Report on OpenLabs at Universities and R&D Institutions

University of Santiago de Compostela

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DISCLAIMER

EXECUTIVE SUMMARY

In the framework of PORTOS project (WP2 Action 5), Universities and R&D institutions (UPORTO, USC, IHCantabria, UNIOVI, EIGSI, UoP and MaREI) open their doors to the local communities (T4) for a day to fulfil O4 fixed in the Project Application Form of PORTOS: to inform society about the benefits of harnessing renewable energy and sustainability in ports and the role of the Atlantic Area programme and PORTOS in this topic. The events are celebrated during school holidays for targeting students. The main activities within WP2 Action 5 (OpenLabs exhibitions at Universities and R&D Institutions) are: (i) keynotes from academia and industry, presenting their outlooks on current developments; (ii) tours of the labs, including demonstration of technologies at tanks, flumes, wind tunnels; and (iii) competitions for students on renewables and sustainability.

In this context, the first OpenLab organized by the University of Santiago de Compostela took place on 12 December 2019 at the Escola Politécnica Superior de Enxeñaría (EPSE). This event gathered a large number of attendees (135) from different places of the province of Lugo and the autonomous region of Galicia with several backgrounds (pre-university students, university students and general public). As a results, this OpenLab succeeded in achieving its final objective of engaging society in PORTOS project and allowing attendees to learn about the potential of marine renewable energies and the long-term benefits of making sustainable choices.

This report constitutes a description of the different activities carried out within this event, including the detailed programme, the number and characteristics of attendees and a summary of the tasks developed.

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1. INTRODUCTION

OpenLabs are conducted in the framework of PORTOS project (Ports Towards Energy Self-Sufficiency), funded by ERDF through the so-called Atlantic Area programme, which seeks for the energy self-sufficiency of marine ports. The main objectives of these events are to disseminate and promote the use of renewable energy, and in particular of marine renewable energy (MRE) throughout society, focusing on the local level. The OpenLabs conducted by the University of Santiago de Compostela (USC) are carried out at the Escola Politécnica Superior de Enxeñaría (EPSE) of Lugo by the Integrated Group in Civil and Geomatic Engineering (CIGEO, by its abbreviation in Spanish). These events are composed by several activities, each of them being focused on a specific sector of the society.

Firstly, several short workshops in the labs are conducted focusing on the importance of harnessing MRE and showing some advanced tools to optimize its exploitation. These workshops are aimed at pre-university students with the objective of increasing their interest in MRE at an early stage of their studies. Then, and once the workshops of the labs are finished, a competition on renewable energy and sustainability is conducted based on the contents previously analysed.

Furthermore, other complementary activities aimed at general public are also conducted. In this way, several keynotes are presented by recognised experts on MRE topics from both the academy and industry.

Finally, the Hydraulics laboratory at EPSE is open to the general public. With this aim, tours are conducted to show the wave-current flume used by the researchers of CIGEO, along with a demonstration of how to test and develop Marine Energy Converters (MRECs).

The first edition of OpenLab-USC took place on 12 December 2019 attaining a total number of 135 attendees from different locations of the surrounding area and with several backgrounds and having a considerable media impact.

2. DETAILED PROGRAMME

The first edition of OpenLab-USC is composed of the following activities: (i) welcome and opening session, (ii) lab workshops, (iii) competition on renewable energy and sustainability, (iv) keynotes from academia and industry, and (v) tests in the Hydraulics Lab.

Three short workshops at the labs aimed at pre-university students are conducted by means of three sessions of 45 minutes duration organized in parallel. In order to have and appropriate organization of these sessions, the attendees are divided into different groups with a maximum number of 30 students per group. This limit of 30 attendees is also fixed for the activities carried out in the Hydraulics Lab. In the same way, the competition is conducted at the same time in two different rooms with a maximum number of 50 students per group, being the attendees subdivided into groups of two students. The remaining activities are carried out for the total number of attendees.

In this way, the detailed programme of the first edition of OpenLab-USC (Figure 1) was designed following the aforementioned criteria. As the programme shows, a one-day exhibition was organized into two different sessions: i) morning session for pre-university students and ii) afternoon session focused on the general public.

