

Task 46 Erosion of Wind Turbine Blades Phase 2

WP1: Charlotte Hasager, OA and Christian Bak, Co-OA

WP2: Sara Pryor and Rebecca Barthelmie

WP3: David C. Maniaci, Beatriz Mendez, Sergio Campobasso

WP4: Nicolai Frost-Jensen Johansen, Motofumi Tanaka

- 7th International Symposium on Leading Edge Erosion and Protection of Wind Turbine Blades, DTU, Risø Campus, Roskilde, Denmark, 3-5 February 2026

Participants

The work plan is delivered by 44 organizations from 12 countries:

- 1 certification body
- 5 wind farm owners
- 2 consultancy
- 5 wind turbine manufacturers
- 8 coating manufacturers
- 22 academic/R&D organizations

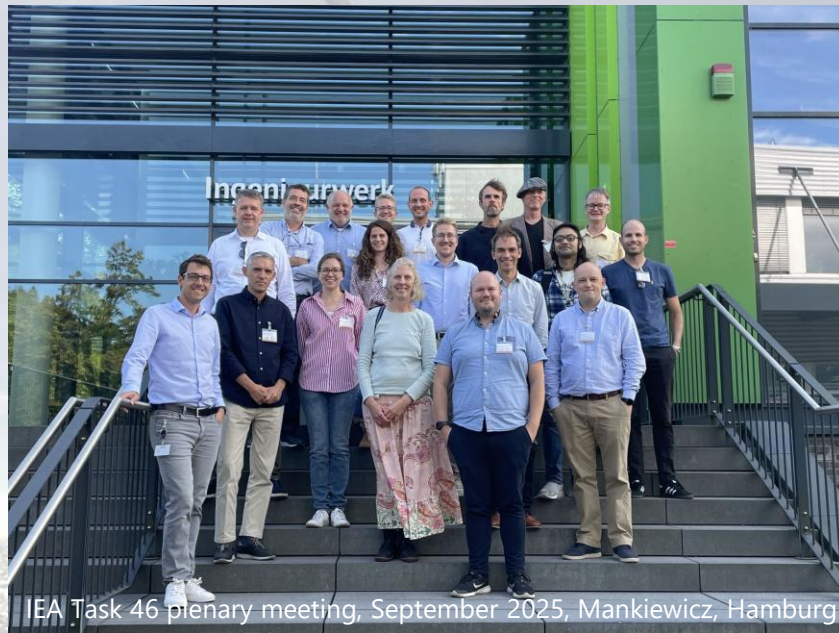
| Country | Contracting Party | Participant Organization |
|-------------|---|---|
| Belgium | Belgian Ministry of Economy | Engie |
| Canada | Natural Resources Canada | WEICan |
| Denmark | Danish Energy Agency | DTU , Hempel, Ørsted, PowerCurve, Siemens Gamesa Renewable Energy |
| Finland | Business Finland | VTT |
| Germany | Federal Ministry for Economic Affairs and Energy | Fraunhofer IWES , Emil Frei (Freilacke), Nordex Energy SE, Mankiewicz, RWE, Henkel |
| Ireland | Sustainable Energy Authority of Ireland | South East Technological University, University of Galway, University of Limerick |
| Japan | New Energy and Industrial Technology Development Organization | AIST, Osaka University, Tokyo Gas Co. Asahi Rubber Inc., CRIEPI, Industrial Technology Institute Fukushima prefectural government, Niigata University |
| Netherlands | Netherlands Enterprise Agency | TU Delft, TNO, Suzlon |
| Norway | Norwegian Water Resources and Energy Directorate | University of Bergen, Statkraft |
| Spain | Centre for Energy, Environmental and Technological Research | Aerox, CENER, DNV Iberica, Nordex Energy Spain, Universidad Cardenal Herrera - CEU |
| UK | Offshore Renewable Energy Catapult | ORE Catapult, University of Bristol, Lancaster University, Imperial College, Vestas UK, Ilosta, Armour Edge |
| US | US Department of Energy | Cornell University, Sandia National Laboratories, 3M |



Recent events



IEA Task 46 workshop, February 2025, DTU, Roskilde



IEA Task 46 plenary meeting, September 2025, Mankiewicz, Hamburg

Work package structure

| Work Package | Lead organization | Deliverables |
|--|--|--------------|
| WP 1: Management | DTU (DK) Professor Charlotte Bay Hasager (Operating Agent) Professor Christian Bak (Co-operating Agent) | D1.1 to D1.6 |
| WP 2: Climatic conditions | Cornell University (US) Professor Sara Pryor (WP-lead) Professor Rebecca Barthelmie (Co-lead) | D2.1 to D2.4 |
| WP 3: Wind turbine operation with erosion | Sandia National Laboratories (US) David Maniaci, PhD, Rotor Blade and Wind Plant Aerodynamics Lead (WP-lead) CENER (ES) Beatriz Mendez, PhD, Head of Aerodynamics and Hydrodynamics (Co-lead) University of Lancaster (UK) Sergio Campobasso, PhD, Senior Lecturer (Co-lead) | D3.1 to D3.8 |
| WP 4: Laboratory testing of erosion and material blade integration | DTU (DK) Nicolai Frost-Jensen Johansen, PhD, Development Engineer (WP-lead) AIST (JP) Motofumi Tanaka, PhD, Senior Researcher (Co-lead) | D4.1 to D4.8 |

Timeline (year #1)

| Time #1 | Event | Status |
|---------------|---|-----------|
| 15/03/2025 | Start of Phase 2 | |
| March/ 2025 | Quarterly coordination telco (WPLs & OAs) | online |
| 26/03/2025 | Kick off meeting | online |
| March/2025 | Invoicing year # 1 | |
| 18-22/05/2025 | Task 46 presents at ExCo #97 (Norway) | In person |
| June/2025 | Quarterly coordination telco (WPLs & OAs) | online |
| Sep/2025 | 2nd bi-annual plenary, Hamburg, Mankiewicz as Host | In person |
| Sep/2025 | Quarterly coordination telco (WPLs & OAs) | online |
| Autumn 2025 | ExCo #98 (online) | online |
| Nov/2025 | Quarterly coordination telco (WPLs & OAs) | online |
| Autumn 2025 | Dissemination public webinar #1 (pending) | online |
| Jan/2025 | Quarterly coordination telco (WPLs & OAs) | online |
| 3-5 Feb/2026 | 7 th International Symposium on Erosion (Roskilde) | In person |
| 6 Feb/2026 | Task 46 Technical workshop #1 (Roskilde) | In person |
| March/2026 | Quarterly coordination telco (WPLs & OAs) | online |
| March/2026 | 3rd bi-annual plenary meeting (online) | online |

