Analysis of Improvement Opportunities at Mutriku Wave Power Plant

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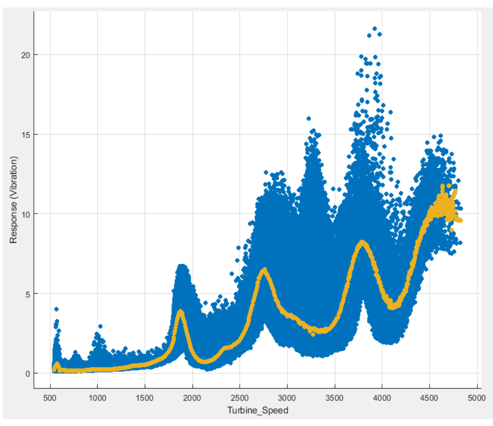
***Abstract* -** After the finalization of the testing programme of the biradial turbine within the Opera project funded by the European Commission within the H2020 framework and similar activities carried out by Oceantec before, Mutriku Wave Power Plant has been consolidated as one of the most suitable testing infrastructure for OWC technology. Although the plant was initially commissioned as a demonstration project, the experience in operation and maintenance has been used to provide essential knowledge so as to promote technological development. At present, the Basque Energy Agency (EVE) also offers the possibility to test new concepts of air turbines, control strategies and auxiliary equipment in one of the OWC chamber orifices.

Despite the early-stage technology implemented at Mutriku Wave Power Plant, in July 2018 the plant supplied 1.7 GWh of cumulative energy in its 7 years of continuous operation. However, on the path to commercialization of this technology there is still much to do in order to reach enough technological readiness level that makes this renewable source profitable. In this context, the proposed poster aims to identify those potential opportunities for improvement that have been observed during these years, so as to encourage researchers and developers nearby to gain more in-depth knowledge and to solve the problems that OWC technology currently faces.

Vibration Monitoring & Analysis

Self- and/or acoustic-resonance, mainly due to the tilting, causes the structure to vibrate.



The most frequent failure caused by oscillating forces in the turbo-generator shaft is usually breakage of the washer between the bearing and the housing of the generator. This may produce undesirable high vibrations attributable to the friction of the bearings against the generator cover. Salt accumulation on the turbine blades may additionally cause significant vibration.

Turbine Control

This might be the most valuable element to improve the WEC capability. As the turbine performance depends on its rotational speed, novel advanced control strategies may help to improve energy conversion efficiency. The control system can be used not only to maximize the output power, but also to reduce undesired vibration.

New Concepts

Novel designs of Wells and impulse turbines may improve the power conversion efficiency of already existing turbines. Additionally, a wide variety of materials may be used to avoid corrosion and fatigue.

Airflow Control

Wells turbines are very sensitive to continuous airflow variations. If the airflow is high enough to produce stall, the turbine efficiency may drop drastically. Therefore it should be limited by a damper, thus allowing airflow control. The use of a fast acting valve may enable more efficient advanced control techniques, e.g. the latching control.

Resource Assessment

An adequate wave resource estimation may help to improve the WEC design, integrating marine renewables into power systems and markets.

