Blade Angle Measurement & Blade Template

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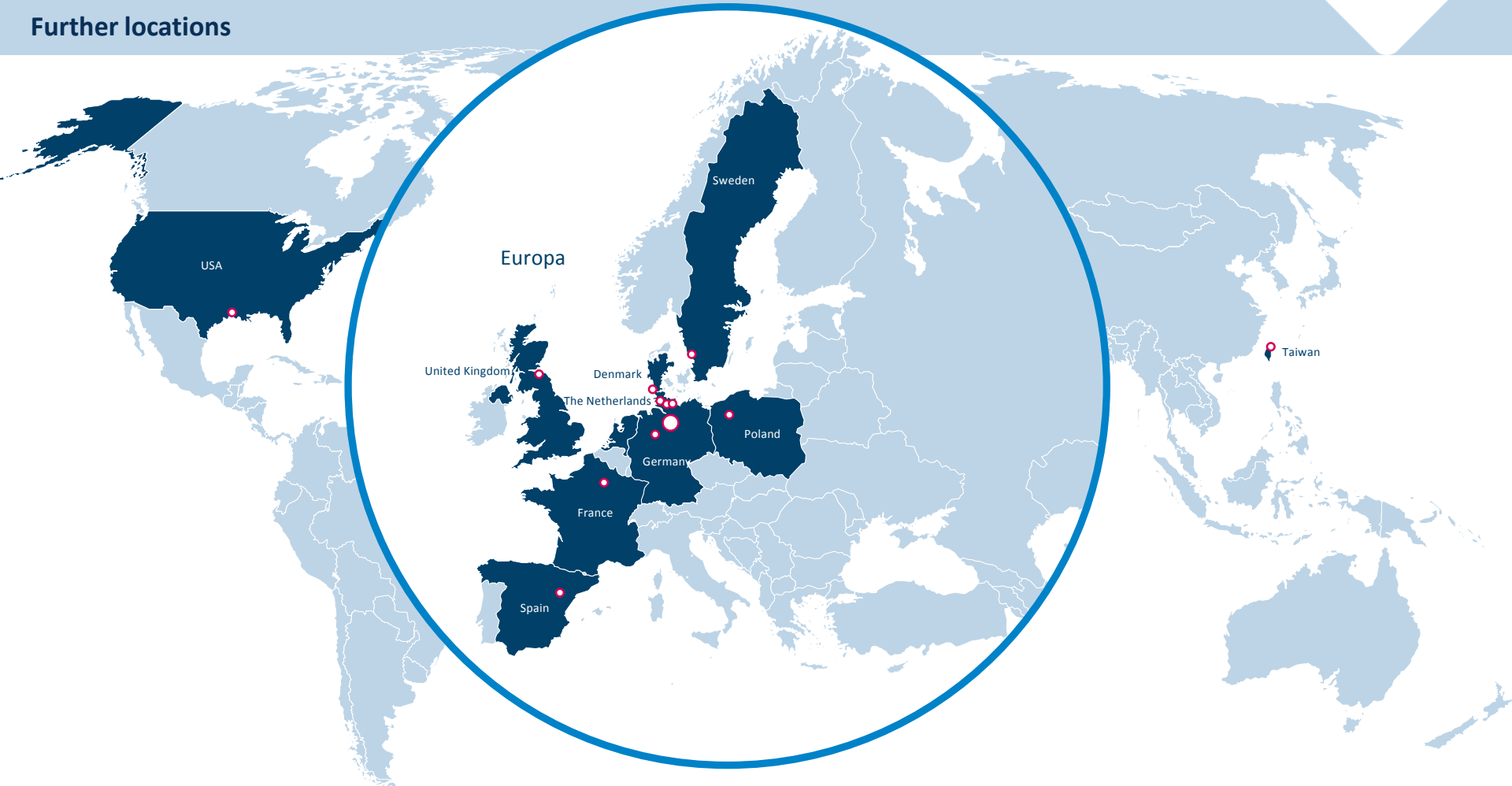
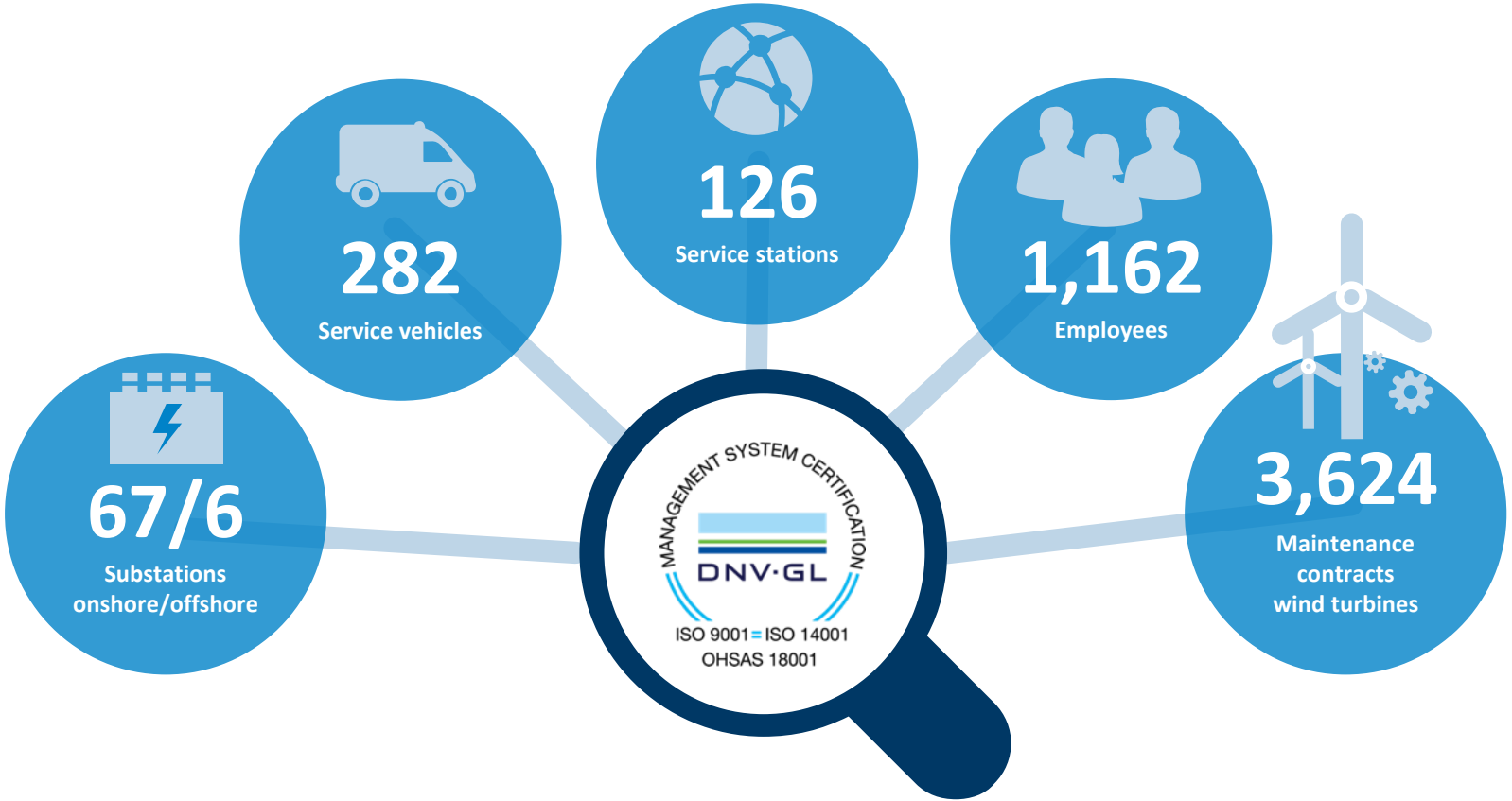
Deutsche Windtechnik