Interreg Atlantic Area European Regional Development Fund EUROPEAN UNION
PORTOS PROJECT PORTS TOWARDS ENERGY SELF-SUFFICIENCY PUERTOS HACIA LA AUTOSUFICIENCIA ENERGÉTICA PORTS VERS UNE AUTOSUFFISANCE ÉNERGÉTIQUE AUTOSSUFICIÊNCIA ENERGÉTICA EM PORTOS

OpenLab 2019 - USC

12 diciembre 2019

EPSE – Escola Politécnica Superior de Enxeñaría
Rúa Benigno Ledo s/n, 27002 Lugo, España

AGENDA

09:30 – 10:00 Bienvenida y sesión de apertura **EPSE | Salón de Actos**
Tomás Cuesta, Director Escola Politécnica Superior de Enxeñaría – USC
Mariluz Gil, Coordinadora CIGEO – USC
Rodrigo Carballo, IP PORTOS – USC

ESTUDIANTES NO UNIVERSITARIOS[1]

10:00 – 13:00 Talleres en laboratorios[2] **EPSE | Zona de laboratorios**
Canal de oleaje y corrientes, Iván López, Rodrigo Carballo & Marcos Arza
Modelización de dispositivos convertidores de energías marinas e impresión 3D
Fotogrametría y Energías Renovables Marinas, Mariluz Gil & Juan Ortiz
Cartografía de alta resolución del fondo marino e inspección de instalaciones
Gestión Integral Zona Costera (GIZC), Mateo Fouz, Néstor Areán & Manuel Torres
Herramientas avanzadas para el aprovechamiento integral de las energías marinas

13:00 – 14:00 Competición: energías marinas y sostenibilidad **EPSE | Salón de Actos**
Alberte Castro & Carlos Núñez

DESCANSO MEDIODÍA

16:30 – 16:45 Presentación sesión de tarde **EPSE | Salón de Actos**
Mariluz Gil, Coordinadora CIGEO – USC
Rodrigo Carballo, IP PORTOS – USC

PÚBLICO EN GENERAL

16:45 – 17:30 Conferencia Industria **EPSE | Salón de Actos**
Generación distribuida y microrredes en ámbitos portuarios: potencial y caso de estudio del Puerto de Shoreham. Ponente: Eva María Méndez, Norvento Enerxía

17:30 – 18:15 Conferencia Academia **EPSE | Salón de Actos**
Explotación del recurso energético marino mediante plataformas multipropósito: su aplicación en el entorno portuario. Ponente: Carlos Pérez, Univ. de Vigo

18:15 – 18:45 Descanso café **EPSE | Cafetería**

18:45 – 19:30 Ensayos en Laboratorio de Hidráulica[1] **EPSE | Zona de laboratorios**
Ensayos a escala en canal de oleaje, Iván López, Rodrigo Carballo & Marcos Arza
Modelización física de un dispositivo convertidor de energía del oleaje OWC

INSCRIPCIONES

https://forms.gle/fbm22ho9FQBvFUsK8

[1]Plazas limitadas
[2]Sesiones paralelas y rotatorias con descanso para café (30 min) a las 11:30h aprox.
Contacto: openlabs.portos.usc@gmail.com

Figure 1. OpenLab-USC 2019 detailed programme (in Spanish)

3. PARTICIPANTS

3.1. ORGANIZERS

In this section, the names and basic information on the staff from USC that organized the 2019 OpenLab-USC event are provided:

Rodrigo Carballo

Dr. Rodrigo Carballo (RC) is a lecturer and Coordinator of the Hydraulic Engineering Section at the University of Santiago de Compostela. His research focuses on several lines, namely coastal and river engineering, including hydrodynamic and morphodynamic characterization of water masses, hydraulic structure design, and environmental impact analysis, amongst others. Of particular interest are his pieces of research developed in marine energy (both wave and tidal), estuarine hydrodynamics and physical modelling of coastal structures.

Iván López

Iván López (IL) is a postdoctoral researcher at the University of Santiago de Compostela. His main research line focuses on MRE (wave energy, development of OWC wave energy converters). Additionally, he is also focused on coastal and port structures (non-reflective breakwater design) and coastal processes (wave agitation, beach morphology). In connection with these lines, IL has developed expertise in physical modelling in wave flume, computational fluid dynamics, and artificial intelligence (artificial neural networks).

Mateo Fouz

Mateo Fouz (MF) is a predoctoral researcher at the University of Santiago de Compostela. He is Civil Engineer by the University of Santiago de Compostela (2017) and Master of Project Management by the same university (2019). Nowadays, MF is PhD student in the Civil and Maritime Engineering Programme of the USC. His research activity is focused on the influence of fluvial discharges on hydrokinetic energy exploitation and on the Integrated Coastal Zone Management through Marine Spatial Planning.

