Detection of Aerodynamic Imbalance

Malmö, 10.12.2014

more wind
engineering solutions

Wind Turbine R&D

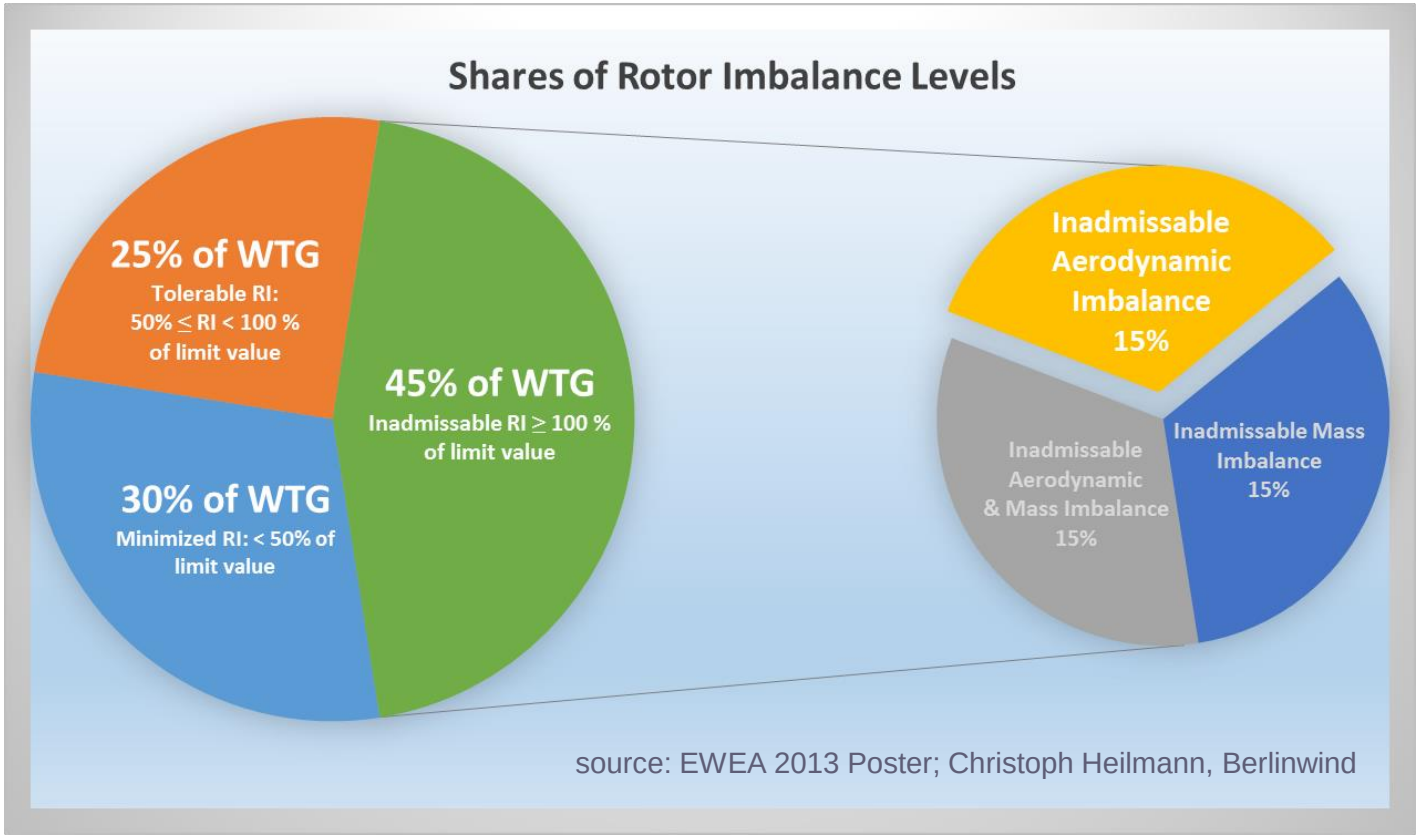
Wind Farm Optimisation

Consulting

Introduction

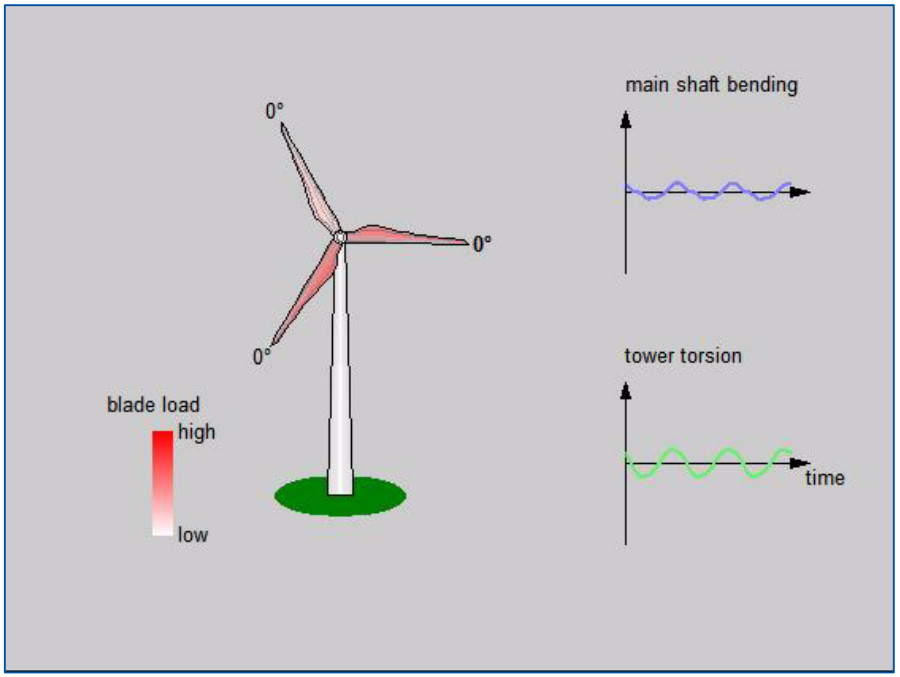
Aerodynamic imbalances lead to:

- Reduction of the annual energy production (AEP)
- Increased vibrations and increased fatigue loading
- Modified noise emission

