Relative Blade Pitch Angle Misalignment Verification

Case study: Dynamic Relative Blade Pitch Misalignment Measurements with Visual Inspection

Campaign details

Objective:	Verify that the detected relative blade pitch angle misalignment measured in a previous campaign has been successfully corrected by the service company. The type certificate indicates that the turbine should operate with a relative blade pitch misalignment ranging ± 0.3°.
Wind turbine:	SENVION MM92, 2.05MW, Rotor 92m
Country:	Canada
Measurement period:	August 2022
Campaign outcome:	Verification of successful correction from a detected relative blade pitch angle misalignment of -0.85° to an accepted by type certification misalignment of -0.14°

General overview

Key facts regarding relative blade pitch angle misalignment:
Leads to a significant increase in loads and power production loss. It is a general assumption in the industry that, even a 1° relative pitch angle difference between the blades could lead to up to 2% of power production loss. Causes aerodynamic rotor imbalance, which leads to increased loads on different components of the wind turbine, reduces lifetime and leads to consequential damages on the wind turbine structure and main components.

Key benefits from correcting relative dynamic blade pitch angle misalignment:

- Increase energy production
- Avoid premature wear due to excessive stress and loads
- Prevent critical component failures and extend turbine lifetime

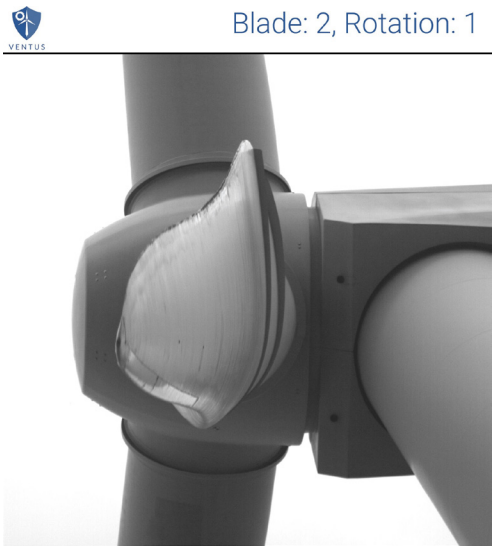
Measurement principle and set-up

In order to detect relative blade pitch angle misalignment between the wind turbine blades, visual inspections of the wind turbine are performed while in operation (Dynamic) for both the detection and the verification measurements. The captured images are then filtered and analysed, using different methods. The camera set-up is placed on the ground, targeting on the wind turbine blades. In addition, the system is located at 4 o'clock rotor position, to avoid the influence of the blade-tower interaction.

Results

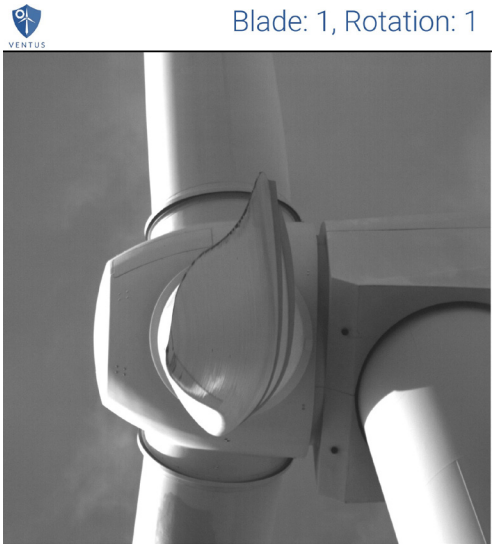
Relative blade pitch angles misalignment detected

Blade 1 – Blade 3	-0.85°
Blade 1 - Blade 2	-0.12°
Blade 3 - Blade 2	0.73°



Relative blade pitch angles misalignment verified after correction

Blade 1 – Blade 3	0.03°
Blade 1 - Blade 2	-0.11°
Blade 3 - Blade 2	-0.14°



Conclusion and recommendations

From the above presented results, it can be noted that there has been a successful correction from a detected maximum relative blade pitch angle misalignment of -0.85° to an accepted by type certification maximum relative blade pitch angle misalignment of -0.14°. For the correction of the detected misalignment, Ventus visual inspection results were used from the OEM.

Another important observation derived from the detection and verification of the relative blade pitch angle misalignment is the flapwise blade bending differences are not present after the correction made by the service team.

This is visual confirmation of the significant importance of relative blade pitch angle misalignment detection & successful correction for achieving the desired aerodynamic rotor balance.