



# INNOVATIVE FUTURE-PROOF TESTING METHODS FOR RELIABLE CRITICAL COMPONENTS IN WIND TURBINES

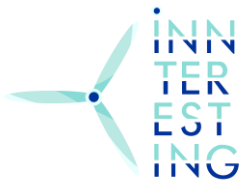
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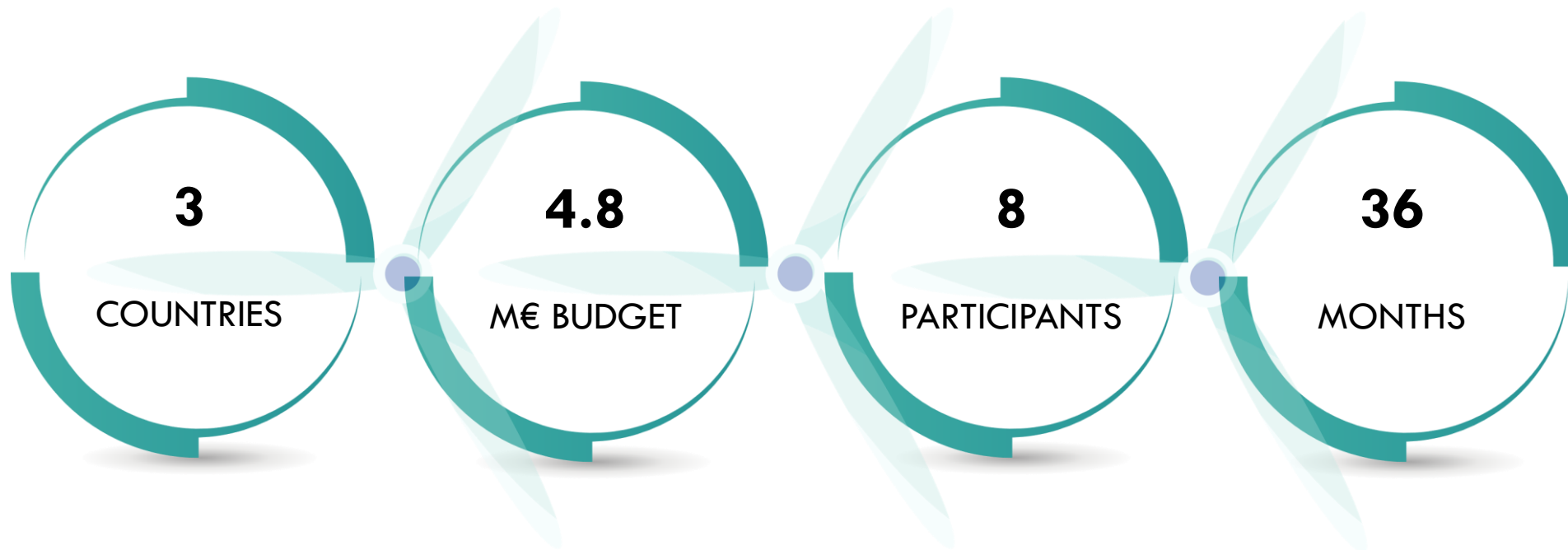
This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 851245

Place and date

# INTERESTING



- *The INNTERESTING project aims to develop a novel hybrid methodology and breakthrough design tools to assess reliability of larger wind turbine critical components without the need of building larger test benches in the future.*