In addition to them, the following academic and/or research staff from USC also participated in preparing the event: María de la Luz Gil, Juan Ortiz, Alberte Castro, Carlos Núñez, Manuel Torres, Marcos Arza, Néstor Areán, Marcos Sánchez and Miguel Álvarez.

3.2. GUESTS

In this section, the names and basic information on the invited guests that participated in the 2019 OpenLab-USC are provided:

Eva Méndez (Norvento)

Eva Méndez (EM) is Agricultural Engineer by the University of Santiago de Compostela. She also is Master of Management and Development of European Projects and Master of Environmental Consulting, both by the Polytechnic University of Catalonia. EM works for the Commercial Department of Norvento for more than a decade, being also the responsible for coordinating the R&D projects of Norvento.

Carlos Pérez (University of Vigo)

Dr. Carlos Pérez (CP) holds a PhD in Marine Renewable Energy by the University of Plymouth (United Kingdom), currently being the Manager of the European Project H2020 SAFEWAY. His main research topics are hybrid MRECs and multiplatform systems, especially co-located wind-wave farms.

3.3. NUMBER AND TYPE OF ATTENDEES

In this section, the information about the number of attendees (135) classified by age and gender is provided. Table 1 summarizes the information regarding their classification by gender; in the same way, Figure 2 shows this information according to their age.

Table 1. Attendees classified by gender

Gender	Number	Percentage
Male	85	63%
Female	50	37%

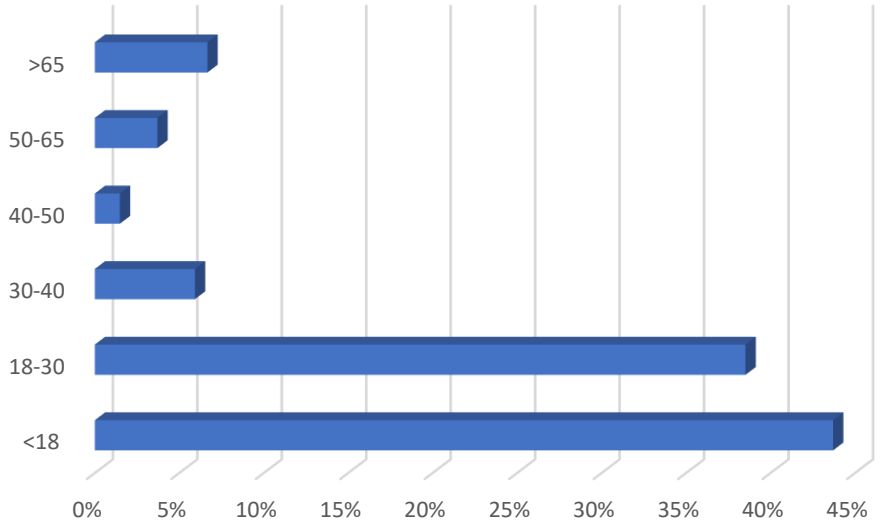

Figure 2. Attendees classified by age

As a result of both classifications, it can be concluded that the average profile of the attendees corresponds with males of ages under 18- or ranging between 18- and 30- years old. In spite of this general figure, it can also be observed that a wide age range is covered. As regards gender distribution, despite of the majority of males, the percentage of females (approx. 40 %) is considered as “normal” due to this figure being common in the so-called STEM (Science, Technology, Engineering and Mathematics) topics of the Spanish education system.

4. SUMMARY OF THE ACTIVITIES PERFORMED

4.1. WELCOME AND OPENING SESSION

The OpenLab starts with a brief reception of the attendees in the Hall of the EPSE. During this opening session (Figure 3) the following speakers take part: first, Alberte Castro, sub-dean of the EPSE briefly presents the facilities and academic degrees available in this centre; next, Rodrigo Carballo, Principal Investigator of PORTOS project at USC introduces the main objectives of this project and the OpenLabs events; finally, María de la Luz Gil, Coordinator of the CIGEO presents the main research lines developed by this research group. To finish this session, the students are divided into three groups of approx. 30 members in order to allow a better development of the subsequent activities.

Figure 3. Speakers during the opening session

4.2. WAVE-CURRENT FLUME

The present activity “Modelling of marine energy converters and 3D printing” is conducted in the Hydraulics Lab of the EPSE by the following academic and research staff: Iván López, Rodrigo Carballo and Marcos Arza.