Further locations



Company Figures



Wind Turbine Portfolio

Deutsche Windtechnik

Vestas®

Siemens®

Senvion®

Nordex®

Fuhrländer®

NEG Micon®

AN Bonus®

Repower®

Gamesa®

Enercon®

Content

1. Causes of Imbalance

The imbalance of the rotor on a WTG can have several reasons. Generally, it is differentiated between **aerodynamic** imbalance and **static** imbalance.

Aerodynamic imbalance

- Different blade angles
- Diverging rotor blade geometries (Profile /Twist/ etc.)
- Damages on the rotor blade
- Cone errors / pitch errors
- Incorrect mounting of components (Pitch cylinder / etc.)

Static imbalance (mass imbalance)

- Major repairs on the rotor blade
- Liquid accumulation inside the rotor blades
- Unequal distribution of mass
- Pitch errors

2.1 Blade Angle Measurement – The Laser

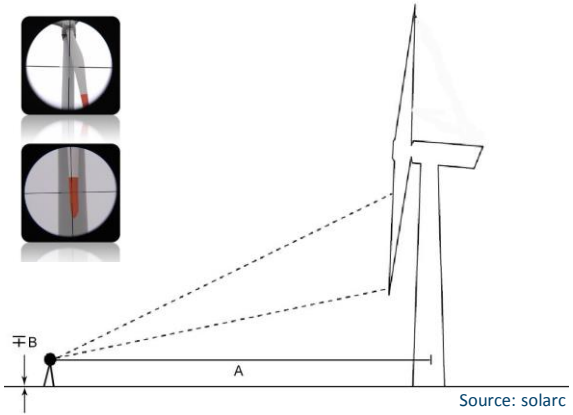
- ROMEG M-20
- Pilot laser class 2 with below 1mW output
- Sampling rate of 2 kHz
- Measuring range 3-400m
- Run with Batterie at 14,4 Volt

Source RIEGL

2.2 Blade Angle Measurement – Function Procedure

- Background: high deviation of blade angles = high vibrations and more intensive wear and tear of components.
  Therefore: avoidance of blade angle deviation = longer life of components

- Based on distance measurement via Laser
- Two laser points are directed at blades/tower at **the operating wind turbine**
- Generation of individual profile of every blade
- Afterwards the blade profiles are compared with each other to determine the relative blade angle deviation
- Additional benefit of the measurement: Evaluation of tower vibrations and individual blade pitch



Source: solarc

2.3 Blade Angle Measurement – Measured Values

relative blade angle

axial tower oscillations

tower to blade distance

radial division

twist angle

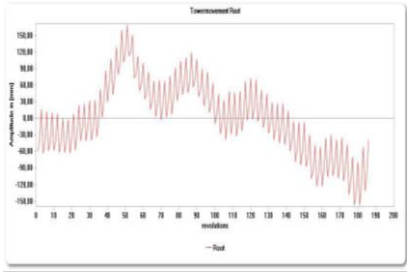
Source: solarc

2.4 Blade Angle Measurement – Advantages

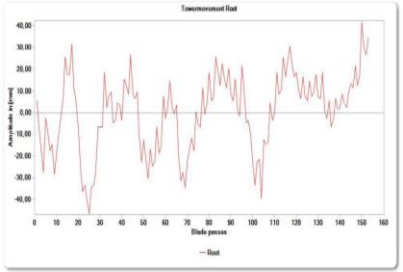
Depending on deviations found during the analysis of the WTG, corrections of the blade pitch would be advisable resulting in the benefits shown below:

- Reduction of forces influencing mechanical components
- Reduction of forces of the tower and foundation
- Potential increase of yield
- Lowered aerodynamic imbalances leading to less blade and tower oscillations
- Lowered noises of the blades
- Fast and straightforward analysis directly at the wind turbine

