

windEXT

Advanced maintenance, lifetime extension and repowering of wind farms supported by advanced digital tools

Newsletter Edition 5, May 2021

Project Overview

Launched in January 2020, **WindEXT** is an ambitious European funded project. The goal of the project is to develop and standardize specialized training integrating digital tools like Virtual Reality or 360° video tours to complete the classical theoretical methods. Furthermore, the project is an advanced integration of partners of different profiles and experiences to facilitate the exchange of knowledge between Universities, Vocational Training centers and private companies, in a model that it is now followed in different countries to facilitate the employability of students leaving both types of centers.



The goal of this approach is to reduce the LCOE of the windfarms in operation, either existing or new ones, by increase the quality of O&M services while extending the lifetime of the assets and

the working HSE conditions of the maintenance personnel. The duration of the project will be three years, so it will end up in December 2022.

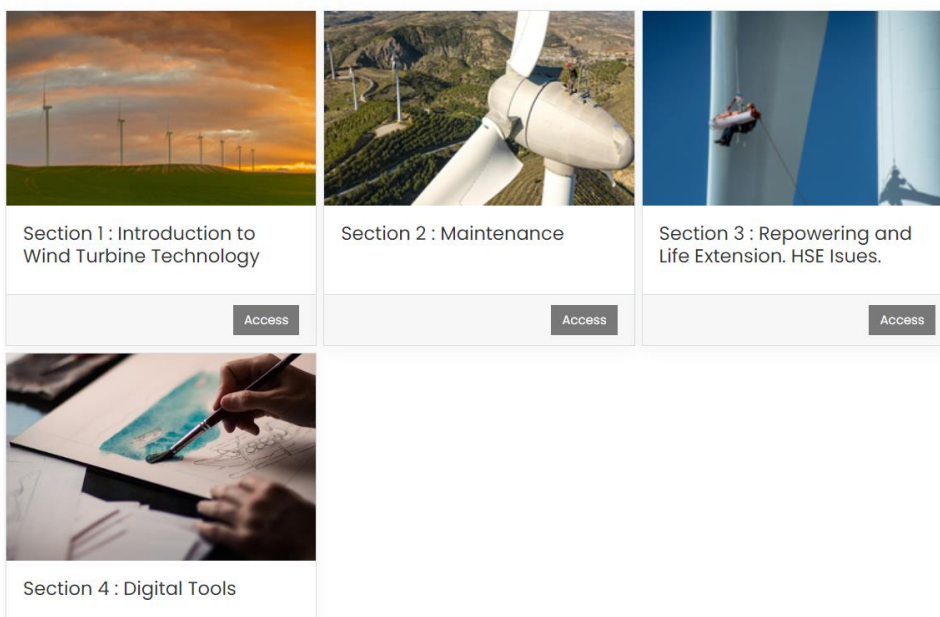
After almost two years since the start up on January 2020, the project has allowed the development of a training course based in a MOODLE platform where all the contents are integrated as well as the different digital tools below presented. The intention of the consortium is to promote the use of either the course as a whole or some independent modules or tools, serving always as practical basis of the theoretical teaching.

The **WindEXT** project receives funding under the [ERASMUS + programme](#) of the European Union.

The structure of **WindEXT** is based on four sections and each section has different modules. The sections are:

1. Introduction to wind turbine technology
2. Maintenance
3. Life extension and repowering
4. Digital tools

Available sections of WindEXT Course



Picture 1: overview of the course structure on Moodle

Within the digital tools, **WindEXT** presents: **WExSiM**, **WExLaB**, **WExViR** and the 'Failure Tree' software **CaDWEx** and a new version of SimulWIND.