During this session the attendees are introduced to physical modelling techniques usually applied in Port and Coastal Engineering (Hughes, 1993), and in particular to physical modelling of MRECs such as Wave Energy Converters (WECs) or Stream Energy Converters (SECs), considering also other complementary techniques, and in particular 3D printing. For this purpose, the researches resort to the wave-current flume (20 m long, 0.65 m wide and 0.95 m height) located in this facility (Figure 4).

Figure 4. Wave-current flume

This activity is divided into three different phases: (i) introduction to physical modelling of MRECs (Figure 5), (ii) introduction to the use of turbines in MRECs by means of 3D printing (Figure 6), and (iii) testing and analysing of turbines in MRECs (Figure 7).

In phase (i), several concepts related to MRE and Port and Coastal Engineering are presented to the students by using materials from previous research projects (coastal barrages, breakwaters, some types of WECs) paying especial attention to the concepts of “scale” and “Oscillating Water Column WEC (OWC)”, topics that constitute a key aspect for the rest of the activity. The main objective of phase (ii) is to present the most common techniques of turbine modelling through 3D printing, making an introduction to the different types of turbines and their implementation in OWCs. Finally, in phase (iii) physical tests of an OWC device are conducted in order to assess the performance of two different models of 3D printed turbines: axial impulse turbine and Wells reaction turbine.

Figure 5. Researchers giving instructions to the attendees (Rodrigo Carballo, left; Iván López, right)

Figure 6. Marcos Arza providing instructions to the attendees (left) and some examples of 3D printed turbines

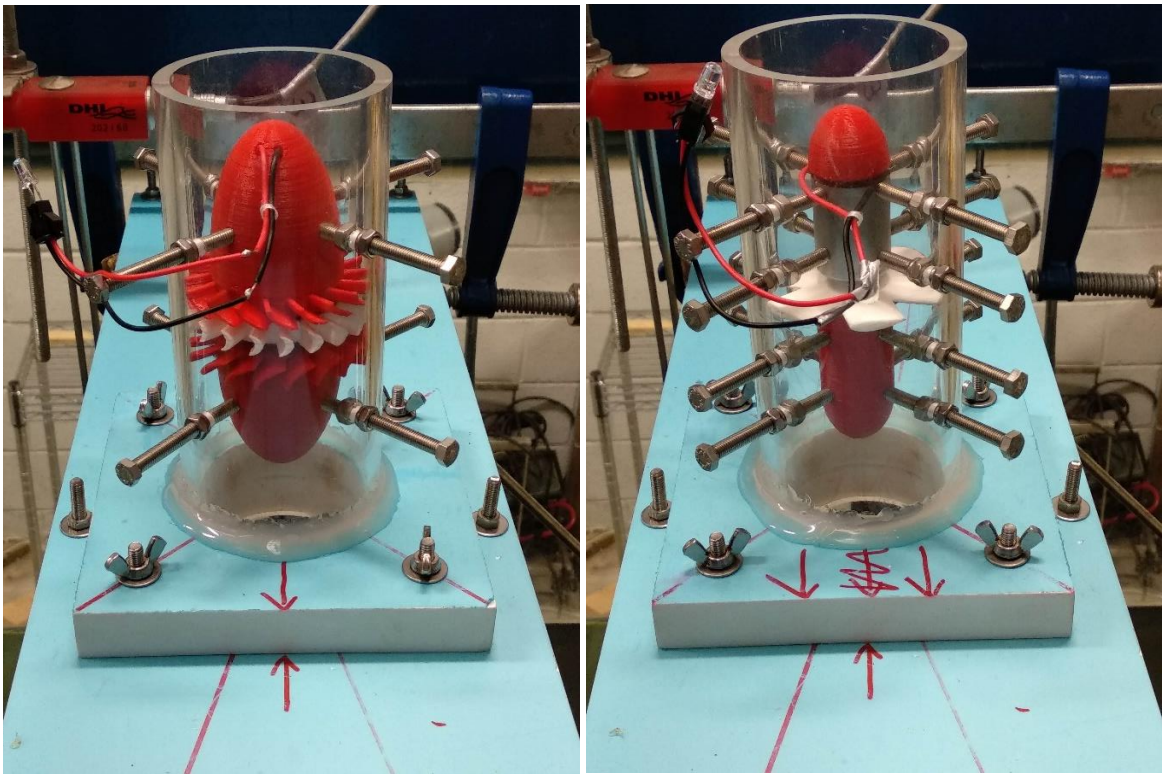

Figure 7. Models of 3D printed turbines. Axial impulse turbine (left), and Wells reaction turbine (right)

4.3. PHOTOGRAMMETRY AND MARINE RENEWABLE ENERGY

This activity called "High-resolution mapping of the seabed and inspection of facilities" is conducted at a specifically designed lecture room by the following academic and research staff: Juan Ortiz and María de la Luz Gil.