## 1. Objectives and Challenges

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# Objectives and challenges

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# CHALLENGES

Increase in wind turbines  
size and power



Installed EU wind fleet near to  
end-of-life



More demanding requirements



Lifetime



CAPEX/OPEX



Reliability



Environment

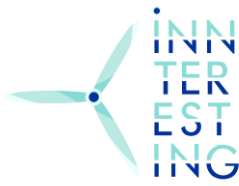


Social

Need of larger/more expensive  
test benches

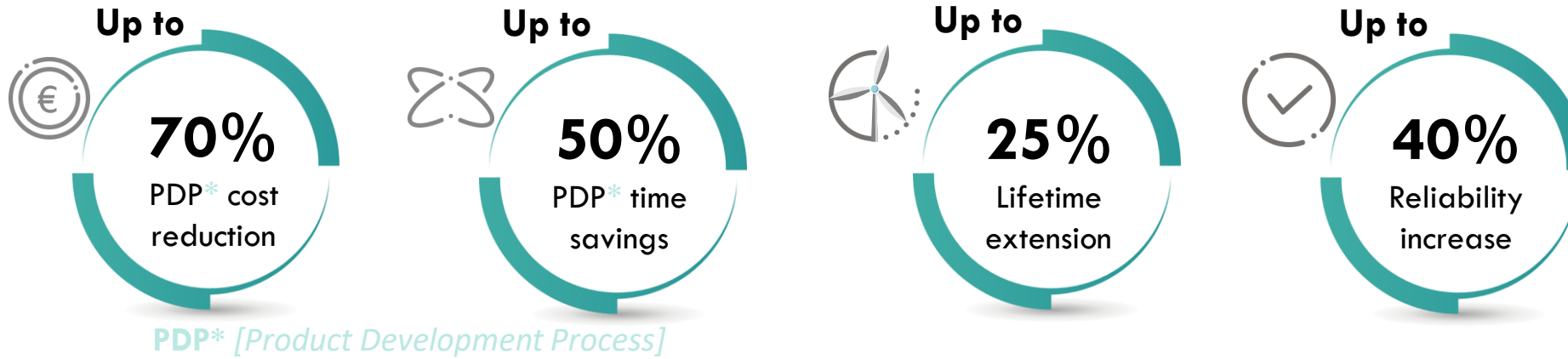


# OBJECTIVES



- **O1.** To develop a hybrid testing methodology able to robustly predict the expected **reliability and lifetime** of large wind turbine components (**up to 20 MW**) without the need of performing physical tests of full-size prototypes (thus removing the need of large-scale testing infrastructures in the future).
- **O2.** To develop **design tools** integrating cutting-edge models and technologies supporting the iNNTERESTING methodology.
- **O3:** To bring two new **ground-breaking designs** of real wind turbine components to a TRL-4, proposing much higher load capacities and increased lifetime.
- **O4:** To validate the methodology in the **assessment of a novel repair solution** (in process of patenting) addressed to increase lifetime extension of already installed pitch bearings
- **O5.** To reduce environmental and economic impact and to improve social acceptance of the newly developed designs, concepts and testing methods
- **O6.** Replication of project results to other components and sectors

# MAIN EXPECTED IMPACTS





# The project





# PARTNERS

- IKERLAN (ES)
- BASQUE ENERGY CLUSTER (ES)
- KU LEUVEN (BE)
- LAULAGUN (ES)
- MOVENTAS (FI)
- SIEMENS INDUSTRY SOFTWARE (BE)
- VITO (BE)
- VTT (FI)

## Finland

moventas GEARED FOR  
NEW ENERGY

VTT

## Belgium

KU LEUVEN

SIEMENS  
*Ingenuity for life*

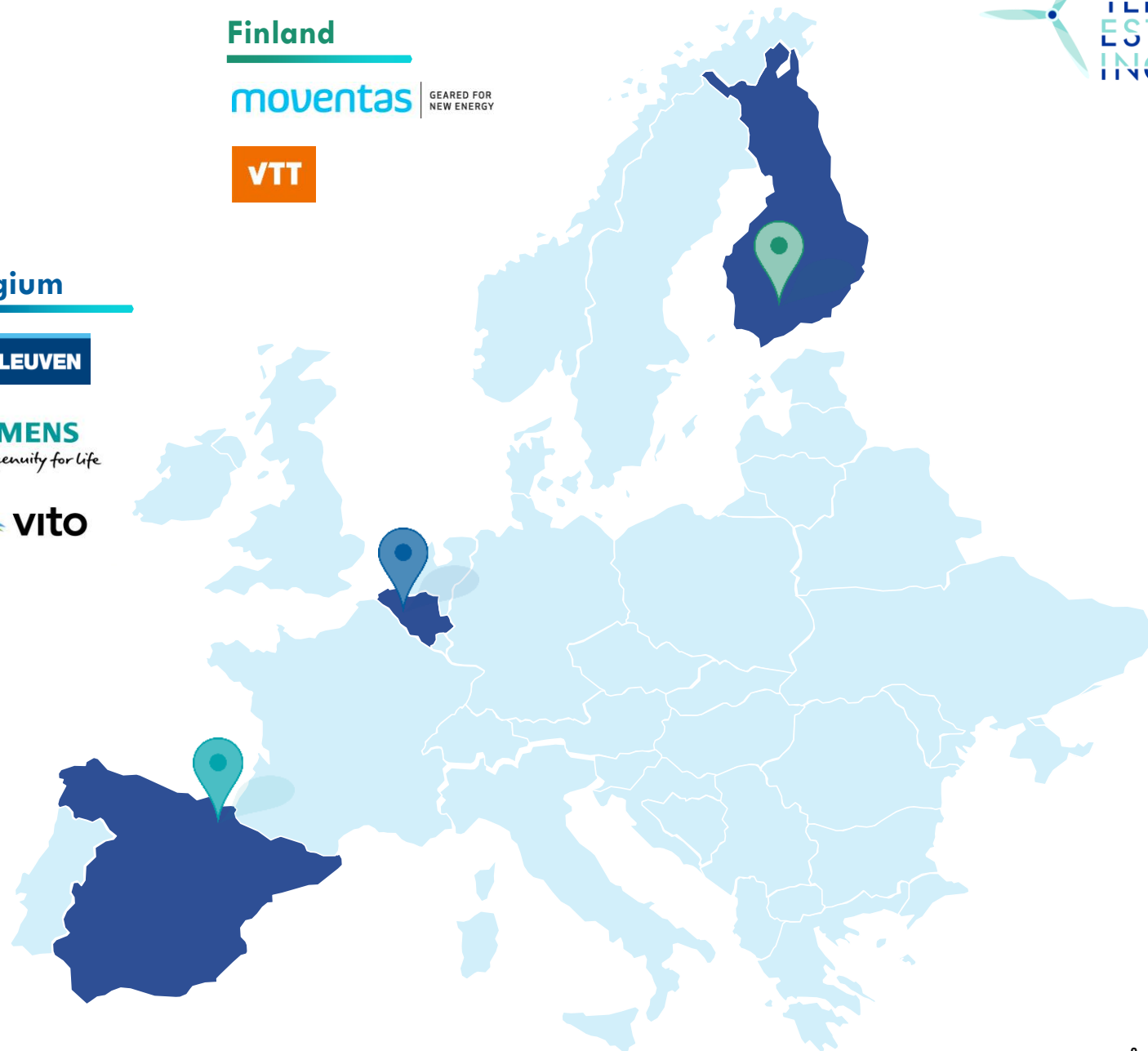
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## Spain

