Interreg Atlantic Area
European Regional Development Fund
EUROPEAN UNION
DURABLE
NEWSLETTER II – October 2020
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# Maintenance drones and robots to enhance renewable energy systems in the Atlantic Area

5 ATLANTIC COUNTRIES

3.9 M€ BUDGET

13 PARTNERS

36 MONTHS (2019-2022)

6 ASSOCIATED ENTITIES

## DURABLE ID

**Title**
DURABLE - maintenance drones and robots to enhance renewable energy systems in the Atlantic area

**Program**
Interreg Atlantic Area

**Duration**
April 2019- April 2022

**Main objective**
To apply disruptive aerospace, robotic, non-destructive inspection and additive manufacturing technologies to evolve towards a better development in the operation and maintenance (O&M) of wind and solar energy parks.

**Partner countries**
France, Ireland, United Kingdom, Portugal, Spain

## UPCOMING EVENTS

Participation in Wind Energy Hamburg

## EDITORIAL

Dear readers,

We are delighted to inform you that DURABLE is successfully achieving every established milestone, and we would like to thank you all for the effort made so far. This edition of the Newsletter covers the activities of the third project semester (03/2020-10/2020).

This time, we would like to show you more in detail some of the activities carried out in this period, namely the online webinar 'Robotic & Aeronautic Technology for solar and wind O&M' organised in April to offer an overview of the technologies applicable in the Operations and Maintenance (O&M) of renewable solar and wind energy.

Further, we will keep you up to date about the project partners´ activities and initiatives related to DURABLE and we will provide you with short summaries of the latest project events. At the end of the Newsletter, we offer you a short overview on upcoming events and initiatives related to the DURABLE topics.

Lastly, we have a new section "getting to know project partners" were you will have the opportunity to read small interviews made to some of our partners!

Latest and updated news can be also followed through our website: www.durableproject.eu and our twitter account (@DURABLEPROJECT).

Yours sincerely,
The DURABLE consortium

This Project is co-financed by the Interreg Atlantic Area Programme through the European Regional Development Fund under grant agreement EAPA_986/2018

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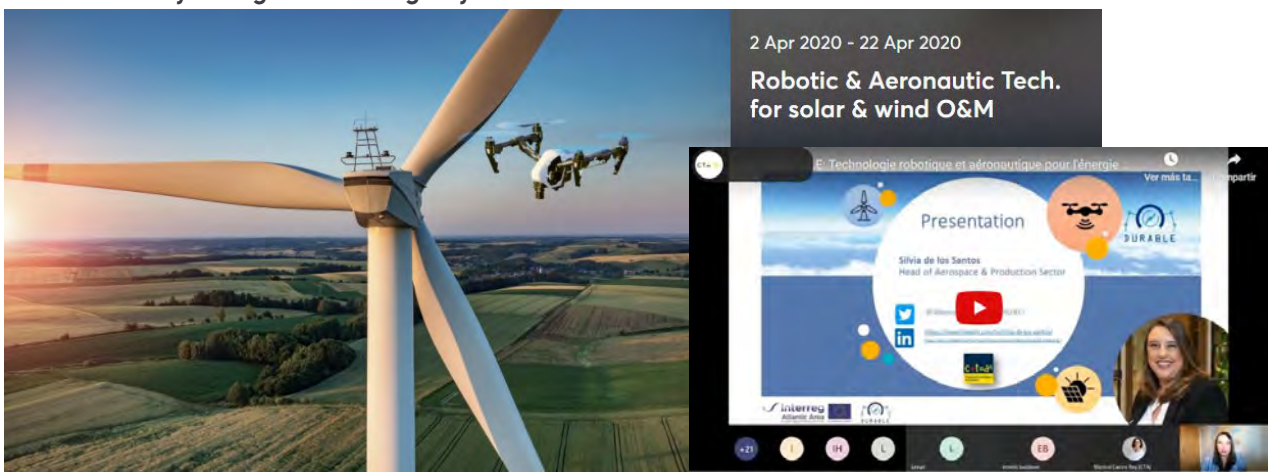
ESTIA institute of technology
Patxi Berard (Project Coordinator)
Email: p.berard@estia.fr

As part of task 4.3, the DURABLE CONSORTUIM organised an online event on aerospace technology and renewable energy that brought together 175 attendees from 15 countries. The meeting was organised by Technological Corporation of Andalusia (CTA) in collaboration with CESEAND, the Andalusian node of the Enterprise Europe Network of Support Centres for SMEs in matters of internationalisation and R&D and innovation, led by the Regional Ministry of Economy, Knowledge, Enterprises and University through the IDEA Agency.