Timeline (year #2)

| Time | Event | Status |
|---------------|---|-----------|
| March/2026 | Quarterly coordination telco (WPLs & OAs) | online |
| March/ 2026 | 3rd bi-annual meeting (online) | online |
| 17/03/2026 | Local meeting in Tokyo organized by Motofumi Tanaka | In person |
| March/2026 | Invoicing year # 2 | |
| 26-29/05/2026 | Task 46 presents at ExCo #100 (Nantes, France) | In person |
| June/2026 | Quarterly coordination telco (WPLs & OAs) | online |
| Sep/2026 | 4 th bi-annual plenary, to be decided | In person |
| Sep/2026 | Quarterly coordination telco (WPLs & OAs) | online |
| Autumn 2026 | ExCo #101 (online) | online |
| Nov/2026 | Quarterly coordination telco (WPLs & OAs) | online |
| Autumn 2026 | Dissemination public webinar #2 | online |
| Jan/2027 | Quarterly coordination telco (WPLs & OAs) | online |
| 2-4 Feb/2027 | 7 th International Symposium on Erosion (Roskilde) | In person |
| 5 Feb/2027 | Task 46 Technical workshop #2 (Roskilde) | In person |
| March/2027 | Quarterly coordination telco (WPLs & OAs) | online |
| March/2027 | 5 th bi-annual plenary meeting (online) | online |

IEA Wind Task46における エロージョン研究

2026
3/17火
13:00~15:00
参加無料・事前申込制

現地
定員80名

日本橋ライフサイエンスビルディング
9階会議室 (LSB-911、912、913)
東京都中央区日本橋本町2丁目3-11

オンライン
定員500名

Microsoft Teams
配信URLは、参加登録者にメールでお送りします

【主催】 国立研究開発法人 産業技術総合研究所 エネルギー・環境領域 再生可能エネルギー研究センター 風力エネルギー研究チーム

IEA（国際エネルギー機関）が推進する、風力発電技術に関する国際共同研究活動のプログラムIEA Wind TCP Task46では、洋上風力で特に懸念となっている風車ブレードエロージョンの対策技術確立に取り組んでいます。日本の研究機関や大学等もPhase1（2021~2025年）から参加し、Phase2（2025~）では、産総研がWork Package 4「エロージョンの地上試験」でリーダーを務めるなど、風力技術の標準化を目指した活動を進めています。

今回のFREA O&Mワークショップでは、Task46のOperating Agentを務めるデンマーク工科大学（DTU）シャーロット・ベイ・ハサガー教授の未日にあわせて、IEA国内登録メンバーが一堂に会し、Phase2におけるTask46の研究概要と、国内のエロージョン研究を紹介する講演会を開催します。

【第一部】 基調講演 英日通訳あり

Erosion research in IEA Wind Task46

シャーロット・ベイ・ハサガー
Charlotte Bay Hasager

デンマーク工科大学 風力・エネルギーシステム部門 教授



【第二部】 国内エロージョン研究の紹介

国立研究開発法人 産業技術総合研究所 再生可能エネルギー研究センター
風力エネルギーチーム 主任研究員 田中 元吏

国立研究開発法人 産業技術総合研究所 再生可能エネルギー研究センター
風力エネルギーチーム 研究員 栗飯原 あや

東京ガス株式会社 グリーンチンスタフォーメーションカンパニー
基礎技術部 次世代技術研究所 風力・流体解析チーム 西田 響子

福島県ハイテクプラザ 材料技術部 分析・化学科 高木 智博

新潟大学 工学部 工学科 准教授 山縣 貴幸

一般財団法人 電力中央研究所 エネルギーチンスタフォーメーション研究本部 酒井 英司

産総研ウェブサイトにて参加申込受付（2026年3月3日（火）17:00締切）



【お問い合わせ】 国立研究開発法人 産業技術総合研究所
エネルギー・環境領域 再生可能エネルギー研究センター
第10回風力O&Mワークショップ事務局
M-FREA-ws10-jimukyoku-ml@aist.go.jp
https://unit.aist.go.jp/renrc/



Deliverables in current progress

- **2.1** PIRT analysis to identify meteorological parameters (aug-25)
- **3.1** Updated erosion classification system with report (dec-25)
- **3.6** Lifetime erosion modeling and O&M decision making (feb-26)
- **4.1** Large-scale comparison and round robin of RET testers (feb-26)
- **4.6** Durability testing and material property (feb-26)

WP 2 Climatic conditions driving blade erosion



Task 46 - Erosion of wind turbine blades: WP#2 Climatic conditions



Sara C. Pryor

sp2279@cornell.edu

Actions & Goals:

1. Perform a Phenomena Identification and Ranking Table (PIRT) analysis to identify parameters of critical importance to LEE and to quantitatively assess current measurement and modelling capabilities.

- *Verify we agree on priorities & research needs!* Mn: 1-6

2.2 Recommended Practice for measurement of LEE drivers

- *Conclude and make (& release) a robust workflow!* Mn: 7-18

2.3 Assessment of modelling capabilities to represent key atmospheric drivers of LEE (V&V exercise)

- *Prediction requires simulation! Quantify current level of skill for e.g. hail prediction with regional models (e.g. WRF for varying model configurations, JPD: RR & U)* Mn: 19-30

2.4 Roadmap for LEE atlas.

- *Develop advanced framework for translating measurements & modelling to robust geospatial descriptions of LEE potential.* Mn: 31-

46

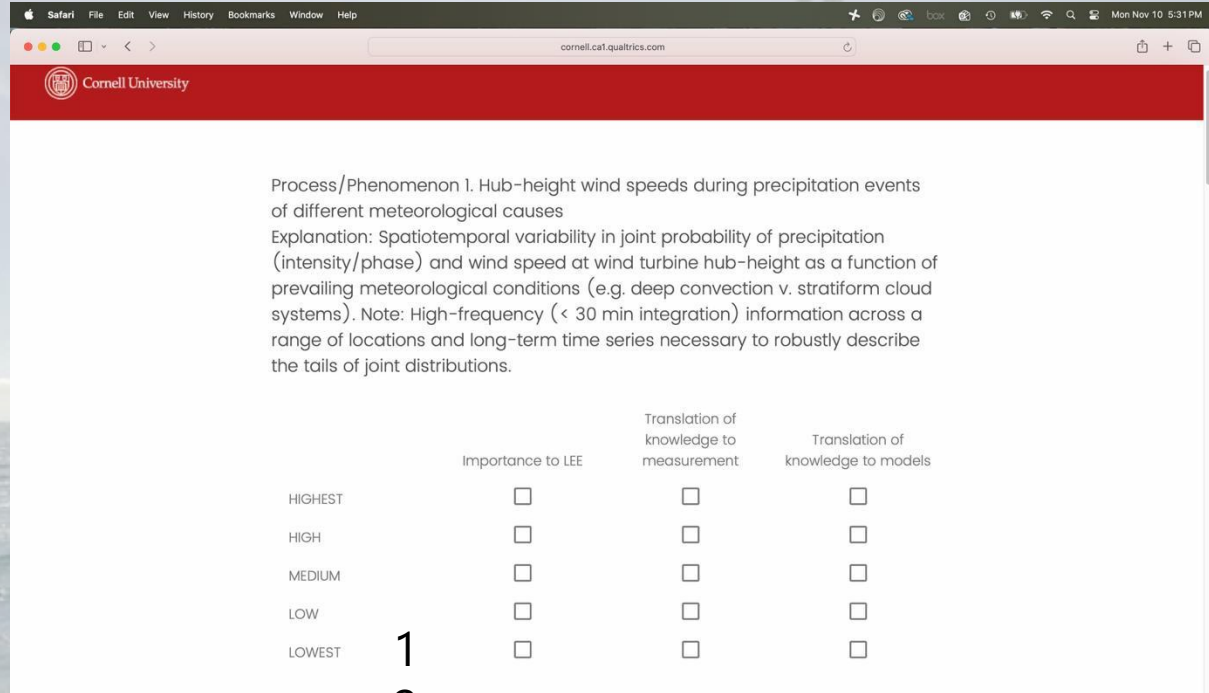


2.1 Phenomena Identification and Ranking Table (PIRT) analysis

Objectives:

- Advance understanding of the processes/phenomena that cause LEE & the consequences of LEE
- Prioritize research to maximally enhance Technology Readiness Level (TRL) of solutions

21 processes/phenomena (7 from each Workpackage). For each rank: (1) Importance to LEE/uncertainty in predictions (2) Translation of knowledge to measurements (3) Translation of knowledge to models

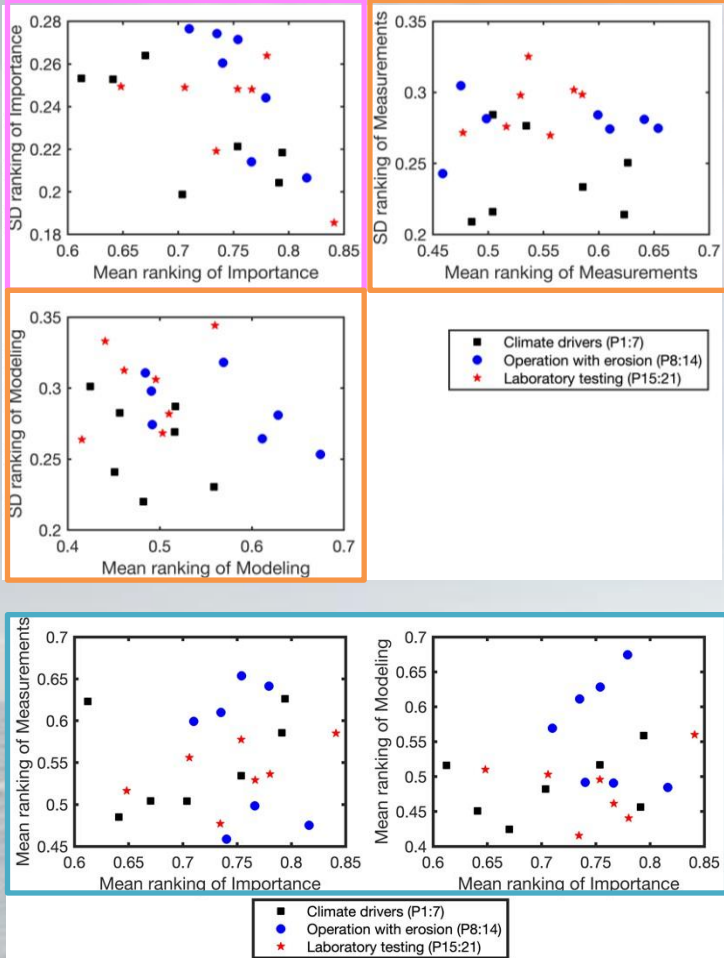


The screenshot shows a web browser window displaying a survey page from Cornell University. The page title is "Process/Phenomenon 1. Hub-height wind speeds during precipitation events of different meteorological causes". The explanation text reads: "Explanation: Spatiotemporal variability in joint probability of precipitation (intensity/phase) and wind speed at wind turbine hub-height as a function of prevailing meteorological conditions (e.g. deep convection v. stratiform cloud systems). Note: High-frequency (< 30 min integration) information across a range of locations and long-term time series necessary to robustly describe the tails of joint distributions." Below the text is a table with five rows representing importance levels (HIGHEST, HIGH, MEDIUM, LOW, LOWEST) and three columns representing ranking criteria: "Importance to LEE", "Translation of knowledge to measurement", and "Translation of knowledge to models". Each cell in the table contains an empty checkbox. A large number "1" is overlaid on the table, indicating the first step in the ranking process.

| | Importance to LEE | Translation of knowledge to measurement | Translation of knowledge to models |
|---------|--------------------------|---|------------------------------------|
| HIGHEST | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| HIGH | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| MEDIUM | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| LOW | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| LOWEST | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |



2.1 Phenomena Identification and Ranking Table (PIRT) results



- Rankings of processes/phenomena importance consistent across all respondents (LOW standard dev. of IMPORTANCE rankings for mean ranking of HIGH IMPORTANCE). i.e. The respondents agree! Spearman correlation (r) = -0.5 (significantly different from 0 at 95% confidence level).
- Respondents vary in terms of how well they think knowledge has been implemented in measurement technologies & models (large SD). r for mean v. standard deviation ≈ -0.1 (no relationship).
- Most important processes are not necessarily best represented in measurements & models. Mean importance ranking v. mean rank for measurement/modeling $r < 0.2$ (no relationship). Implies need for some re-alignment of research investments.

2.1 Phenomena Identification and Ranking Table (PIRT) outcomes

First-tier priorities:

- Process/Phenomenon 21 Materials properties that dictate damage initiation and progress
- Process/Phenomenon 14 Operational decision factors

Second-tier priorities focused on improved measurement technologies are:

- **Process/Phenomenon 2 Hydrometeor size distribution & phase as f (prevailing meteorological conditions)**
- **Process/Phenomenon 5 Impinged water as f (hydrometeor diameter/phase and prevailing flow conditions)**
- Process/Phenomenon 9 Material loss through different operating conditions
- Process/Phenomenon 15 Repeatability and variability of Rain erosion tester (RET) experiments
- Process/Phenomenon 16 Influence of material defects in RET
- Process/Phenomenon 20 Post-incubation damage growth

Second-tier priorities focused on improved modeling technologies are:

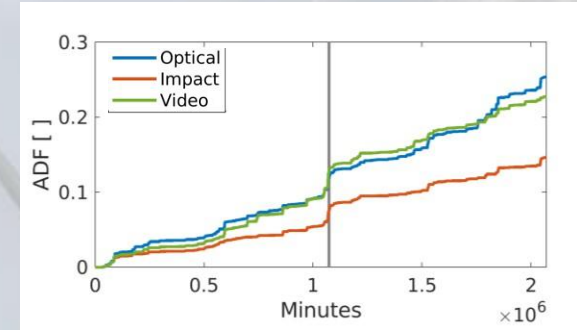
- **Process/Phenomenon 1 Hub-height wind speeds during precipitation events of different meteorological causes**
- **Process/Phenomenon 2 Hydrometeor size distribution & phase as f (prevailing meteorological conditions)**
- **Process/Phenomenon 5 Impinged water as f (hydrometeor diameter/phase and prevailing flow conditions)**
- Process/Phenomenon 9 Material loss through different operating
- Process/Phenomenon 15 Repeatability and variability of Rain erosion tester (RET) experiments
- Process/Phenomenon 16 Influence of material defects in RET experiments
- Process/Phenomenon 20 Post-incubation damage growth



2.2 Recommended Practice for measurement of LEE drivers

Efforts underway to:

- Collect publicly available data sets on droplet size distribution & phase from disdrometer, microradar etc.
- Document HOW data are being/should be processed (*collaborating with global hydroclimate community*)
- Perform collective data analyses with common codes & assumptions to understand if e.g. One instrument almost always gives more smaller droplets etc.... Diagnose by pooling data across different climates when there are largest discrepancies.