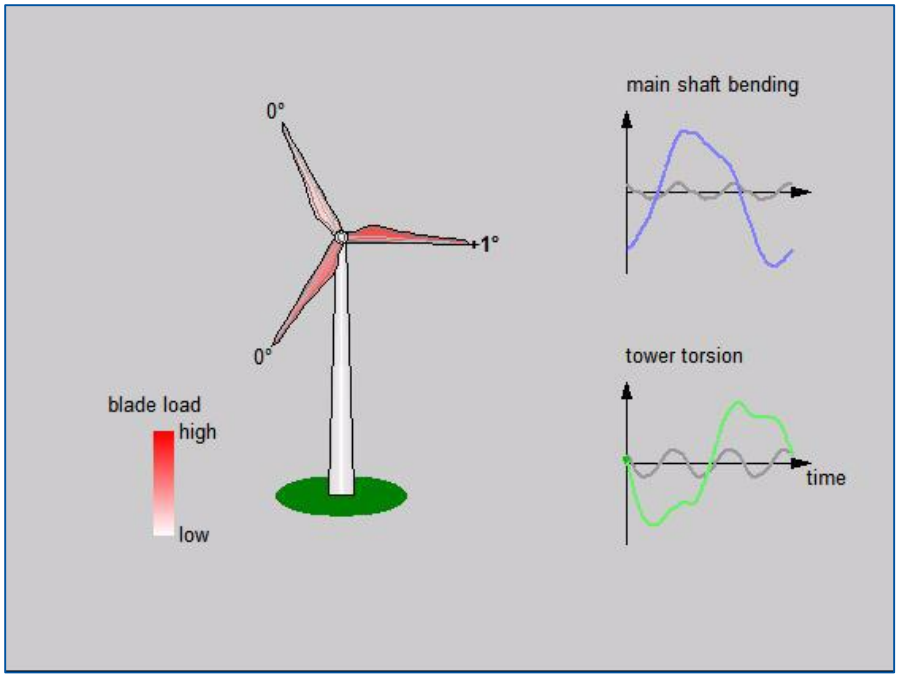


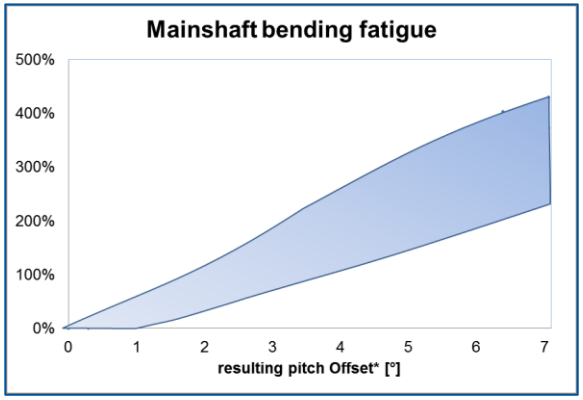
Impact on Turbine

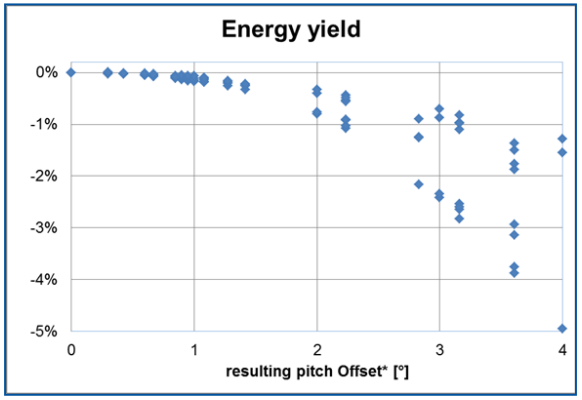
no imbalance



with aerodynamic imbalance



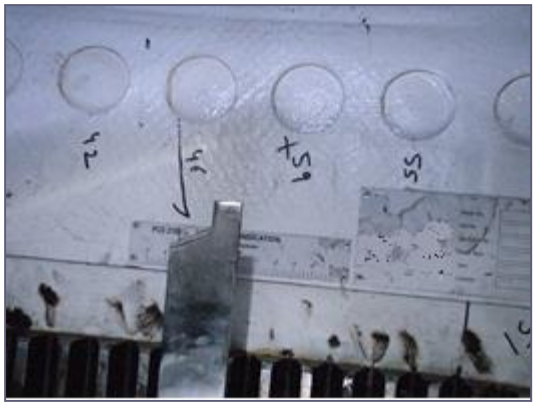


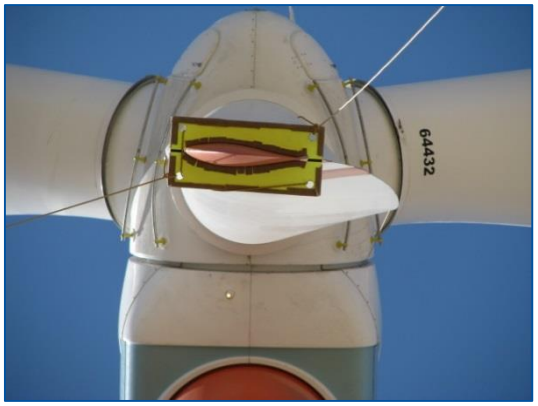


→ critical if **relative error** between 2 blades is > 1°

State-of-the-art:
Pitch angle misalignment measurement

- ↓ Shut down of WTG
- ↓ Significant time consumption

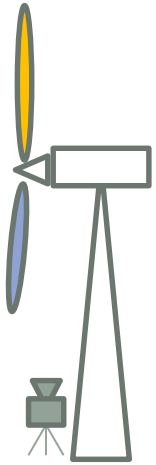


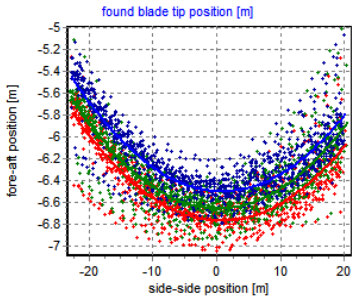


mwRotate: Concept

Varying pitch angles or modified aerodynamics lead to different blade bending during production

Measurement setup → Video Recording → Tip Trace Detection → Data Analysis → Estimation of relative pitch offset