"Durable Forums on robotic and aeronautic technologies for solar and wind energy O& M activities" served as a framework to exchange demands and technology offers for inspection and maintenance of solar and wind infrastructures. The Forums had two main activities:

- Technology Webinars: 3 webinars on latest robotics and aeronautic technologies along April 2020
- Virtual B2B meetings between technology providers of DURABLE consortium and assistants to the webinars to check real needs of wind and solar M&O sector.

The participating research centres and universities of DURABLE project were ALERION, ESTIA, Dublin City University, LORTEK, University of Seville, FADA-CATEC, UWE Bristol and the Instituto Superior Técnico de Portugal.

Within this framework, the most promising technologies with potential impact for renewable sector were analysed and collected in a catalogue ""Robotic and aerospace technologies with potential application to O&M in renewable energies" where companies can identify the latest technologies, their benefits, technology readiness level and directly obtain the contact of the developers of each technology in the Atlantic Area. Aerial inspection and sensing and monitoring technologies are clearly the most interesting ones for lowering the cost of renewable energy.

## PROJECT PROGRESS

Durable has had a lot of activity done in this last period, and this section shows the progress of some of the partners:

# VALEMO:

As an operator and maintenance service provider of solar and wind energy plants, VALEMO is often involved in the repair or replacement of damaged units or parts. This positioning made it possible to access to damaged parts which were made available to the Project partners for research and testing in their respective laboratories.

One former wind turbine blade was cut in 5 different parts in order to be sent to the different labs, and 3 solar panels, with different types of damages (electrical, mechanical…) were also provided for both non-intrusive and destructive tests. With a few delays caused by the global sanitary context, the parts were successfully delivered to their recipients and now being used for the next steps of the trials. The series of tests performed by CATEC, LORTEK and ESTIA will allow an optimization of the tools and technologies before the next step of on-site experimentation.

(VALEMO)

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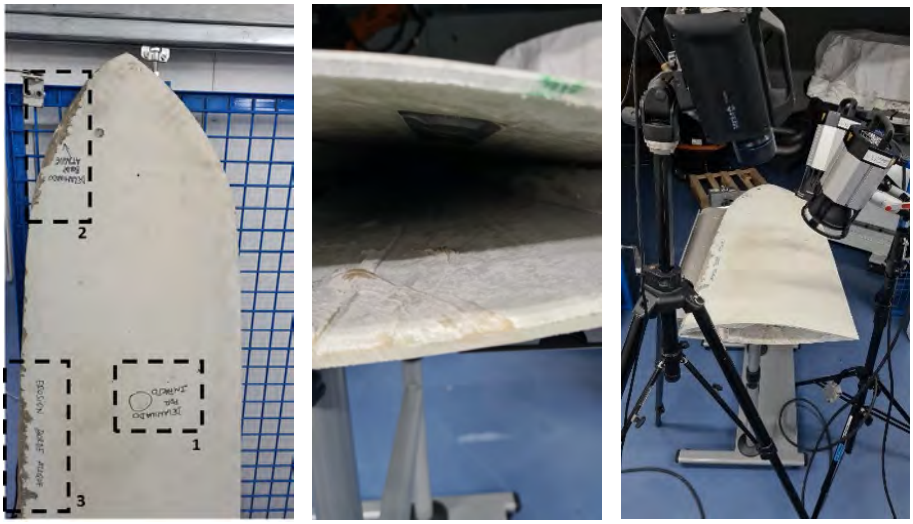
# LORTEK:

Thanks to the collaboration with INGETEAM, who provided a sample of a blade end that presents several delamination, LORTEK was able to carry out inspections using active thermography on wind turbine blades. Said blades present typical superficial and subsurface defects.



Real defects (left) and artificial defects (centre). Set up (right) (LORTEK)

The tests consisted of heating of different lengths, with sufficient cooling to reach a stable temperature. This heating was generated by two halogen lamps of 2kW each, and the sequences were recorded with a cooled thermal camera.

