

Task 46 Erosion of Wind Turbine Blades Work Package #3

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Technology Collaboration Programme

by **iea**

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WP 3 : Wind turbine operation with erosion

This work package has three key overarching objectives:

1. Promote collaborative research to mitigate erosion by means of wind turbine control, assessing the viability of erosion safe mode.
2. Improve the understanding of droplet impingement in the context of erosion.
3. Improve the understanding of wind turbine performance in the context of erosion, specially the effect of LEE surface roughness on aerodynamics.

WP code	Activity
WP3.1	Model to predict annual energy production loss on blade erosion class
WP3.2	Report on standardization of damage reports based on erosion observations
WP3.3	Droplet impingement model for use in fatigue analysis
WP3.4	Potential for erosion safe-mode operation
WP3.5	Accuracy of LEE performance loss model based on field observations (validation)

WP 3: Activity Description

WP3.1: Model to predict annual energy production loss on blade erosion class

- Develop a common model of aerodynamic performance loss due to leading edge roughness and erosion standardized classes.

WP3.2: Report on standardization of damage reports based on erosion observations

- Standardization of damage reports for validation of any erosion potential assessment and to allow effective integration of data from operators with laboratory derived estimates.

WP3.3: Droplet impingement model for use in fatigue analysis

- Develop a standard model for droplet impingement, validated with wind tunnel experimental data.

WP3.4: Potential for erosion safe-mode operation

- Report describing potential for leading edge erosion safe mode operation. This report will be used for seeking participation from industry and research funders towards a coordinated project designed to assess viability and cost-benefit of leading edge erosion safe mode operation.

WP3.5: Accuracy of LEE performance loss model based on field observations (validation)

- Carry out iterative aerodynamic loss benchmarks with model development and new wind tunnel testing for calibration and validation. Validation of complete performance loss model using probabilistic analysis of field observations.



Work Package 3: Work Plan Year 1

WP3.1: Model to predict annual energy production loss on blade erosion class

Develop a common model of aerodynamic performance loss due to leading edge roughness and erosion standardized classes. Quantification of performance degradation (loss of AEP) as a function of roughness and 'erosion climate'.

Timeline: *All work to be completed during year 1.*

- Mn#1: Finalize workplan (2021/03/01).
- Mn#2-3: Participants review past models and define requirements of new model, share references via [Sharepoint site](#).
- Mn#3: Define test data set(s) and common turbine definitions for new erosion model.
- Mn#3-4: Participants define model inputs and outputs.
- Mn#5: Participants build model(s).
- Mn#7: Participants compare model results if multiple models or compare to past models.
- **Deliverable:** Model to predict annual energy production loss based on blade erosion class (model, 2022/01/15).

Next Steps:

- Define benchmarks for round-robin comparisons of different types of models.
- Build model for proposed target turbine for erosion prediction (~2MW onshore).
- Participants compare model results if multiple models or compare to past models for AEP loss due to erosion.

Work Package 3: Work Plan Year 1

WP3.2: Report on standardization of damage reports based on erosion observations

Standardization of damage reports for validation of any erosion potential assessment and to allow effective integration of data from operators with laboratory derived estimates.

Timeline: *All work to be completed during year 1.*

- Mn#1: Finalize workplan (2021/03/01).
- Mn#2-4: Participants collect example erosion reports and data (2021/05/01).
- Mn#5: Participants draft erosion report categories (2021/07/01).
- Mn#6-8: Participants draft erosion report standard (2021/10/01).
- Mn#9: ZOOM Meeting to get feedback on standardized erosion reports (2021/11/15).
- Mn#10, **Deliverable**: Draft report on erosion damage report standardization.

Next Steps:

- Draft erosion report categories.
- Draft erosion standardisation recommendations report.

Retrospective (Months #1 - #6)

Collaboration through monthly meetings focused on specific topics:

- Starting more focused groups to work toward collaboration on deliverables.
- [Sharepoint](#) database for sharing articles and information.

Past meeting topics:

- Sharing of background information on existing erosion models and papers.
- Fundamental aerodynamic knowledge and testing for LEE, needs for physics-based modeling and design improvements.
- Needs for AEP performance model.
- Available sites and partners for field validation.
- Defined needs for turbine information for validation of LEE performance models.
- Coordination with IEA Task 43 Digitalization on topic of Risk-Based Maintenance for Blades.
- Coordination on erosion class standardization.
 - Review of existing erosion classification systems and methods.
 - Discussion of what existing partners do now.

Work ahead (mid term, months #7 - #12)

- Coordination on erosion class standardization.
 - Draft erosion report categories.
 - Draft erosion standardization recommendations report.
- Model to predict annual energy production loss based on blade erosion class.
 - Build model for proposed target turbine for erosion prediction (~2MW onshore).
 - Participants compare model results if multiple models or compare to past models for AEP loss due to erosion.
- Develop plan and start round-robin benchmark LEE performance loss model and aerodynamic model comparisons.
 - Define process for sharing data for benchmarking for each type of comparison.
- Collaborative meetings on fundamental aerodynamic knowledge and testing, needs for physics-based modeling and design improvements.
- Continue discussing available sites and needs for field validation.

Collaboration & interactions

- How does the weather affect erosion performance degradation potential for a site? Address through collaboration with WP2.
- Aerodynamic impingement model will help improve fatigue analysis, collaboration with WP4 and WP5.
- IEA Task 43 Digitization: Do I repair now or later? Risk based maintenance of blades, first step is to create a turbine lifetime value model for LEE.

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