Influence of measurement technology (disdrometer type) on Accumulated Distance to Failure (from Springer). Ref: Letson & Pryor (2023): *Energies*

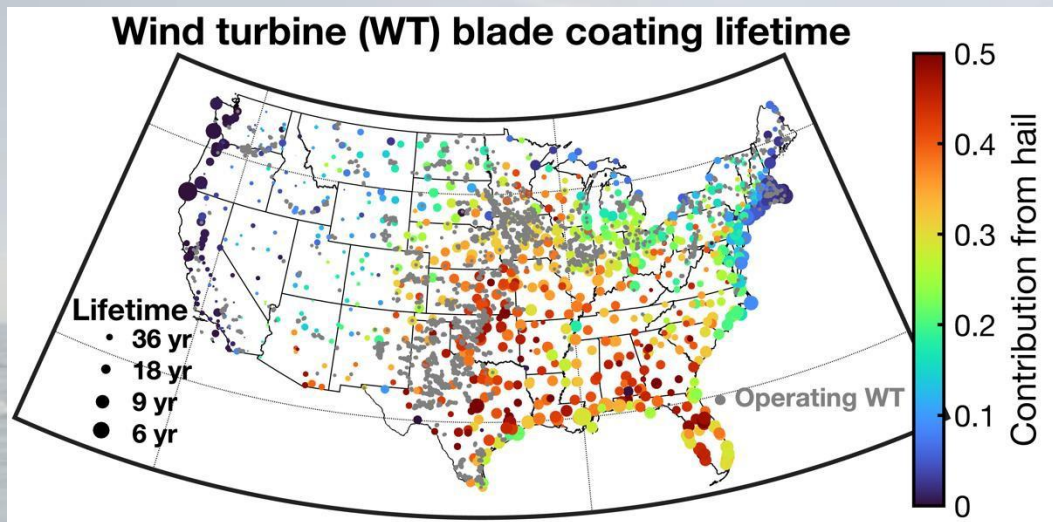
2.3 Assessment of modelling capabilities to represent key atmospheric drivers of LEE

- @ Cornell: Sensitivity analyses of WRF physics settings complete. Long-term dx=4-km underway including hail (1 yr to completion). Compiling datasets for V&V exercise
- Seeking others to conduct similar simulations elsewhere
- Joint development of V&V framework development planned



2.4 Roadmap for LEE atlas

- New geospatial & temporal (5-min resolution) wind turbine blade coating atlas developed & released for > 800 sites across USA that includes erosion due to both RAIN and HAIL.
 - Based on 20-years of near-surface observations & dual-polarization radar data with ADF from Springer model.
- Template for workflow development & can be applied to other jurisdictions.



Atlas & MATLAB codes available for download
(<https://zenodo.org/records/16420233>)
Reference: Pryor S.C. and Barthelmie R.J. (2026): Hail as a damage vector for renewable energy. *IScience* **29** 114439
([10.1016/j.isci.2025.114439](https://doi.org/10.1016/j.isci.2025.114439))

WP 3 Wind turbine operation with erosion



Task 46 Erosion of Wind Turbine Blades

Work Package #3: Wind Turbine Operations with Erosion

Sandia National Laboratories is a multimission laboratory managed and operated by National Technology & Engineering Solutions of Sandia, LLC, a wholly owned subsidiary of Honeywell International Inc., for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-NA0003525.



Technology Collaboration Programme

by **iea**








iea wind

WP3: Updated Erosion Classification System

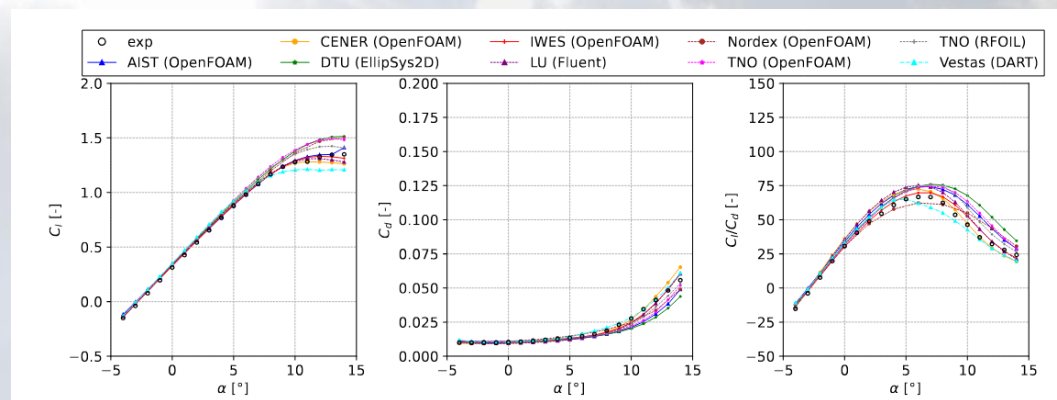
- An openly available scheme for categorising blade leading edge roughness/erosion related aerodynamic and noise performance losses
- Reference to a clean wind tunnel model. The initial blade surface is more similar to Category A.



