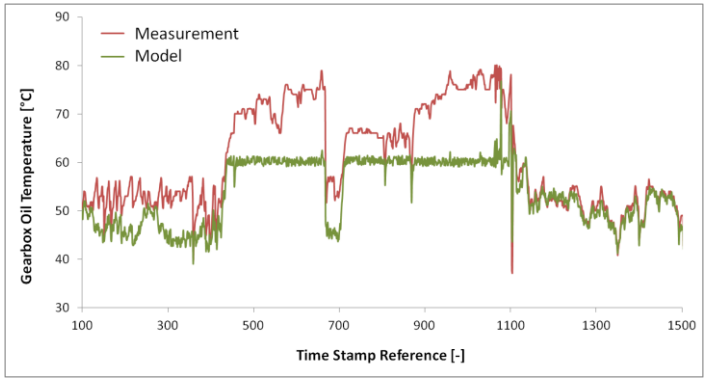


Failure prognostics

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct
Turbine 1	1.04	1.04	0.96	1.02	0.99	0.96	1.01	0.95	0.98	0.96
Turbine 2	1.02	1.00	1.03	1.04	1.01	0.96	1.02	1.01	1.01	1.00
Turbine 3	1.00	1.00	0.97	1.03	1.00	0.97	1.03	0.95	0.99	0.98
Turbine 4	0.99	0.96	0.96	0.90	0.90	0.95	0.98	0.97	1.00	0.96
Turbine 5	0.88	0.89	0.89	0.90	0.93	0.89	0.89	0.87	0.87	0.97
Turbine 6	0.87	0.91	0.96	0.91	0.94	0.97	0.88	0.89	0.95	0.88
Turbine 7	1.04	1.00	0.98	1.05	1.01	1.01	1.01	1.03	1.03	0.98
Turbine 8	1.01	1.00	0.97	1.03	1.02	0.97	0.98	1.04	0.96	1.01



Yaw misalignment detection & correction



Outlier detection

SCADA can be applied for a large range of tasks relating to wind turbine operations

