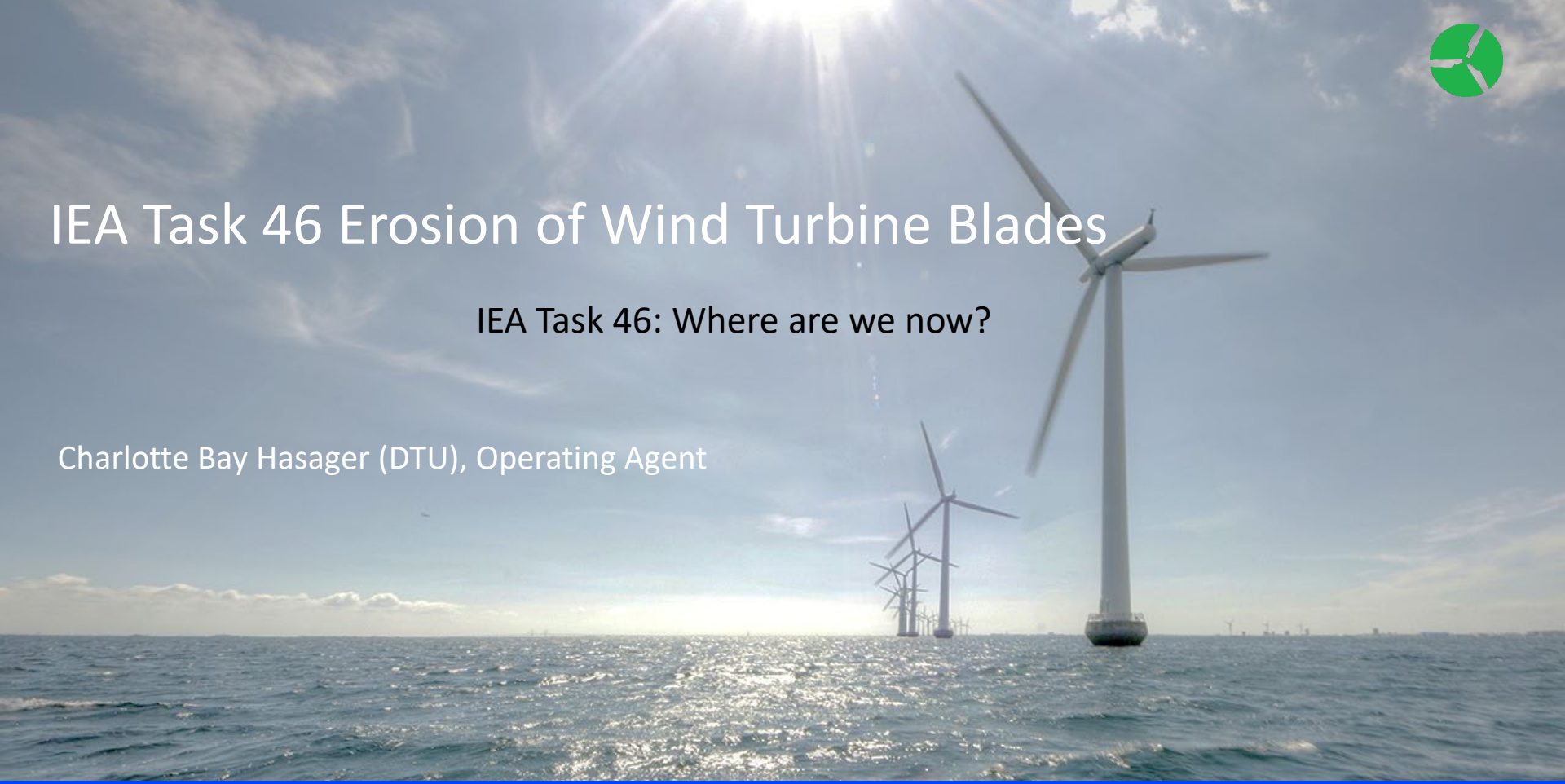


IEA Task 46 Erosion of Wind Turbine Blades

IEA Task 46: Where are we now?