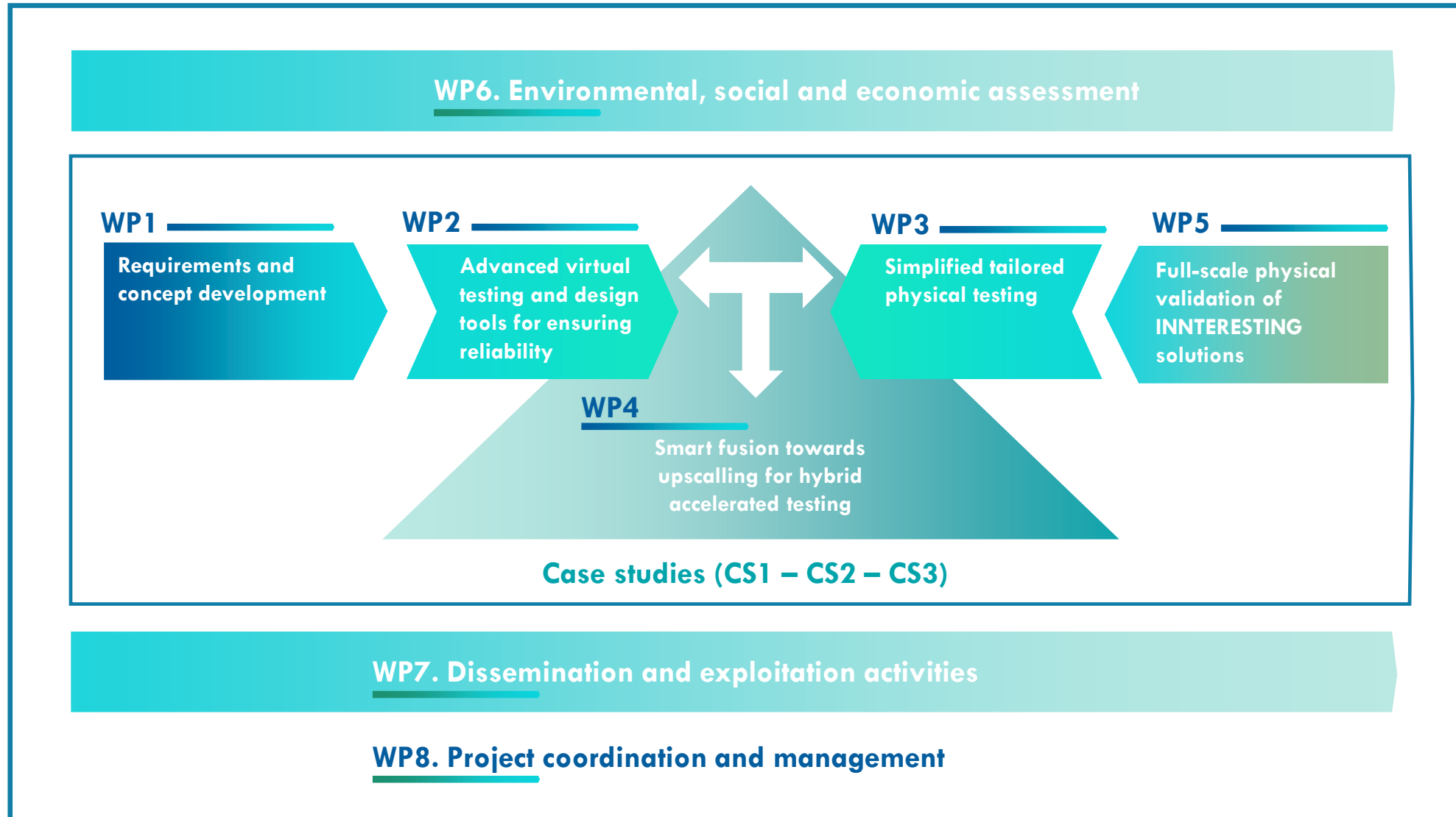
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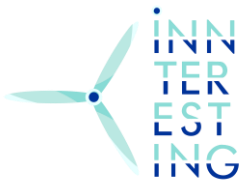
  