During this session the attendees are introduced to the so-called near object photogrammetry technique (McGlone et al, 2004), and in particular to the different applications that this technique may have as a precision

measurement tool and, more specifically, in order to: (i) map the seabed, (ii) measure the sediment transport, and (iii) control structural deformations. For this purpose, the students use a free APP called SCANN3D which allows them to obtain a 3D model based on photos taken with the mobile phone. This model can be exported and scaled so as to obtain high-accuracy measurements.

This activity is divided into three different phases: (i) taking photos and postprocessing (Figure 8), (ii) an introduction to photogrammetry and its applications in the framework of PORTOS project, and (iii) visualization of the 3D model generated (Figure 9).

Figure 8. Students taking photos during the activity

Figure 9. Students visualizing the 3D model generated

During phase (i) several concepts related to photogrammetry and the implementation of specific rules in order to obtain an accurate 3D model (number of photos, different views of the object that should be photographed, parameters of the camera that should be configured…) are presented. Next, in phase (ii) a brief introduction to the key aspects of photogrammetry and its applications on MRE field is conducted (how XYZ coordinates of a near object can be determined, the particularities of underwater photography, the inspection of facilities based on 3D models, etc.). Finally, in phase (iii) once the 3D model is generated, the students explore different advanced tools based on this model (shape registration, 3D measurement, sharing this information on the web, 3D printing, etc.) and the possibilities of these tools in several fields, with a particular focus on MRE.

4.4. INTEGRATED COASTAL ZONE MANAGEMENT

This activity is entitled “Advanced tools for an integrated exploitation of marine energies” being conducted in a computer lab of the EPSE by the academic and research staff: Mateo Fouz, Néstor Areán and Manuel Torres.

During this session the attendees are introduced to Integrated Coastal Zone Management (ICZM) techniques commonly used in the field of Coastal Engineering (Cicin-Sain et al., 1998), and in particular to the requirements to incorporate the Marine Spatial Planning (MSP) as a powerful tool in order to integrate the different coastal uses in the decision-making process. In the same way, the students are introduced to other transversal tools that can be implemented in the context of ICZM and MSP such as Geographic Information Systems (GIS) and numerical modelling.

This activity (Figure 10) is divided into three different phases: (i) an introduction to ICZM, (ii) a brief description of the advanced tools for ICZM in the framework of MRE, and (iii) a case study of ICZM and MSP in the Ribadeo Estuary (NW Spain).

