

Wölfel ACCELERATING THE INTEGRATION OF JOINT ICE AND DAMAGE DETECTION







- 1. Relevance of Structural Monitoring
- 2. Blade-based Ice & Damage Detection
- 3. Adaptive Model Referencing
- 4. Take-home Messages



Insight in IEC-TS-61400-28 "Through Life Management and Life Extension of Wind Farms"

 \rightarrow Guideline applicable in every phase of the lifecycle of a wind turbine:



Wölfel | BY APPLYING IEC 61400-28 WIND TURBINES CAN BE OPERATED OPTIMALLY



The current and future level of knowledge of a WTG determines its total lifetime.

Wölfel MONITORING OF PRIMARY LOAD PATH WILL BE CRUCIAL



IEC61400-28: Basis is the evaluation and assurance of the structural integrity of all components in the "**primary load path**".

A general perspective on SHM:

- Life-time extension 20+ (beyond design life)
- Reliable ice detection to protect equipment and environment
- Early detection of fatal structural damage
- Safe continued operation (after damages occurred)
- Rotor imbalance detection and correction

Wölfel | STRUCTURAL HEALTH MONITORING SYSTEMS (SHMS) WILL REDUCE LEVELIZED COST OF ENERGY (LCOE)



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Illustrative field experiences with ice accretion and structural damages → Monitoring of rotor blade vibrations gives us the full picture!



Source: Wind Energy Journal 2019, Wei et al., A review on ice detection technology [...] for wind turbines, DOI: 10.1002/we.2427



Source: https://www.windpowerengineering.com/wpcontent/uploads/2011/07/Ice-on-Turbine-Blades.jpg



Source: https://nawindpower.com/wp-content/ uploads/2016/01/12970_the_elgin_review_1.jpg

VIBRATION-BASED SYSTEMS FOR ICE & DAMAGE



- Holistic state monitoring
- robust & mature technology
- Reliability is reached by ...

- Safe & sound ice detection involves ...
- reliable sensors

- advanced algorithms
- dynamics expertise





Vibration-based detection is not limited to ice...

... compensation of imbalances & early damage detection.





Wölfel AGENDA

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Ice accretion & structural damages affect the blade properties

- Continuous learning from past events
- Continuous learning of new behaviour
- Independency from the wind turbine type
- Generate value from fleet monitoring

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Winterwind Skelleftea / Joint Ice and Damage Detection / PUBLIC

→ Adaptive & automated model referencing

Clustering the rotor blade model using artificial intelligence (AI)



HIGH PREDICTION ACCURACY THROUGH AI MODEL Wölfel

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Wölfel MINIMUM RISK AND INCREASED YIELD

Keys to safe and economical ice detection

- Structural Health Monitoring Systems will reduce LCOE
- Customized model reference for each wind turbine for increased accuracy
- Sophisticated algorithms to generate more value beyond ice
- → Tackle the ice throw risks and maximize the energy yield in safe operation by automatic restart



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