Charlotte Bay Hasager (DTU), Operating Agent

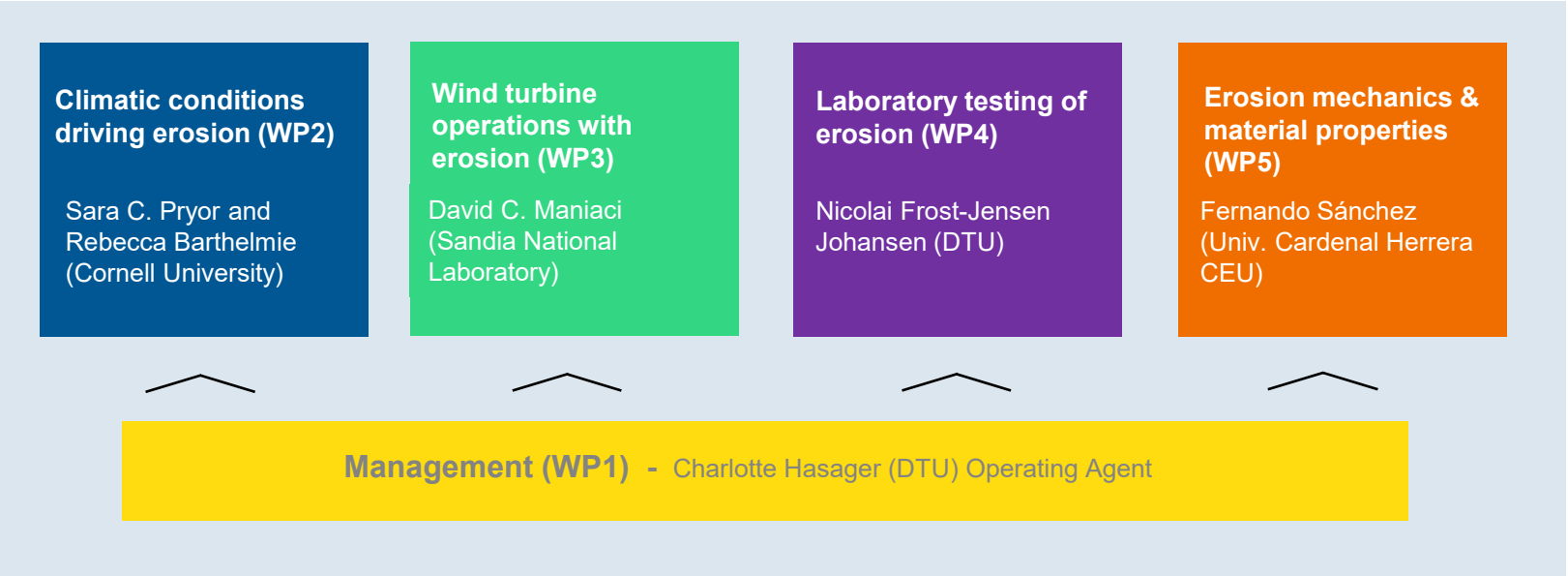
The purpose of IEA Task 46 is to

IEA Wind TCP

- improve understanding of the erosion driving factors,
- develop datasets and model tools to enhance prediction of leading-edge erosion likelihood,
- identify damage at the earliest possible stage and,
- advance potential solutions.