Tower vibration

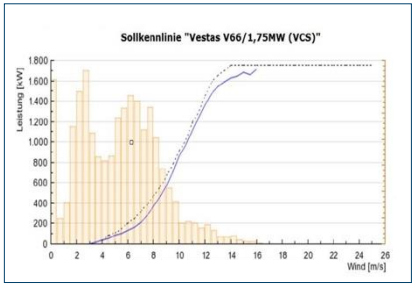


Before: Blade angle deviation> 1.0°

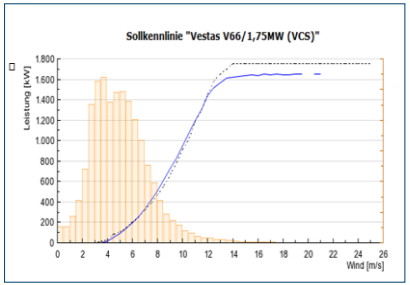


Afterwards: Blade angle deviation < 0.5°

Performance Characteristic curve



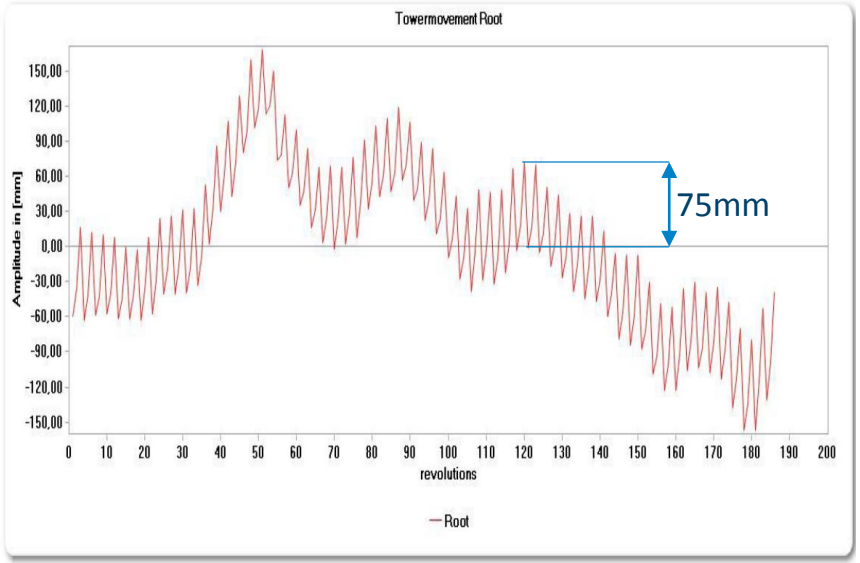
Before: Blade angle deviation > 1.0°



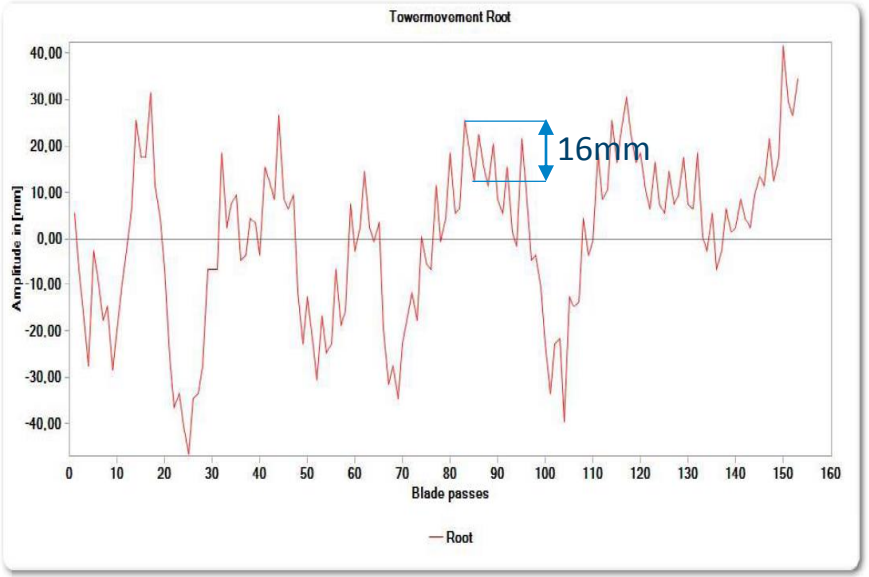
Afterwards: Blade angle deviation < 0.5°

