Technology for a real-time simulation-based system monitoring of wind turbines

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FEDEM = Finite Element Dynamics in Elastic Mechanisms


FEDEM WindPower

Engineering and analysis services

Fedem (Technology) AS

SAP SE acquires Fedem Technology AS

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Our vision enables Digital Inspections of Wind Turbines based on real-time Digital Twins

- Real-time Monitoring Stress & Fatigue
- Transparency about remaining useful-life
- Detection of degradation/changed physical behavior
Goal: optimizing power production as well as minimizing structural DAMAGE under operation

Design
- Documented state of the system at any time combined with adaptive control systems may reduce the need for conservative safety factors.

Operation
- Continuously adapting the control strategy to maximize energy production while optimizing structural loading and condition.
  - Recording accurate and reliable history of structural response enables cost-efficient prolongation of life beyond design lifetime.

Maintenance
- Preventive actions may be selected based on detailed insight into the development of structural integrity over time.
  - Adaptive maintenance strategy can be based on actual accumulated damage and expected remaining life for different parts of the structure.

Reduced CAPEX
Increased INCOME
Increased UPTIME
Fedem wind demonstrator 2016

- Havøygavlen, Finnmark, owned and operated by ARCTIC WIND

- NORDEX N80 equipped with motion sensors since March 2016

- Data feed to server and digital twin representing state of system in real-time

- Online application for data access

- Partially funded by Innovation Norway
Strain gauge verification

- Comparison of physical and virtual strain gauges at tower bottom
- Demonstrator limited to first order movements of the tower structure based on IMU at tower top
Strain gauge verification

- Production to stop scenario
- Tower structure oscillates in its first eigenmode for several minutes
- Data compliance in both amplitude and period achieved by virtual strain gauges
Fatigue analysis

- Simulation study on the contribution of structural modes to fatigue
- Number of recorded structural modes by sensors determines the accuracy that can be achieved in the fatigue analysis
Simulation studies and further work

- Bottom-fixed and floating offshore wind turbine
- Extending the solution to cover complete wind turbine system
- Transferring technology into other industries
Digital twin based **structural integrity monitoring**