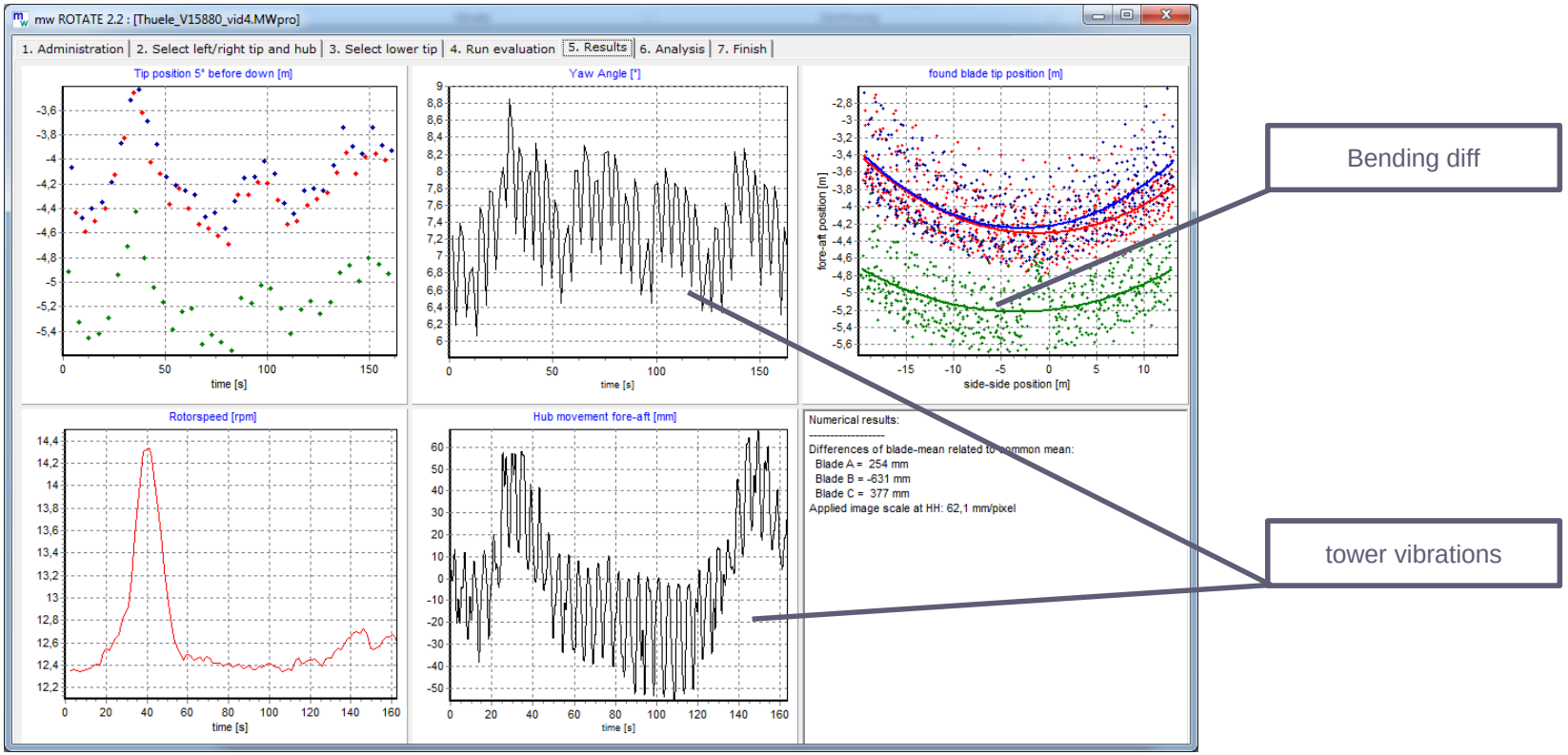


DEMO-Video

….switch to video….

Case study

- 6 turbines of the type Vestas V80 on 60m tower were investigated for a customer in Germany.
- 1 Turbine showed a huge offset (deflection difference approx. 1m)
- Abnormal Tower and yaw vibrations could be observed on the mwRotate screen
- The turbine was stopped → A loose pitch cylinder could be found



Case Study (2)

Business Case

Assumptions:

- 100 WTG 2MW rated power
- Time interval 10 years
- Site capacity factor 0.3
- Feed in tariff 0.12EUR/kWh
- 15% of the fleet have an offset >1° *
- Aerodynamic imbalances are causing 3.5Mio EUR repair costs on blades, drive train and yaw system over 10 years*
- average AEP loss resulting from imbalance is 0.5% **