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BASQUE ENERGY CLUSTER



# WP STRUCTURE



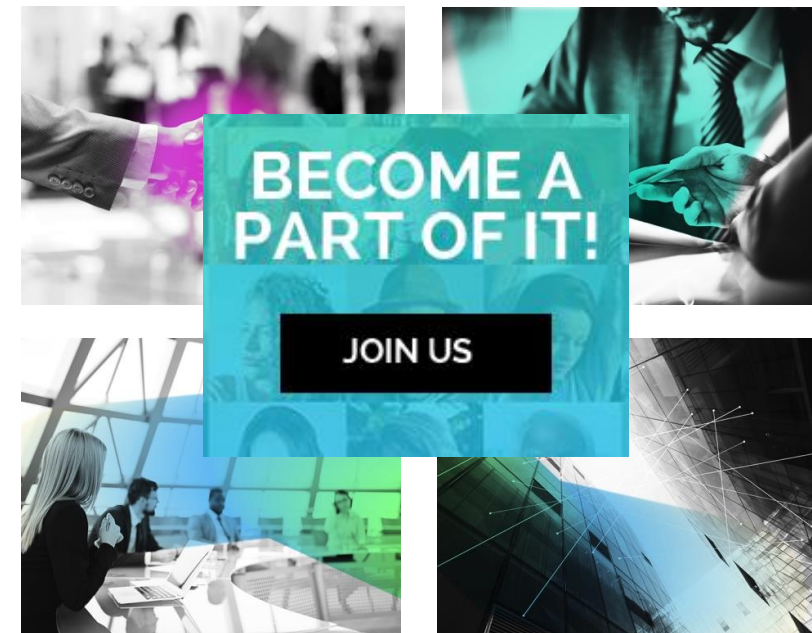
# STAKEHOLDER ADVISORY BOARD



- INNTERESTING research and innovation activities will be driven by the opinion of stakeholders involved in the Stakeholder Advisory Board, which will be the main group supporting the consortium in providing expert advice to ensure consistency in the project outcomes in accordance with market expectations. Their feedback will be carefully monitored throughout the project duration since they are relevant and committed market and non-market players of various exchange views and standpoints.
- Currently, we are still seeking people interested in becoming part of the board in order to finish building it.

[ LOGOS TO BE INCLUDED 5<sup>TH</sup> MAY ]

**TO SUPPORT THE CONSORTIUM  
AND GIVE EXPERT ADVICE**



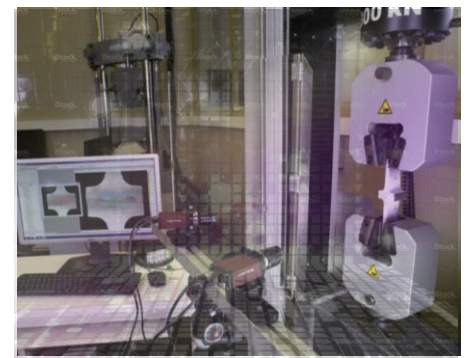
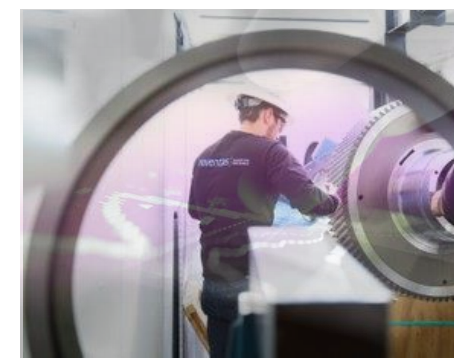
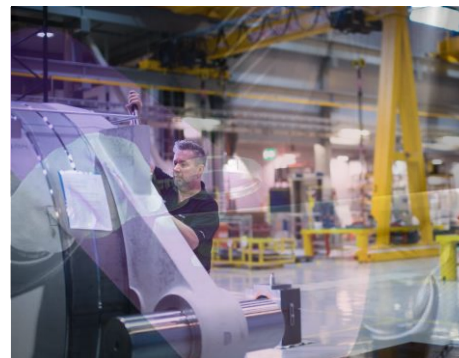
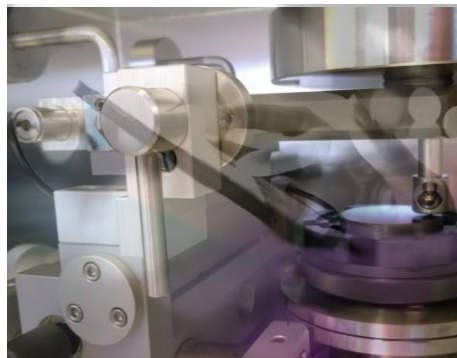
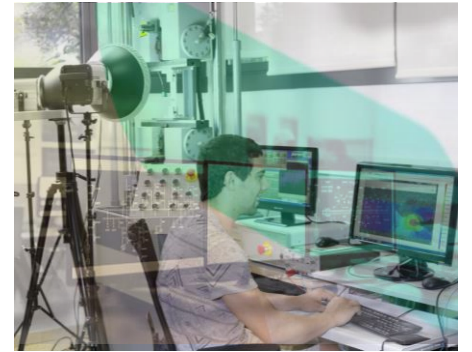
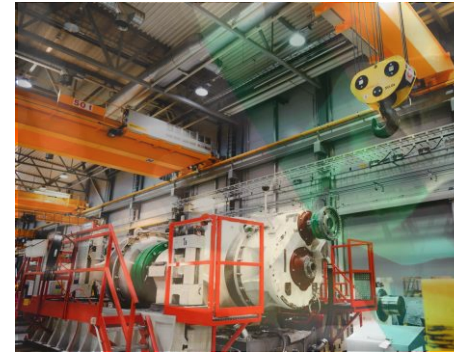
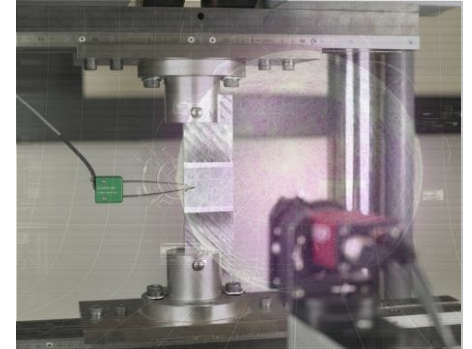