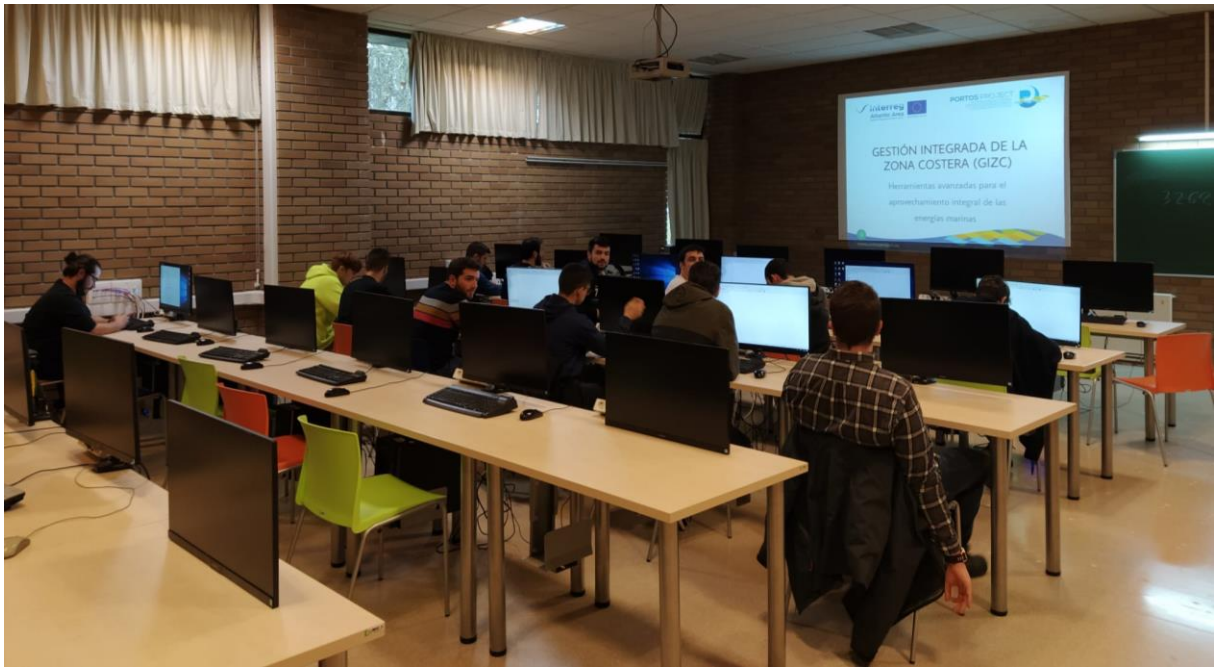

Figure 10. Attendees during ICZM activity

In phase (i) of this activity, the students are introduced to the key role of coastal environments from different points of view (i.e. natural, economic and cultural) by providing them with a description of the main coastal and marine uses and the relationship of these uses with the anthropogenic influence on the littoral region. A result of this influence, several rules must be prescribed in order to accurately distribute the maritime-terrestrial space following sustainable development perspectives. This approach is reintroduced again to the students in phase (ii) in the framework of MRE planning, highlighting the needs of considering not only the resource requirements (analysed through numerical modelling) and introducing them into the analysis socio-economic and environmental aspects (by means of GIS techniques). Finally, in phase (iii) so as to summarize all the topics analysed in the previous phases, the students implement a case study in the Ribadeo Estuary (NW Spain) that allows them to combine though GIS software different types of geospatial information (resource, technical, socio-economic and environmental limitations) in order to determine the most suitable location for a hydrokinetic energy farm within this estuarine area.

4.5. COMPETITION ON RENEWABLE ENERGY AND SUSTAINABILITY

The last activity conducted during the morning session is a competition on renewable energy and sustainability in which the students must solve different questions related to the topics explained during the short workshops. The competition is developed in two different parts: (i) the competition itself and (ii) an awards ceremony.

In the competition, the students are divided into two groups, each of occupying a different room and being led by the lecturers Alberte Castro and Carlos Nuñez. In each room the students are organised in couples (Figure 11 and Figure 12) that must solve a total of 17 questions (6 related to the wave-current flume and 3D printing, 5 related to photogrammetry, 6 related to ICZM) with four possible answers (Figure 13) per question (only one is valid) through Kahoot! tool.

Figure 11. Students being informed about the rules of the competition (room led by Alberte Castro)

Figure 12. Students being informed about the rules of the competition (room led by Carlos Núñez)

Figure 13. Example of Kahoot! question and four possible answers

The time for answering 15 out of 17questions is set to one minute due to their simplicity. In the case of the remaining 2 questions, this interval is set to 4 minutes due to their complexity requiring the use of spreadsheets or Internet browsers.

4.6. PRESENTATION OF AFTERNOON SESSION

In this short activity, Rodrigo Carballo, Principal Investigator of PORTOS project at USC introduces the main objectives of PORTOS project and María de la Luz Gil, Coordinator of CIGEO presents the main research lines developed by this group (the attendees do not correspond with those during the morning session). Then, the speakers of the different keynotes (i.e. academia and industry) are briefly introduced by Rodrigo Carballo.

4.7. KEYNOTE #1: INDUSTRY

In this first keynote (Figure 14) Eva Méndez (EM) from Norvento presents the concepts of distributed generation and microgrids to the attendees, along with their implementation in port areas through a case study conducted by this company in Shoreham Port (United Kingdom) in which two wind turbines of 100 kW were installed as an example of the suitability and integration of renewable energy in harbour areas. During her speech, and amongst other aspects, EM indicates that the growth of renewable energy generation provokes that ports can have a key role in the context of a decentralized energy system, principally due to the converge of energy resources and electricity demand that occurs in these areas. After the presentation an intense and fruitful discussion is developed.