Through the **WExSiM** tool, various scenarios can be reproduced in 3D simulation software. **WExLaB**, shows students the basic concepts and design of a wind turbine. Especially the design of wind turbines is explained with the help of MATLAB Simulink®. **WExViR**, shows the various maintenance areas (preventive, corrective and predictive) of wind turbines through the H5P tool. Finally, the **CaDWEx** "Failure Tree" software allows, through a mathematical function, a set of data is taken as input and as output we get the evolution over time of the damage of a machine component.

Project situation

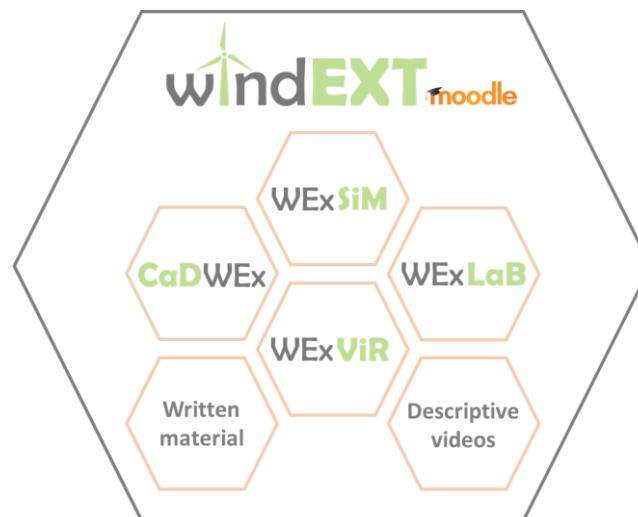
After a project period of almost two and a half years, the development is largely complete. We have also started the first pilot test and extensively tested the **WExSiM** module. In addition, we presented the **WExSiM** module and the new version of SimulWIND to the public at Wind Europe in Bilbao at the booth of our project partner AEE.

For our “Failure Tree” software we implemented a fourth module called **CaDWEx**.

We look forward to the last half year of our **WindEXT** project with confidence and are optimistic that we can bring it to a successful conclusion according to the expected results.

Project progress

All the content of **WindEXT** project will be in the MOODLE platform, from the theoretical content to the digital tools, with the exception of **WExSiM**, which will be accessed externally.



Picture 2: structure of our **WindEXT** course

WindEXT . Digital tool: WExSiM

The simulation runs on the Oculus Quest 2. We have now completed 5 training procedures, which can be viewed on our homepage www.windext.com and on our YouTube®-channel **WindEXT**. The 5 training scenarios are:

- Maintenance and replacement of a yaw drive
- Blocking High speed shaft
- Evacuation from service lift
- Hydraulic torque wrench operation
- High voltage cabinet fuse replacement

This part of the project has been completed in its development and we are now waiting for the feedback from the pilot tests in order to improve and optimize the individual scenarios accordingly.

WindEXT .Digital Tool: new version of SimulWind

WindEXT has developed a new version of the SimulWind that allows the software to be used in up to four VR Googles, Vive PRO, Vive Pro 2, Oculus Rift and Oculus Quest 2. That makes possible 13 vocational training centers in Spain are using now SimulWind as training tool.

WindEXT. Section 1: Introduction to wind turbine technology. Digital tool:

WindLaB

Section one of MOODLE, “Introduction to Wind Turbine Technology” is divided into seven modules:

- Introduction to the Wind Turbine Components
- Design of a Wind Turbine Rotor
- Load Analysis of a Wind Turbine
- Operation and Control of a Wind Turbine
- Wind Farm Component Layout and Design Criteria
- Reliability, Failures, Faults and Fault Tree Analysis
- Contractual Models

The purpose of these sections is to familiarise course participants with different technological aspects and challenges related to the wind turbine. The course aims to answer the main questions that people are going to face when starting out in the wind turbine operations and maintenance field.