# Technological approach



# TECHNOLOGICAL APPROACH

- ININTERESTING will develop an innovative hybrid testing methodology that will be not only useful for validating large wind turbine components, but also for evaluating lifetime extension concepts that must be implemented in already existing wind farms in order to extend the remaining life of the structure.
- ININTERESTING project also pursues the validation of the developments through 3 different case studies dealing with innovative pitch bearing concept (CS1), new gearbox component design (CS2) and innovative repairing solution for lifetime extension of pitch bearings (CS3).





# INTERESTING HYBRID TESTING METHODOLOGY

- The INNERESTING hybrid testing methodology combines results from simplified physical tests and advanced virtual testing through smart fusion process and upscaling techniques to robustly predict reliability, lifetime and failures of full-scale wind turbine components.

## CURRENT TESTING PYRAMID

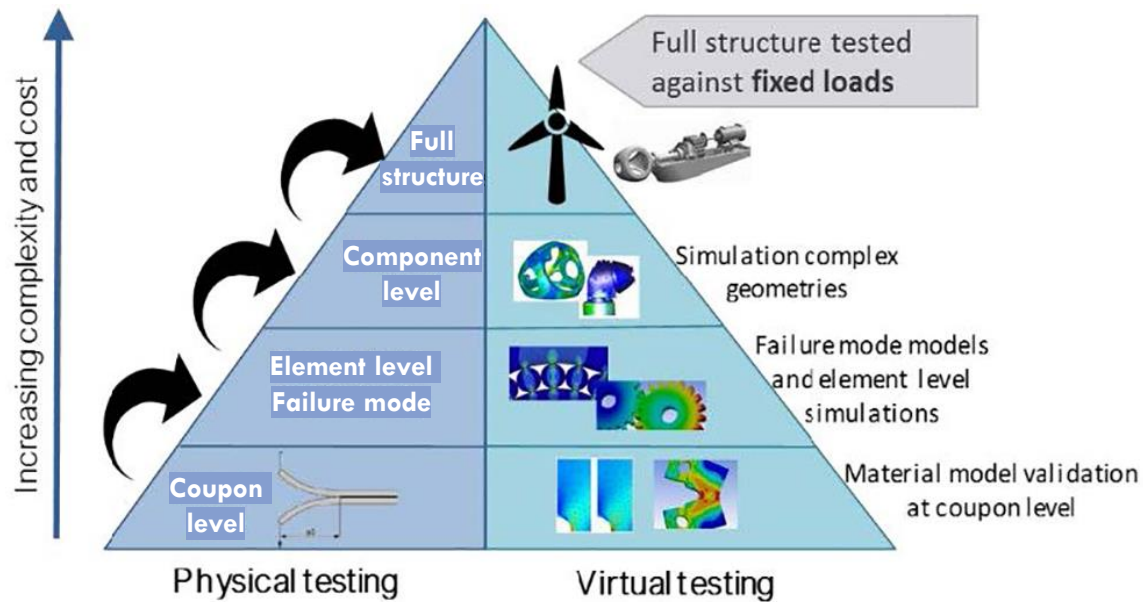


FIGURE 1: CURRENT TESTING PYRAMID COMBINING PHYSICAL AND VIRTUAL TESTING

## INNERESTING HYBRID TESTING METHODOLOGY

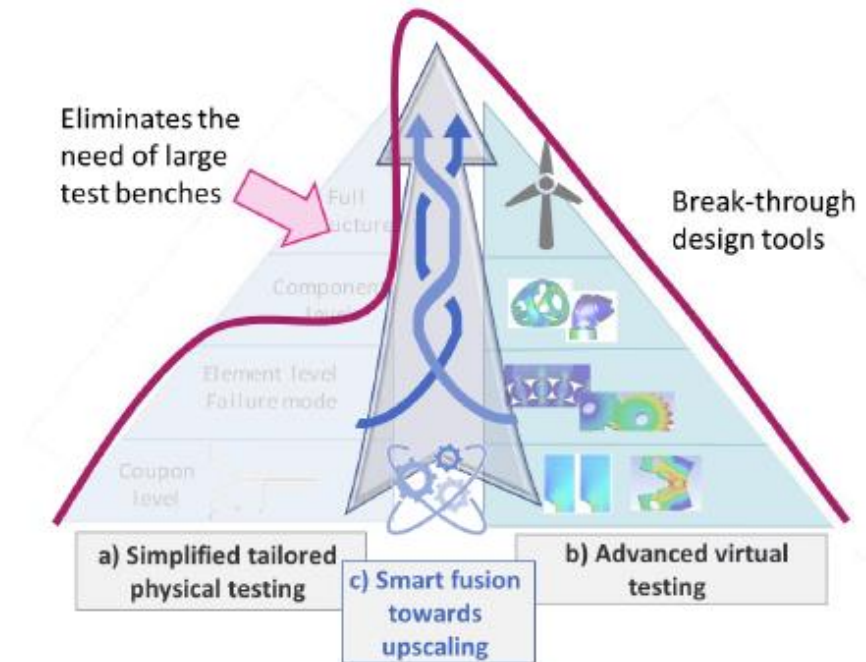
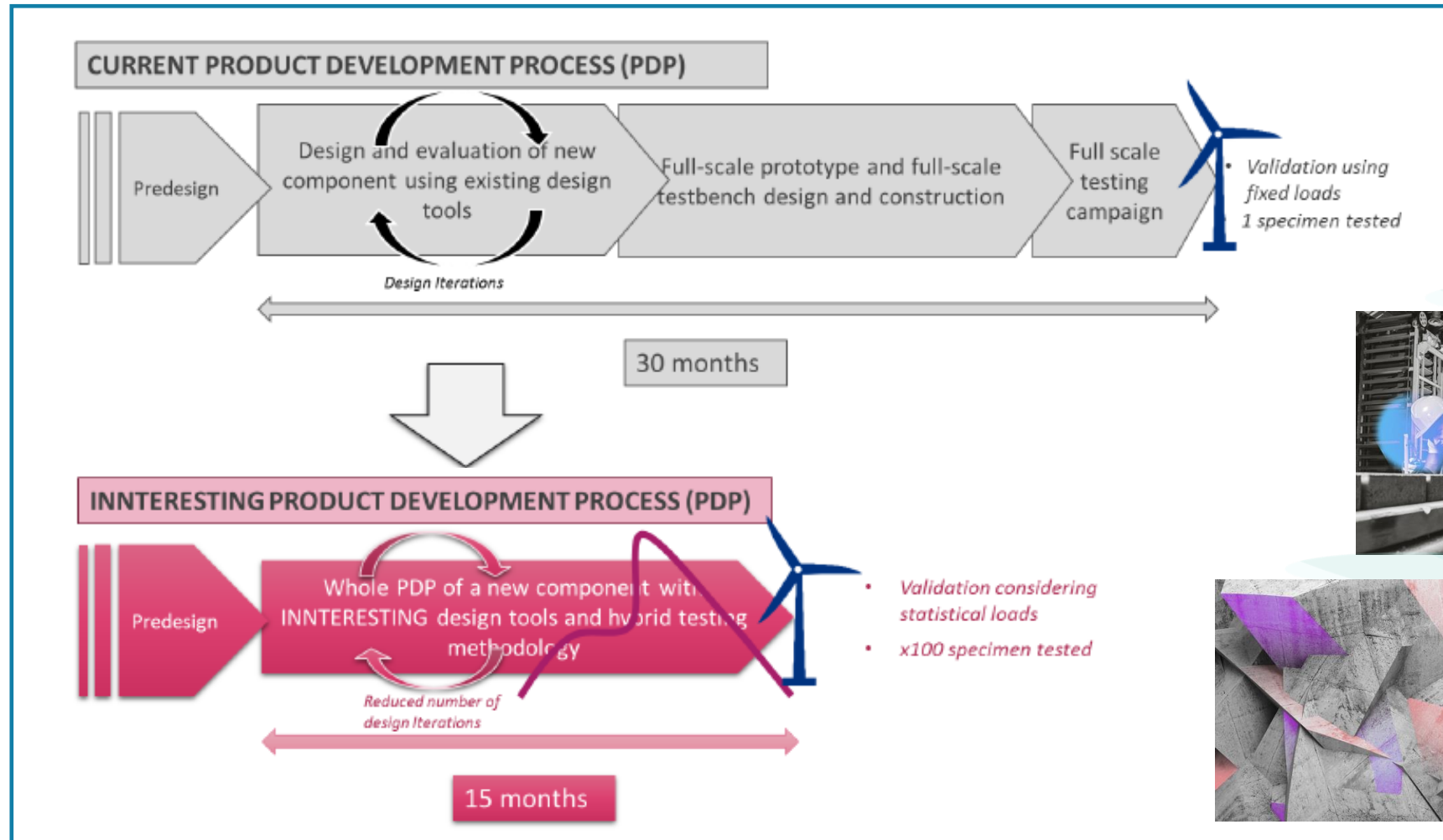