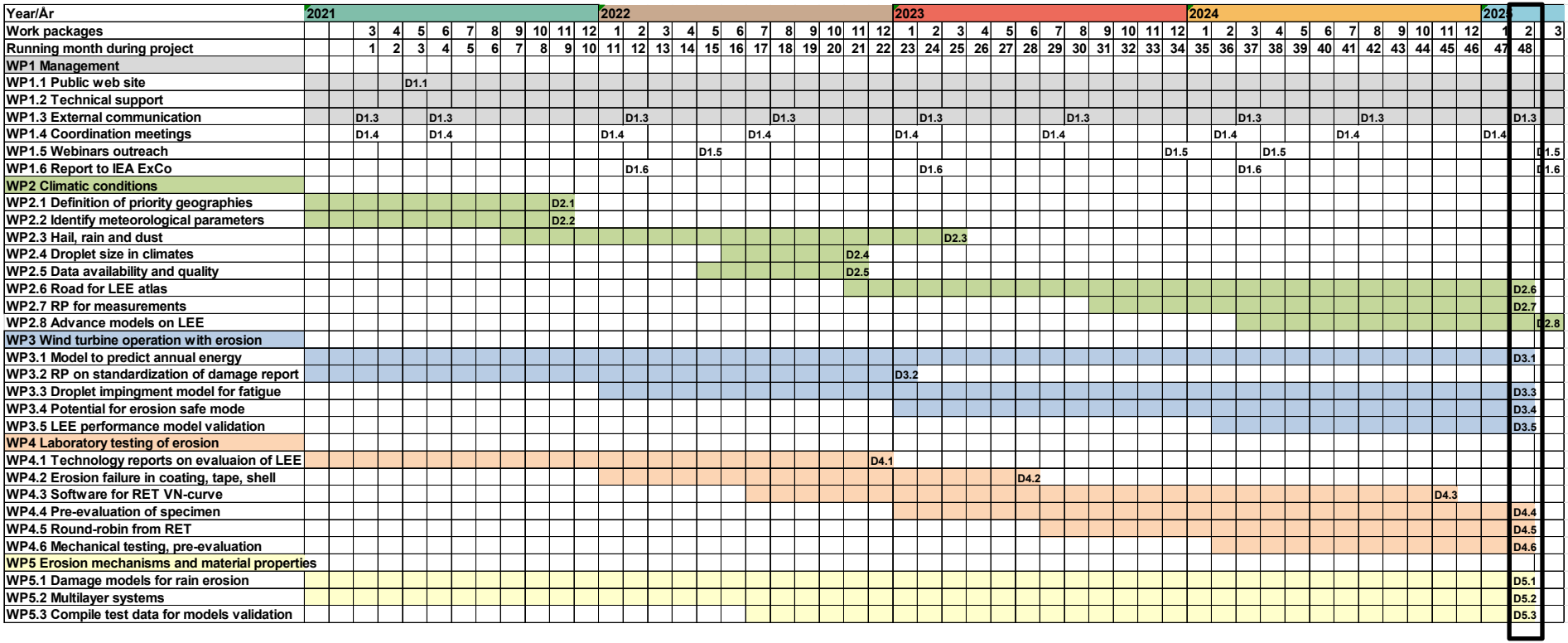
Coordination

IEA Wind TCP



Gantt timeline

IEA Wind TCP



Timeline (year #4)

IEA Wind TCP

Date	event	status
31/03//2023	Invoicing year # 4	August 2024
18/04/2024	7th bi-annual plenary meeting (online)	online
21-24/05/2024	Task 46 presents in ExCo #94 (Italy)	Face-to-face ExCo
Aug/2024	Quarterly coordination telco (WPLs & OA)	
17-18/09/2024	Presentation at Blade workshop, NM, USA	Face-to-face public
19/09/2024	Special Session from Task 46 Albuquerque, NM, US - Sandia as Host	Face-to-face public
19-20/09/2024	8th bi-annual plenary meeting in Albuquerque, NM, US - Sandia as Host	Face-to-face task participants
Autumn 2024	ExCo #95 (online)	online
Nov/2024	Quarterly coordination telco (WPLs & OA)	online
5 Dec/2024	Dissemination public webinar	online
Feb/2025	Quarterly coordination telco (WPLs & OA)	online
4-6/02/2025	Final presentations 6th Erosion symposium	Face-to-face public
7/2/2024	Technical Workshop	Face-to-face task participants
March/2025	Final bi-annual plenary meeting (online)	online
14/03/2025	FINAL REPORT	

