watereye
RESEARCH
& INNOVATION ACTIONS

WATEREYE has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 851207

O&M Tools Integrating Accurate Structural Health in Offshore Energy

Welcome

Dr. Ainhoa Cortés
WATEREYE Project Coordinator

Dear reader,

The project has reached its half-way and we could not be more satisfied with its first outcomes and the degree of fulfilment of the objectives set. However, there are still great challenges ahead to develop the WATEREYE's integral solution and complete its validation in a relevant environment (TRL5).

In this third newsletter, you will find the latest activities conducted by our partners, who are fully committed to the achievement of the objectives. As a result, FMAKE has developed and deployed a software tool for visualizing the corrosion level of a monitored WT tower structure. Furthermore, you will find detailed information about the ultrasound sensor nodes being developed for the fixed monitoring solution, and the progress on the development of the sensor placement system and the Drone Docking Station. TU Delft and SINTEF-Energy Research have made good progress with the weather forecast and the O&M decision support tools respectively. Regarding the WATEREYE Exploitation Plan, nineteen components designed within the framework of the project have been identified, whose commercialisation is of great interest to the offshore O&M sector.

Furthermore, you will find information about the latest communication tests conducted in a real offshore wind turbine in the Canary Islands.

As part of the meetings plan, the External Expert Advisory Board took place on 17th March and was composed of five offshore wind and corrosion specialists which provided valuable recommendations to be considered during the project implementation.

Thank you for your interest in the WATEREYE project, enjoy the reading!

Ainhoa Cortés.

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About WATEREYE

The WATEREYE integral solution will allow Wind Farm Operators to accurately predict the need for future operations & maintenance (O&M) to reduce its costs, which can represent up to 30% of the Levelised Cost of Energy (LCOE) (an estimated LCOE of 70€/MWh in 2030), and to increase the annual energy production from the offshore wind thanks to an accurate structural health monitoring and control of the Offshore Wind Farms.

For this purpose:

1. WATEREYE aims to develop high-accuracy, fast-response, and non-invasive ultrasound smart sensors to detect and estimate corrosion levels by analysing wall thickness, which will be integrated into a high-precision indoor "drone-based mobile platform" inspection system capable of monitoring the entire critical area.
2. Design a robust wireless communication system and a custom protocol that will prevent data losses or corruption even in a harsh environment.
3. Collect, store, and provide efficient access layers for the wind turbine data to ensure optimal understanding of structural health.
4. Develop accurate mathematical corrosion models for offshore wind turbine structures to characterize the corrosion phenomena in the wind turbine tower.
5. Develop condition-based maintenance tools for fault diagnosis; corrosion prognosis algorithms; decision support to define predictive O&M; and fault-tolerant control of offshore wind structures.
6. Develop control algorithms for adaptive O&M strategies of individual wind turbine and the overall plant. The WATEREYE monitoring system will determine the condition of the structures. This information, together with O&M tasks, will minimise the need for human inspection, vessel transfer, and optimising onshore logistics.

Visit us at www.watereye-project.eu to extend this information

Download here our leaflet to get more details about WATEREYE concept and methodology

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Meet the WATEREYE Team

*Click on logos to access the partner's webpage

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Follow us and share it

We would like to encourage you to follow us on our website, Twitter or LinkedIn as well as to tag @watereyeproject in your tweets to circulate news, publications or events on our Twitter feed. In the same way, we encourage you to use @WATEREYE PROJECT in your LinkedIn public actions regarded to WATEREYE.

WATEREYE News

The WATEREYE project releases its first promotional video

The WATEREYE project is glad to release its first promotional video, which aims to present the integral solution that will be developed within the scope of the project.

In this video you will find the main objectives and innovations that are being developed, putting the focus on those critical systems that have a key impact into the O&M processes, identifying a clear need for smart monitoring and structural failure detection.

WATEREYE integral solution will allow to accurately predict the need for future maintenance, to reduce O&M costs and to increase the offshore wind annual energy production.

Watch the video here.

Enjoy it!

Ceit progressing on the Ultrasound Monitoring System

Ceit has developed their miniaturized ultrasound sensor nodes (120 mm x 70 mm) for the fixed monitoring solution to be deployed at the splash zone and for the mobile solution to detect the corrosion of the most critical points of the atmospheric zone.

