IEA Wind TCP

Task 46 Erosion of Wind Turbine Blades

Work Package #5 Erosion Mechanics and material properties

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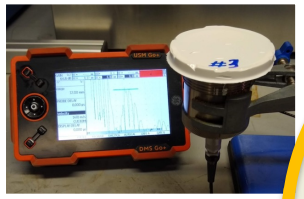
Motivation. Leading Edge Protection problem

- A typical wind **turbine may be expected to operate continuously for approximately 15 years** over its service life. During these years, the materials of the blade are exposed to a varied environmental conditions and fatigue load. The **erosion of wind turbine blade leading edges has seen a dramatic increase** in both the frequency of occurrence, and the rate at which leading edges are eroding. Erosion has been seen to be occurring **within 2 years in off-shore blades** and in 5 year warranty period in onshore applications.

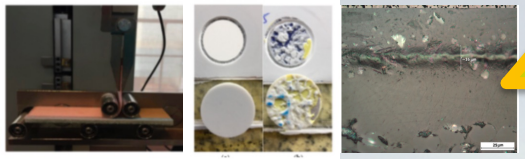
- Annual Energy Production **AEP losses** due to **roughness/damage progression** affecting the **costs associated with erosion in terms of loss of power performance and repair** and downtime costs have a large impact on the LCoE (Levelized Cost of Energy) for wind.
- Non predictible blade **repairs impact on Annual Energy Production**. Field repairs are complex and affecting overall response during lifetime (blade access, removal of damage, filler application, lamination, filler, LEP application, paint,…)
- **Anti-erosion material solutions need to be assessed**.

Erosion mechanics & Material properties. A scrutiny of material choice

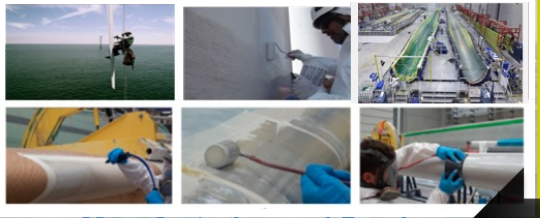
Material & process characterization



Multilayer fundamental properties

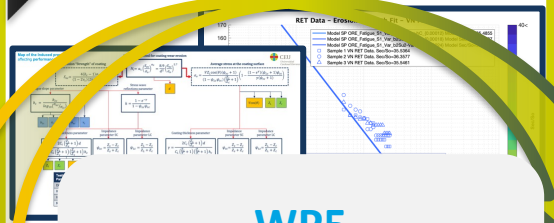


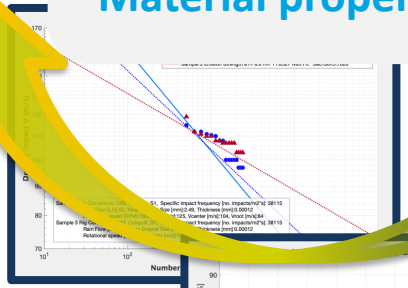
Interface characterization

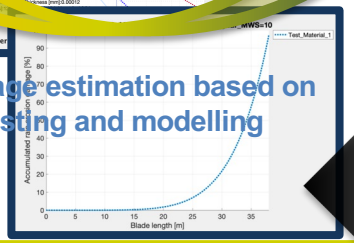


Manufacturing and Service application processes

Modelling & parametric analysis

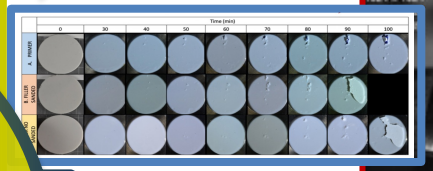




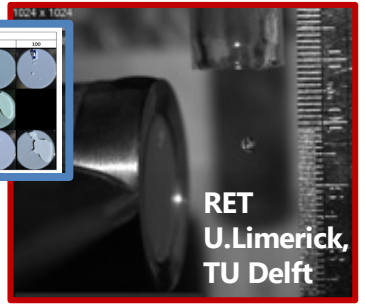


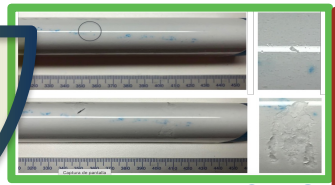
Field damage estimation based on RET testing and modelling