Dissemination events planned beyond Phase 1

IEA Wind TCP

- Wind Europe 18-20 April 2025 in Copenhagen
  - Oral presentation *Hasager et al.*

- Wind Energy Science Conference (WESC) 24-27 June 2025 in Nantes
  - Mini-Symposion: Leading Edge Erosion: An Aerodynamic Perspective

MS#03.2 Leading Edge Erosion: An Aerodynamic Perspective

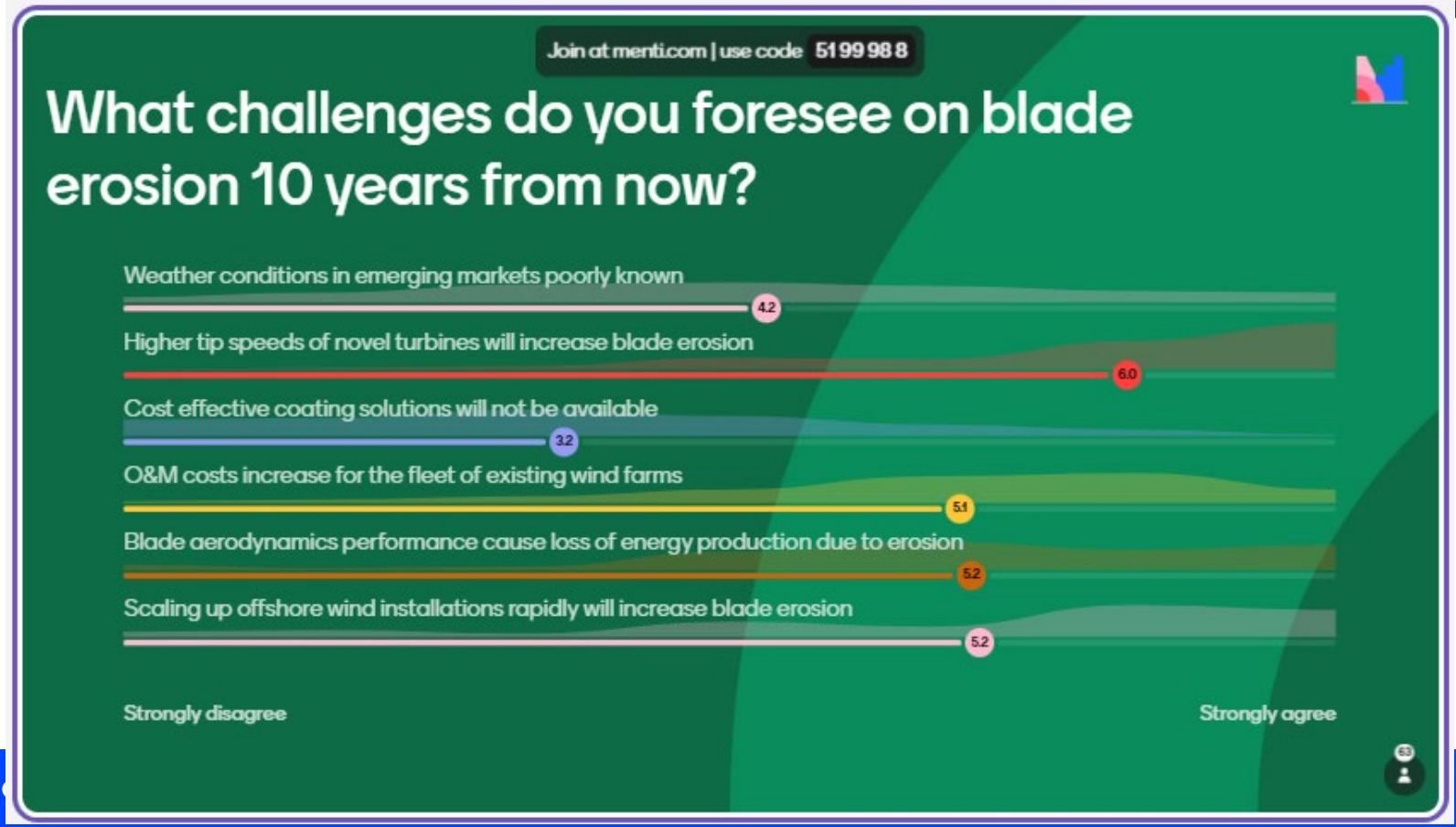
IEA Wind TCP

- **F. GRASSO[1], D. MANIACI[2], G. SCHEPERS[3], A. OLSEN[4]**
  [1] Vestas Technology Centre Porto|[2] Sandia Lab|[3] TNO|[4] DTU Dept of Wind and Energy Systems

- **Aerodynamics, aeroelasticity and acoustics**
  The erosion of the leading edge is a critical issue which reduces the lifetime of the blades. Tailored maintenance strategies and protective solutions for the leading edge became more and more popular development topics. The symposium focuses on the impact of the erosion on the rotor performance and its implications in terms of aerodynamic modelling and blade design strategy.
- The IEA Task 46 (Erosion of wind turbine blades), the IEA Task 47 (TURBINIA TURBulent INflow Innovative Aerodynamics), and the Danish project LERCat (Leading Edge Roughness Categorisation) jointly organize the mini-symposium.

Mentimeter – Results From the Survey at the Sandia Blade Workshop, September 18, 2024

EA Wind TCP



IEA Task 46 Phase 1 and Phase 2

IEA Wind TCP

- Phase 1 started 15 March 2021 and end 14 March 2025
- Phase 2 starts 15 March 2025 and end 14 March 2029

Purpose of the Task 46 extension

IEA Wind TCP

- The purpose of the extension of the IEA Wind Task 46 is to further improve understanding of the erosion driving factors, develop datasets and model tools to enhance prediction of leading-edge erosion likelihood, identify damage at the earliest possible stage and advance potential solutions.

Task Scope Alignment with Research Priorities by IEA Wind TCP

IEA Wind TCP

- ***Resource and site characterization***: Improving the practices in resource characterization regarding susceptibility to erosion at wind farm sites.