Different piezoelectric sensors from several suppliers have been tested. For 5 mm thickness samples, a very narrow time response is required with the aim of keeping a high accurate Time-of-Flight estimation (≈1µm) even when we measure coated samples.

Figure 1. Test setup for ultrasound sensor nodes

SINTEF-Industry has produced 40 mm thickness samples with the aim of proving the monitoring solution in a more realistic scenario since the structure's thickness can be from 40 to 80 mm. Thus, 40 mm thickness samples have been measured in Ceit using the ultrasound technique and compared with the reference thicknesses measured by SINTEF-Industry using conventional methods. Ceit has achieved a flexible solution able to work also with real thicknesses.

Flanders Make releases the 3D visualization software tool

A software tool (SW) for 3D visualization of corrosion status of offshore wind turbine structures using ultrasound measurement data has been developed and deployed on the

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WATEREYE server. The SW tool is developed based on pvbrowser® platform with an architecture tailored to offshore wind turbine applications as illustrated in Figure 2. This framework allows multi user functionality as shown in the figure.

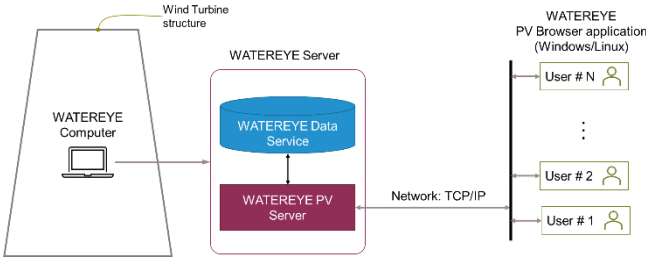

Figure 2. Data flow and communication achitecture

Every end-user who wishes to interact with the graphical user interface (GUI)/human-machine interface (HMI) can launch a software tool PV-Browser (executable for Windows and Linux available), and multi-platform through a docker container. Figure 3 shows the screenshot of the GUI.

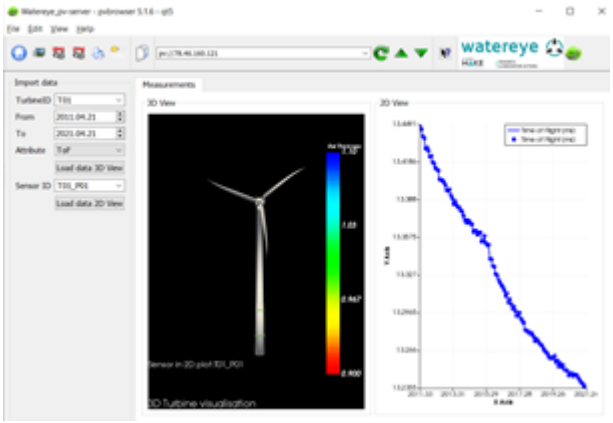

Figure 3. Human machine interface (HMI) WATEREYE pv browser

TU Delft developing a weather forecast tool

It is crucial to develop the weather forecast tool for wind energy engineering. On the one hand, the short-term wind field forecast can help to develop more accurate and efficient WT controllers for load mitigation and power optimization. On the other hand, the long-term weather forecast can support the prediction of the WT corrosion status, which helps for WT health prognosis and operation and maintenance (O&M) scheduling. Therefore, TU Delft develops potential weather forecast tools that can be applied to the offshore WT engineering.

For the control-oriented purpose, TU Delft develops a baseline torque controller integrated with the Weather Research & Forecasting (WRF) - Generalized Actuator Disk (GAD) model. This can simulate the power and torque performance of the offshore WT under predicted realistic wind field. At the same time, it can capture the influence of the WT has on the surrounding numerically predicted atmosphere. Moreover, it provides the potential to develop more efficient controller in realistic working condition.