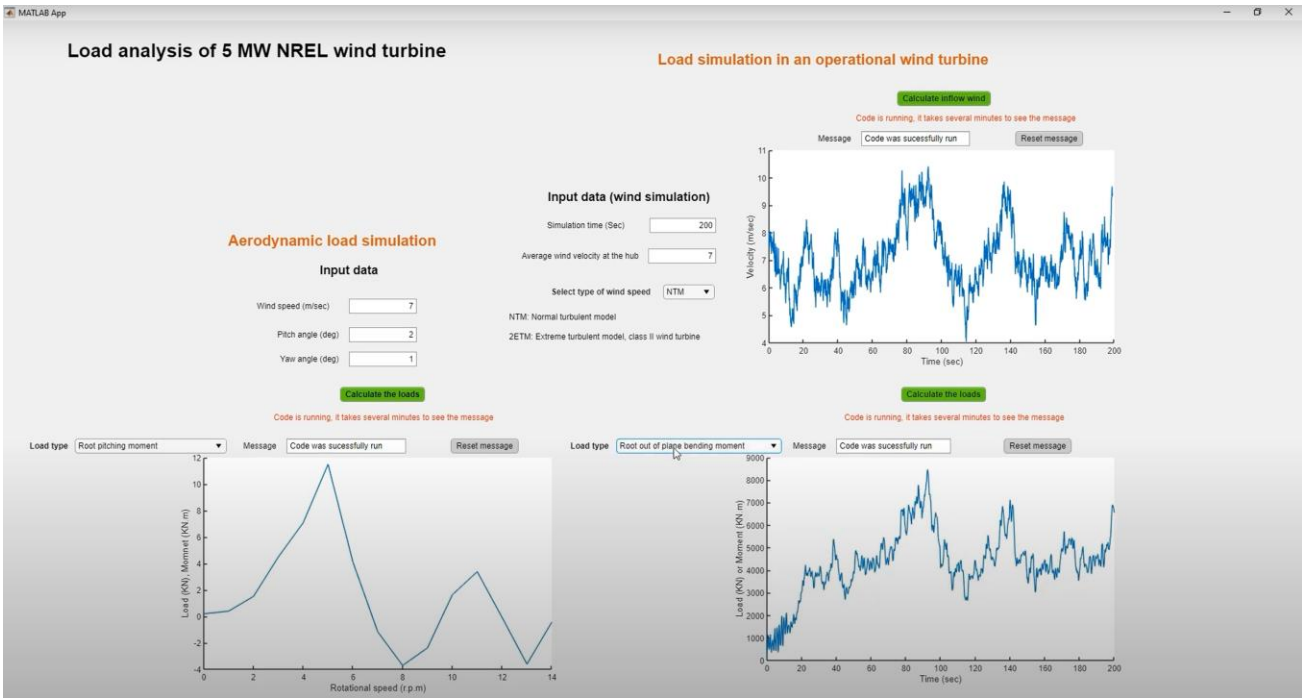
The digital tool associated with this section is WExLaB. This software integrates OpenFAST source code with a standalone MATLAB application as a graphical user interface. We have developed 4 parts of software:

- System level analysis
- Modal analysis
- Load analysis
- Operation and control of the wind turbine

The system level analysis and the modal analysis were described in the fourth newsletter.