2.4 Blade Angle Measurement – Advantages

Tower vibration



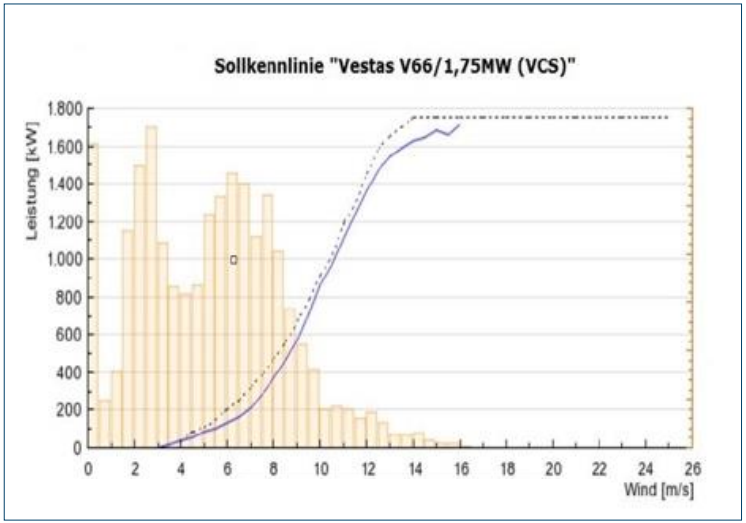
Before: Blade angle deviation> 1.0°



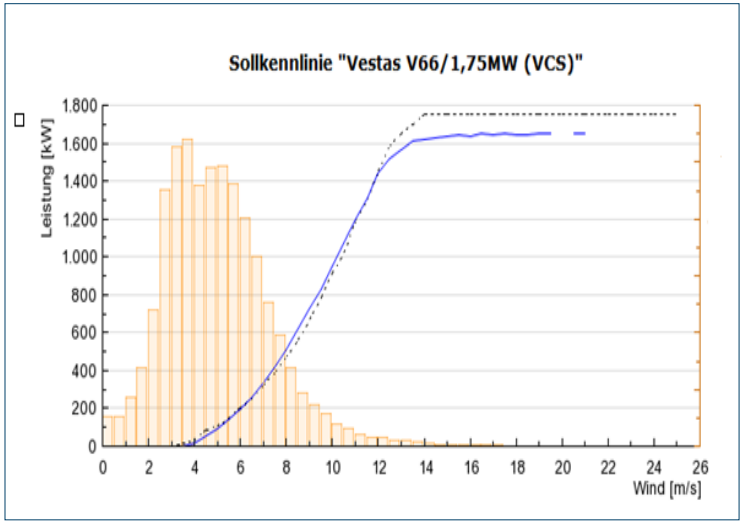
Afterwards: Blade angle deviation < 0.5°