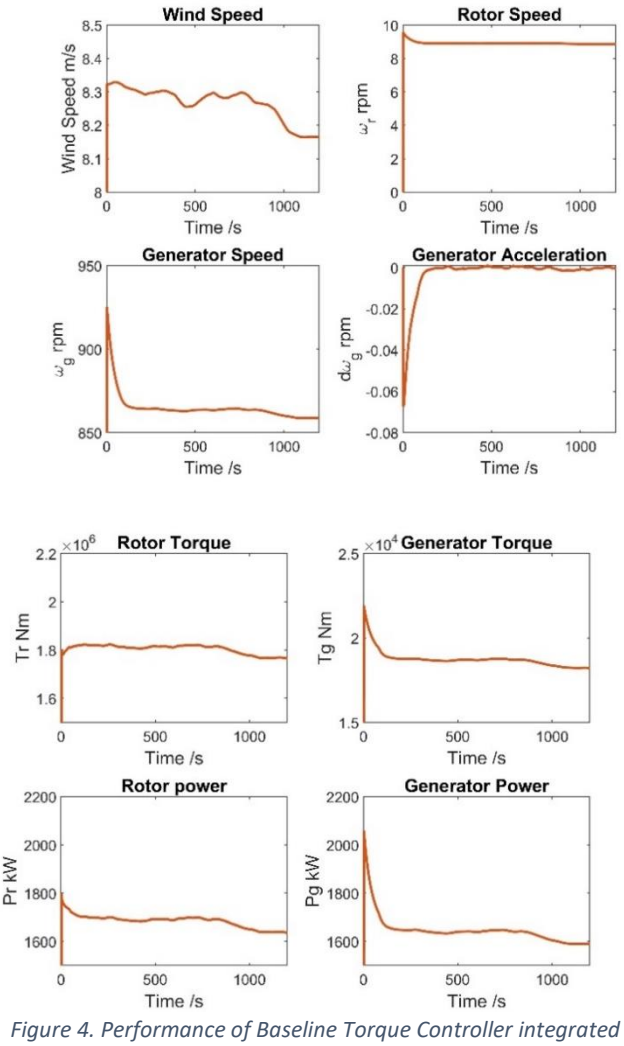

Figure 4. Performance of Baseline Torque Controller integrated with WRF-GAD model

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For the long-term WT health prognosis, we develop a Gaussian Process (GP) based weather prediction model. This model can predict the key weather factors that influence the corrosion process, such as the sea level temperature and the humidity. This long-term prediction method will definitely help to increase the accuracy of the corrosion prediction, and O&M strategy design. Thus, it can help to reduce the O&M costs.

Delft Dynamics progressing on drone adaptations

Delft Dynamics has been working on the drone and is progressing on the development of the sensor placement system. This system will be mounted on the rotor guards of the mobile platform to make high precision wall thickness measurements. Software and hardware has been developed to make the drone fly indoors and to know the exact location of the thickness measurements.

Figure 5. Test setup for Indoor Positioning System

Furthermore, Delft Dynamics has been working on a Drone Docking Station (DDS), which can store the drone when not in use. It has a built-in elevator system to raise the mobile platform to ensure optimal take-off and landing conditions. After an inspection flight has been performed, the mobile platform will land back on the landing pad which then will be lowered. A roller shutter will close after the elevator has been lowered to shield the drone from the environment. The dronebox also houses a winch and tether system to give the drone unlimited flight time via a theter.

SINTEF-Energy Research progresses towards O&M decision support tools

SINTEF-Energy Research started its main tasks in WATEREYE with the beginning of WP4 "Wind farm control and management tools" in January 2021. Two promising methods suitable for real-time uncertainty quantification were identified and are currently being developed and evaluated for the use in a probabilistic analysis tool for wind farm control. The probabilistic strategies are tested using SINTEF's STAS wind farm system dynamics and control software, available on Github here.

Iver Bakken Sperstad hold a presentation on "O&M decision support tools" at WESC 2021, putting the WATEREYE project into context of previous research on maintenance strategies. A maintenance planning model was implemented and is being refined now towards smart routing and scheduling for operational decision support.

WATEREYE Exploitation Plan being developed by Cobra

By now, 19 components designed within the framework of the project and whose commercialisation is of great interest to the offshore O&M sector have been identified.

These components have been classified according to the industry needs they cover:

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1. Solutions for monitoring Corrosion inside WT.
2. Solutions for monitoring, prediction and control of Structural Health in offshore WTs.
3. Tools for WF analysis, control and O&M smart decision including SHM.

Ceit tests a wireless communications system in the Canary Islands

Last 2nd of June, different tests were conducted on the Esteyco's ELICAN prototype, installed on the PLOCAN marine test site. The trials, led by the project coordinator Ainhoa Cortés, aimed to test the range and robustness of the wireless communication solution developed by Ceit in WATEREYE (based on Ultra Wide-Band, UWB) in a realistic scenario, such as the offshore wind turbine located on the east coast of Gran Canaria.

