

LM Glasfiber – Lifecycle Solutions

02 April 2009, Dallas



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Your reliable partner in developing and providing advanced blade services



LM Global

Agenda

§ **LM Glasfiber**

§ Industry Drivers and Challenges

§ Lifecycle management – what is important ?

§ Responding to the industry needs

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- Top five markets 2008
- Administration office
- Global business office
- R&D
- Production and service facilities
- Main service facility
- Headquarters Denmark

...new production and service unit in Poland

§ Largest blade manufacturer with global manufacturing and aerodynamic design capabilities

- 25 % market share worldwide

- Partners with 8 of the Top 10 WTM's

- Installed base in excess of:

> 105,000 blades

§ Service and manufacturing presence in all the leading wind energy markets

- 15 production facilities in 7 countries

- Blade O&M support worldwide from 9 locations

- Regional workshops for difficult and bigger repairs

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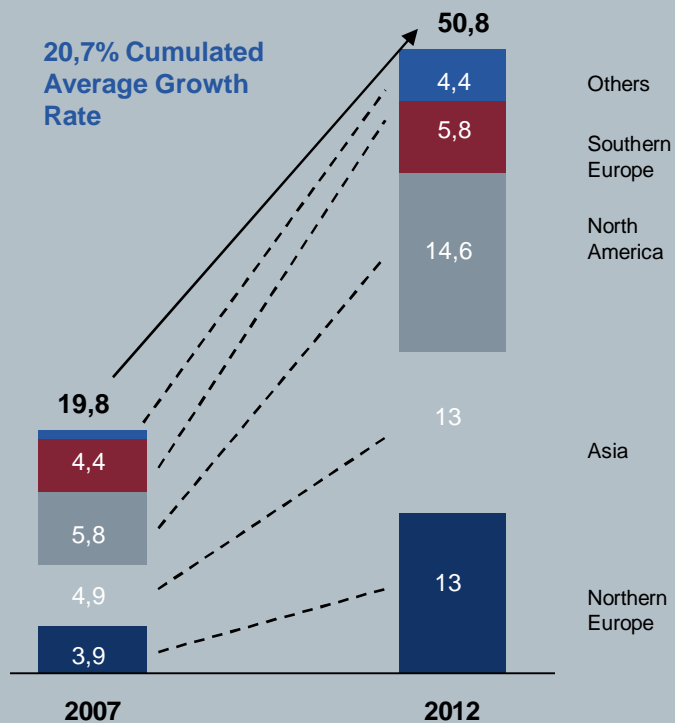
§ **Industry Drivers and Challenges**

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Service needs in a truly global industry...

New wind power capacity by region, 2007 vs. 2012 forecast (GW)



Source: BTM Consult

Key Trends

§ Installed wind capacity increasing at double digit growth rates

§ O&M needs expected to grow at double digit growth rates

§ Higher than forecast O&M costs

§ WTMs facing competition from ISPs and in-house divisions of utilities and other IPPs

§ Emerging sub-contracting of work by WTMs to ISP's

§ Maturing, concentrating and globalization of the WTM industry

§ Point where warranties expire is getting crucial

- Continue with WTMs or consider ISPs ?