2.4 Blade Angle Measurement – Advantages

Performance Characteristic curve



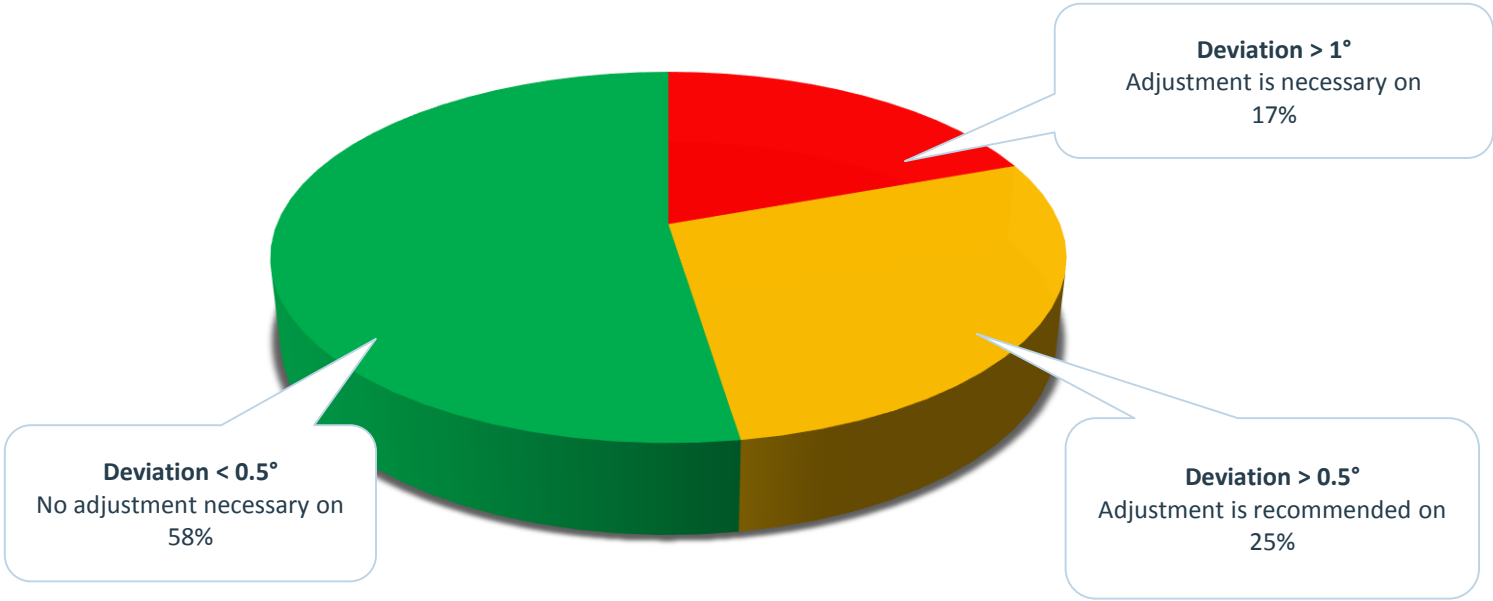
Before: Blade angle deviation > 1.0°



Afterwards: Blade angle deviation < 0.5°

2.5 Blade Angle Measurement – Necessity

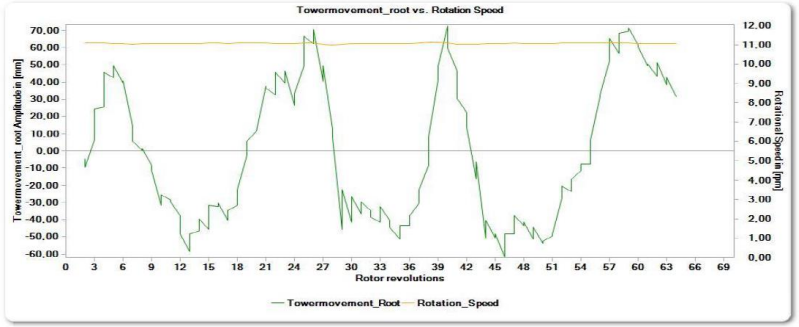
Figures shown below are based on the inspection and analysis of 780 WTGs:



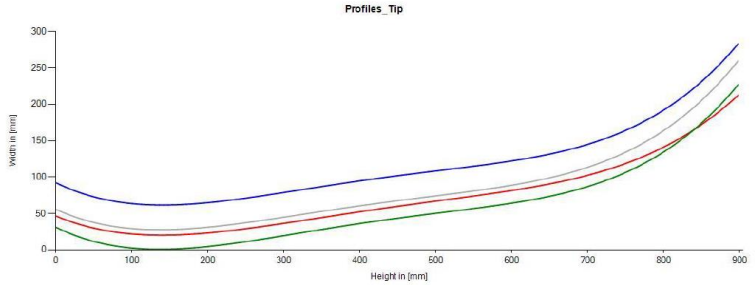
2.6 Blade Angle Measurement – Protocol

Ergebnisse				
Initial	**Rotorblatt 1 (A)**	**Rotorblatt 2 (C)**	**Rotorblatt 3 (B)**	**Differenz**
Root[°]	0	0,02	-0,02	0,04
Tip[°]	0,1	0,07	-0,16	0,26
Twist[°]	0,1	0,04	-0,14	
Teilung[°]	-0,02	0,02	0	