- Verification costs with video analysis 250EUR/WTG per year
- whole fleet checked → 25.000EUR/year
- Further adjustment costs 1000EUR/WTG on 15% of the fleet per year

total balancing costs	- 400,000.00 €
saved Production losses	473,040.00 €
saved repair costs	3,500,000.00 €
cost saving per WTG (10 years)	35,730.40 €

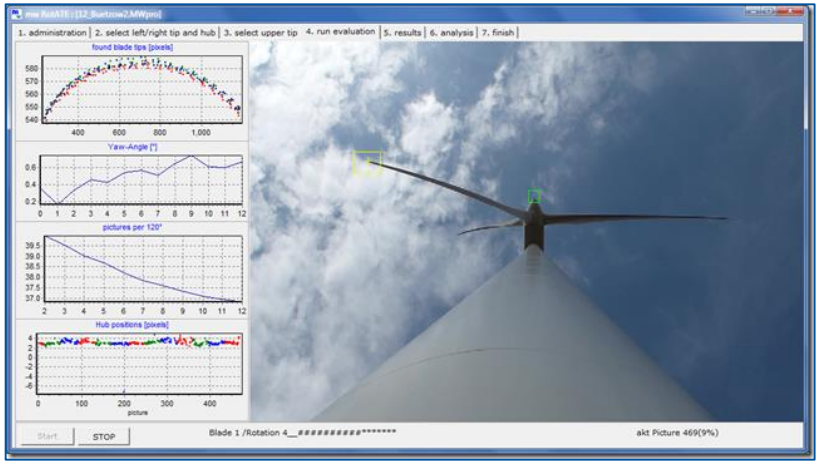
* based on EWEA 2013, PO.128 – PAYBACK ANALYSIS OF DIFFERENT ROTOR BALANCING STRATEGIES, BerlinWind GmbH

** less than assumptions in EWEA 2013, PO.128 – PAYBACK ANALYSIS OF DIFFERENT ROTOR BALANCING STRATEGIES, BerlinWind GmbH

Conclusion

mwRotate: our quick and simple way to verify aerodynamic rotor imbalances

- no special equipment or skills
- no downtime
- real imbalance indication
- fast reaction
- low costs



Thank you! Any Questions?