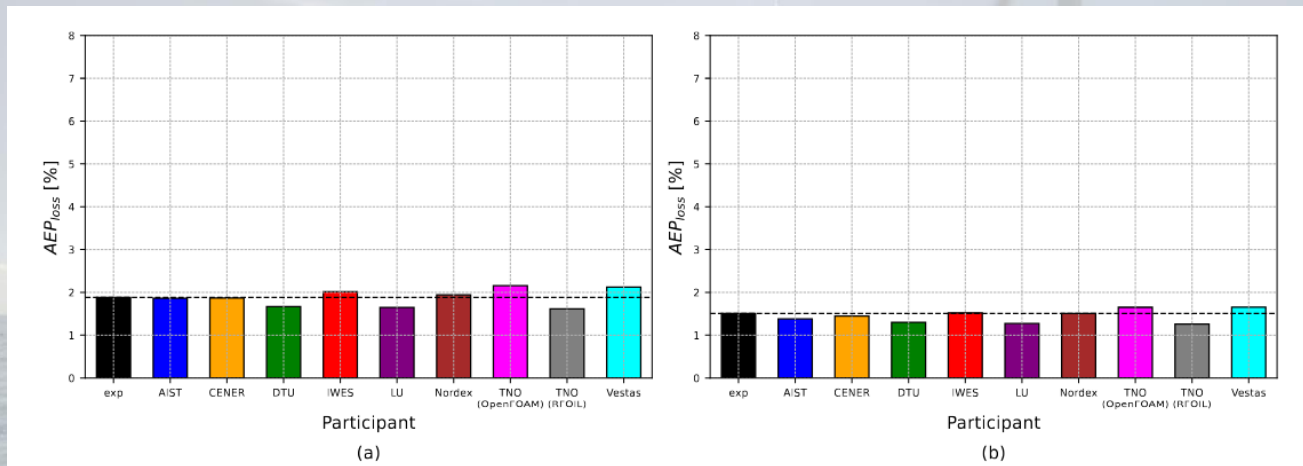
| Picture | LER Category | Label | Tagging | $C_{lmax}/C_{lmax, clean} [-]$ | $(C_l/C_d)/(C_l/C_d)_{clean} [-]$ | $C_d/C_d, clean [-]$ | $C_l/C_l, clean [-]$ | $\Delta OA SPL [dB]$ |
|---|--------------|---|---|--------------------------------|-----------------------------------|----------------------|----------------------|----------------------|
|  | A | Minor localised damage / roughness | Top coat Scratch Flaking Discrete | 0.975+/-0.025 | 0.86 +0.14 (-0.18) | 1.15 +0.27 (-0.15) | 0.99 +0.01 (-0.03) | 1.2 +1.8 (-1.0) |
|  | B | Discrete erosion | Topcoat Pinholes Peeling Discrete | 0.925+/-0.025 | 0.68 +0.14 (-0.15) | 1.41 +0.34 (-0.21) | 0.96 +0.02 (-0.03) | 3.0 +2.3 (-1.4) |
|  | C | Continuous mild erosion | Topcoat Erosion Continuous | 0.875+/-0.025 | 0.59 +0.11 (-0.12) | 1.60 +0.33 (-0.23) | 0.94 +0.02 (-0.03) | 4.3 +2.2 (-1.5) |
|  | D | Continuous severe erosion | Laminate Erosion Continuous | 0.825+/-0.025 | 0.54 +0.09 (-0.10) | 1.72 +0.30 (-0.21) | 0.93 +0.02 (-0.03) | 5.1 +2.0 (-1.4) |
|  | E | Very severe damage, incl. through-going holes | Structure Through Erosion Hole Continuous | 0.775+/-0.025 | 0.52 +0.07 (-0.08) | 1.78 +0.28 (-0.18) | 0.92 +0.02 (-0.03) | 5.5 +1.9 (-1.2) |

WP3: Phase 1 Aerodynamic Benchmark

- 2 wind tunnel measurement campaigns
- 9 airfoil analysis codes
- AEP loss analyses based on 5 MW turbine
- Preparing for publication of results



Comparison of measured data and computed results of the rough NACA63s418 airfoil of the Texas A&M experiment.



AEP losses of the NACA633-418 airfoils from model predictions: (a) onshore TI and (b) offshore TI.

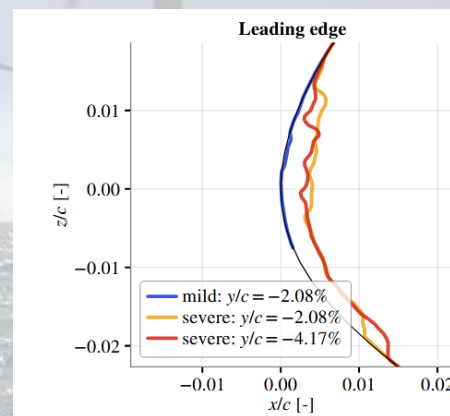
WP3: Phase 2 Aerodynamic Benchmark

Aero Benchmark Phase2 - LERCat (coordinated by DTU)

- Benchmark codes on simulating FFA-W3-211 (21%) with roughness and erosion
- All cases are from LERCat and available online
Roughness is modelled, whereas erosion is resolved
- Participants: AIST, CENER, DTU, IWES, TNO, Vestas, Lancaster University

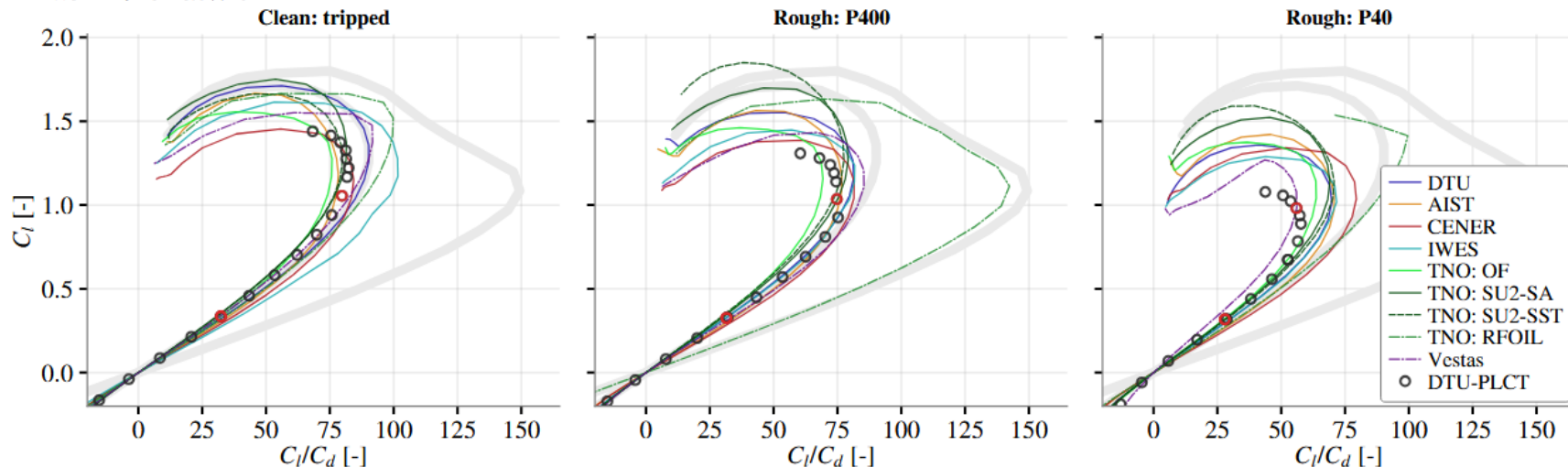


Eroded leading edge models from DTU LERCat project.