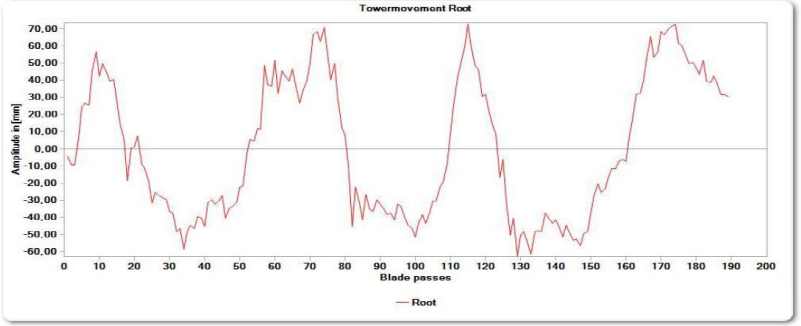
Towermovement_Root vs. Rotation Speed



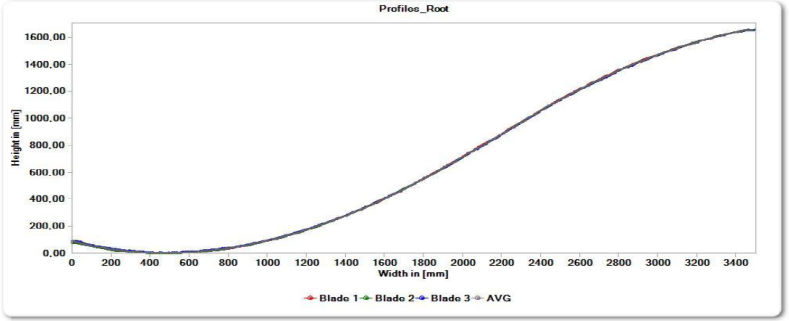
Profiles_Tip



Towermovement Root



Profiles_Root

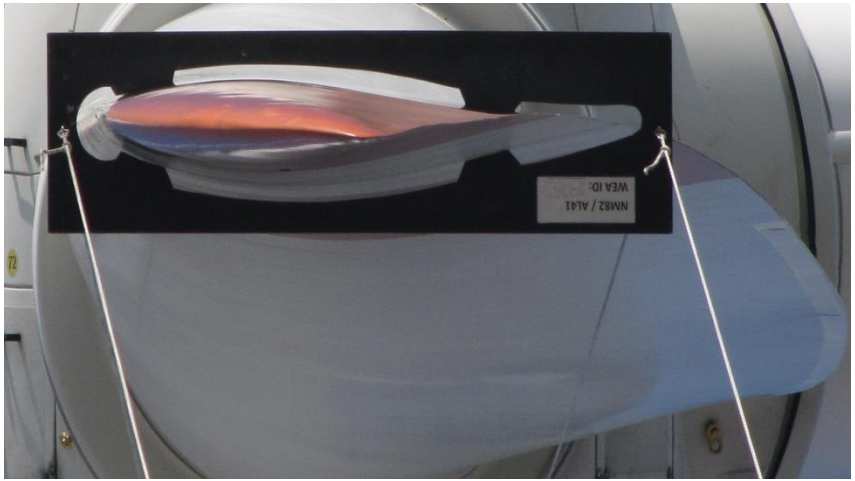


3.1 Blade Template – Function and Procedure

- To get a precise analysis of the blade pictures the relevant blades are positioned at the mechanical end stop.
- Actual deviation to 0° of each blade will be determined by the blade template.
- Independent from the basic setting of the blades an accurate calibration of the hub computer will be assured