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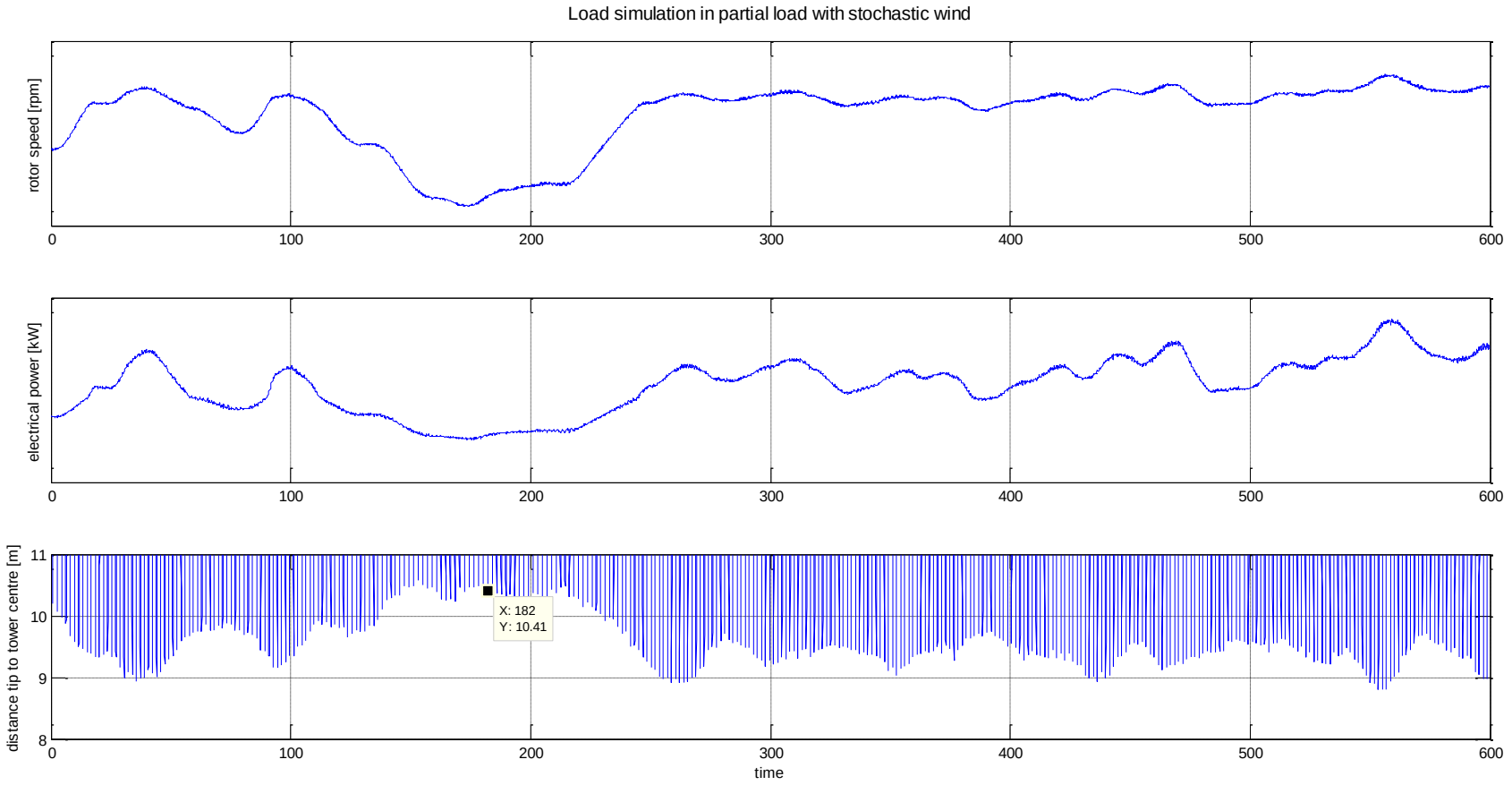
Proof of concept

- Parameter study: generic 3MW and 120m diameter wind turbine using aeroelastic load simulation
- Result: pitch angle offsets = main influencer of tip deflection variations



Load Simulation Results

- Overlay of the blade passage (blade tip to tower distance)
- Blade 1 (red) has a varying pitch offset
- Results from 10min simulation time under stochastic wind conditions with Vmean=8m/s.