FIGURE 2: INNERESTING TESTING METHODOLOGY WITH THE HYBRID TEST CONCEPT

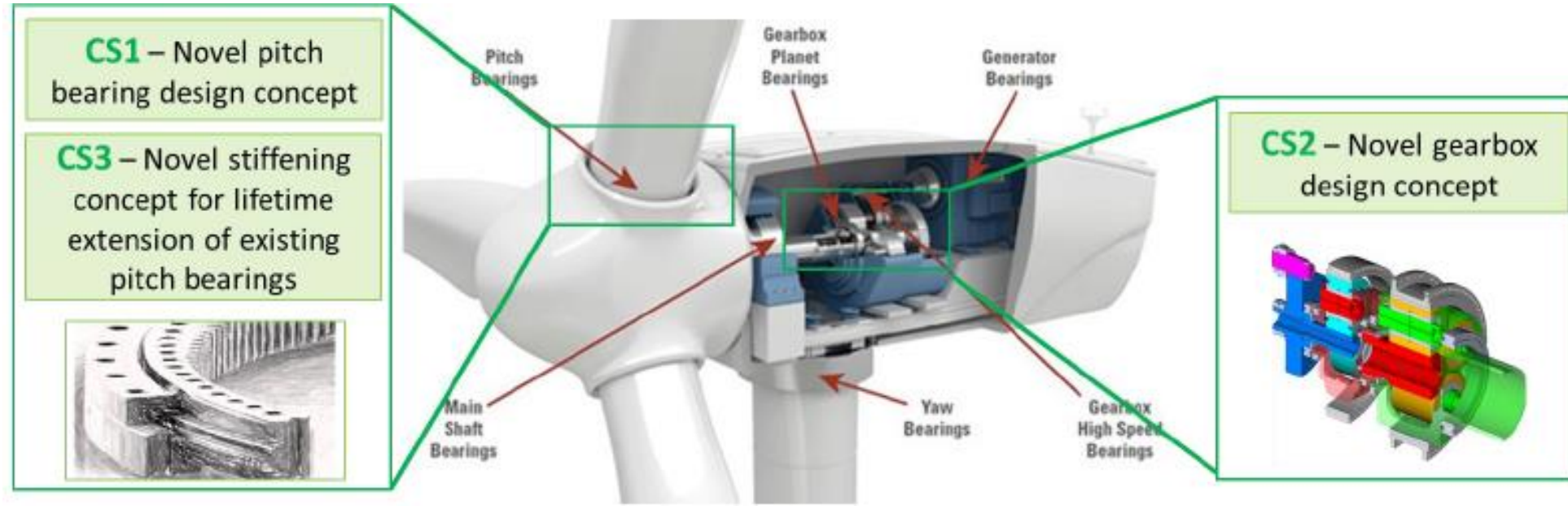
# INTERESTING HYBRID TESTING METHODOLOGY

- iNNTERESTING aims to eliminate the need of building large test benches in the future by simplifying the product development process (PDP) of new wind turbine components, reducing costs and time.



# CASE STUDIES

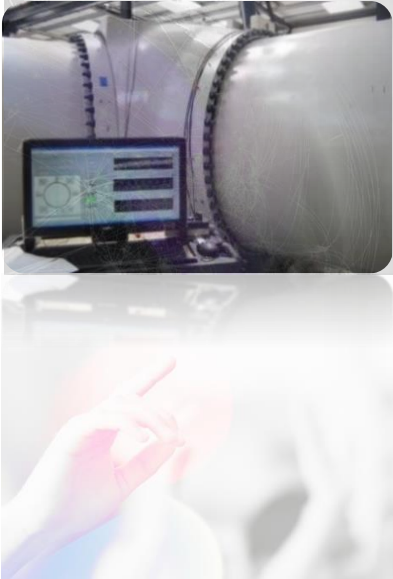
- Three Case Studies will be developed:



- **CS1** - Experimentally validated prototype of the **new pitch bearing concept** developed during the INNTERRSTING project for being used in future larger wind turbines (by 2030-2050).
- **CS2** - Design and verify a next generation **wind turbine main gearbox GBX concept** including novel gearing and bearing systems to increase torque density and reliably. The scope of this project is to build virtual and physical prototype demonstrator based on the new concept, furthermore, combine virtual and physical testing into hybrid testing.
- **CS3** - Experimentally validated innovative **pitch bearing lifetime extension concept** developed during the INNTERRSTING project for being used in already installed wind turbines for pitch bearing stiffening and reparations.