Infrastructure, Software, Processes

Requirements for effective application of SCADA analytics

Next Level SCADA

EFFICIENT PROBLEM IDENTIFICATION → OPTIMISATION

Condition Monitoring, Business Intelligence, Reporting, Analytics

Centralised SCADA Database

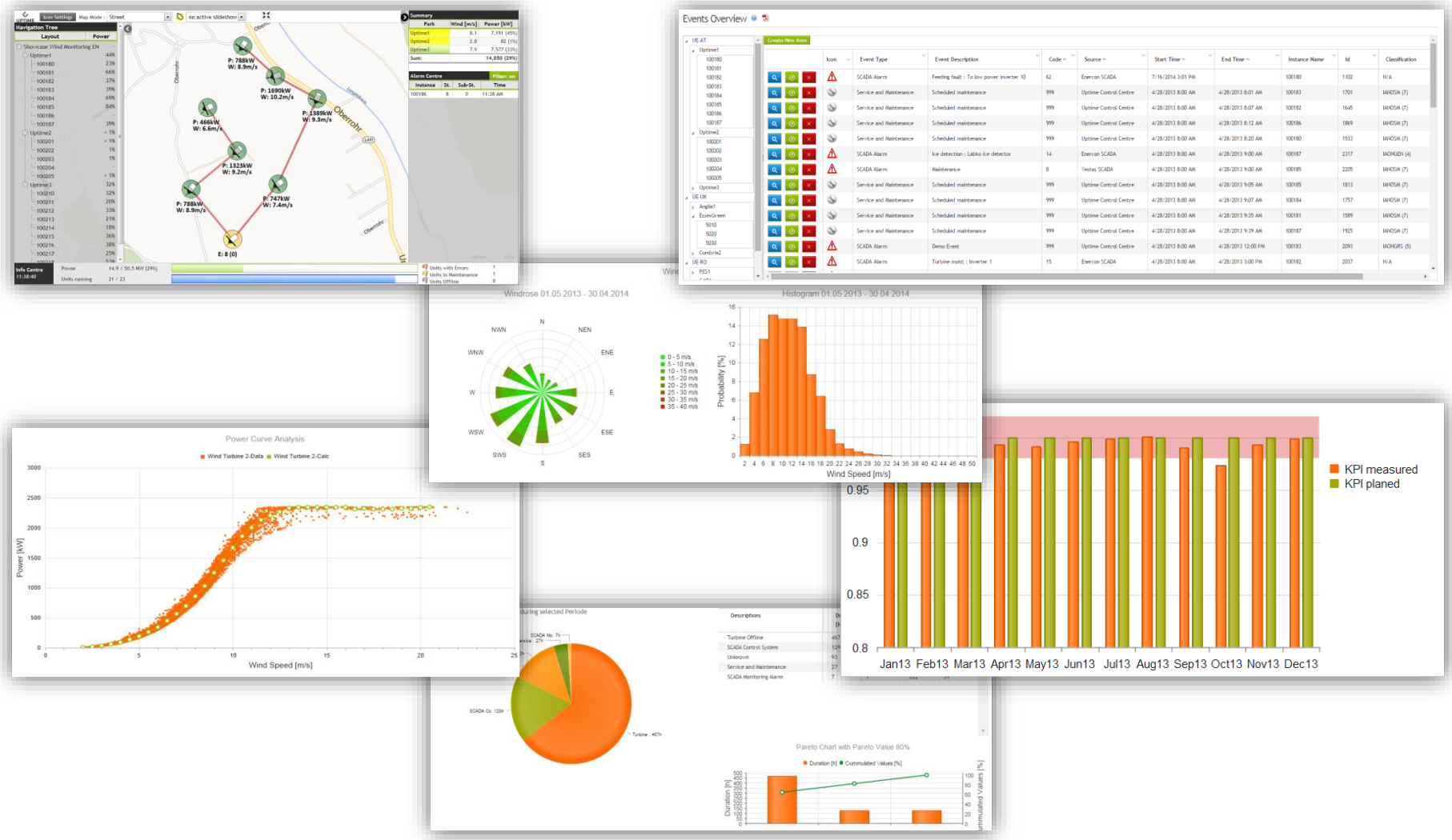
SCADA
OEM #1

SCADA
OEM #2

SCADA
OEM #3

Multiple Information Sources
(bill of materials, service reports, CMS etc)

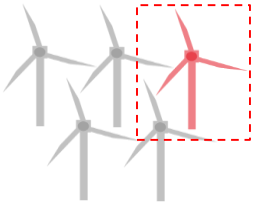
Software & Analytics

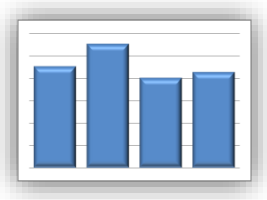


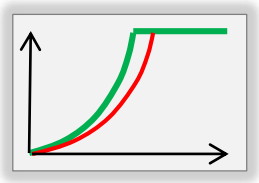
Software should allow the operator to quickly evaluate past, present and future operations

