PO.061

Boost Wind Turbine Yield and Life Expectancy Through Rotor Blade Angle Correction

Michael Melsheimer, Anke Grunwald, Christoph Heilmann
BerlinWind GmbH, Germany, www.berlinwind.com

BERLINWIND

Abstract

Independent measurements at the rotors of wind turbines (WT) without suspicion reveal that approx. **three quarters exceed the tolerable design limit values for blade angle deviation (BAD) and/or mass imbalance (MI)** of the type certification. The changed aerodynamics from BAD significantly lower the annual energy production (AEP). MI and BAD both increase vibration amplitudes, fatigue loads and life time consumption, so does the OPEX from damages and downtimes.

A case study shows that a **mean absolute BAD per rotor of 1.0° reduces AEP by 7.4 %**. Hence, adjusting blades correctly has a huge potential to boost the energy yield. But it is essential to measure every blade using proven methods capable to determine the yield-relevant absolute BAD. As effective measurement methods are available at a fraction of lost yield and avoided damage costs, blade angle correction is a very cost effective tool for boosting AEP and life expectancy of WT.

Objective

Increase AEP and life expectancy, decrease OPEX through correct blade angle measurement and adjustment.

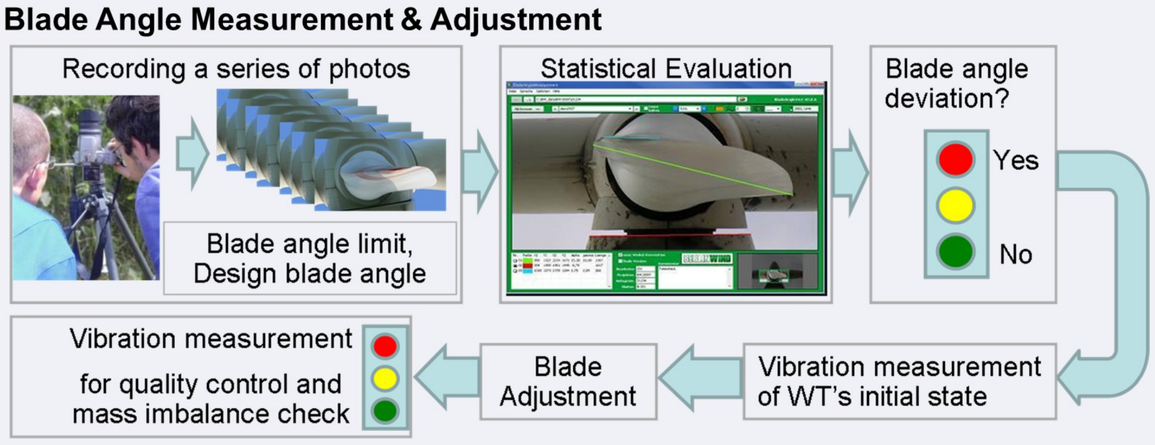
Method

Blade Angle Deviation

Absolute BAD: difference to design blade angle, mainly responsible for AEP deficits

Relative BAD: difference between individual blades of a rotor, mainly responsible for increased vibration

Blade Angle Measurement & Adjustment



Blade Angle and Imbalance Statistics

- Absolute blade angle measurements of 383 WT (average 2.2 MW, with and without known BAD issues)
- Relative blade angle and mass imbalance measurements of 239 WT (without known BAD or imbalance issues)
- Independent, statistically safe photometric blade angle measurements
- Absolute BAD limits of +/- 0.3° acc. to DNV-GL WT certification guideline

Power Curve Comparison before and after Absolute Blade Angle Adjustment

- Based on operational data of wind turbines for identical seasonal sections

Cost-Benefit Study

- German wind farm with 10 x 2 MW Pitch wind turbines, AEP 410T€, 20 years planned service life
- Estimation of damage and repair costs with increasing mass and aerodynamic imbalance based on O&M statistics
- Yield loss from aerodynamic imbalance (AI) due to absolute BAD estimated by comparing yield of WT with and without AI in the same farm

Conclusions

Statistics show that only a minority of wind turbines has correctly adjusted blade angles. The large share of faulty adjustments proves that the typical production and commissioning procedures are not sufficient. Neglecting this fact will result in huge yield losses and damage costs, while conducting effective measurements and implementing corrective measures comes at a fraction of these costs.