To do this, different types of antennas and UWB channels were tested. In this way, the operator emulated being the mobile node (the drone) climbing the ladder inside the wind turbine tower.

Figure 6. Test setup inside the wind turbine tower

On the other hand, three fixed nodes were located on the access platform: one for the estimation of distances, another for UWB communication that was also connected to a 3G module to send all the data to a server deployed by Ceit in real time. The third node served to test in parallel another communications link as a redundant system based on subGHz technology.

Figure 7. Fixed nodes located on the access platform

First External Expert Advisory Board (EEAB) – Online - 17th March 2021

On 17 March, the first EEAB was held virtually, with the attendance of Wedge, OWILab, EnerOcean, Ingeteam and C-Cube representatives. Firstly, a general overview of the WATEREYE project was presented and then a presentation of the active work packages was conducted. During the presentations, a series of questions were discussed among the partners and the EEAB members, who showed their interest in the WATEREYE research. Considering their huge expertise and knowledge in coating, corrosion & structural health monitoring, wind farms O&M and offshore platforms, it is considered that the WATEREYE activities are in line with the offshore wind necessities.

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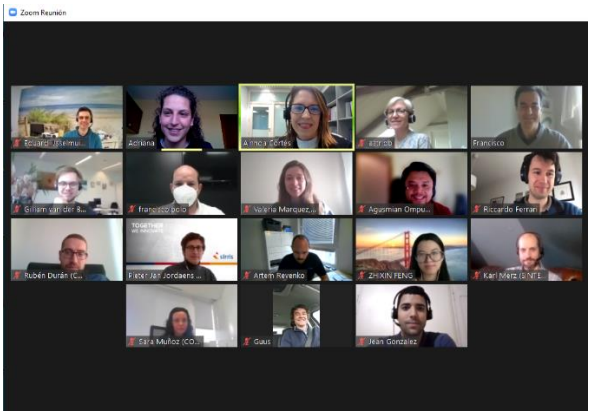

Figure 8. 1st EEAB Meeting

4 Conference papers have been presented at WESC (Wind Energy Science Conference) – Online Event – 25th -28th May 2021

WATEREYE partners Ceit, FMAKE, TU Delft and SINTEF-Energy Research were present at the Wind Energy Science Conference, which took place over four days last May. Our colleagues presented their conference papers based on the work conducted within the scope of the WATEREYE project.

1. U.Chathurani, A. Cortés, A. Irizar. Smart corrosion monitoring system to improve the O&M in offshore wind farms.
2. A. P. Ompusunggu, I. Coudron, J. Wan. Towards a Digital Twin for Corrosion Monitoring of Offshore Wind Turbine Structures.
3. Feng, Y. Liu, R. M.G. Ferrari, J-W van Wingerden. Wind turbine control using a WRF-based meteorological model: a case study on a 5MW benchmark.
4. I. Bakken Sperstad. Operation and maintenance decision support tools – benchmarking and outlook.

Figure 9. Presentations at WESC

SINTEF Industry participated in EERA DeepWind 2021 Conference on 13th-15th January 2021

Our colleague Catalina H.M.H from SINTEF-Industry presented the WATEREYE Project at EERA DeepWind 2021 Conference, with the title "Corrosion and corrosion monitoring of structural steel in offshore wind turbines".

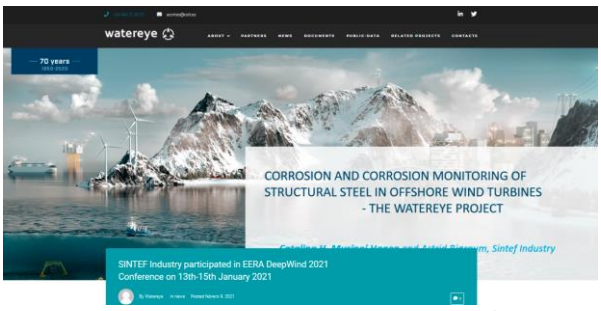

Figure 10. SINTEF-I presentation at EERA DeepWind 2021

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Events

Wind Europe Electric City 2021 postponed until 23-25 November

Wind EUROPE ELECTRIC CITY 2021
23-25 NOVEMBER
COPENHAGEN

Ceit will participate at Wind Europe Electric City 2021, which will take place on November 2021 at Copenhagen. Ceit's aim is to demonstrate its capability of measuring the Time-Of-Flight (TOF) using its US (ultrasound) testbed on different type of samples. In April, Ceit will show the US miniaturized solution. In any case, the US testbed allows us to send the US measurements done to the cloud with the aim of plotting the historical data from previous measurements through the web application designed by SWC (Semantic Web Company).