Once the thermographic sequences weere acquired, they were analyzed in the frequency domain using the Fourier transform, calculating the phase images at different frequencies.

The detection of a defect at a certain frequency can give us an estimate of its depth. The image shows how a more superficial defect (leading edge delamination) is detected at a higher frequency than a deeper one (impact delamination).

Impact delamination FFT 0,012 Hz (left), leading edge delamination, FFT 0,018 Hz (center) and leading edge erosion FFT 0,012 Hz (right). (LORTEK)

In the case of artificial defects, we can see how the three coins are detected, and they generate a signal according to their size. Regarding active thermography using UAV, LORTEK has worked together with Bristol University defining the characteristics of a small inspection system to be mounted on a drone. As a result of the research carried out, small flash lamps and acquisition system will be mounted on a drone, allowing the inspection in conditions in which a UGV cannot operate.

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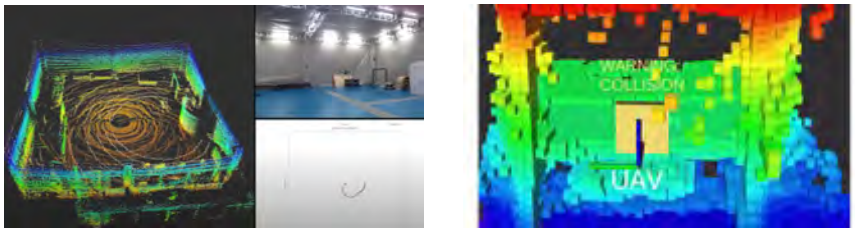
# CATEC:

In the last months, FADA-CATEC has been working in the design and development of advanced autonomous functionalities for unmanned aerial systems or drones. In this sense, FADA-CATEC developed an architecture that allows a drone to integrate advance perception and planning capabilities, transforming a drone into a real aerial robot. This architecture can be used to develop an intelligent navigation system, that allows to automatically detect and avoid possible obstacles, tracking of mobile objects, 3D mapping, etc. while completing the inspection mission. This higher level of autonomy will facilitate the execution of inspection missions, especially where the drone flies close to the infrastructure and other obstacles.

Right now, FADA-CATEC has started to test these technologies in a controlled environment (indoor testbed; see below).




Preliminary tests of autonomous functionalities for drones in FADA-CATEC indoor testbed (CATEC)

On the side of the adaptation of Non-Destructive Inspection methods and its implementation in UAVs, FADA-CATEC is working in the development of two drones specially designed to be used in the following inspection use cases:

- Inspection of solar panels with drones using infrared cameras.
- Inspection of wind blades using drones with contact inspection devices.

These drones are right now under development and they are expected to be ready in 2021.

In parallel, FADA-CATEC is defining and analyzing the main weaknesses & defects to be monitored in wind blades (flaws, cracks, impacts, delamination…). Two DURABLE partners, INGETEAM and VALEMO, sent two sections of wind blades in order to be analysed within contact and non-contact non-destructive inspections techniques, first at laboratory level and subsequently with drones.


[A] UAV flight over parabolic trough power plant Andasol 3, Marquesado Solar for Infrared Thermographic inspection. In the insert, thermogram taken of a tube in good operating conditions in the top and a tube with vacuum loss.
[B] Infrared thermographic inspection over Ingeteam wind blade section for detecting defects in GFRP after solar warming and heating / cooling excitation in a climatic chamber
[C] Set-up for Ultrasonic inspection over Ingeteam wind blade section for detecting defects
[D] A-Scan of a "safe" area and A-Scan of an impacted area. The back-wall echo disappears in the impacted region

FADA-CATEC has started working with two main NDT inspection techniques: Ultrasonic (UT) contact inspection and Infrared Thermography (IRT) as non contact inspection.

Regarding the solar energy inspection, FADA-CATEC is working on the definition and analysis of main weaknesses & defects to be monitored in Concentrated Solar Power plants (vacuum loss in HCE, loss of insulation, leakages, …) and in Photovoltaic ones (broken cells, solder defects in cell junctions, shadows, interconnection defects…).