WP5
Erosion mechanics & Material properties



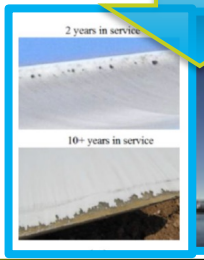
RET ASTM G73-10
Mass loss & Inc.Time





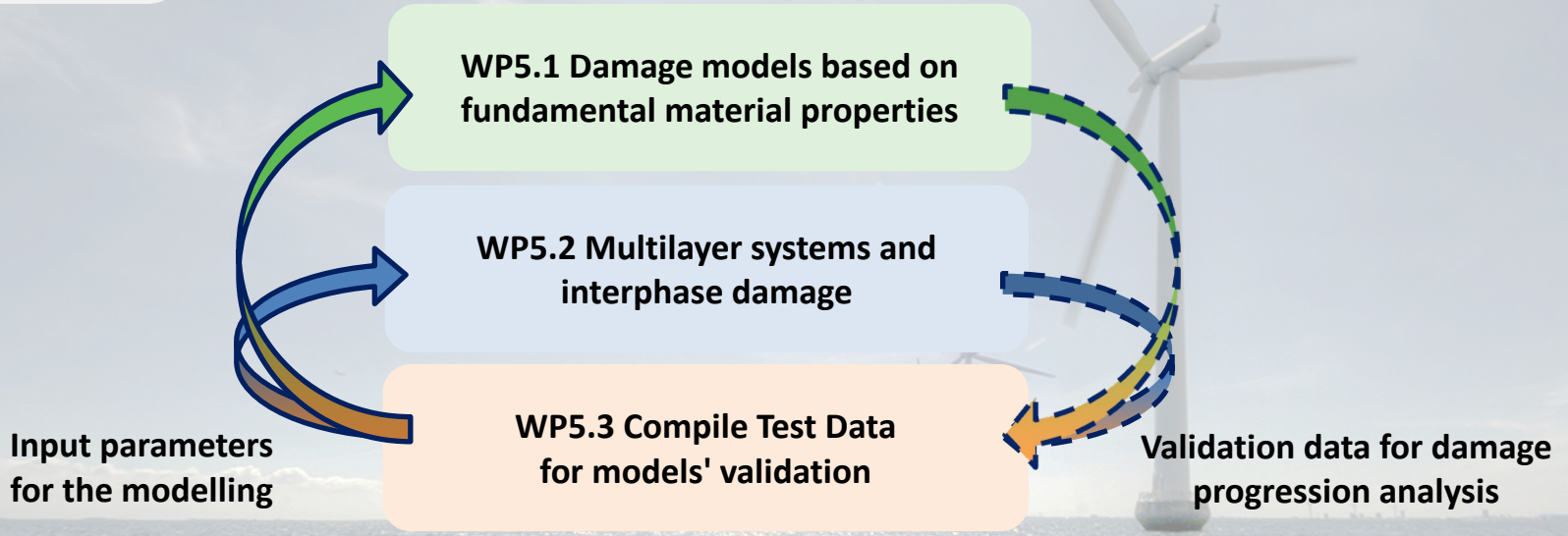
RET V-N. BICEPS
DNVGL-RP-0171

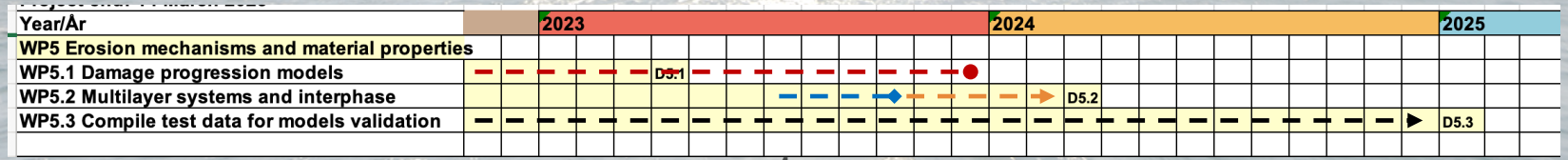
COBRA.
DNVGL-RP 0573



WP5 Erosion Mechanics & material properties

WP5 Aim & Scope: Appropriate **modelling techniques and material properties** characterization methods **will be defined and used** to understand erosion mechanics for LEP system technologies and **to quantify the influence on the performance**.