Using statistically safe, independent optical blade angle measurements, blade angles can be re-adjusted to the optimum design angle from certification. Vibration measurements validate the achieved load reduction. Therefore, blade angle correction is an essential tool to significantly increase AEP and life expectancy of wind turbines, and reduce OPEX.

Results

80% of measured blades exceed limit for absolute Blade Angle Deviation (BAD)

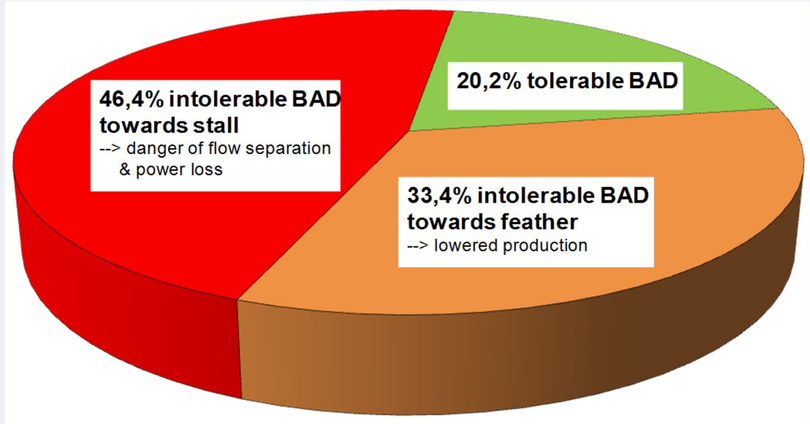


Fig. 1: Statistics for absolute blade angle measurement of 1149 individual blades of 383 wind turbines (with and without known BAD issues)

Mean absolute Blade Angle Deviation of 1.0° reduces AEP by 7.4 %

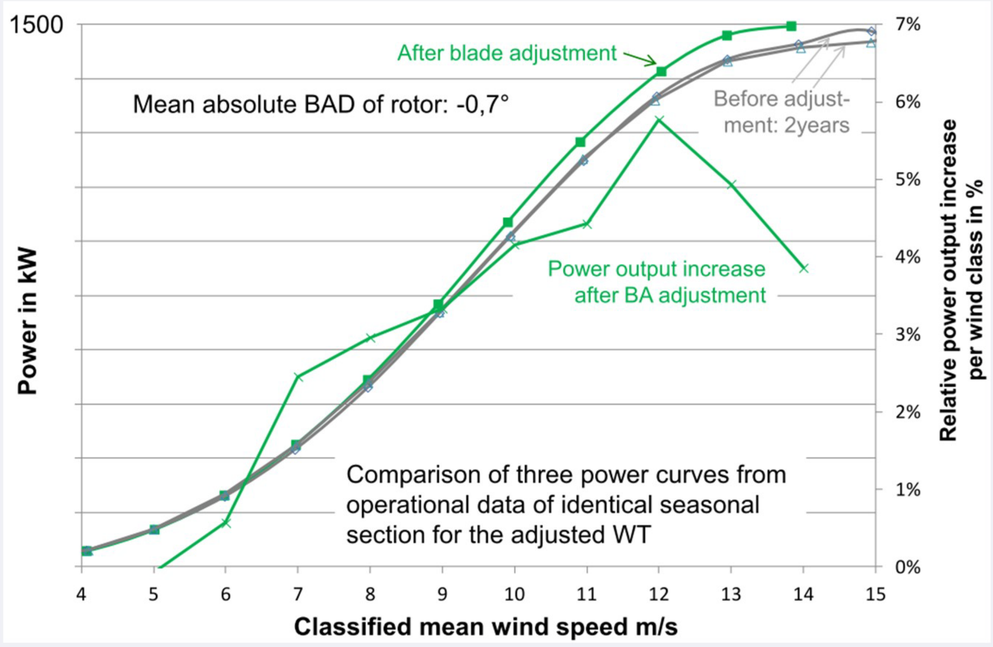


Fig. 2: Power curve improvement through absolute blade angle adjustment

73% of all wind turbines are affected by intolerable Blade Angle Deviation (BAD) and/ or Mass Imbalance