Meanwhile, Energía de Portugal (EDP) is preparing the shipment of several PV panels from its plant in Évora to perform non contact NDT insepction both in FADA-CATEC laboratories and with drones, combining different inspection techniques.

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# UWE:

## Drone avionics simulation environment

UWE completed the setup and test of an "AirSim" simulated test environment, ready for integration with ESTIA's virtual cockpit laboratory, including an in-house developed Graphical User Interface to demonstrate compatibility with the industry standard protocols for drone control and streaming of on-board video.

This will enable a pilot to fly a real or simulated drone from a remote location and for us to test drone avionics without the risks and costs of flying a real drone.

## System development testbed UAV

UWE developed and tested the first two variants of "systems testbed" UAVs capable of being operated in laboratory spaces, but containing all the systems to be deployed on future larger variants.

This will allow UWE to develop the custom UAVs and systems needed to support both ESTIA's Virtual Cockpit and LORTEK's Solar Panel Inspection Sensor.

Systems testbed UAVs (UWE)

## Remote UAV communications

UWE completed development and demonstration of both drone control and "First Person View" (FPV) video streaming over both WiFi and 4G mobile telephony on an "Iron bird" avionics rig. This will enable a remote pilot to control a drone from anywhere in Europe that has 4G, and therefore reduce the reliance on local infrastructure at inspection sites.

Control and FPV flight test (UWE)

## Environmentally protected UAV

UWE developed and outdoor flight tested a prototype custom airframe equipped with an environmental cover. This gave valuable experience of the airframe design and manufacturing techniques that they intend to use for the final Solar Panel Inspection Drone, verification of their battery and motor energy consumption estimating methods, and useful input on improving the ergonomics of the drone during maintenance and flight operations. The flight operations themselves also gave them valuable experience clarifying the currently evolving UAV legislation, and developing appropriate flight test procedures.

Custom airframe flight test at UWE campus (UWE)

## UAV flying qualifications

Steve Wright completed 75% on his training for the new UK UAV operator's qualifications, due to come into force on 1st January 2021. Patxi Berard of ESTIA is completing his equivalent qualifications as well, so with UWE's Joonas Neelov's existing qualifications, they shall have a good team of pilots to support the Virtual Cockpit and Solar Panel Inspection projects.

## Solar panel inspection UAV

UWE had multiple productive discussions with LORTEK on the Solar Panel Inspection Sensor. This will allow them to converge on a sensor design that is sufficiently compact to be integrated with a practical drone, and a drone that can position the sensor accurately and steadily enough for the sensor to be effective.

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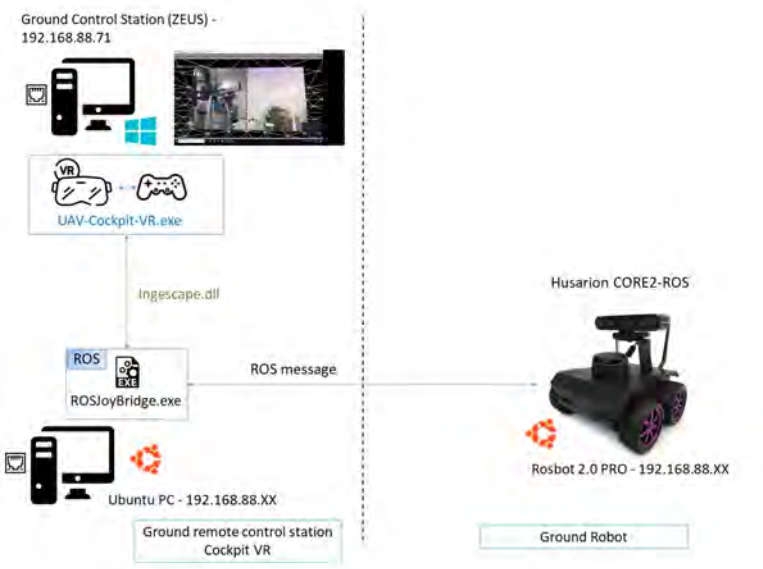
# ESTIA :