Figure 14. María de la Luz Gil between Eva Méndez (left) and Carlos Pérez (right) during the keynotes

4.8. KEYNOTE #2: ACADEMIA

In the second keynote (Figure 14) Carlos Pérez (CP) from the University of Vigo talks about multiplatform systems for marine energy exploitation and the key role that this type of devices can have in the context of climatic change as far as the reduction of human footprint is concerned. In this way, CP presents several classifications and types

of multiplatform systems (i.e. co-located systems, hybrid systems or island systems), focusing his intervention also in the main advantages and inconveniences of this type of technologies. On the one hand, CP highlights how co-located systems can present several synergies, such as for example those related to less expenditures in terms of Operations and Maintenance (O&M); on the other hand, he also remarks the complexity of characterizing the so-called shadow effects that occur between devices and how they can reduce the performance of both types of technologies (e.g. hybrid wind-wave farm). After the presentation an intense and fruitful discussion is also developed.

4.9. TESTS IN HYDRAULICS LAB. SCALED TESTS IN A WAVE FLUME

This activity "Physical modelling of an OWC wave energy converter" consists in a tour which is conducted in the Hydraulics Lab of the EPSE by the academic and research staff Iván López, Rodrigo Carballo and Marcos Arza.

This session presents a similar structure and background to that of the short workshop "Modelling of marine energy converters and 3D printing" developed in the morning session; however, the contents are adapted to the specific profile of the attendees and focused on OWC devices (Falçao, 2010), that have a key role in this session.

For this reason, this activity (Figure 15) is divided in the same phases as those in the aforementioned workshop in the morning session; however, as it has been mentioned before, several adaptations are included in all of them. The different phases are: (i) introduction to physical modelling of MRECs, (ii) introduction to the use of turbines in MRECs by means of 3D printing, and (iii) testing and analysing of turbines in MRECs.

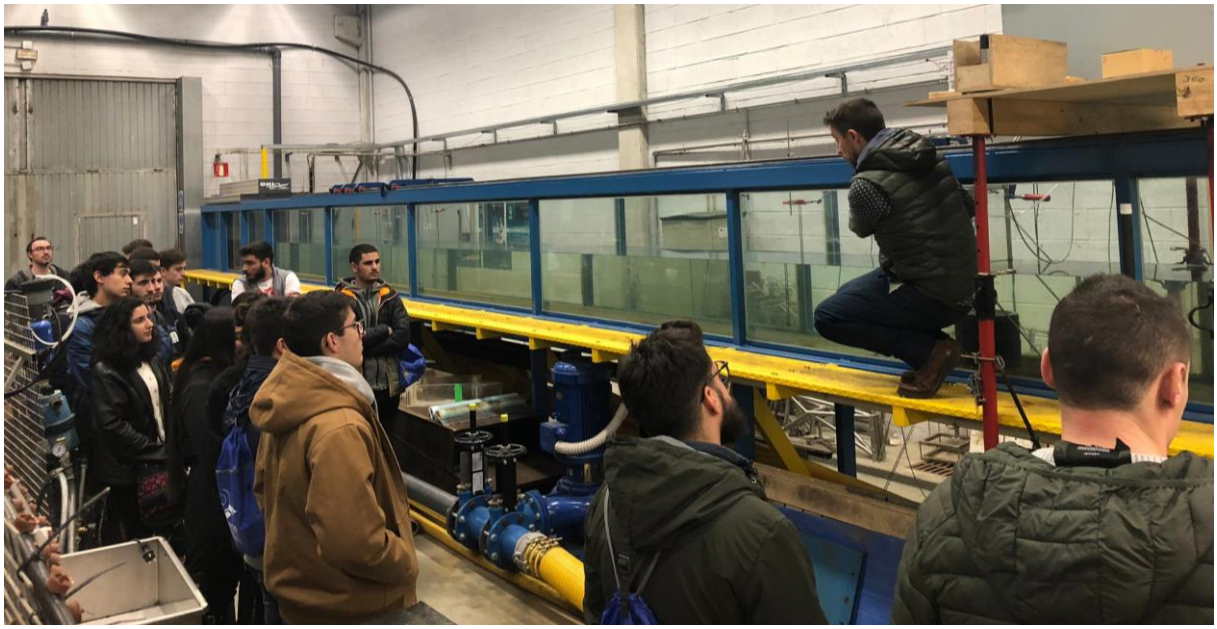

Figure 15. Attendees receiving explanations from Iván López (left) and Rodrigo Carballo (right)

Phase (i) comprises the description of several sensors (Figure 16) and instrumentation commonly used when testing in a wave flume. In phase (ii) the most common techniques of turbine modelling through 3D printing are shown, extending the information provided in terms of different printing parameters. Finally, in phase (iii) physical tests of an OWC device are conducted so as to assess the performance of different 3D models of printed

turbines, introducing new aspects such as air compressibility, modelling of head losses though orifices or membranes (Figure 17).