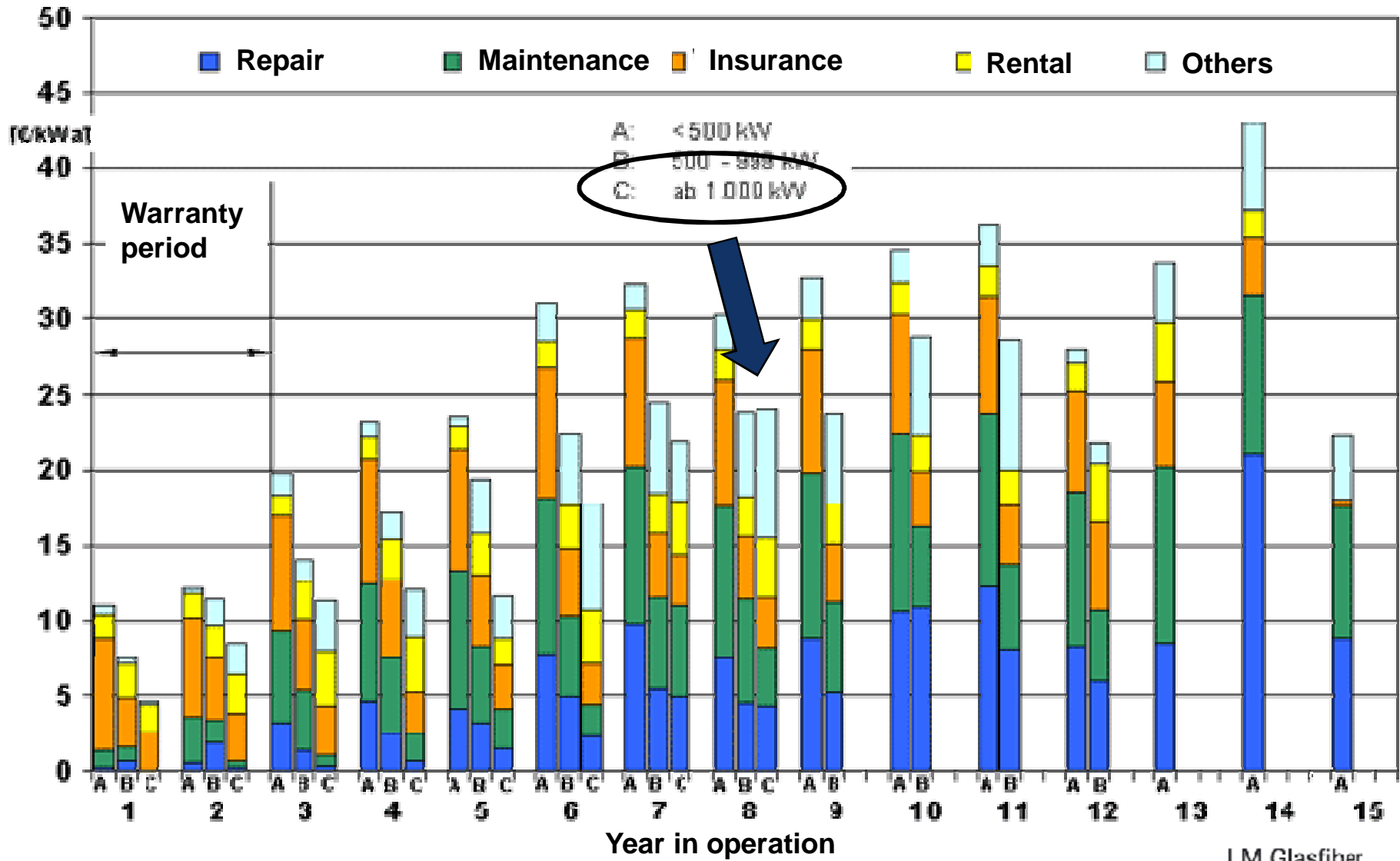
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...poses challenges to owners & operators:

- § Costs of O&M vs. forecast becoming important
- § Increases a reliance on government and regulatory support
- § Shortage of blade knowledge and skills