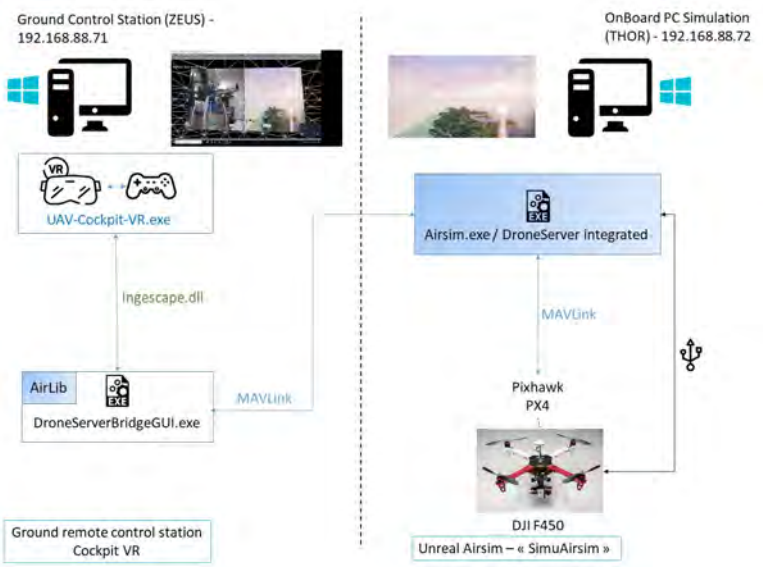
In the last months ESTIA could move forward significative on the technical development aspect. For the WP5 action n°5: Virtual and augmented reality for robots control: both aerial and ground the previous development for the remote control of a DJI 450 Flame with Pixhawk in HITL with AirSim was optimised to prepare the onboard PC in the goal of the achievement of the real fly. For the pilots ESTIA will use a more professional drone, the DJI M600 pro.

For the ground robot aspect, ESTIA can remotely control the robot (Rosbot 2.0 PRO) by using a Saitek Pro joystick controller through the ROS communication and get the video stream back. The development is running on an Ubuntu PC independent of the rest of the virtual cockpit environment system. Now they investigate the lidar data communication. After that, they will plug everything into the virtual cockpit.

Regarding the WP6 action n°4 : Virtual and augmented reality for using robots in persistent manual tasks ESTIA also moved forward, successfully capturing the operator body motion with the **neuron perception motion capture suit** and being able to display the avatar of the pilot into the cockpit by the Unity API.

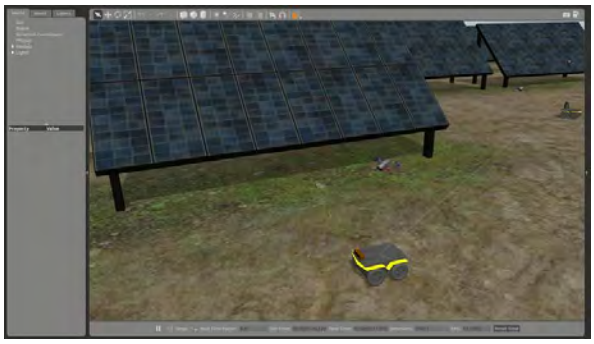



System architecture (ESTIA)




# IST:

IST made some simulations of their robot with solar panels. They also visited EDP's solar farm where they plan to have tests near the end of the project.



Simulations of robot with solar panels (IST)

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## In this section, project partner will let us know more about them and about their ambitions. In this edition, Patxi Berard from ESTIA and Silvia de los Santos from CTA have answered short questions regarding different topics, and here is the result!

PATXI BERARD, ESTIA

Patxi Bérard is an engineer graduated in 2011 from ESTIA. At the same time, he obtained the validation of the Master of Automated Processes (MPA) course from ESTIA and the "Master of Science Digital and Image Processing (DSIP)" from the University of Cranfield. He joined the PEPSS team in September 2011 as a design engineer. He is Project Manager for the development of innovative solutions at PEPSS. PEPSS Platform is integrated in Estia-tech service.

### Why does it make sense to transfer technologies from the aerospace sector to renewable energy?

The aerospace sector is an industrial sector where the main actors always search the best technical performance and to reduce the cost of the operations. They are at the forefront of technology, always using the new technologies the most efficient. For this reason, I think it makes sense to use aerospace technologies in any other industrial sectors, especially in the renewable energy, where the equipment is remarkable complex technologies (e.g. The wind turbines and the photovoltaic panels) and where the efficiency search is an obsession to make the energy production more productive.

