

Integrated leading edge protection (LEP) system

Publieke samenvatting / Public summary

Background

Offshore wind energy has the huge potential for producing more energy collected from very large wind turbines. Currently, the offshore wind energy faces a pressing challenge: rain erosion of the leading edge due to harsh environment at offshore. This causes a significant loss of annual energy production (AEP). The blades are considered as the engine of turbines and at present, there is no predictable, reliable and durable leading edge protection (LEP) system integrated to an offshore wind turbine blade with ultra-high tip speeds (>100 m/s). The current LEP systems suffer from a high repair frequency which hampers minimizing the offshore levelized costs of energy (LCoE). How to develop a durable LEP bonded to a composite blade is still not known because the bonding quality and performance of the interface between the LEP and main blade shell after the manufacturing and its influence on the rain erosion mechanisms are currently not well understood and described. In addition, how to modify the properties of LEP material with respect to blade location and weather conditions is unclear.

Objective

The main aim of this project is to develop a durable and optimized hybrid LEP concept integrated to the blade structure by a proper understanding of bonding process and resulting rain erosion performance at offshore conditions. The project will enable robust LEP of offshore wind turbine blade and the new integrated LEP concept will contribute to reducing the LCoE by 6% via increasing AEP and

Projectinformatie / Project information

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Algemene informatie / General information

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Publicaties en materialen / Publications and attachments

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reducing CAPEX&OPEX costs due to LEP failure and repair.

Short description of activities

A reliable aerodynamic design of the blade LEP which is integrated to the main blade part by co-molding during the vacuum infusion process will be developed. The LEP materials optimum for a proper bonding with the composite blade will be identified by characterizing the bonding quality and resulting bonding strength. Corresponding processing guidelines for this integration will be determined for the first time. In order to evaluate the rain erosion performance of the integrated LEP, an instrumented rain erosion test (RET) setup will be developed which will provide various in-situ measurements, e.g. force and strain, which will be a more advanced and comprehensive than the current state-of-the-art RET setups. A fast and accurate numerical simulation tool will be developed to interpret the RET measurements and provide in-depth information on the erosion mechanisms. The predictions will be validated by the experiments. The developed new knowledge will be applied to a demonstrator at sub-component level which will be validated in a high-fidelity RET setup. The economic impact of the innovative LEP concept will be critically assessed considering CAPEX, OPEX, and AEP.

Results

- Validated LEP concept demonstrator at sub-component level illustrating the potential of the developed technology which can be used by 2030 after establishing commercial production line, further field testing and arranging certification
- Processing guidelines for a proper bonding of LEP material to the composite blade shell with the new knowledge on the physical and chemical bonding
- Comprehensive instrumented RET setup which will enable developing new knowledge on the erosion and damage evolution during liquid particle impact
- Validated numerical design tool enabling the design and optimization of the LEP concept. The developed model will enable prediction of the LEP lifetime in a more accurate and faster than currently

available.

- An analysis of the economic feasibility of the proposed integrated LEP concept

De data in deze applicatie is afkomstig van de Rijksdienst voor Ondernemend Nederland (RVO) en wordt in samenwerking met de Topsector Energie ontsloten.

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