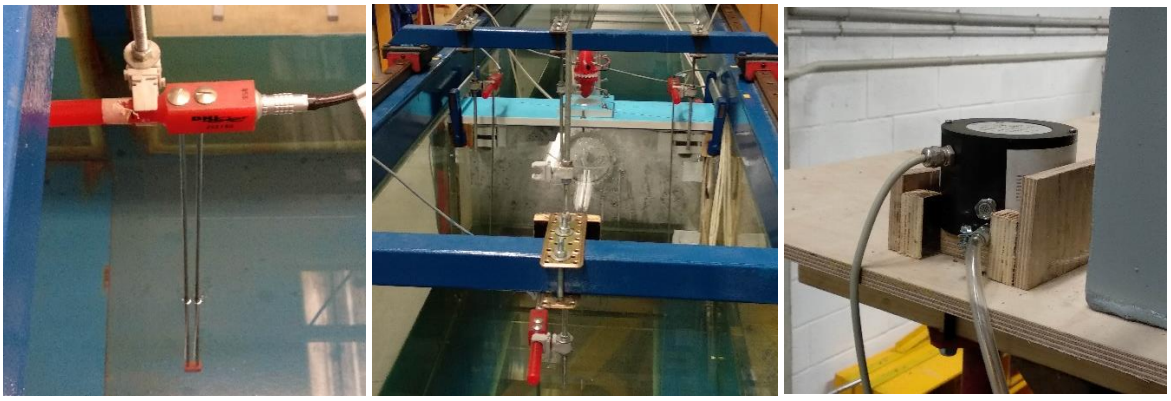

Figure 16. Different types of sensors for water level measurements either resistive (left) or ultrasonic (centre), and for pressure measurements (right)

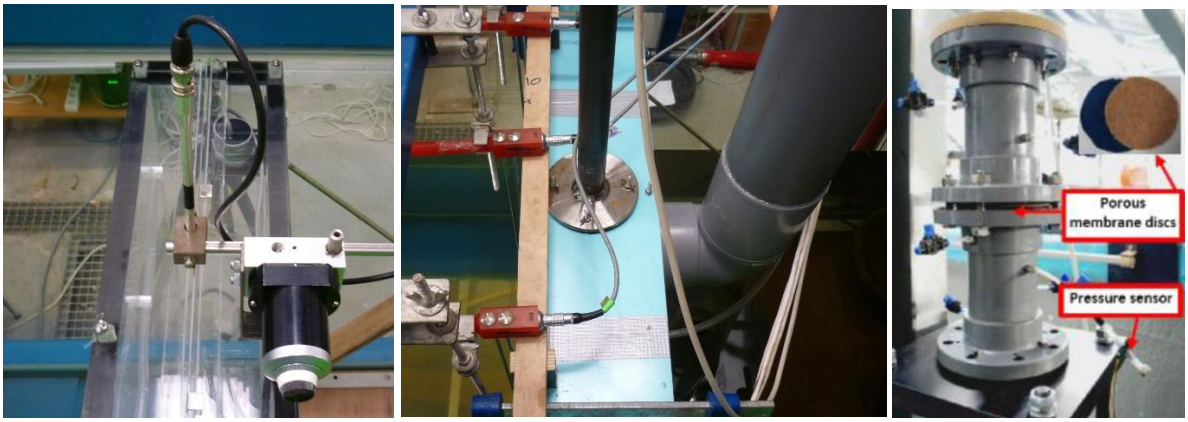

Figure 17. Different ways for modelling turbines: axial turbine though a slot (left) and an orifice (centre), and Wells turbine by a membrane (right)

5. MEDIA IMPACT

The 2019 OpenLab-USC event had a significant repercussion in several social networks, such as those managed by PORTOS project. In addition, the Press Office of the University of Santiago de Compostela published an article about this event. The article is available (in Galician) in the following url: https://www.usc.gal/gl/xornal/novas/eps-enxenaria-explora-caladoiro-enerxias-marinas. Finally, the regional press *El Progreso* also published an extensive article including the celebration of this event.

6. REFERENCES

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