References

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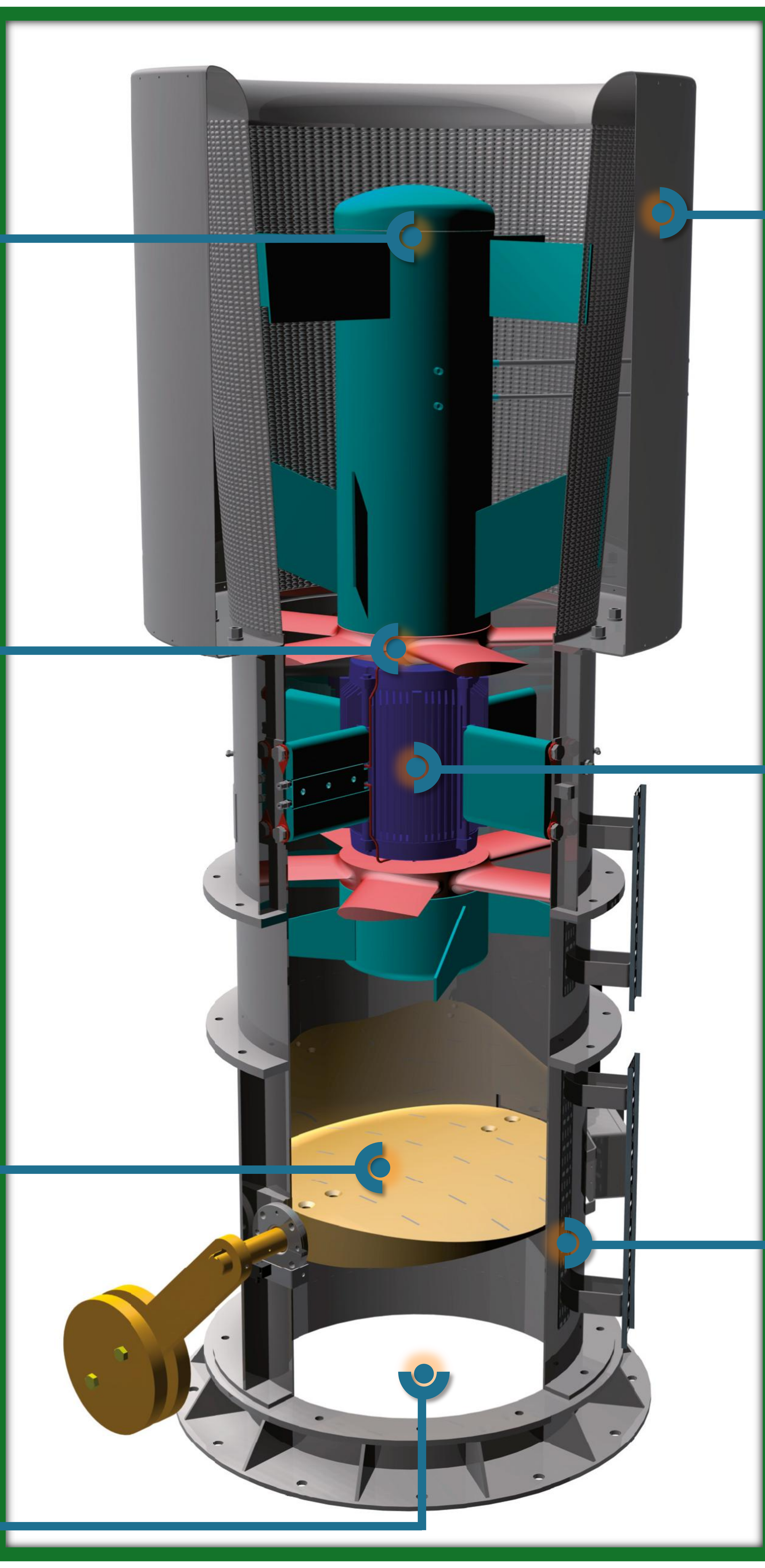
[2] J. Lekube, O. Ajuria, M. Ibeas, I. Igareta, A. Gonzalez, "Fatigue and Aerodynamic Loss in Wells Turbines: Mutriku Wave Power Plant Case" in Proc. of the International Conference on Ocean Energy, Cherbourg, France, 2018, pp. 1-7.

