TESTING OF LARGE BLADES – CHALLENGES AND TRENDS

2018 Sandia Blade Workshop, August 28-29, Lubbock, Texas

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A little bit about LM Wind Power*

- Since 1978, LM Wind Power has produced more than 205,000 blades corresponding to a capacity of approximately 93W.
- Contributing to saving more than 189 million tons of CO₂ per year.
- ~10,000** employees, 15 manufacturing facilities in 8 countries on 4 continents.
- Rotor solutions are supplied to 10 global and national wind turbine manufacturers, for Onshore and Offshore wind.

LM Wind Power: a leading blade supplier to the wind industry.


*Acquisition completed on April 20, 2017.
**Employee number does not include contractors.
Big, Bigger, Biggest

Calculations are based on European data.
GE Renewable Energy is developing Haliade-X 12 MW, the biggest offshore wind turbine in the world, with 220-meter rotor, 107-meter blade, leading capacity factor (63%), and digital capabilities, that will help our customers find success in an increasingly competitive environment.

One Haliade-X 12 MW can generate 67 GWh annually, which is 45% more annual energy production (AEP) than most powerful machines on the market today, and twice as much as the Haliade 150-6MW.

The Haliade-X 12 MW turbine will generate enough clean power for up to 16,000 European households per turbine, and up to 1 million European households in a 750 MW configuration windfarm.

12 MW capacity
220-meter rotor
107-meter blades
260 meters high
67 GWh gross AEP
63% capacity factor
38,000 m² swept area
Wind Class IEC: IB

Flat Iron Building | Statue of Liberty | Washington Monument | Chrysler Building | Empire State Building | Haliade-X 12 MW | Eiffel Tower | London Eye | Big Ben | Tower of Pisa | Arc de Triomphe

285 ft 87 m | 305 ft 93 m | 555 ft 169 m | 1046 ft 319 m | 1454 ft 443 m | 853 ft 260 m | 443 ft 135 m | 315 ft 96 m | 186 ft 57 m | 162 ft 49.5 m
Blade design is not just aerodynamics, materials and structure... it's Cost of Energy and Reliability
Cost-effectiveness and reliability through understanding of interaction between materials, process and design

Test pyramid picture from IEA task 35
Final validation through full scale static and fatigue testing

- Measurement of blade eigen-frequencies and mode shape
- Static test in min. four direction with extreme loads distribution applied to the blade
- Fatigue testing in flap- and edgewise direction simulating operational lifetime
- Post-fatigue static test to demonstrated blade strength after end of lifetime
- Extensive non destructive testing programme using infrared and ultrasound scanning
- Also full scale crash tests are performed in order to determine durability and scale effects
Is there a benefit of advanced full scale blade testing?

From 17m onwards the most fatigue critical element is the same element which is used to define the single axis (flapwise) fatigue test.

LM 88.4 P case study*

In terms of Palmgren-Miner damage sum, this blade will not benefit from bi-axial testing except near the root.

*Work performed by ORE Catapult, UK in the XL-Blade project (DemoWind)
Trends - future test paradigm

- Reduce cost and time for testing
- Replace full scale testing by more sub-component testing
- Learn about fatigue behavior on all levels – the devil is in the details
- Perform virtual full scale testing through a digital twin representation of physical blades including imperfections

RELIABLE is a project funded by EUDP (A program supporting research, development and demonstration (FUD) of energy technology and financed by the Danish Ministry of Energy, Utilities and Climate)
Thank you for your time

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