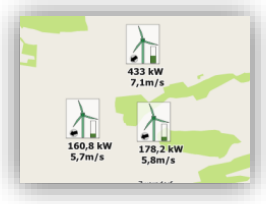
Process Integration

FOCUS → ANALYSE → INSPECT → CORRECT → CONFIRM → MONITOR







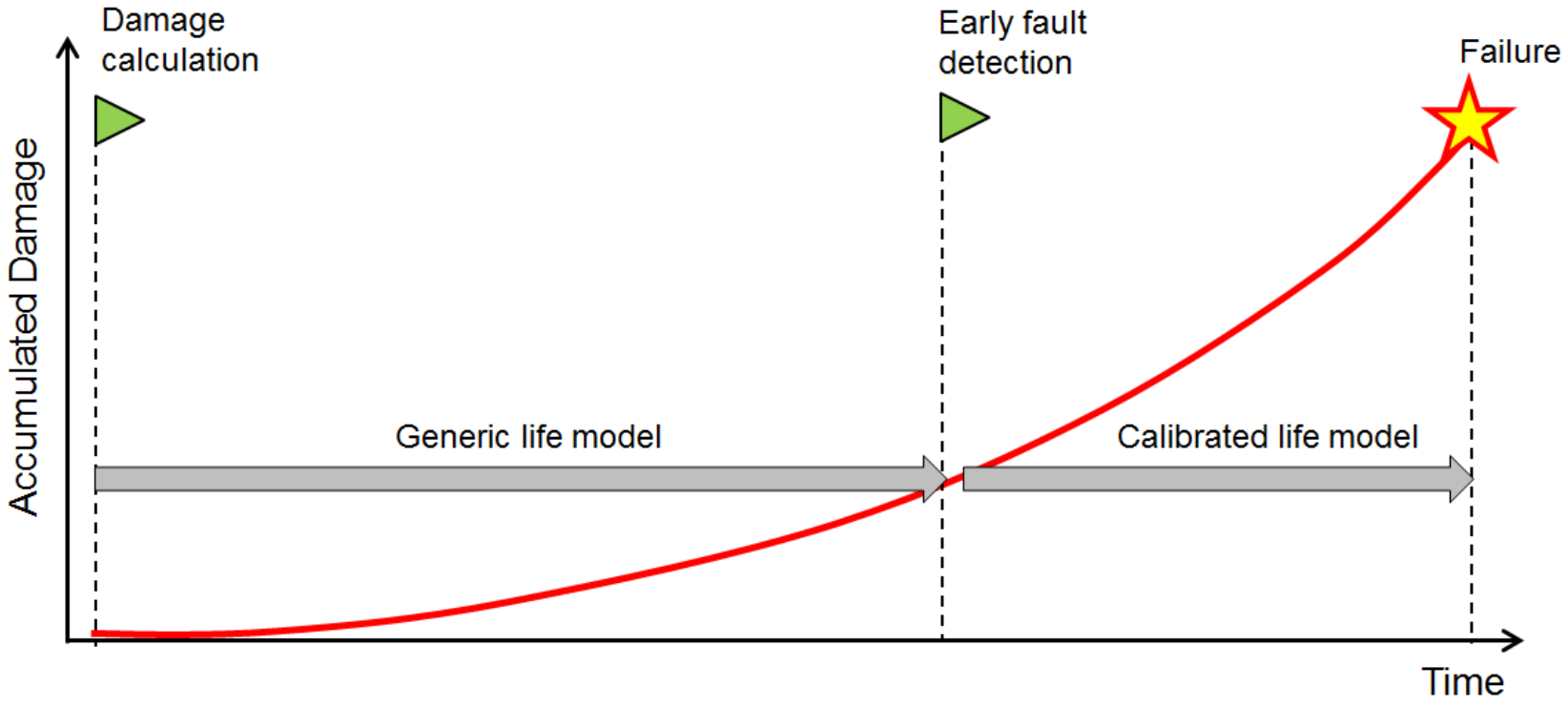


Data analytics must be effectively integrated into operational processes for value generation