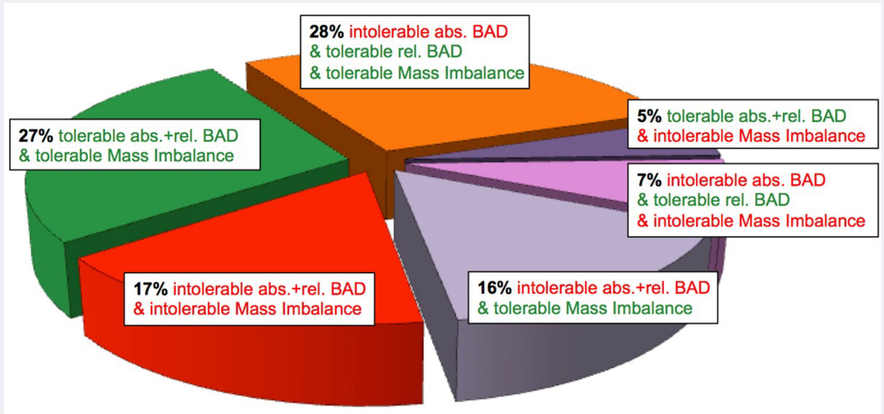


Fig. 3: Shares of wind turbines (without known BAD or Imbalance issues) affected by blade angle deviation and/ or mass imbalance

Investing 100T€ in periodic blade angle and vibration measurements prevents damage and AEP-related losses up to 7 Mio €

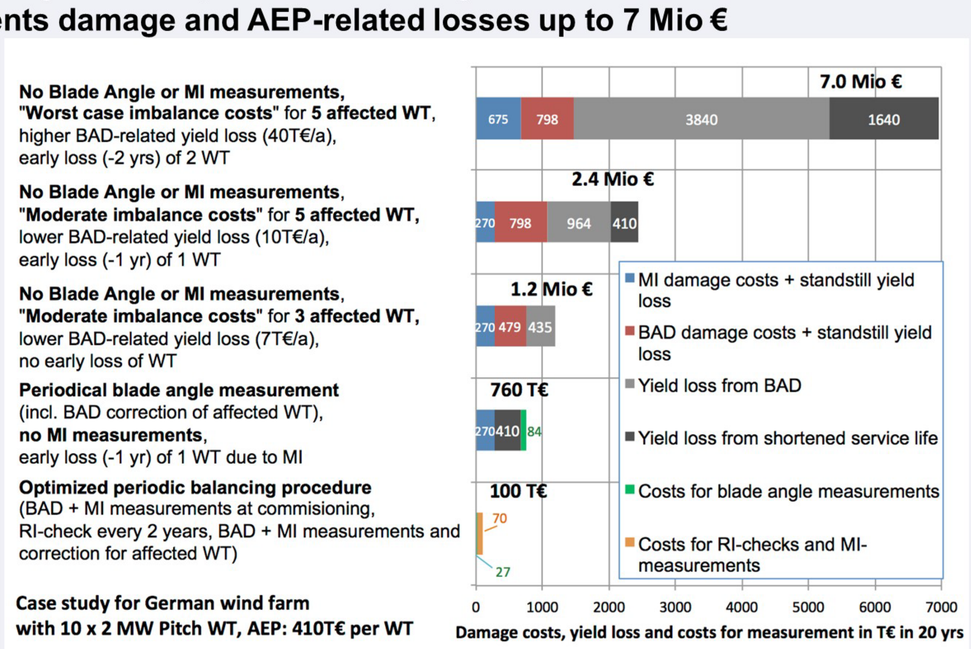


Fig. 4: Cost-Benefit-Study of financial impact of blade angle and mass imbalance measurements