Relative blade angle deviation

Deviation of blade angle to 0° position

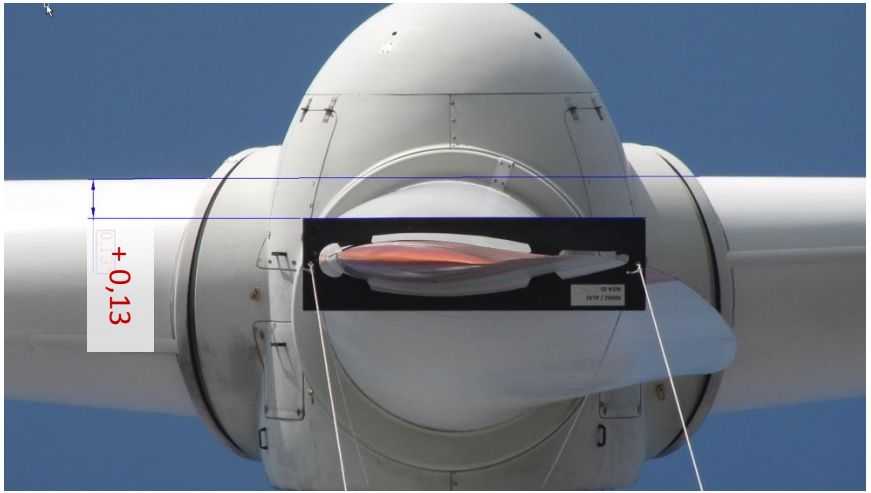


Blade Template

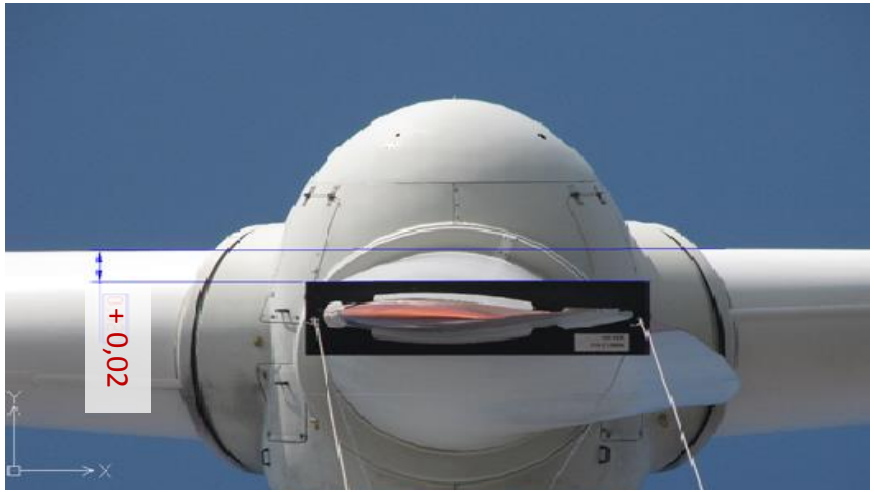
3.2 Blade Template – Advantages

Using a blade template leads to the following advantages:

- Expected increased yield
- Lowered aerodynamic imbalances leading to less blade and tower oscillations
- Decreased load effects to turbine components
- Correct speed performance characteristics



Before: deviation +0.13°



Afterwards: deviation +0.02°

4. Blade Angle Measurement vs. Blade Template

	Blade Angle Measurement	Blade Template
Measurement concept	Relative	Absolute
Performance improvement Higher yield	Potential	Target
Expenditure of time		
Measurement only	1h (Turbine in run)	4h (Turbine stopped)
Adjustment on pitch/active-stall WTG	2h	2h
Adjustment on stall WTG	8h	8h
Required weather conditions		
Wind speed	4-10 m/s	0-8 m/s
Rainfall	No	No
Fog	No	No
Standardized weather conditions	Available	Available
Measurement possible at WTG	All stall turbines	NTK 500/41, 600/43
	All NEG Micon active-stall WTG	NM 44/48/52/64/64c/72/72c/82
	All Vestas pitch WTG	V66/V80/V82/V90
	All Siemens (non DD) WTG	Blade typ: LM 26.1 / LM 29 / LM 36.8

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