- ***Advanced technology***: erosion damage models, material properties, characterization of erosion resistance; characterization and improvement of wind turbine operation with erosion.

Task Scope Alignment with Grand Challenges

IEA Wind TCP

- Wind resources, atmospheric science, and the physics of air flow at wind farms.
- System dynamics and materials involved in wind turbines and wind farm technology.
- Optimization and control of wind farm operation and maintenance for reliability and resiliency.

IEA Task 46 Phase 2 coordination

Wind TCP

Work Package	Lead organization
WP 1: Management	DTU (DK) Professor Charlotte Bay Hasager (Operating Agent) Professor Christian Bak (Co-operating Agent)
WP 2: Climatic conditions	Cornell University (US) Professor Sara Pryor (WP-lead) Professor Rebecca Barthelmie (Co-lead)
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 Hidrodynamics (Co-lead) University of Lancaster (UK) Sergio Campobasso, PhD Senior Lecturer (Co-lead)
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)

Objectives and Expected Results

IEA Wind TCP

WP 2: Climatic conditions	**PIRT (International Phenomena Identification and Ranking) analysis to identify meteorological parameters of critical importance to LEE** **Recommended report for measurement of LEE drivers** **Assessment of modelling capabilities to represent key atmospheric drivers of LEE** **Roadmap for LEE atlas**

Objectives and Expected Results cont.

IEA Wind TCP

WP 3: Wind turbine operation with erosion	**Updated erosion classification system with report, collaboration across work packages with recent participant results** **Aerodynamic benchmarking and simulations, and reference models** **AEP loss and reference erosion turbines models** **Design of an experiment to assess the accuracy of LEE performance loss models** **Development of methods for erosion safe-mode operation** **Lifetime erosion modelling and O&M decision making** **Improved droplet impingement model for use in fatigue analysis based on field observations** **System integration and uncertainty analysis**

Objectives and Expected Results cont.