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RESULTS: **Specific Technical Activitity. WP5.1 Damage models based on fundamental material properties & WP5.3 Compile Test Data for models' validation**

- ✓ **FINISHED: UV Degradation combined weathering and RET; Different chemistry comparison**
- ✓ **FINISHED: Damage progression analysis based on 1) images V-N curves, 2) intermediate mass loss and**
  - **ON GOING: 3) damage progression based on intermediate geometry loss**

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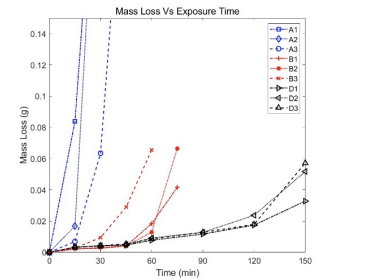
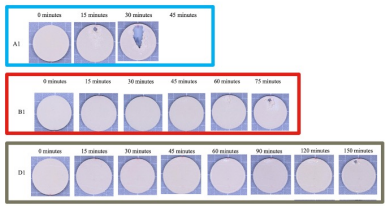
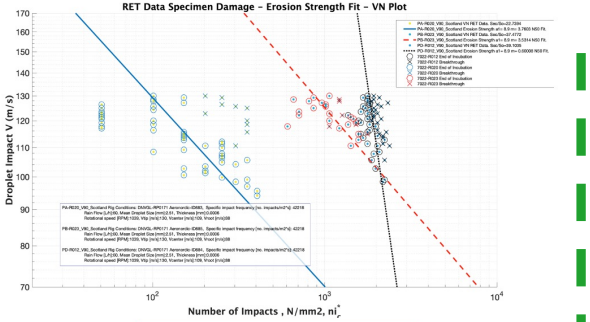
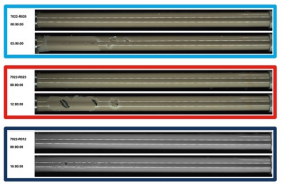
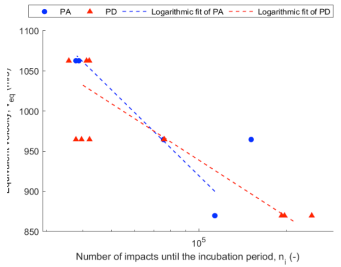


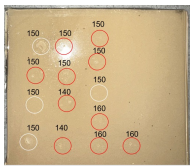








(b) $v_{eq} - n_i$ curve



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RESULTS: Specific Technical Activities WP5.2 Multilayer & WP5.3 Compile Test Data for models' validation

- ✓ FINISHED: RET , MicroCT and Peeling –tests for initial case developments.
- ○ ON GOING: To extend RET related with interfaced damage
- ○ ON GOING: Further RET and material analysis and appropriate analysis for **Manufacturing issues** due to **LEP configuration**, application procedure, LEP **blade integration** technology.

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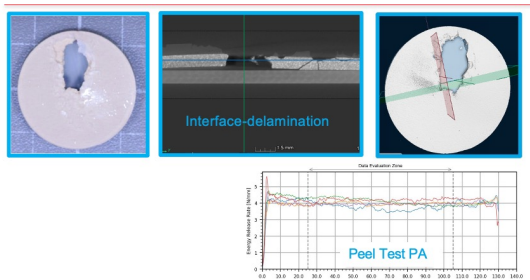