Load analysis

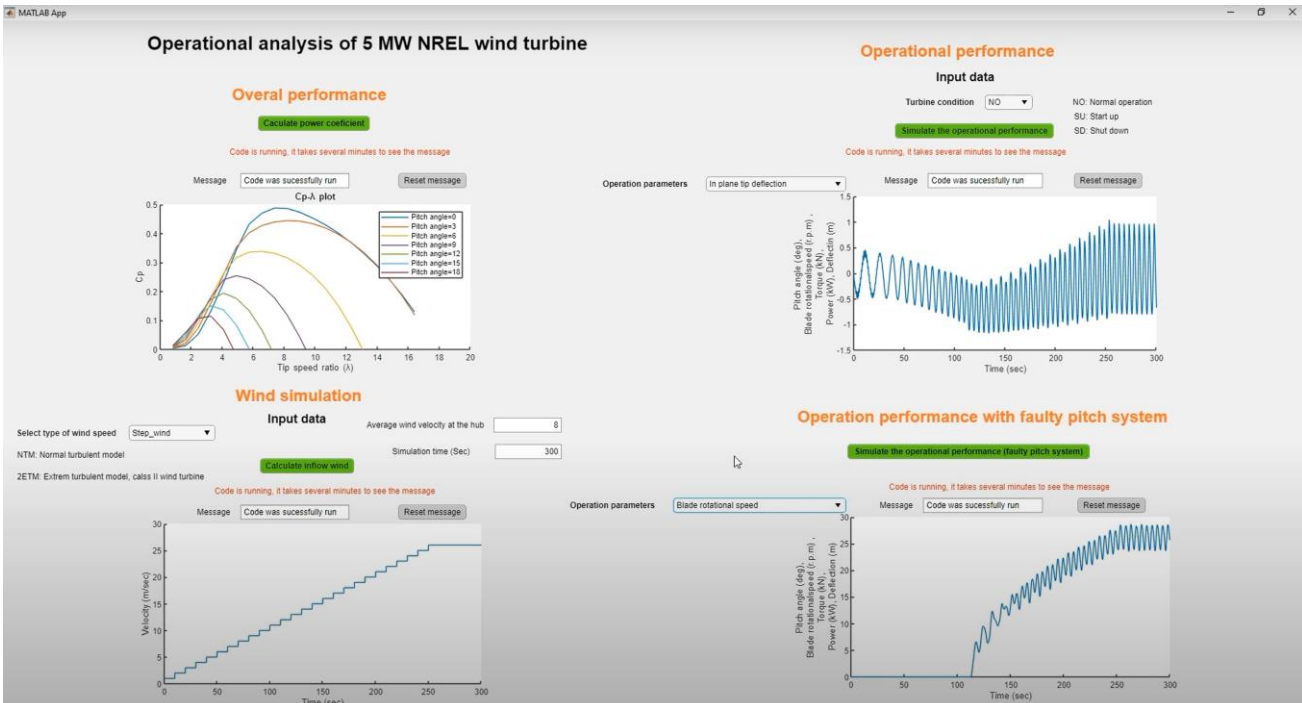
To calculate the load on each blade and to understand the different parameters of the wind turbine that can alter the load on the blade or tower is the main purpose of this part of simulation of software. In this part of the software, in addition to the load on each blade, the blade performance or $C_p-\lambda$ can be calculated. This part of the software is still under construction.



Picture 3: Load analysis

Operation and control of the wind turbine

This part of the software suite shows how the wind turbine is controlled across its operational range of wind speed. The blade torque and the blade pitch angle can be calculated during the operation of the wind turbine. This part of software is still under construction.



Picture 4: Operation analysis

WindEXT. Digital tool: Failure Tree CaDWEx

CaDWEx (Cascade Damage Explorer) is a software that allows to explore the chains of damage of a specified component in the area of fault tree analysis. And as example it focus on the gearbox. All possible faults were analysed and listed. The subsequent faults were defined for each individual fault with subsequent numbers as it can be observed in the tables below, so that a complete fault tree was created. Using this fault tree, the students can now learn about the faults, and how individual faults develop in the gearbox of a wind turbine along time. The learning material should also show when and how to react correctly to the respective faults. The software easily adapts to other components if the information of the fault development is provided.

The screenshot displays the CaDWEx software interface for fault tree analysis. It features a search bar for 'Daño a buscar' (Ring 2) and a 'Lectura del Excel desglosado - Codificado' section. The interface is divided into three main data tables: 'Tripletas encontradas', 'Cuartetos', and 'Nonetos'. Red and blue boxes highlight specific fault paths, and green arrows indicate the flow of damage from one level to the next. A blue circular arrow icon is also present.