WP3: Phase 2 Aerodynamic Benchmark

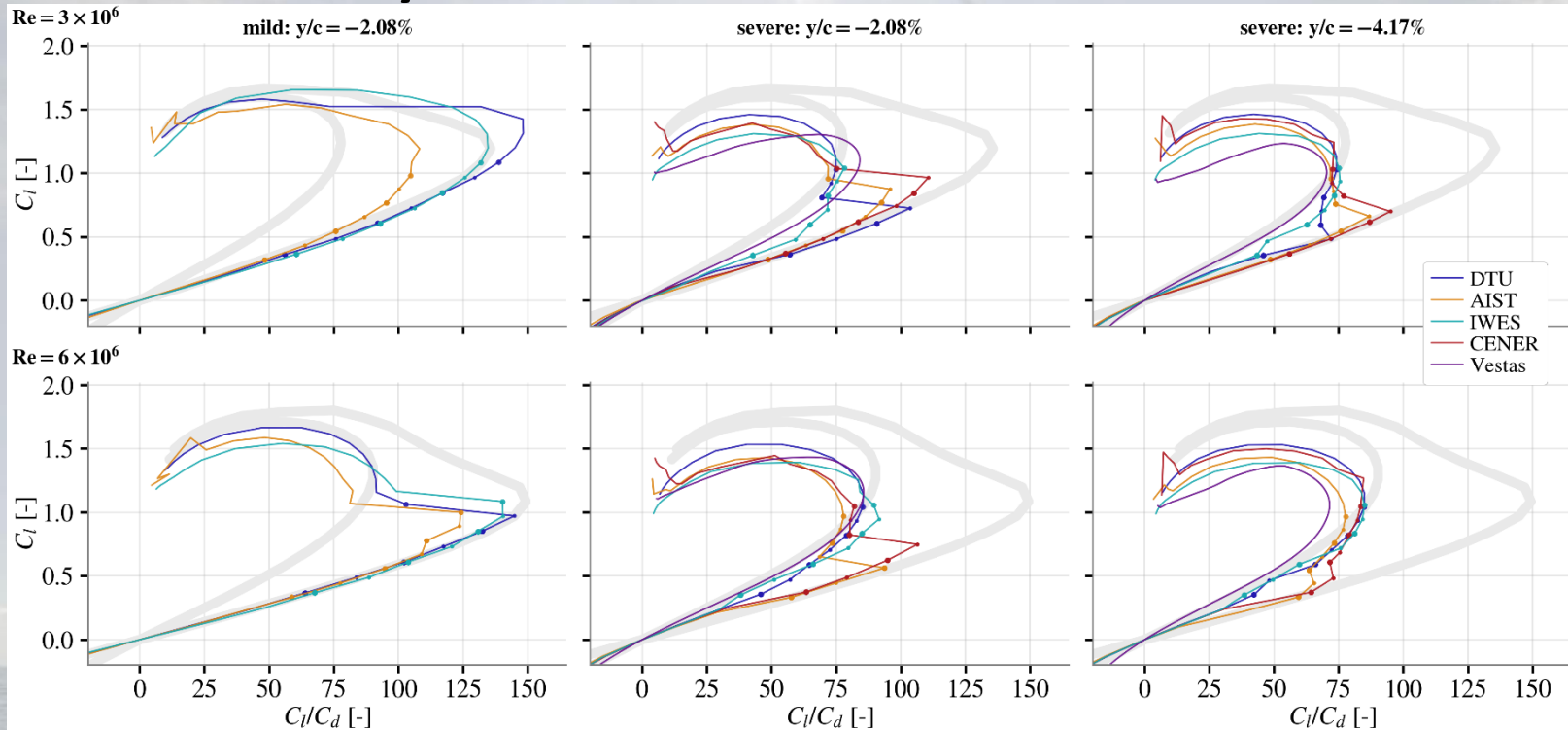
FFA-W3-211 | $Re = 6.0 \times 10^6$



Performance of the FFA-W3-211 at a Reynolds number of 6 million, when tripped at the LE (left) or with P400 and P40 sandpaper covering the LE. Gray lines provide clean and tripped reference (DTU).

Results will be presented at Torque 2026

WP3: Phase 2 Aerodynamic Benchmark



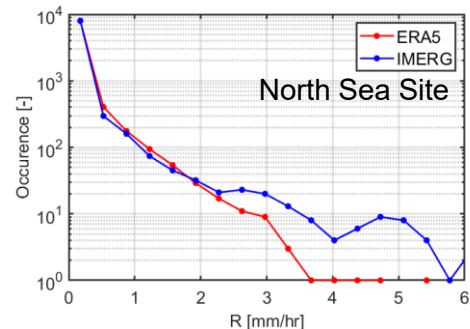
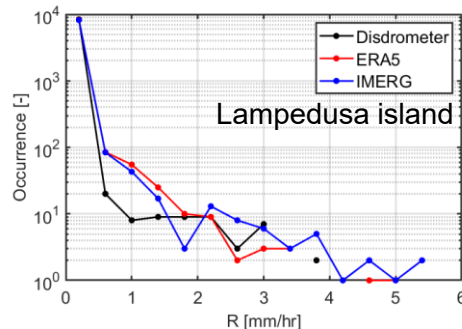
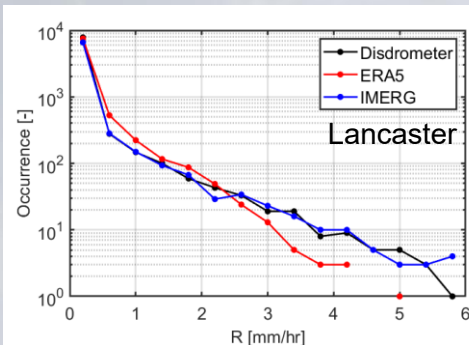
Performance of the FFA-W3-211 with three different erosion profiles (mild, severe 1 and severe 2).

Dots indicate AoAs from 0° to 6° in 1° steps.

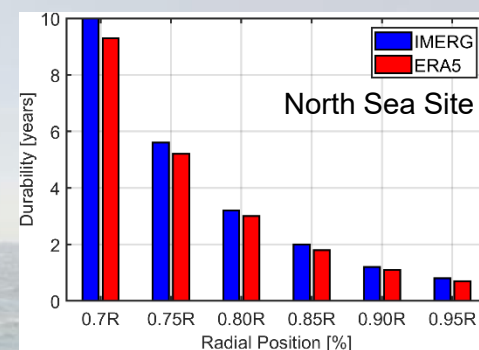
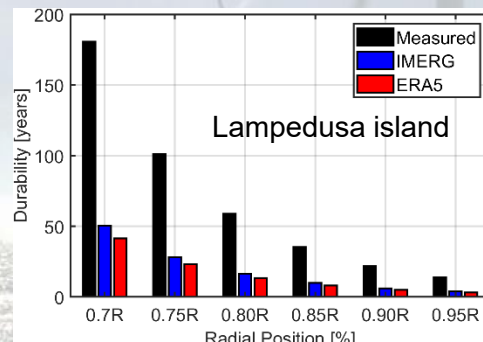
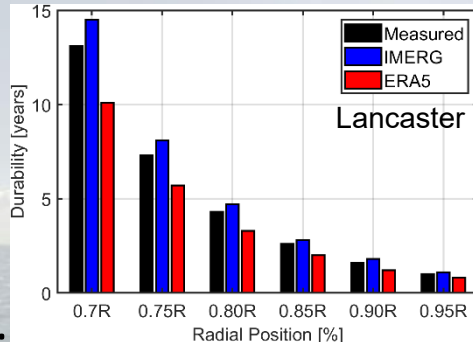
Gray lines are for reference from numerical predictions of clean and tripped (DTU).

WP3: Sensitivity of erosion predictions to rain measurement method

- Disdrometer, ERA5 and satellite rain measurements
- Sites: Lancaster, Mediterranean and North Sea.
- Presented at Torque 2026¹.
- IEA 22 MW WT.