IEA Wind TCP

WP 4: Laboratory testing of erosion	**Large-scale comparison and round robin of RET testers** **RET under different climatic conditions and effect of droplet size and impact rate on coating lifetime** **Impact of microplastics emissions from erosion** **Incorporation of weathering into RET protocol** **Design of specimens with predefined defects** **Bridging the gap between several durability testing and material property** **Analysis on failure modes and mechanisms of various soft materials to integrate into modelling** **Material failure in the real blade erosion**

Gantt diagram

Project title: IEA Wind Task 46 Erosion Phase 2
Project start: 15 March 2025
Project end: 14 March 2029

Year/År	2025										2026												2027												2028												2029		
Work packages/Projektets arbejdspakker:	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
Running month during project	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	
WP1 Management																																																	
WP1.1 Public web site			D1.1																																													
WP1.2 Technical support			D1.2																																													
WP1.3 External communication	D1.3			D1.3								D1.3						D1.3						D1.3					D1.3						D1.3					D1.3						D1.3		
WP1.4 Coordination meetings	D1.4			D1.4							D1.4						D1.4						D1.4					D1.4						D1.4					D1.4						D1.4		
WP1.5 Outreach webinars													D1.5											D1.5												D1.5												
WP1.6 Report to IEA ExCo												D1.6												D1.6												D1.6												
WP2 Climatic conditions																																																
WP2.1 PIRT analysis to identify meteorological parameters						D2.1																																									
WP2.2 Recommended Practice for measurement of LEE drivers																		D2.2																														
WP2.3 Modeling capabilities of key atmospheric drivers of LEE																														D2.3																		
WP2.4 Roadmap for LEE atlas																																														D2.4		
WP3 Wind turbine operation with erosion																																															
WP3.1 Updated erosion classification system with report									D3.1																																						
WP3.2 Aerodynamic benchmarking and simulations																		D3.2																														
WP3.3 AEP loss and reference erosion turbines models																					D3.3																												
WP3.4 Design of an experiment to assess the accuracy of LEE performance loss																											D3.4																				
WP3.5 Development of methods for erosion-safe mode operation																																									D3.5						
WP3.6 Lifetime erosion modeling and O&M decision making												D3.6																																			
WP3.7 Improved droplet impingement model for use in fatigue analysis																								D3.7																							
WP3.8 System integration and uncertainty analysis																																														D3.8		
WP4 Laboratory testing of erosion																																															
WP4.1 Large-scale comparison and round robin of RET testers												D4.1																																			
WP4.2 RET under different climatic conditions																								D4.2																							
WP4.3 Impact of microplastics emissions from erosion																																										D4.3						
WP4.4 Incorporation of weathering into RET protocol																																													D4.4		
WP4.5 Design of specimens with predefined defects																																															D4.5
WP4.6 Durability testing and material property												D4.6																																			
WP4.7 Failure modes and mechanisms of soft materials																																														D4.7		
WP4.8 Material failure in the real blade erosion																																															D4..8
Milestones																																																
M1 Kick-off meeting	M1																																															
M2 Release of first technical deliverables						M2																																									
M3 First outreach seminar												M3																																				
M4 Release of Recommended Practise report																		M4																														
M5 Half of technical deliverables completed																								M5																							
M6 Final outreach at International Symposium on Erosion																																															M6	

Deliverables

IEA Wind TCP

Approximately 20 technical documents with actionable information for the industry and academia:

- 8 deliverables with high TRL results including recommended reports and validated models.
- 12 deliverables with low TRL results including literature surveys, state of the art reports, roadmaps and reports on available technologies.