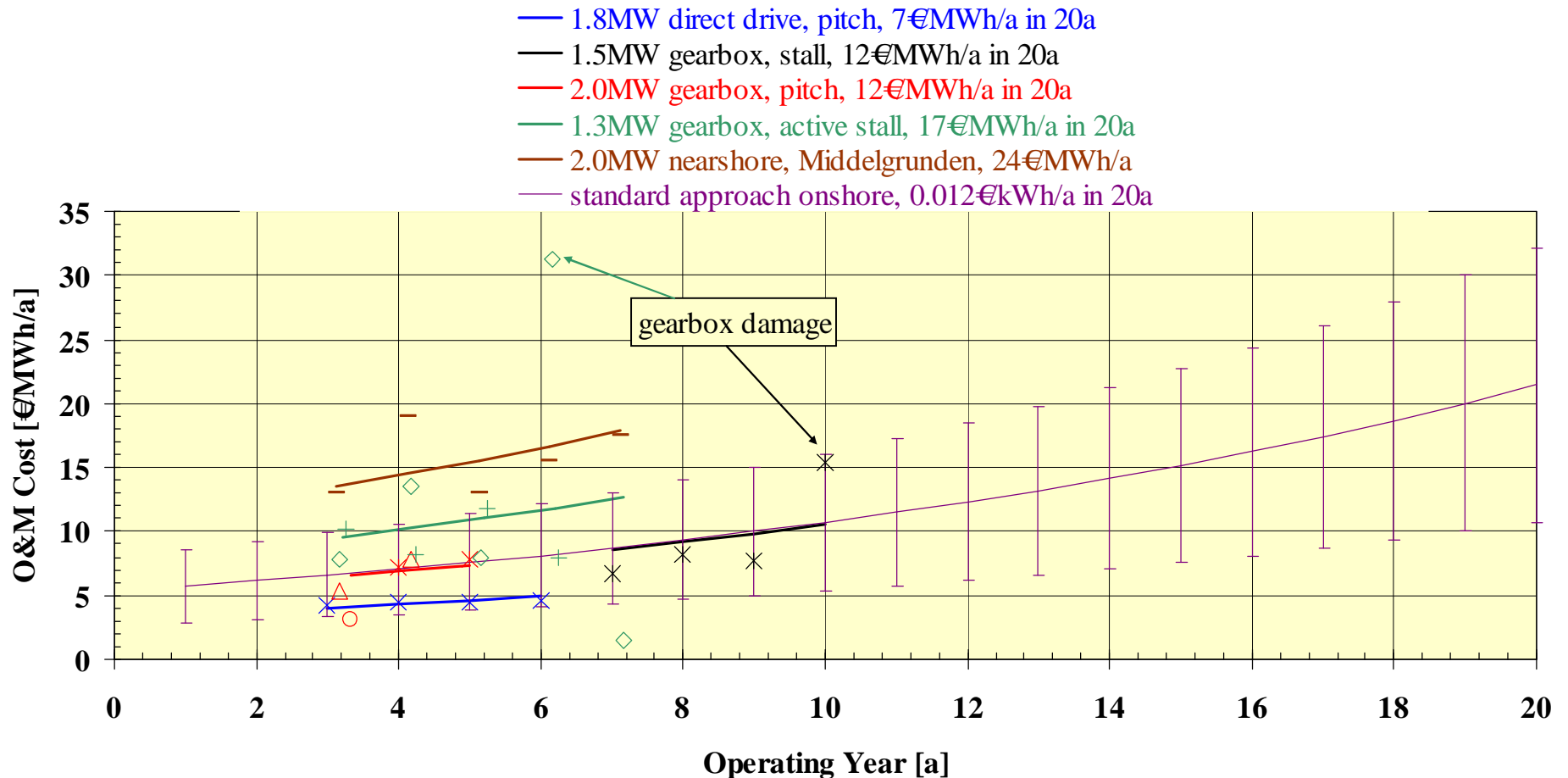
Operational Costs by WT Age (According to WMEP 2006)