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Picture 5: fault tree analysis

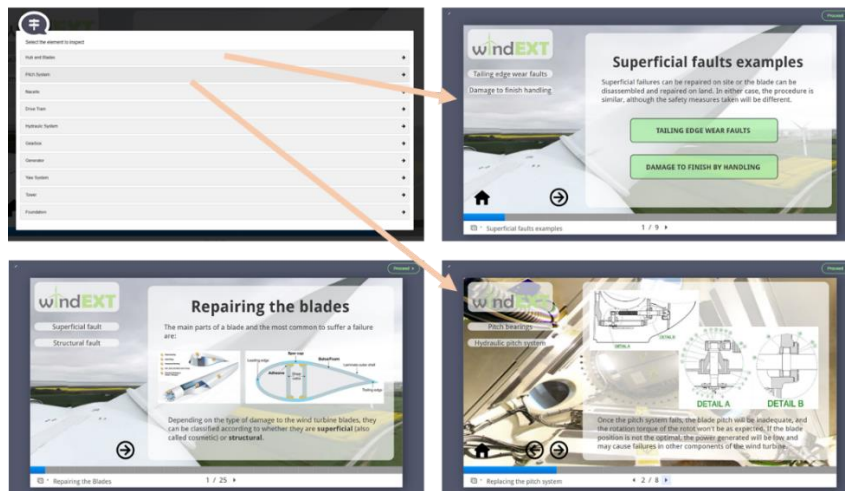
WindEXT. Section 2: Maintenance: Digital tool: Virtual Reality WindViR

In the second section of the course, students are taught the different approaches to maintenance strategies. This includes preventive, corrective and predictive maintenance. The theoretical teaching material for each section is available on the Moodle platform.

Through the WindViR digital tool, the theoretical concepts of this section can be better assimilated using interactive contents that allow for a friendlier approach than the traditional written material, developed in H5P as a *Guided Tool*. Besides, virtual tours have been developed through a wind turbine with 360° images using the H5P tool as well, in this case as a *Move-around Tool* that allows for a more independent use, for the students to have a complete overview of the different maintenance procedures.

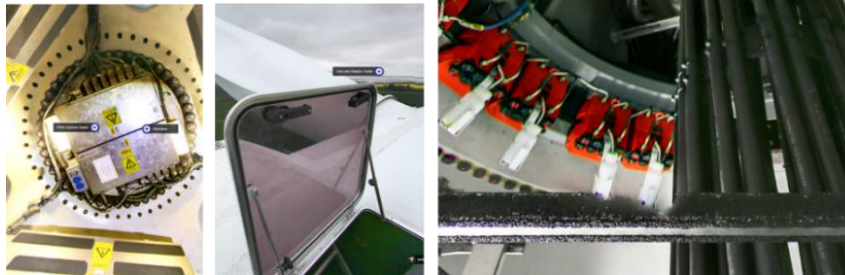
WExViR

Guided tool



WExViR

360° Move around tool



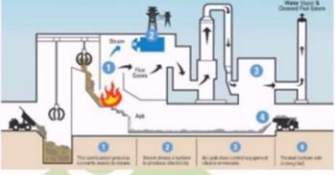
Picture 6: impressions of the WExViR tool

WindEXT. Section 3: Life extension, Refitting, Repowering: Interactive videos.

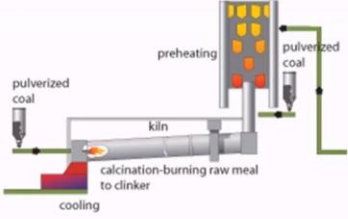
DP2i has been developing different training videos on the subject, with the special function of interactivity. During the last meeting in Bilbao, the first video and its interactivity function were shown. The development has been done with the collaboration of different educators and teachers. After the approval of the different members of the consortium, the remaining videos will be recorded to complete the course content.

Energy recovery from blade incineration

Incineration consumes polymer but leaves glass fiber behind.