### Which are the most significant challenges and opportunities related to DURABLE technologies in your opinion?

From my point of view, DURABLE project is a formidable opportunity to create disruptive innovant technologies more efficient, easier to understand, simplify the hurting tasks and reducing the cognitive task load of the operators. In the case of disruptive technologies, the challenge is double. The first one is technological, manage to create an efficient technology due to the complexity of the work, it is for that we call that "research", isn't it? And the second one is : even if you create a brilliant and efficient brand-new technology it is not always accepted by the operators. Because even when it is more efficient, when you are accustomed to do something in one way, sometimes it is really difficult to change your habits.

### Regarding your field of expertise, which application of augmented or virtual reality do you think will have a higher impact in the renewable energy sector?

In the DURABLE project we are involved into the development of a virtual cockpit to achieve two tasks.

First of all, to manually control the drones remotely in a rich 3D environment to enhance the immersion of the pilot and give him the sensation as he is physically into the drone. The goal is giving to him the opportunity to drive the drone like he would do with his own car. With the regular method, using a remote controller and watching the drone flying from the ground, when the drone quit your vision field you can only count on the video frame feedback if you have one and you have limited options to interact with the drone.

With the use of the 3D technology you can be totally involved into the flying operation like you are into the car driving. You can access to a 3D map of your environment, access to a lot of sensors feedback into a rich 3D cockpit like a plane one. You could be aware of your surroundings environment by getting the lidar point of cloud feedback and such as see your surrounding environment fitted at your scale like if you are the drone inside pilot.

The second use of this kind of technology is for the supervising of a drone swarm. Effectively, a regular supervising ground station is an addition of screens displaying a mountain of information making the understanding and the interaction difficult. We think with the virtual reality you can create and design 3D interactive content to supervise a drone swarm allowing natural interaction with them. The 3D map is a good example of the opportunity of that.

So, with this kind of technology you achieve two goals: the manually remotely control of the drone and when it is needed the supervision of the mission.

### How will DURABLE contribute to making this application a reality?

In this project we work with other partners who are expert on drone development and operational flying for detecting failure on wind turbines and photovoltaic panels. We also talk to potential end users of the technology which are wind turbines and photovoltaic panels fields owners and maintainers. Thanks to their help we will try to design a virtual cockpit for achieving real supervision and maintenance tasks to be tested during the on-site pilot (WP7) to be as close as possible of the real needs for this kind of expert task. Also, the collaborative work allows regular discussion and brainstorming which help us to create operational functions to implement into the cockpit which we didn't think about at the beginning of the development.

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SILVIA DE LOS SANTOS, CTA

Industrial engineer from the University of Seville. MSc. in Industrial Waste Management. Currently, she is Aerospace and Production Technical Officer at Technological Corporation of Andalusia (CTA), where she develops national and international R&D projects. She is also expert of the European Commission evaluating different H2020 calls. For 8 years, she has been Head of Knowledge Management and R&D Programmes at the Advanced Aerospace Technologies Centre (CATEC).

Social Media: @sildelosa
www.linkedin.com/in/silvia-de-los-santos/

### What is the role of CTA within the DURABLE project??

CTA leads the work package aimed at identifying and matching the necessities of the solar and wind energy producers in operation and maintenance actions and detecting the most innovative solutions available for the sectoral transfer.

### Where do renewable energies may benefit more from the transfer of aerospace technologies?

The operation and maintenance (O&M) of renewable energies is one of the areas that can benefit the most from the application of aerospace tech. For instance, the use of drones and robots is now a useful tool for monitoring the health of the infrastructures. In addition, additive manufacturing could be a cheap and fast solution to replace broken pieces. Finally, the virtual reality is developing techniques to control other technologies for inspection and maintenance of remote operations.

### How did you identify the needs of renewable sector regarding these technologies?

The consortium of DURABLE project has elaborated an analysis about the main needs regarding aerospace technologies for the SMEs of solar and wind sector. For the analysis, the project partners have carried out interviews and surveys with renewable energy companies throughout the Atlantic Area (Spain, Portugal, France, United Kingdom and Ireland). In addition, the results of this analysis were contrasted in B2B meetings between partners and companies, during the DURABLE Forums. The study reveals that 63% of the SMEs consider that remote inspection to reduce time, human resources and risks were the main needs. Secondly, there are other secondary needs regarding predictive maintenance (11,5%) and remote manipulation (7%).