"Electric City" is a new onshore and offshore wind event, with participants from wind and beyond – heavy industry, mobility, district and domestic heating, storage, hybrids, hydrogen and many more – to join the conversation on how we build a clean economy.

More info HERE.

European Control Conference – June 29 – July 2, 2021. Virtual Conference

The paper "Active Power Control of Waked Wind Farms: Compensation of Turbine Saturation and Thrust Force Balance" conducted by our colleagues from **TU Delft** has been accepted in the European Control Conference 2021 that will be held from June 29 to July 2.

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Active power control regulates the total power generated by wind farms with the power consumed on the electricity grid. Due to wake effects, the available power is reduced and turbulence is increased at downstream wind turbines. Such effects lead to a design challenge for wind farm control, where the delicate balance between supply and demand should be maintained, while considering the load balancing in the wind turbine structures. TU Delft is proposing a control architecture based on simple feedback controllers that adjusts the demanded power set points of individual wind turbines to compensate for turbine saturations and to balance thrust forces. The effectiveness of the proposed feedback controller is demonstrated using high-fidelity computational fluid dynamics simulations of a small wind farm.

The conference aims to bring together academic and industrial professionals in the field of systems and control, and to promote scientific cooperation and exchanges within the European Union and between Europe and other parts of the World.

More info HERE.

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Partner's corner

Flanders Make

FLANDERS MAKE
DRIVING INNOVATION IN MANUFACTURING

Flanders Make is the strategic research centre for the manufacturing industry. From our sites all over Flanders, we stimulate open innovation, both in SMEs and large companies, through excellent research in the field of mechatronics, methods for developing products and technology to make them. Our goal is to contribute to the technological development of the vehicles, machines and factories of the future. By doing so, we create added value for the manufacturing industry.

SUPPORTING A SUCCESSFUL DIGITAL TRANSFORMATION

Together with companies, we perform pre-competitive research into shared challenges. The results are applicable to a wide range of companies that often face similar technological challenges. Together, they can innovate better and faster. In addition, companies can work together with us in a custom innovation trajectory. They can call upon our knowledge and services to develop a new concept or validate a solution of their own.

TEST AND VALIDATION INFRASTRUCTURE

Flanders Make also enables companies to have access to high-tech research infrastructure. This allows them to assess, validate and demonstrate new products and processes. We offer specialised test and validation infrastructure all over Flanders, where companies can optimise their products in real conditions. In addition, they receive guidance and support from our experienced researchers. They take charge of the innovation project and help the company to develop and market new products more efficiently.

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LONG-TERM PARTNERSHIPS

Flanders Make also attaches great importance to international cooperation in the field of innovation and to participation in European research projects. We join forces in one single innovation ecosystem and work together with companies, knowledge institutions and other research organisations. This significantly narrows the gap between theory and concrete applications matching the actual needs of companies.

Today Flanders Make counts over 700 researchers who work full-time as a unique research community on a joint industrial research agenda. With facilities across the whole of Flanders, Flanders Make also collaborates seamlessly with the five Flemish universities.

WATEREYE

Flanders Make developed a software tool compatible with SCADA systems that visualises the corrosion level of wind turbine structures based on ultrasound measurement data. This software tool will serve as a foundation to establish a digital twin for operation and maintenance of offshore wind farms. Flanders Make has extensive experience in the development of prognostics and health management (PHM) and decision support tools for predictive maintenance of mechanical and mechatronic components. This experience will be extended to offshore wind turbines in the WATEREYE project. To this end, Flanders Make will develop a set of algorithms for corrosion diagnosis, and prognosis of offshore wind turbine structures by employing the corrosion mechanism driven model and the ultrasound measurement data. Flanders Make also plays a role as the scientific coordinator in the WATEREYE project controlling the technical approach and the deliverables quality together with Ceit as the project coordinator.