Practical Examples

Diagnostics, Prognostics, CBM

Diagnostics & Prognostics



Failure mechanisms can be understood, modelled, quantified and monitored

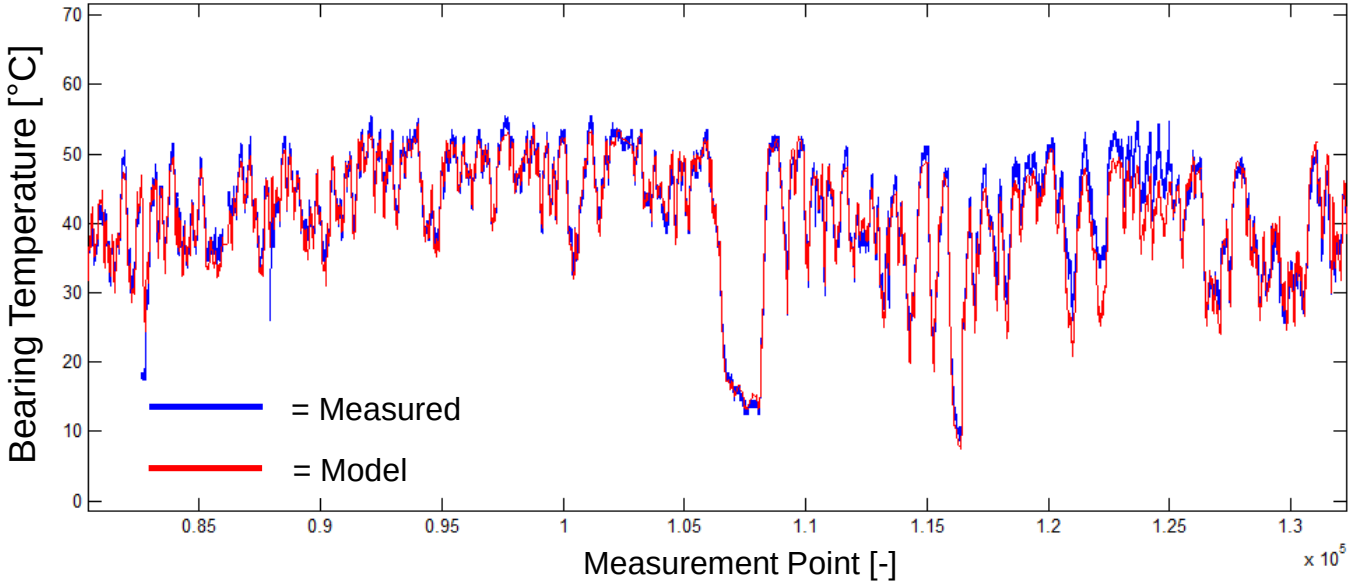
Knowledge Database

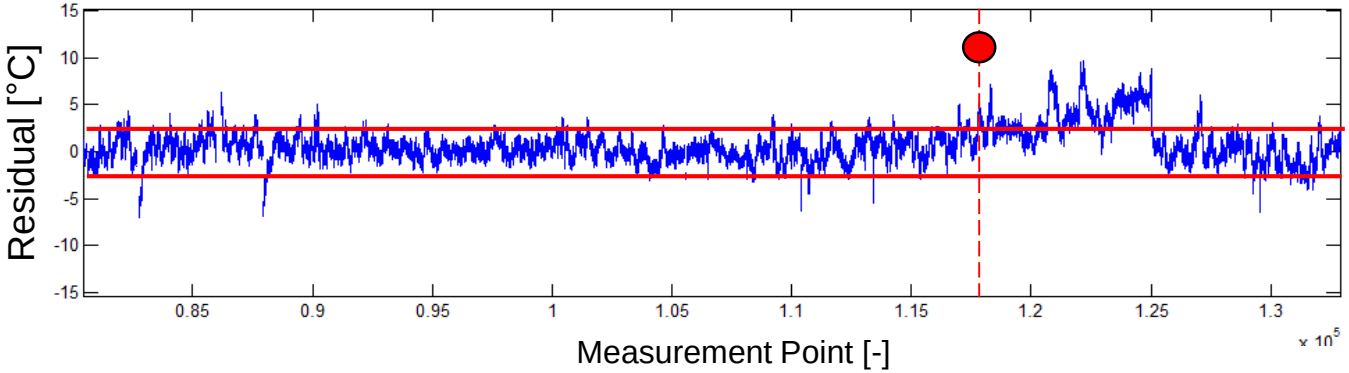
Failure Mode	erosion
Failure Location	leading edge progressive towards periphery
Root Cause / Effect chain	salt, dust and sand (SiO2) in air erodes blade surface at point of momentum transfer (air flow re-direction)
Damage Promoting Operating Mode	high wind speed, high rotor speed
Aggravating Boundary Conditions	sand, salt, dust, ice in air - seasonal effect desert, semi-arid, coastal, off-shore or actic location of turbine
Damage Drivers	wind speed, rotor speed
State Indicators	power curve (power loss, particularly variable speed region) pitch curve (unusual behaviour)
Maintenance Task	Lifetime (20 years)
Inspection Method	Visual inspection of blade. Hammer test to check acoustic response Access via mobile platform or rope

Uptime HARVEST™ knowledge DB (example: Blade)

Structured information storage within an integrated system support continuous improvement