Cement co-processing



- Consumes polymer and E-glass
- Substitute 1000kg blade waste= 600 kg coal

Source: University of Cork © Your Company 22





- Waste
- Blades
- Composites
- Recycling
- Mechanical [↗](#)
- Thermal [↗](#)
- Chemical [↗](#)
- Reusing
- 2nd Market [↗](#)
- Energy rec. [↗](#)

Picture 7: Interactive training video

Pilot tests

The first Pilot Test has been carried out in Pamplona at the TESICNOR center.

The students of the National Reference Center for Renewable Energies and Energy Efficiency (CENIFER) have been testing WExSIM, the Virtual Reality simulator of WindEXT.

CENIFER students have dedicated two sessions to identify improvements in experiences that recreate the work activity of the wind sector. The feedback received was very satisfactory. "It's very real, really," admits Diego Salinas, a second-year student in the Higher Degree in Renewable Energies who has worked for four years in wind farms. His partner, Verónica Aceña, agrees that through virtual reality "you can see very clearly the work you have to do and the risks you may have".



Picture 8: students performing pilot test in Pamplona

The next pilot tests will take place at Renewable Skills & Consultant GmbH in Germany, at INESTEC in Portugal and at TUDelft in the Netherlands.

Other minor tests have been performed by other partners like in Catarroja (Spain) where Simulwind and WExSim were tested by the teachers of eight vocational training centers on Wind Industry of the Autonomous region of Valencia in Spain. Other minor tests will be done in next months in León (Spain) and Lleida (Spain), and we are looking to make a test in France.

WindEXT goes WindEUROPE annual event 2022 in Bilbao

WindEXT was present at the WindEurope Annual Event that took place in Bilbao from April 5 to 7, 2022. All those attending the fair could try WExSiM and SimulWIND, the virtual simulator, at the AEE stand. In addition, on April 6, the entire windext consortium was at the stand to present the project and answer questions from the attendees.



Picture 9: fair visitors test WExSiM

TU Delft was also present at the WindEurope Annual Event and Exhibition at Bilbao to promote the WindEXT project and the pilot of the Moodle platform.



Picture 10: Simon Watson (TU Delft) explains WindEXT

Project meetings

Forth meeting, April 6, 2022, Bilbao

Our fourth transnational project meeting took place on April 6th at the Wind Europe fair in Bilbao. After the Corona Pandemic, our project partner UTEC from Uruguay was also able to attend the meeting in person.

More than two thirds of the project duration have now passed and the development of the individual modules is nearly completed. We discussed the final details of each module during the project meeting. In addition, preparations have been made for further pilot tests so that they can be carried out in May and June 2022. The WExSiM module, which has already been completed, has already been extensively tested by the project partners with the help of the VR glasses. As in every meeting, the administrative matters were also discussed and prompt processing was requested.



Picture 11: project consortium at project meeting in Bilbao

Overall, we are very satisfied with the progress of our project and are pleased to be able to present the results to the public.

Disseminations and Exploitation of project results

On the project website www.windext.com, all results will be published. There will be also published 6 newsletters during the project. If you are interested in this newsletters, you can register in our database at info@windext.com to get newsletters automatically.

Finally, the project has its own Twitter channel. Follow [@Wind_EXT](https://twitter.com/Wind_EXT) and you will be informed about the current project status.

Project Consortium

A consortium of European key players in the Wind Industry (entrepreneurial associations and maintenance companies), Universities and vocational training centres come together, to create the reference training course **WindEXT**.

The presence of UTEC/CEFOMER from Uruguay is considered fundamental to adapt the contents to another sociological/legal scenario as the LATAM countries.

Project Leader:
Asociación Empresarial Eólica (AEE)



Projectpartner



Web: www.windext.com | E-Mail: info@windext.com | Twitter: [@Wind_EXT](https://twitter.com/Wind_EXT)