### Which are the companies that should be paying more attention to this technology transfer? Manufacturers? Service providers?

It's depends on the technology applied but, in general, the SMEs are the main beneficiaries of aerospace technologies, in order to reduce their internal costs and increase the productivity. For manufacturers, for example, additive manufacturing will be really useful, reducing stocks of products and allowing the customization of pieces for singular installations. Finally, services providers could be the great beneficiaries because most of the new applications are focus on reducing time of inspections, increasing safety, etc.

### Could you mention some of the technologies that may have a higher impact for lowering the cost of renewable energy?

In DURABLE project we have analyse the most promising technologies with potential impact for renewable sector and we have elaborated a catalogue where companies can identify the latest technologies, their benefits, technology readiness level and to obtain the contact of the developers of each technology in the Atlantic Area. Aerial inspection and sensing and monitoring technologies are clearly the most interesting ones for lowering the cost of renewable energy.

For example, there are many technologies mostly available for inspection operations: autonomous drones for inspection with contact that allows to perform inspections flying automatically the drone, but allowing to perform a manual contact inspection of specifics areas, microdrones for non-contact inspection, drones with robotic arms and manipulation capabilities, drones with infrared or visual technologies, etc.

Other technologies such as Radio Emission Spectroscopy could be used for potentially classify the turbine faults at an early stage. Different techniques of Additive manufacturing could produce pieces cheaper and faster or Mixed Reality (MR) can also be used for the remote control of different vehicles used in maintenance operations.

We have organized 3 DURABLE Forums on Robotic & Aeronautic Tech for solar & wind O&M to explain these technologies to the renewable industry and provide the opportunity to ask directly to the technology providers. The recording of the event can be found here.

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## March 2020 | TÉCNICO TEAM + USE + CATEC achieves great results at MBZIRC 2020 (mohamed bin zayed international robotics challenge)

ISR/Técnico, the University of Seville and FADA-CATEC engaged in this competition to develop together technologies which are also paramount for DURABLE, namely the use of mobile manipulator UGVs (Unmanned Ground Vehicle), UAVs (Unmanned Aerial Vehicle) and their joint performance of cooperative tasks. ISR team won the victory in one of the MBZIRC2020's challenges. The team also won an honourable 4th place in the Grand Challenge.

## June 2020 | DURABLE partners ALERION and EDP RENEWABLES collaborate in an autonomous wind turbine inspection

The DURABLE partner ALERION, carried out this inspection in one of the EPD Renewable´s Wind Farms in Spain. They performed a FULLY AUTONOMOUS Complete 3 Blade inspection flight in under 15 minutes: Fast, Efficient, Reliable & Safe.


## March 2020 | ERF 2020 (Málaga, Spain)

DURABLE participated in The European Robotics Forum 2020 (ERF2020), the most influential meeting of the robotics community in Europe, was held in Malaga, Spain, on 3-5 March 2020, under the theme Future Robotics: Unlocking Human Potential. About 1000 top European robotics experts attended the conference. ERF2020 covered all aspects and current themes related to the field of robotics. Researchers, engineers, managers, and a growing number of entrepreneurs, bussiness people, and public funding officers from all over Europe came together to discuss technology push and market pull and how innovation in robotics and AI can be accelerated.


## September 2020 | 2020 International Conference on Unmanned Aircraft Systems (ICUAS'20)

ICUAS 2020 was a hybrid conference, including both physically and remotely presented papers. DURABLE was mentioned in the conference during a presentation as speaker of one of our partners, FADA-CATEC:

"Autonomous drone with ability to track and capture an aerial target, Manuel García, FADA-CATEC"

ICUAS

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## September 2020 | Our project partners Miriam Garcia and Eider Gorostegui, both from LORTEK, talked about the DURABLE project on the basque radio programme called "EKOSFERA"

The program was broadcast last September 3 and Miriam Garcia and Eider Gorostegui from LORTEK presented the DURABLE project and its main goals.