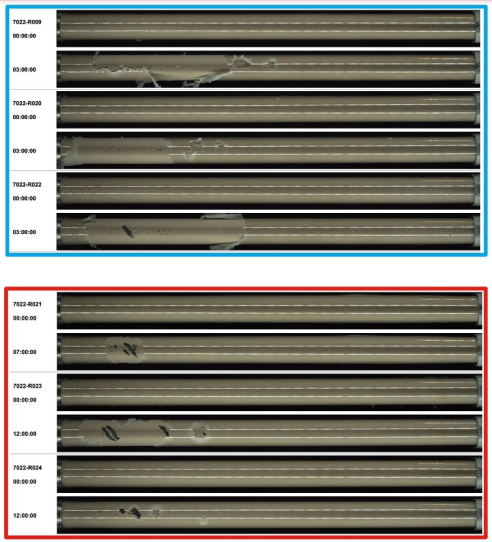

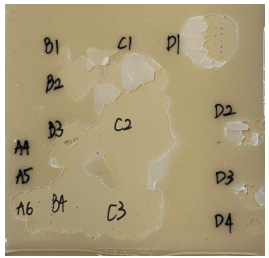

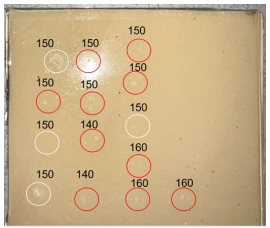

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Specific Technical Activities WP5.1 Damage models based on fundamental material properties & WP5.3 Compile Test Data for models' validation

- ✓ **FINISHED: Literature Review:** scientific paper as a review and extend to IEA Technical Report Identify lacks and drawbacks on state-of-the-art erosion damage modelling techniques.
- ✓ **FINISHED: RET performance modelling analysis. Springer Modelling Validation** from RET DNV-GL0171 V-N data and from Fundamental material properties. **In relation with 5.3**
- ✓ **FINISHED:** Development of a **modelling web-based platform for remote lifetime performance analysis based on DNV-GL RP 0573.**
  - **ON GOING:** Under validation within WP5 members with shared data.

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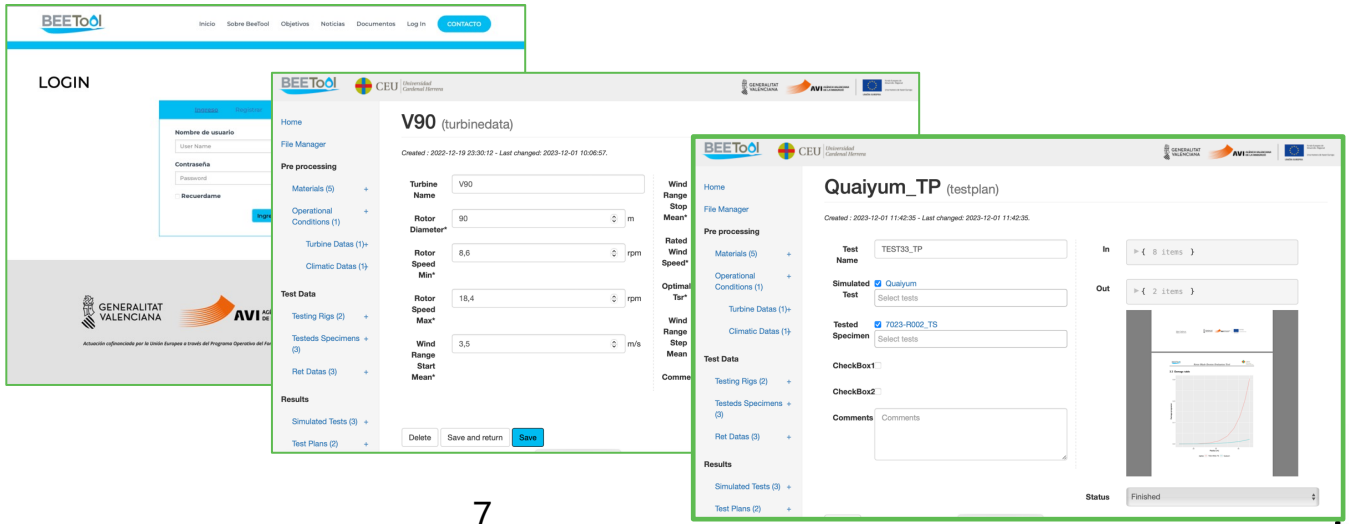

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IEA TEM on LEE