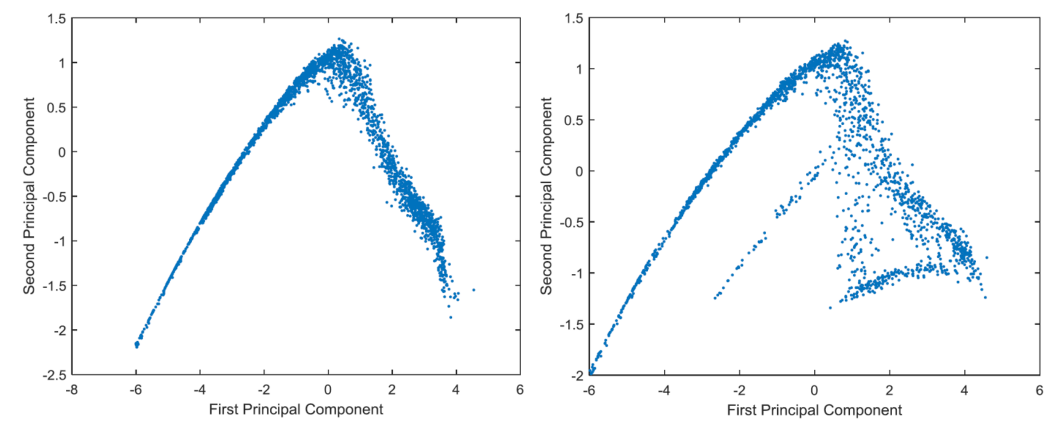
Number of OWC Chambers	16
Chamber Size	4.5 x 3.1 x 9.1 (m)
Co-rotating Double Monoplane Wells Turbine	
Diameter	750 mm
Squirrel-Cage Rotor Induction Generator	
Rated Power	18.5 kW
Rated Speed	3000 rpm



Predictive Maintenance

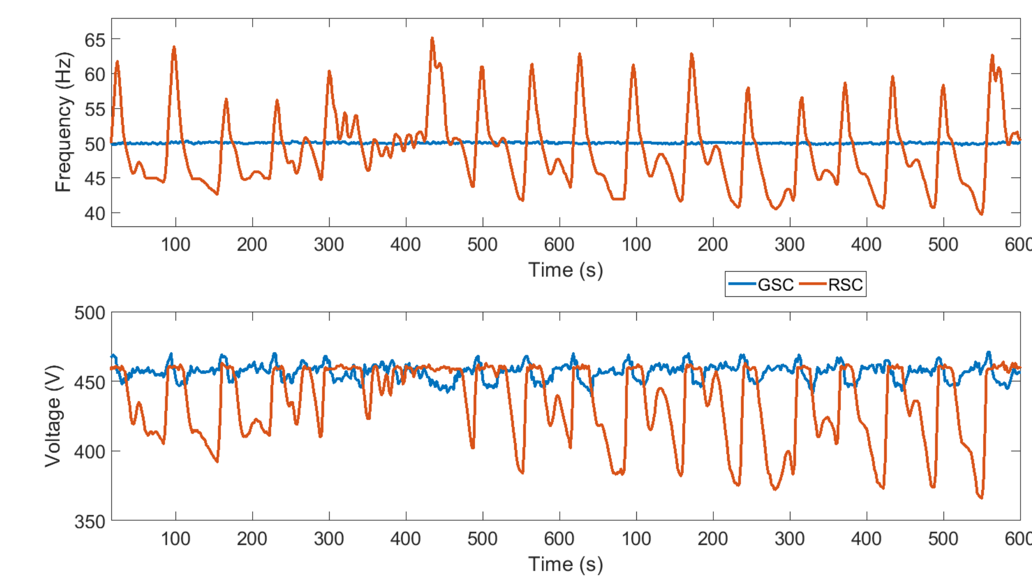
Following traditional maintenance approach, failures or breakages may occur, thereby necessarily triggering a reactive maintenance response to change or repair the component(s) in question. As a result, costs associated with plant shutdown during maintenance work may have a considerable impact on the cost of energy.

By collecting data from the facility and applying **machine learning** techniques, it is possible to develop algorithms that enable predictive maintenance to be performed.



Frequency &Voltage Stability

In order to supply energy to the power grid the stability of both frequency and voltage must be ensured, as well as limiting the total harmonic distortion produced by the power electronics.



Energy storage systems, such as flywheels and supercapacitors, may help to smooth the generator output.

Sensors & Data

Sensors are broadly used in marine energy sector. Some of current commercial sensors do not offer suitable features to operate in harsh environment. Moreover, emerging concepts such as the **Industrial Internet of Things** (IIoT) may help to interconnect remote sensors and users.

In addition, advances in big data analytics generate new concepts of so-called **digital twins**, much more accurate and versatile than existing models and which enable realistic simulations to be made adapted to real operations.