## October 2020 | S-MOVING: Smart, Autonomous and Unmanned Vehicles Forum

Advanced Center for Aerospace Technologies (CATEC) participated in S-MOVING event, the reference space for companies, professionals, entities and public administrations of the Intelligent, Autonomous and Connected Vehicles sectors. They took the advantage to disseminate DURABLE project during the forum.

## 2020 | UWE had a paper published on "Technology and Risk Considerations in Shaping Future Drone Legislation" in the International. Journal of Technology, Policy and Management

"The global aviation industry has decades-old and highly successful legislation enforcing safety in conventional manned aerospace. This framework has been evolved gradually around a set of mature technologies with particular goals and implementations, and legislators are now struggling to integrate the profoundly different implications of Unmanned Aerial Vehicle (UAV) technology into this regulatory environment. This paper seeks to inform future UAV policy by highlighting its technological and distinctiveness from conventional aviation and making recommendations for future legislation, based on these observations."

Check these and more DURABLE stories in **www.durableproject.eu**

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## UPCOMING EVENTS

### December 2020 | Hamburg: WIND ENERGY EUROPE (online format)

DURABLE will participate in an online format meeting of the Wind Energy Hamburg event. The world's leading wind energy event brings together the most important representatives from politics, industry and research in a global, digital meeting. This year, the event will go completely digital, and it will be held from the 1st to the 4th of December. The way in which DURABLE will participate is still to be determined.

Wind Energy Hamburg
The global on & offshore event

### January 2021 | 3rd progress meeting

The 3rd progress meeting of DURABLE will take place in January, and it will serve as an opportunity to get an overview of the progress so far and to plan further steps and tasks of the project. Agenda and format of this 3rd meeting are still to be determined.

We hope that you enjoyed the DURABLE Newsletter and already look forward to the next editions.

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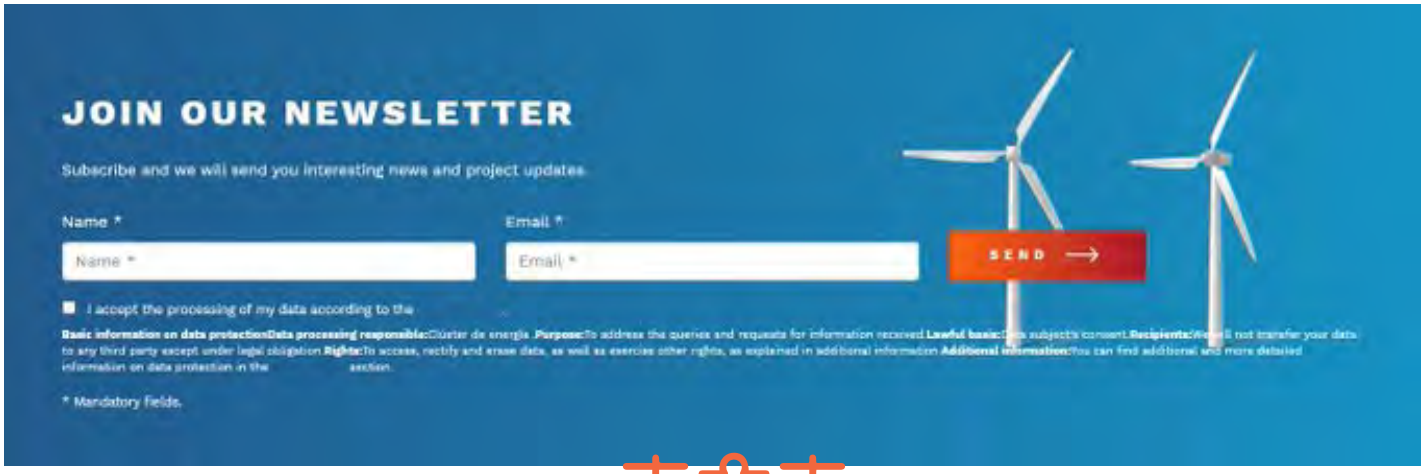


Sincerely,

The DURABLE consortium

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DURABLE

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ALERION
CATEC
Cluster Energía BASQUE ENERGY CLUSTER
CTA Corporación Tecnológica de Andalucía
DCU
edp new
LORTEK
Ingeteam
TÉCNICO LISBOA
UNIVERSIDAD D SEVILLA
UWE Bristol
VALEMO


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