## CASE STUDY 1 NOVEL PITCH BEARING

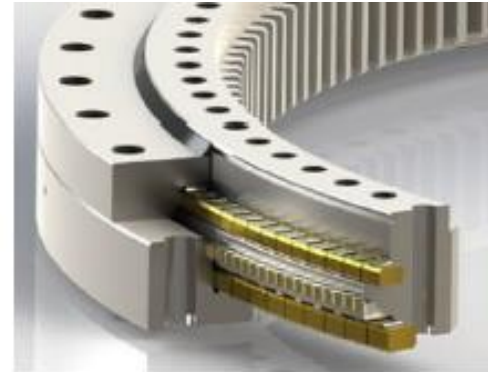


A pitch bearing is a component that connects the rotor hub and the rotor blade. The bearing allows the required oscillation to control the loads and power of the wind turbine.

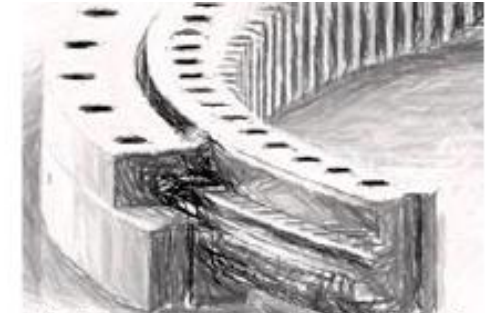
- The **new pitch bearing design** must fulfil the loading, environmental and structural specifications defined for future larger wind turbines: **higher static capacity, longer lifetime** and longer **fatigue loading requirements** are expected.
- Final Rolling Contact Fatigue (RCF) failure mode validation will be performed on the 1,5 MW test bench at LAULAGUN's facilities. Other major failure modes will also be analysed and validated during the development of the component in order to verify the results obtained by hybrid testing implemented during ININTERESTING.



- Currently the most common pitch bearing concept is the Four-point contact (4PC) bearing design, widely used in the wind industry.



- In the last years 3 Row Roller (3RR) bearings have gained an increasing presence in the sector



**Future pitch bearing concept**

- But in any case, a bearing concept for supporting higher loading conditions is needed for future wind turbines.



## CASE STUDY 2 NEXT GENERATION WIND TURBINE GEARBOX (GBX)



**GBX is an essential part of the turbine's drivetrain converting torque and speed to be better suitable for generator.**

- The **next generation wind turbine GBX concept** will have at least two novel technologies implemented.

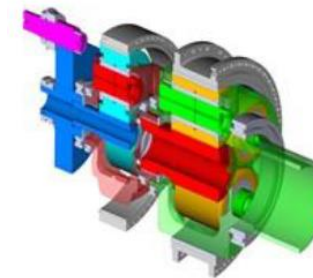
- **Novel gear materials** that will allow higher load carrying capacity for the geared components.
- **Novel hydrodynamic plain bearings** in selected positions.

These two new technologies are the enablers to increase the load carrying capacity with less material spend (torque density Nm/kg) compared to current designs targeting the level of 200Nm/kg.

- **Third key factor** is to build up a **virtual prototype and hybrid testing method**, which will bring significant advantages to design and verification process.



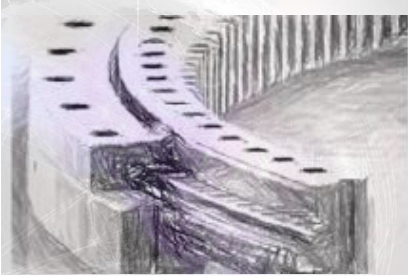
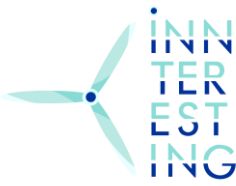
- Wind turbine gearboxes are mostly using roller element bearings nowadays.



- Hydrodynamic journal plain bearing (HBP) solutions have been used in the latest high torque density designs.



## CASE STUDY 3 INNOVATIVE PITCH BEARING LIFETIME EXTENSION CONCEPT



- The **new pitch bearing lifetime extension** concept must fulfil the loading, environmental and structural specifications defined for the extension of lifetime in already installed wind turbines.

### PROBLEMS

- The need of retesting the components for assuring longer lifetimes is a problem for the manufacturers
- When there is a failure of the component in use (e.g. Ring structural fatigue (RSF) failure mode) the replacement of the component can be difficult

### REQUIREMENTS

- The desired time to implement the idea must be short
- The wind farm must remain in operation working with a high confidence level

### OBJECTIVE

To verify lifetime extension and reliability evaluation of the new lifetime extension concept for pitch bearings.

- To **verify the new lifetime extension concept** viability for stiffening and/or reparation in pitch bearings.
- To verify the suitability of the **hybrid testing methodology** during validation process of novel lifetime extension concepts for pitch bearings with respect to the current processes.



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# THANK YOU!



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