Extending the lifetime of WTG
Securing and improving the performance of WTG

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8.2 Group

Decentralized network of experts in renewable energies

Established for more than 20 years in the wind industry | 120 Experts | active in > 50 countries

Wind Onshore
Wind Offshore
Photovoltaics
Biogas/Biomass
Grid Integration
Condition Monitoring

27 independent 8.2 offices worldwide

8.2 Group

www.8p2.de 22.03.2016
8.2 Expertise

- In-depth knowledge of all turbine types
  - > 20 000 turbines inspected

- Due Diligence of more than 6 000 MW onshore/offshore worldwide

- International Due Diligence of more than 2.5 GW PV projects

- More than 17 years of experience in the area of CHP technology with biomass/biogas

- Design review performed for most turbines (onshore / offshore)

- Technical consulting
- Technical due diligence
- Technical inspections
- Recurrent and condition based assessments
- Rotor blade inspections
- Damage and value analysis
- Continued operation of WTG after 20 years
- Factory and warranty assessments
- Grid connection expertise
- Construction supervision
- Operation optimization
- Online und Offline Condition Monitoring
- Video endoscopy
- Design Review
The life time of the WEC has to be minimum 20 years.
Lifetime Calculation of Wind Turbines

» First long-term experience with turbines > 20 years
  • especially in Denmark and Germany

» Structural safety is designed for 20 years
  • Source: Standards and Guidelines like IEC 61400

» Germany: turbines have to be dismantled after 20 years
  • … or independent expertise and recalculation of the lifetime
Lifetime Calculation of Wind Turbines

- commissioning
- shutdown and decommissioning
- planned operating lifetime
- remaining operation lifetime
- total operating lifetime
- operation period

Individual operating lifetime
Assessment and Evaluation for Extended Operation
Issued by DIBt / BWE Association

**Analytical Proof**

The object of the analytical proof is to calculate the remaining life time with the aid of mathematical analysis.

**Practical Proof**

The complete WTG has to be assessed in a recurrent inspection by the expert with respect to the fatigue of the components and type- and series-specific risks.
Lifetime Calculation of Wind Turbines

Aging mechanisms

- fatigue
- wear
- corrosion
- extreme loads
Lifetime Calculation of Wind Turbines

» WEC as a perfect „Fatigue Maschine“

[Diagram showing Wechselbiegespannungen (Wechselbending stresses) vs. Lastwechselzahl (Number of load changes) with Wechselbiegespannungen values and different structures (Vehicular, Bridges, Helicopter, WEA ~ 2x10E8).]
Fatigue failure rotor shaft
Fatigue failure Blade root
Lifetime Calculation of Wind Turbines
Fatigue failure Bolt connection
Lifetime Calculation of Wind Turbines

Sophisticated calculations

» Calculate the WTG completely with state of the art standards like IEC 61400

» Component-specific calculation of remaining lifetime.

» High costs but reliable.
Lifetime Calculation of Wind Turbines

Input parameters for Design Calculation

- Extreme wind speed → IEC class I - III
- Mean wind speed → IEC class I - III
- Turbulence → A B C
- Period of time → ≥ 175.200 h / ≥ 20a
- Mode of operation → various load conditions
Lifetime Calculation of Wind Turbines

![Graph showing estimated and actual loads over years of operation. The graph indicates the fatigue limit and highlights the difference between estimated and actual loads.]
» Modelling of operation mode and loads

» Calculation tool for WTG type and structure

» Simulation to generate time series and the underlying loads

» Capacity of the material to withstand stresses

» Proof of structural integrity / permit to extend operation
### Lifetime Calculation of Wind Turbines

#### Enercon E-70 / 2MW

<table>
<thead>
<tr>
<th>Component</th>
<th>Material</th>
<th>Wöhler-curve</th>
<th>planned lifetime</th>
<th>Lifetime of WTG</th>
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<tr>
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<td>E-70</td>
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<td>20a</td>
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<td>Tower bottom</td>
<td>Spannstahl</td>
<td>5</td>
<td>20a</td>
<td>≥ 119a</td>
</tr>
</tbody>
</table>

High interest by Operators / Project Developers / Investors
Lifetime Calculation of Wind Turbines

- 132 WTG Type NM750
- Task: Calculation of the overall lifetime
- Considering site condition
- Considering turbulence
**Lifetime Calculation of Wind Turbines**

**Calculated minimum lifetime blade root connection:**

- Min. Turbulence (WEC 29) **28.9 years** (min 28.2 years, max 29.4 years)
- Max. Turbulence (WEC 109) **26.5 years** (min 25.8 years, max 27.0 years)
- Ave. Turbulence (WEC 1-132) **27.8 years** (min 27.1 years, max 28.3 years)

The WEC component with a higher lifetime is the foundation. *(Remark: design relevant for the foundation is bending moment \(M_y\))*

**Calculated minimum lifetime foundation:**

- Min. Turbulence (WEC 29) **88.6 years** (min 80.4 years, max 92.9 years)
- Max. Turbulence (WEC 109) **45.6 years** (min 41.4 years, max 47.8 years)
- Ave. Turbulence (WEC 1-132) **65.4 years** (min 59.3 years, max 68.6 years)
Lifetime Calculation of Wind Turbines

Total operating lifetime ≥ **26.5 years**

(for only the weakest component of NM750 / based on site specific wind conditions)

Lifetime has been calculated based on:

- complete aeroelastic simulations
- the current standards for new designed WTGs
- common guideline IEC 61400 (turbulence)
- consideration of structural dynamics
- partly with conservative assumptions
Lifetime Calculation of Wind Turbines

WTG lifetime in years / > 30 Projects

- NTK 500
- E-82 E2
- E-30
- NM48-750
- V39
- E-33
- M570-200/40
- E-40/6.44 E1
- E-40/5.40
- M750/250
- Ventis 20/100
- E-18

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## Practical Proof

The complete WTG has to be assessed in a recurrent inspection by the expert with respect to:

- fatigue of components
- type-specific risks
- series-specific risks
Lifetime Calculation of Wind Turbines

» Misalignment

Blade angle -5,2°
Lifetime Calculation of Wind Turbines

Missalignement Blade angle

Annual Yield - 12%!
Lifetime Calculation of Wind Turbines

» Missalignement Blade angle (5 years)

Lifetime of rotor shaft - 30%!
Lifetime of welding 12 years!
Summary | Securing the performance

» Each WEC has an individual life time
» Analytical methods are available to calculate life time of components
» Learn more about the weak points of turbine
» Adapt / include results in your individual maintenance plan
  ▪ Schedule repairs / critical components
» Risk based recurrent inspections
» Adjust operation mode - reduce the loads

Life Time Extension with high Reliability
Thank you for your interest.

Please contact us for further details:

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