Credits: Deutsche WindGuard GmbH, Dipl.-Phys. Axel Albers

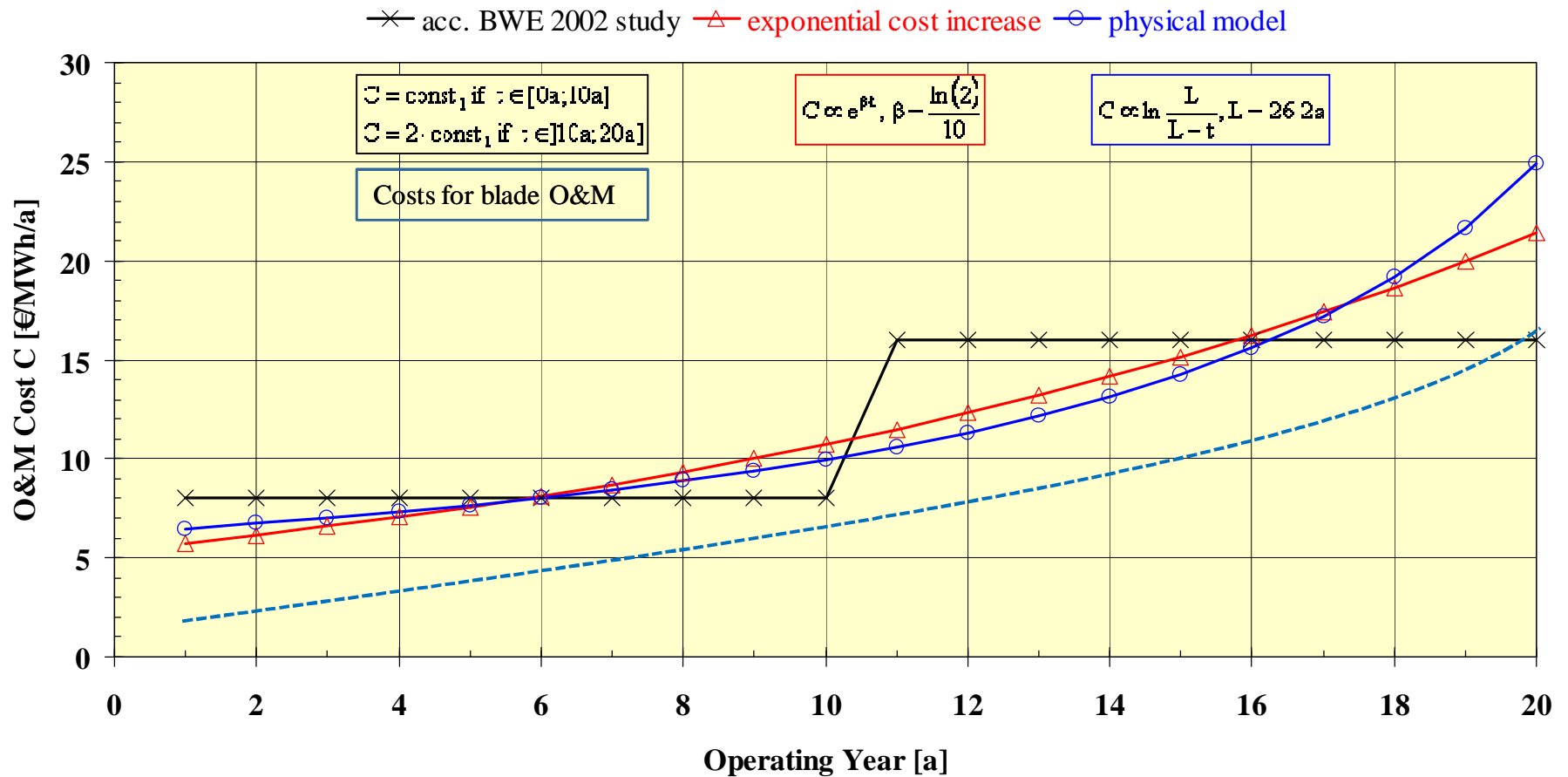
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Extrapolation of Repair and Maintenance Cost



- § standard approach : 0.012€/kWh/a averaged over 20yr assumed (value from BWE-study 2002)
- § Estimated standard uncertainty of standard approach: 50% of modelled cost

Improved forecasting of Repair and Maintenance Cost



- § There is no reason to assume a step function.
- § Integrated cost increase in 2nd decade compared to 1st decade overtaken from BWE 2002 study (double cost in 2nd decade)

Credits: Deutsche WindGuard GmbH, Dipl.-Phys. Axel Albers

What does this mean?



- § Long-term O&M cost often underestimated in development phase:
 - often about 85% EBITDA-margin expected over 20 years
 - latest study of BWE from 2009: 76% EBITDA-margin
 - (average of 66 wind farms)
- § Individual modelling of expected O&M cost and availability over the powerplant lifetime is recommended
- § Good cost modelling coupled with proper preventative maintenance will often results in positive earnings even after 20 years

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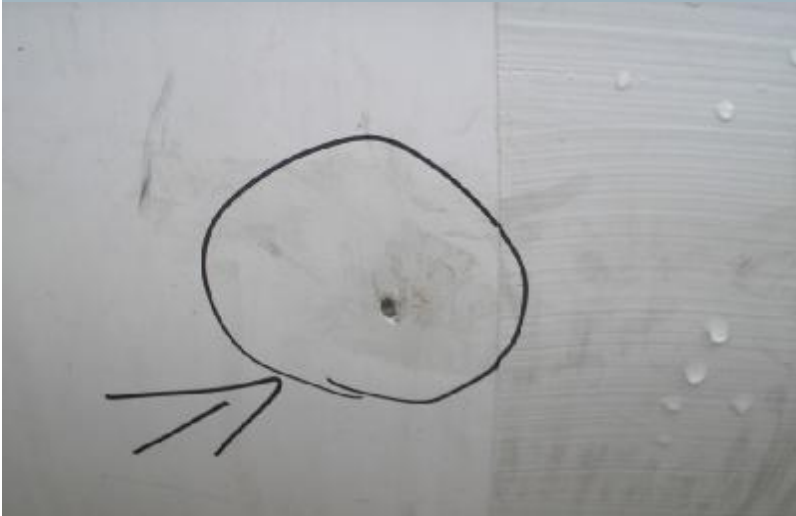
§ Responding to the industry needs

Industry needs?