Measured rainfall rates at three sites using disdrometer, ERA5 reanalysis data and satellite data (IMERG)

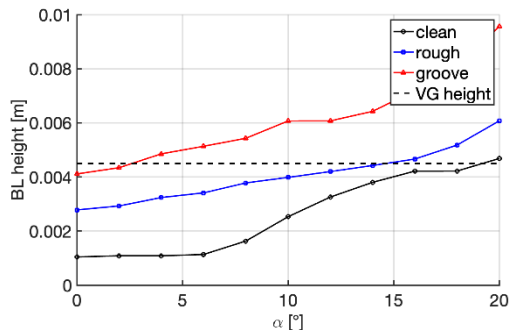
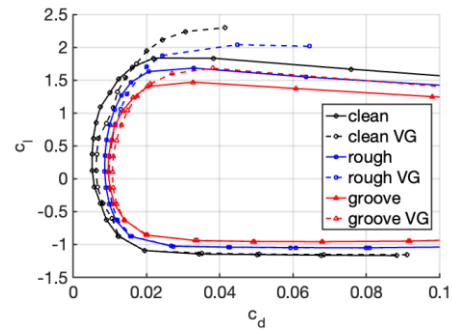
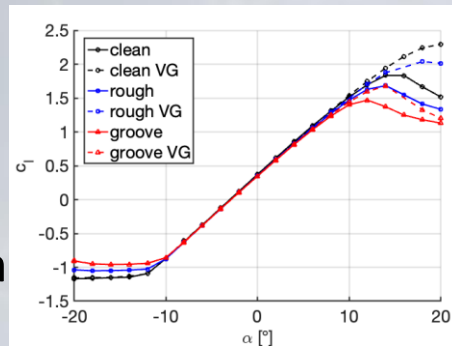


Life of coating protection at three sites based on different rain measurement type (same wind in all cases).

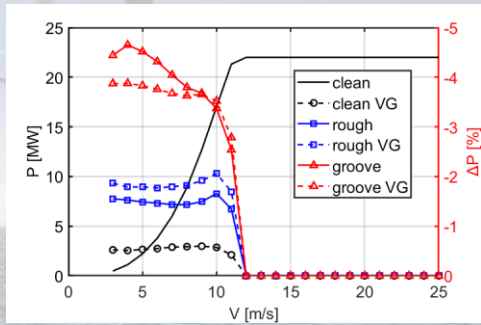
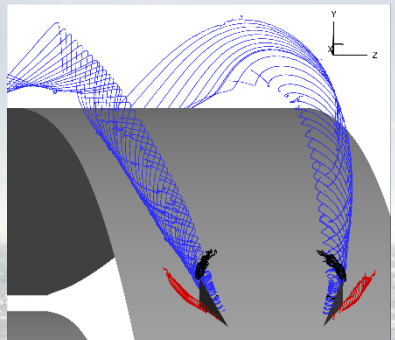
1. S. Shende et al., *Comparative analysis of wind turbine leading edge erosion using reanalysis and measured rain data*

WP3: Use of Vortex Generators to Alleviate severe LEE Power Losses

- Study on VG potential to mitigate impact of severe LEE on AEP losses.
- Moderate & severe LEE.
- Presented at Torque 2026¹.
- IEA 22 MW WT.



c_l (left) & c_d (middle) of clean/eroded FFA W3 221 airfoils without/with VGs; BL thickness at VG position (right).



VG-induced vortices (left); power variation curves with erosion and VGs (right) offshore.

1. T. Collin et al., *Can vortex generators reduce power losses of utility-scale wind turbines due to blade leading edge erosion?*

WP3: Upcoming Activities

- AEP Loss benchmark kickoff: decide on reference turbine.
- Modelling and benchmark on aerodynamic effects and loss due to several representative LEP solutions. Investigate higher Reynolds numbers effects.
- Development of methods for erosion safe-mode operation: reference turbine controller demonstration.
- Improved droplet impingement model for use in fatigue analysis .
- Design of an experiment to assess the accuracy of LEE performance loss models based on field observations.
- Lifetime Erosion Modeling and O&M Decision Making: aerodynamic and material model deployment for decision making with uncertainty.

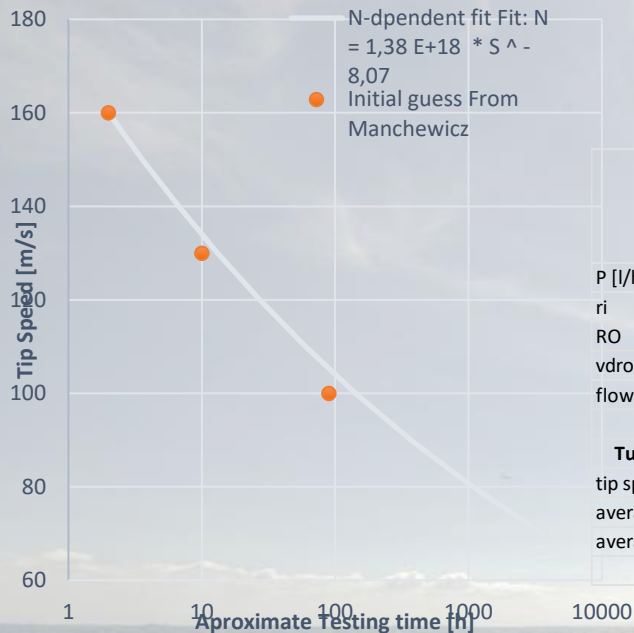
WP 4 Laboratory testing of erosion and material blade integration



Large scale round robin: 4.1 work

- Testing of 1 coating system
 - Samples Donated by Mankiewicz
- Testing must be done at minimum 2 different speeds
- We can include up to 7 R&D style testers
 - Currently
 - DTU, ORE, Mankiewicz and AIST, Akzo Nobel
- Other testers are welcome if we can reasonable manufacture the samples
 - Farunhoffer IWES is checking comparability
 - NPL, is checking if the coupon single row RET can fit the samples
 - Niigata university wants to include their pulsed jet
- Testing to begin in March

Initial guess at testing times



| | | Initial guess from Manchewicz at | | | | RET [h] | H[m] | Impingment | Turbine life [Years] |
|---|-------------|----------------------------------|------|---------------|-------|---------|--------|------------|----------------------|
| | | RPM | Omeg | RET tip speed | 60l/h | | | | |
| Base rain erosion tester paramaters | | | | | | | | | |
| P [l/h] | 60 | 1282 | 134 | 160 | 2 | 2,0 | 2,8 | 0,1 | |
| ri | 0,802 | 1202 | 126 | 150 | | 3,6 | 4,6 | 0,2 | |
| RO | 1,192 | 1122 | 117 | 140 | | 6,7 | 8,1 | 0,4 | |
| vdrop | 2,38 | 1041 | 109 | 130 | 10 | 13,2 | 14,8 | 0,7 | |
| flow [m/s] | 1,66667E-05 | 961 | 101 | 120 | | 27,2 | 28,2 | 1,5 | |
| | | 881 | 92 | 110 | | 59,9 | 56,8 | 3,2 | |
| Turbine and and site paramaters for lifetime calculation | | 801 | 84 | 100 | 90 | 142,1 | 122,7 | 7,6 | |
| tip speed | 100 | 721 | 76 | 90 | | 369,6 | 287,1 | 19,8 | |
| average annual rain | 1 | 641 | 67 | 80 | | 1075,9 | 742,9 | 57,6 | |
| average fall velocity | 6,2 | 561 | 59 | 70 | | 3612,7 | 2182,7 | 193,3 | |
| | | 481 | 50 | 60 | | 14626,3 | 7574,2 | 782,7 | |