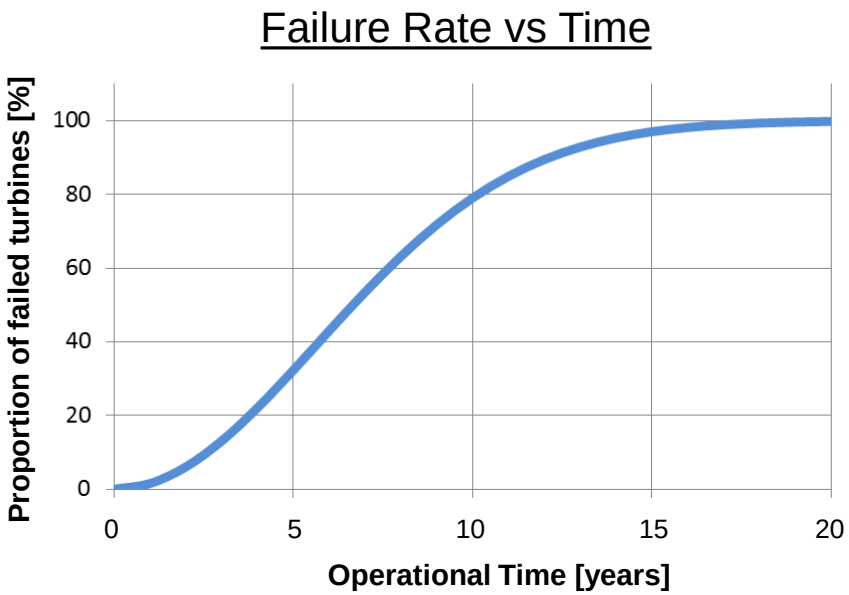
Outlier Detection

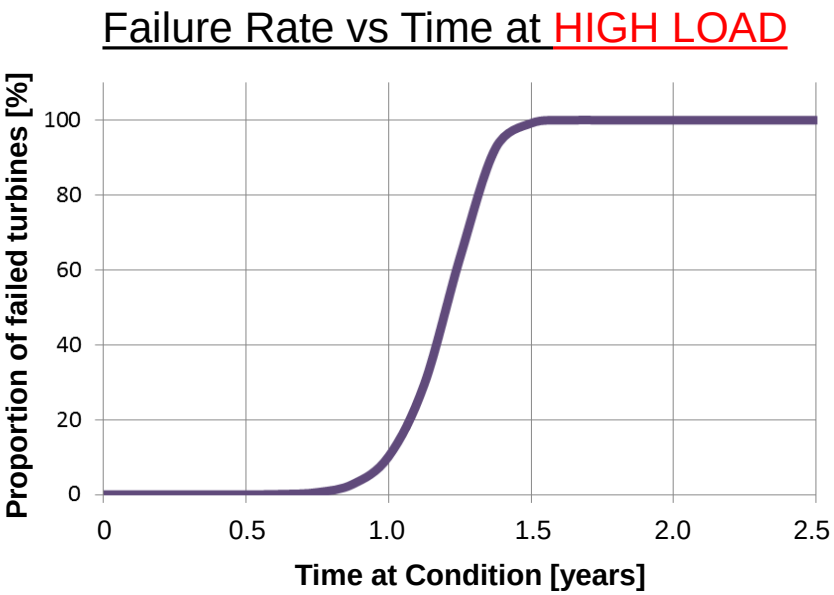


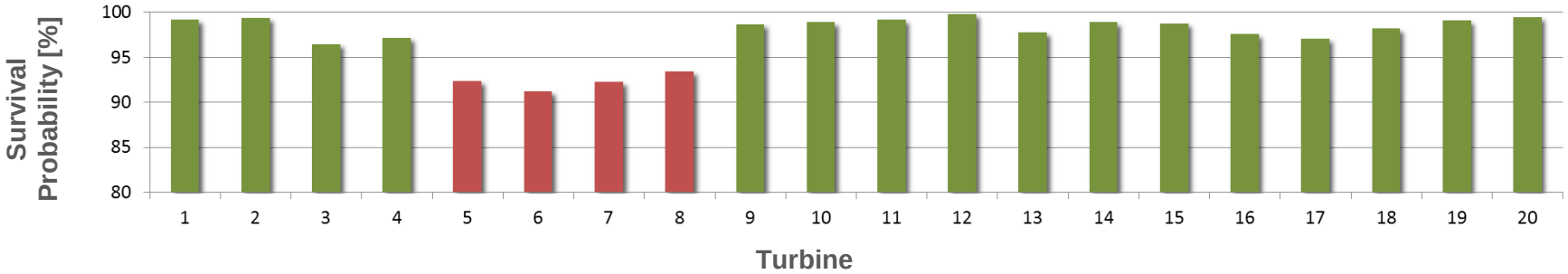


Fully automated and accurate outlier detection using physics-based models

Physics of Failure

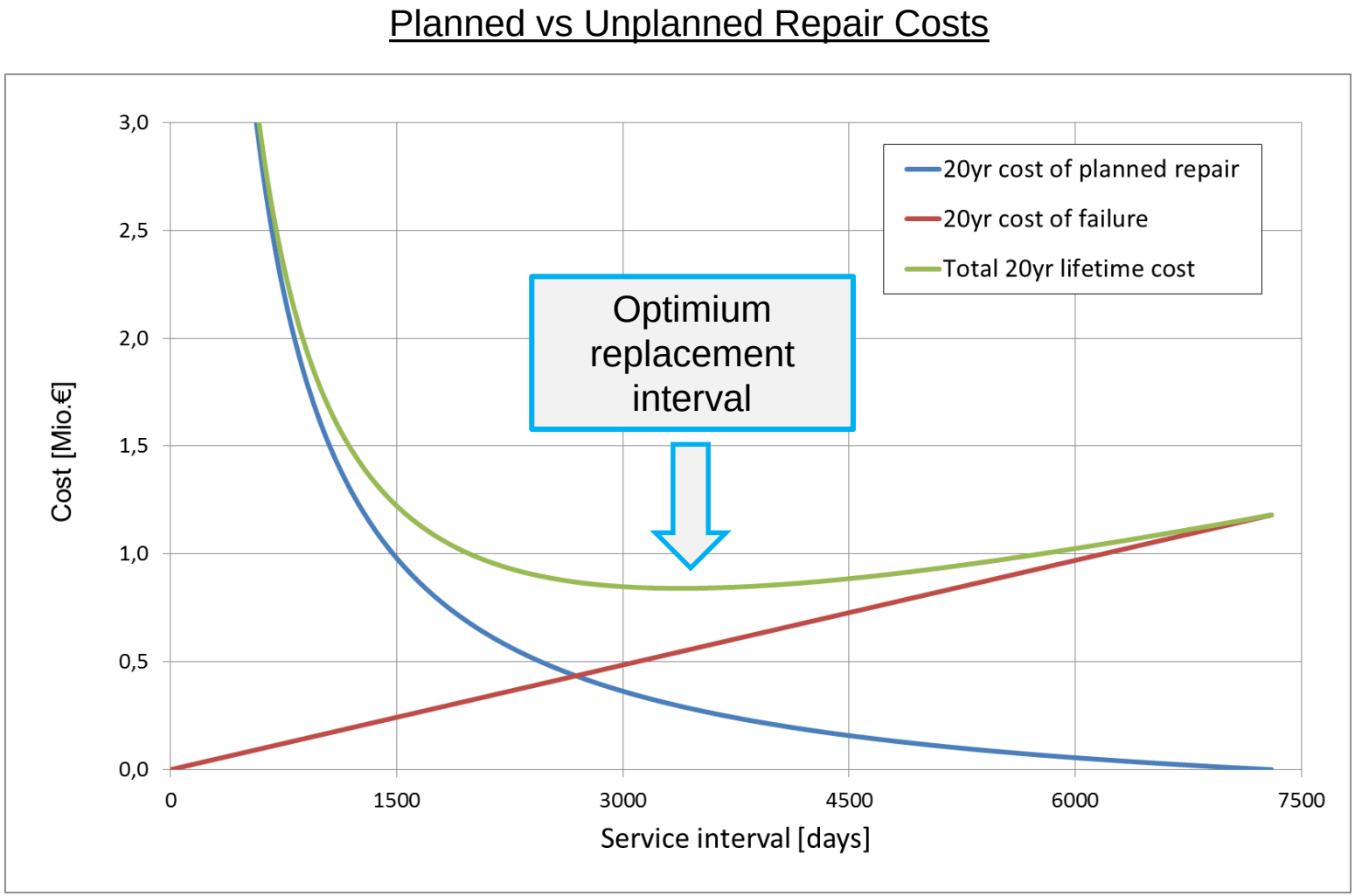






Physics of Failure modelling combined with SCADA improves prognosis accuracy

Cost Minimisation

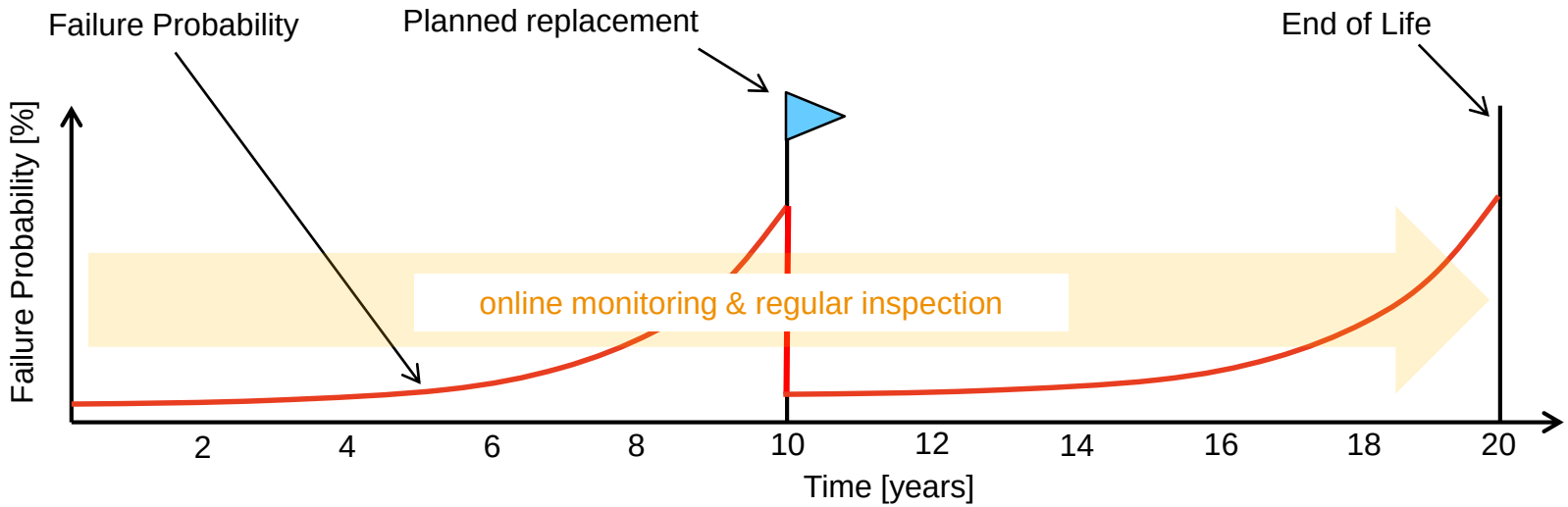


Introduction of well-timed preventative maintenance reduces overall costs

Improvement: Recommendations and Potential

Recommendations

- Intermediate replacement, instead of run-to-failure
- Prioritisation according to accumulated damage
- Online monitoring (SCADA, alarms)
- Failure rate tracking and adaptation of plan



Combination of maintenance scheduling, monitoring and prognostics for minimum total cost

Summary

- Data analytics can support a wide range of optimisation activities
- Requirements: data infrastructure, software, analytics, process integration
- Physics based methods provide transparency and are highly effective
- A combination of diagnostics, prognostics and CBM provides financial gains
- **Power of SCADA: available, plentiful, continuous, detailed, growing**

Thank you

UPTIME
ENGINEERING®

www.uptime-engineering.com