- § **Technical expertise**
Well engineered solutions
Constant research for more efficient solutions
Detailed blade structure and performance knowledge
- § **Global one-stop-shopping**
Global customers need support anywhere, with efficient offerings from inspection, repair, overhaul to preventive maintenance
- § **Response time**
Defined reliable response time
- § **Cost of servicing**
Forecastable pricing with long term cost visibility
- § **Performance**
Availability guarantees
Consistent service with highly skilled staff
- § **Fast access to spare parts and replacement products**
Guaranteed critical spare parts availability
Availability of replacement blades in all sizes

Maintaining life: Fatigue loading of composite structures



Structural design life of rotor blades from fiber composite materials are based on:

- design margins (minimums given by certifying bodies)
- composite materials fracture mechanics
- actual loading (operation – wind etc)

As composite materials are exposed to fatigue loading, the degradation of the mechanical integrity starts with microcracking – not visible without microscope.

As components starts wearing out, visible cracks may develop from microcracks.

By understanding correct repair methods such cracks may be repaired with lower effort and down time.

Maintaining the structural integrity of the rotor blade for a maximum period of time.

Condition monitoring and preventive maintenance



Performing regular inspections of blades with reference to OEM maintenance manual will prevent minor defects to develop into structural cracks.

Surface damage due to erosion or lightning may be repaired at low cost if repaired early.



Most rotor blade structures are sensitive to stress concentrations from minor damage that may develop over time.

Condition monitoring and preventive maintenance



Loss of control during Icing



Hydraulic oil contamination

Linking turbine operation SCADA data to blade operation conditions may address blades with highest operational loading, which may be used as indicator for general need for maintenance.

Early analysis and repair of visible cracks are important to avoid larger repairs in the future.

Doing the right maintenance



Understanding the materials and design of composite rotor blades is essential to selecting the appropriate repair methods.

A defect that look insignificant may be of greater importance to blade safety, if positioned on a load carrying part of the rotor blade.

Using the OEM know how during inspection and maintenance of rotor blades will assure necessary competences in the damage evaluation and repair method selection.

Blade competence can improve the value of regular blade inspections

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State-of-the-art access technologies



The right tool for complex tasks



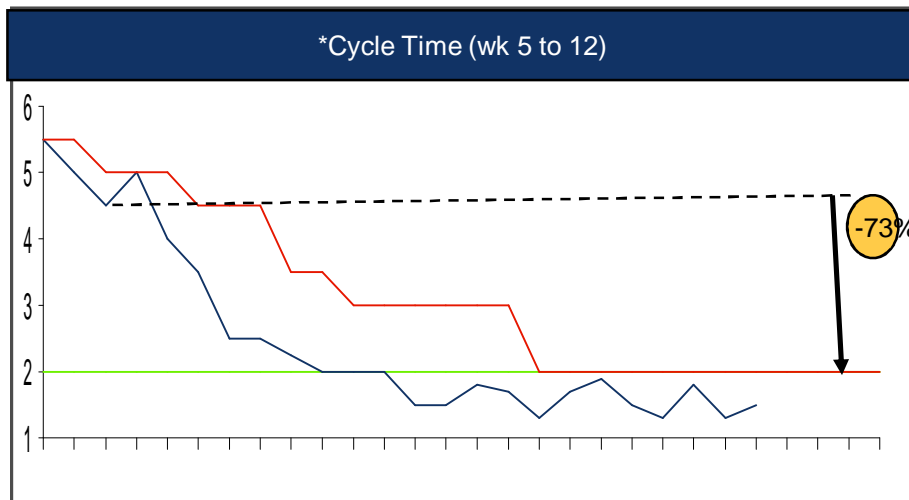
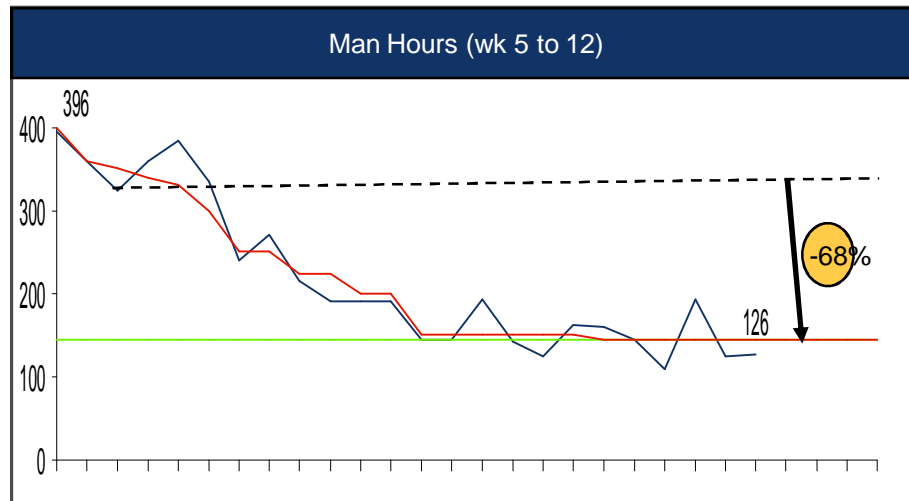
- § Innovative platform concept
- § Faster setup time
- § Usable for all blade and tower types
- § Cost efficient
- § Easy and fast logistics
- § Safe solution