Open points

$$\varphi = \frac{I}{v_{drop}} = \frac{\text{flowrate}}{\text{fall velocity}} = \frac{60l/h}{2,38m/s} = \frac{1,66E - 5}{2,38}$$

- Temperature of testing
 - At minimum should be reported
 - Can we settle on a single temperature?
- For R&D style tester
 - Fixed or variable liquid water content during testing?
 - We can normalize the data to get around this
 - ASTM impingement of non-dimensional impact
 - General guidelines for inspection intervals
 - Suggestion 4-5 inspections before onset of erosion?
 - For 160m/s about up to 20(maybe should be 10 min) min between inspections
 - @100 about 60min should be fine

Outcomes

- Achievable minimum COV% for a reference coating system (DNVGL-RP-0171 context)
- Quantified baseline uncertainty for inclusion in lifetime estimation models
- Identification of normalization approaches that are robust across tester types and operating conditions
- Defined comparability limits between R&D-style erosion testers
- Practical recommendations for inspection intervals and reporting practices
- Supply of free-film materials to WP4.6

4.6-4.8 Erosion from material science perspective

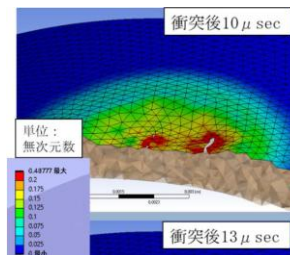
The discussion will also include the materials science perspectives necessary to achieve this objective. One of the objectives of this work package is to accumulate knowledge on the relationship between fatigue properties and material properties, various factors affecting them, and testing methods for evaluation for various soft materials through computer-aided engineering (CAE) and experiments, and to share this knowledge widely in the industry in order to develop materials that will sufficiently endure for the life of wind turbines, or materials and application methods that minimize uncertainties in life-time prediction.

4.6 Bridging the gap between several durability testing and material properties



- focusing on erosion initiation
- understand the difference among testing

4.7 Analysis on failure modes and mechanisms of various soft materials to integrate into modelling



- focusing on erosion progress
- understand elementary process on soft materials

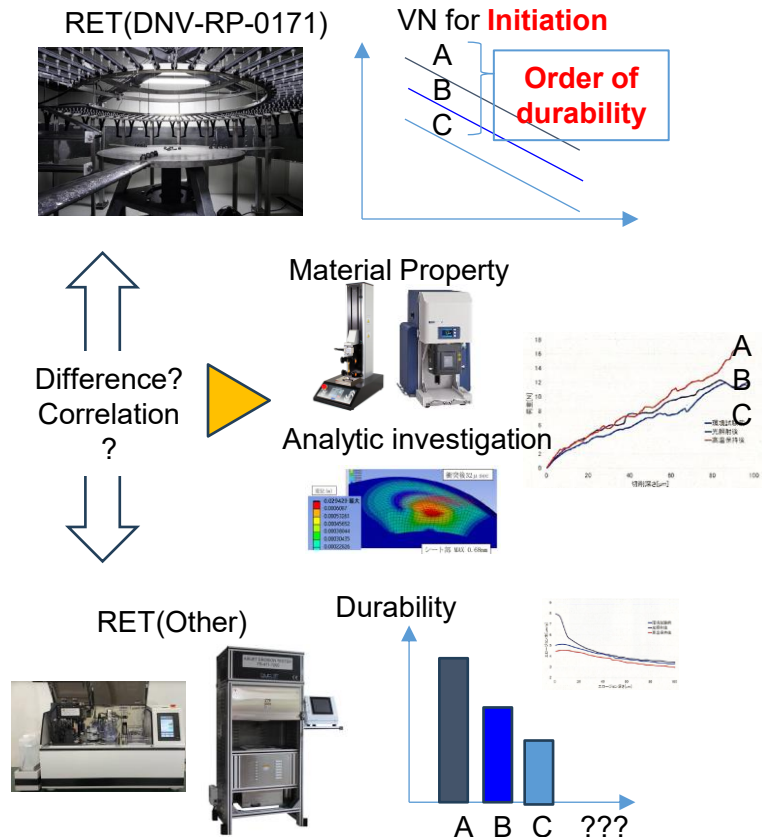
4.8 Material failure in the real blade erosion



- focusing on erosion in field
- understand realistic erosion from the knowledge of 4.6 & 4.7



4.6 Bridging the gap between several durability testing and material properties



<Objective>

- Investigate correlations between RET and other durability tests, focusing on the order of durability between materials.
- Try to understand the cause of this correlation in terms of material properties.
- Gather case studies from participants' experience.

<Expectation for participants>

- Provision of test materials
- Conducting various tests
- CAE analysis
- Sharing of relevant knowledge

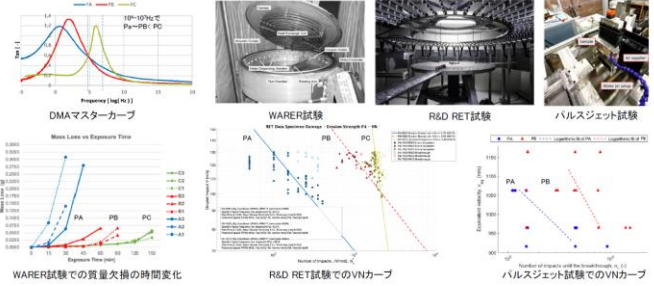


<Research item>

-Literature survey

- Report 5.2 of Phase1:

WARER vs R&D vs DUCOM vs DMA
 PU coating with different viscoelasticity
 Similar failure modes and durability rankings
 Rather complex failure modes with delamination



-Preparation of test pieces

- Simple failure mode, free from ambiguity by application process are expected
- Discussing with Japanese manufacturer to provide samples with different material property

- **Following the discussion in WP4.1 about Round Robin test using a special coating.**

-Perform various durability and material property tests

- R&D A/S, Pulse Jet, MSE, ...

-Investigation using CAE

-Making report

**Discussion of WP4.6 will start in February.
 We look forward to your participation.**



Extra optional WP4 meeting in Japan Sep 26.

Visit to Kitakyushu Hibikinada Offshore Wind Farm

- Location: Fukuoka prefecture
- Total Capacity: 220MW (V174-9.5MW x 25)
- Water depth: 8-30m
- Foundation: Jacket



Meeting at Kokura

- Participants:
 - Johansen, Yamagata, Takagi, Aihara,
 - Tanaka, Sakai(online), Minegishi(online)
- Topics:
 - Wind energy in Denmark
 - Stress reduction by water film formation
 - Swirling flow in RET
 - Evaluation of damage progression
 - Pulsed jet testing on LEP



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