Outreach and Dissemination

IEA Wind TCP

- Webinars outreach yearly

- Face to face contributions to conferences such as the International Symposium on Erosion of Wind Turbine Blades each year

- Deliverables at the Task 46 website

IEA Task 46 Phase 2 project plan

IEA Wind TCP

The approved Phase 2 project plan is available at

https://share.dtu.dk/sites/IEA_WIND_T46_493900/Shared%20Documents/Forms/AllItems.aspx?id=%2Fsites%2FIEA%5FWIND%5FT46%5F493900%2FShared%20Documents%2FPhase%202%2FWork%20Plan

Participants

- The work plan is delivered by 41 organizations from 12 countries:
  - 1 certification body
  - 6 wind farm owners
  - 2 consultancy
  - 4 wind turbine manufacturers
  - 8 coating manufacturers
  - 19 academic/R&D organizations

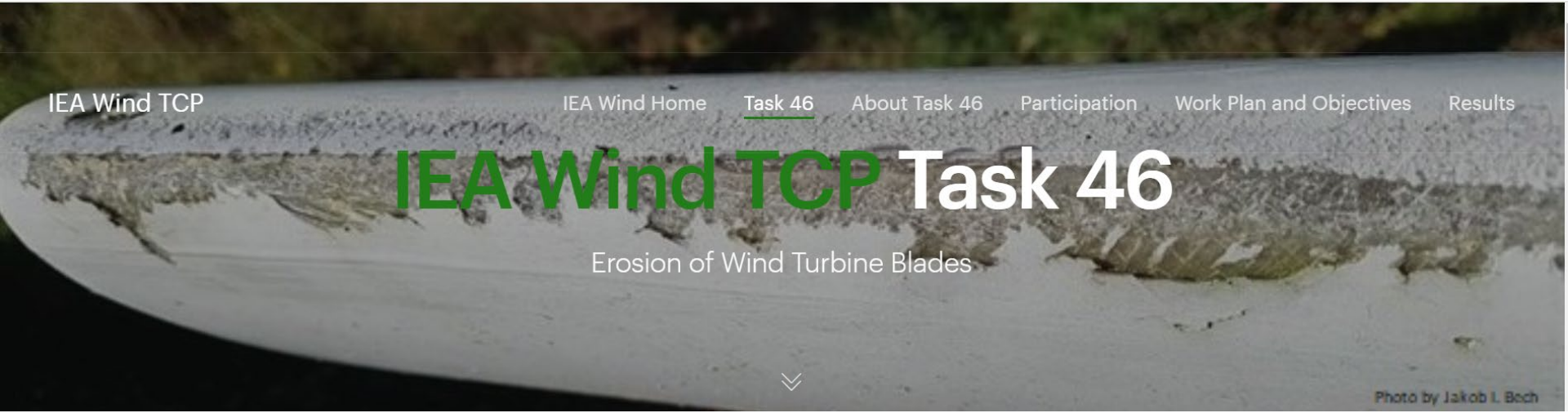
Country	Contracting Party	Participant Organization
Belgium	Belgian Ministry of Economy	Engie
Canada	Natural Resources Canada	WEICan
Denmark	Danish Energy Agency	DTU , Hempel, Ørsted, PowerCurve, Siemens Gamesa Renewable Energy,
Finland	Business Finland	VTT
Germany	Federal Ministry for Economic Affairs 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.
Netherlands	Netherlands Enterprise Agency	TU Delft, TNO
Norway	Norwegian Water Resources and Energy Directorate	Equinor, University of Bergen, Statkraft
Spain	Centre for Energy, Environmental and Technological Research	Aerox, CENER, Nordex Energy Spain, DNV Iberica, Universidad Cardenal Herrera – CEU
UK	Offshore Renewable Energy Catapult	ORE Catapult, University of Bristol, Lancaster University, Imperial College, Vestas UK, Ilosta
US	US Department of Energy	Cornell University, Sandia National Laboratories, 3M

Wind TCP

Who can participate in Task 46?

IEA Wind TCP

https://iea-wind.org/task46/



Thank you!

IEA Wind TCP

IEA Wind TCP functions within a framework created by the International Energy Agency (IEA).

Views, findings, and publications of IEA Wind do not necessarily represent the views or policies of the IEA Secretariat or of all its individual member countries.

IEA Wind is part of IEA's Technology Collaboration Programme (TCP).

Contact

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