Rope teams going all the way



- § Special trained teams to repair and inspect all kind of blades
- § New methods to repair the most damages up tower
- § Continuously developing new access equipment
- § Cost efficient
- § Fast setup

Up-Time counts Down-Time wastes



— Prediction — Actual performance — Target

Special and customized access equipment

- Reduced setup time
- Best practice
- Regular training and workshops for our technicians and site leaders

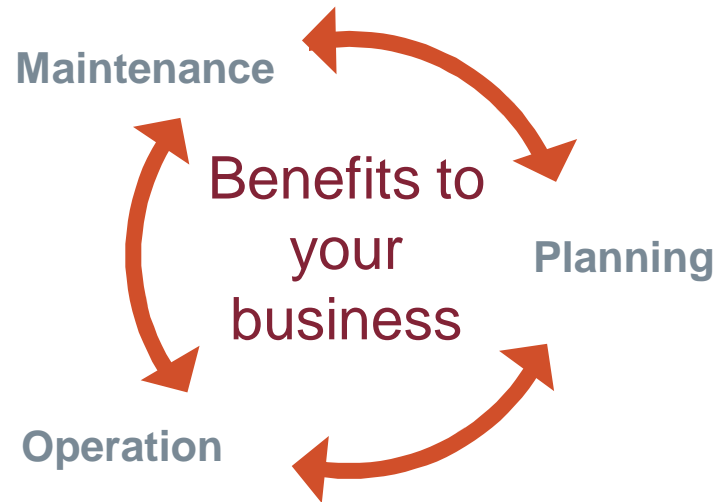
Summary:

Reducing of wind turbine down-time over 60%

Reliable solutions over 30 years

- § New repairs that improve the quality of our on-site repairs and reduces downtime
- § Service Engineering Department continuously developing new solutions to reduce critical downtime
- § Operations and Service Engineering building on 30 years of experience
- § As a blade designer we know the best way to service blades
- § Customized blade improvements
- § Specialized repair methods

LM Glasfiber adding value to your business



- § **Technical expertise**
Strong Service Engineering Department constantly researching for efficient service solutions
- § **Global one-stop-shopping**
We offer inspection, repair and preventive maintenance anywhere from 9 locations.
We have regional workshops for more complicated overhauls and repairs
- § **Response time**
Response time according to customer needs
- § **Cost of servicing**
Reliable LM Glasfiber service offerings mean long term cost visibility
- § **Performance**
Availability warranty acc. to customer needs
Consistently high performing and highly skilled global service staff with specialized training
- § **Fast access to spare parts and replacement products**
We offer critical spare parts and availability of replacement blades
- § **Past experience and good references**
We have built 1/3 of the world's installed base of blades and with 30 years of blade experience shared in our global organization

Q&A

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