Case Study – European OWC pilot plant Pico/Azores

Project Name	European Wave Energy Pilot Plant – Pico OWC
Location	Pico Island, Azores/Portugal
Installed capacity	400 kW
Technology Type	Shoreline gully Oscillating Water Column; the wave chamber is integrated in a natural gully, fitted into the rocky coastline.
Project Type/Phase	Pilot Plant testing; preparation of test bed for air turbines.
Year	First installation and punctual operation in1999, partly destroyed Recovery from 2004-2006, first operation October 2005 Continuous and autonomous operation planned for 2008

Project Description

The European Pico OWC plant was built from 1995 to 1998 within the framework of two EC JOULE projects and co-funding from EDP (Electricidade de Portugal) and EDA (Electricidade dos Açores), respectively the national and regional utilities. Instituto Superior Técnico (IST), Lisbon was responsible for the conception and basic engineering studies of this plant and co-ordinated the project. The plant is a bottom-mounted shoreline structure, equipped with a Wells turbine with guide vanes.

The plant was completed in 1999 but flooding and malfunction of the Wells turbine affected the testing program of the plant, leading to long delays (Falcão, 2000). Full scale testing was only performed during a short period in October 1999. In 2003, the Wave Energy Centre (WEC), a non-profit association dedicated to the development and promotion of ocean wave energy, created in Portugal, obtained national funding to proceed with the refurbishment of the plant, under a specific funding scheme for pilot projects related to scientific innovated systems (PRIME/DEMTEC).

In 2004-2006 a set of relevant repair works were undertaken under the co-ordination of the WEC, as part of a national funding scheme and a program of monitoring tests accompanied the commissioning of the plant.

The basic function of the plant was reconstituted in autumn 2005. Substantial limitations of the operation persisted, mainly due to the inappropriate design of the turbine support structure, inherited from the original project. The automatic operational modus was insufficient due to the original plant layout and equipment. Since 2005, three minor accidents (affecting guide vanes, bearing, and glass-fibre of the air tunnel) and insufficient funding prevented the project from a faster and complete recovery. Progress has been made and it is expected that by end of 2008 the plant should be capable of operating at rated power autonomously. EDP provided the investment to refurbish the functional and visual aspects of the Pico OWC.

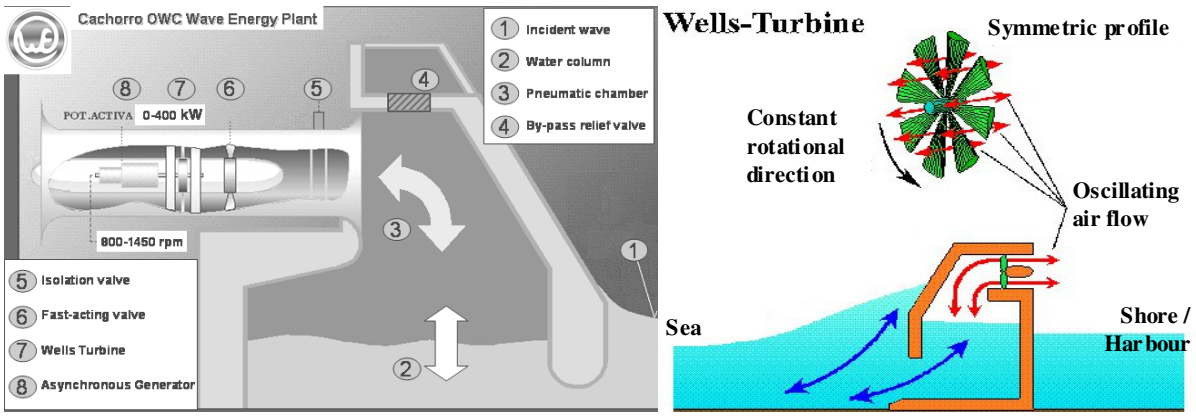
There are plans to prepare the second turbine slot of the structure as a turbine test bed, which is intended to serve as an open air turbine test facility in real-sea conditions.

The Pico OWC from the sea (left); plant under heavy sea (centre); the coastline with Pico OWC integrated (right); (*WavEC)*

The Pico OWC has contributed and will contribute substantially to the development of this type of plant, in particular with respect to two issues. The plant has existed for almost 10 years now, of which significant part may be considered as abandoned. The degradation of equipment and components and the moderate efforts necessary to re-activate the plant are unique. As there is no commercial information on the Pico project itself, some data has been revealed to the technical-scientific community as it has become available and open discussion is now being sought.

The Technology

The basic function principle of the OWC is the incident wave motion excites the oscillation of the internal free surface of the entrained water mass inside a pneumatic chamber, which produces a low pressure reciprocating flow that drives the turbine, installed in a duct between the chamber and the atmosphere (see illustration). A detailed description of the design of the Pico plant and electrical-mechanical equipment can be seen at Falcão, 2000.



Cross-section of the pilot plant of Pico, Azores (left) and working principle of an OWC and the Wells turbine (right; *Prof. Graw, Dresden University [6])*

Related projects

LIMPET OWC: The shoreline-based LIMPET device was built in 2000 by the Scottish company Wavegen (now Voith Siemens), in collaboration with Queens University of Belfast (QUB). The LIMPET is a modern sister project of the Pico OWC, as its structural design, construction process and turbine concept were innovative. The device was initially conceived for 500kW (2*250kW counter-rotating Wells turbines). It was downscaled to 250kW, and later used as test facility for smaller turbines. Little data from the LIMPET plant has been published, due to the non-disclosure policy of the developers.

BREAKWAVE project: applied in late 2006 for EU funding, lead by the Portuguese utility EDP, Labelec. It concerns the integration of an OWC plant in a caisson breakwater head in northern Portugal (*Foz do Douro*, Oporto), consisting of two chambers equipped with three (2+1) Wells turbines, resulting in 750 kW installed capacity. In 2001, the plans to build a new breakwater at the Douro estuary ('Foz do Douro') in Oporto, northern Portugal, brought up the possibility of realising the idea of integration of a OWC in a breakwater; the maritime consultant Consulmar asked WavEC for a preliminary study on concerning this possibility in the breakwater head. Using that study as a baseline, the company submitted the proposal to integrate an OWC in the breakwater as part of the public tender, which they later won. After the concession of the breakwater construction in 2004, a consortium has proceeded with preparatory works concerning the integration of an OWC into the breakwater. The project was abandoned due to a non-responsive public body in the critical phase for decisions.

Mutriku OWC Breakwater: Several small OWCs integrated in the new outer breakwater of Mutriku (Basque country, under construction 2007-08) using the technology from Wavegen, form a demonstration project partially funded by the European Commission under Framework Programme 6 with an investment of 3.5M€. The project is promoted by the Basque government and EVE, the Basque Energy Agency. It consist of 16 turbines with a capacity of 20 kW each one (320 kW of total capacity).

Project Partners

Initial project (1992-1998): IST (Instituto Superior Técnico, Lisbon, Portugal); EDA (Electricidade dos Açores, Azores, Portugal); EDP (Electricidade de Portugal, Lisbon, Portugal); INETI (Instituto Nacional de Engenharia Tecnologia e Inovação, Lisbon, Portugal); EFACEC - Sistemas de Electrónica SA (Portuguese supplier and developer of electrical equipment), PROFABRIL (Portuguese designer company of engineering projects), UCC (University College Cork, Cork, Ireland); QUB (Queens University of Belfast, Northern Ireland). A.R.T. (later renamed into Wavegen) subcontracted for the design and manufacture and installation of the mechanical parts.

Recovery Project (2004-2006): the Wave Energy Centre (WavEC) overtook responsibility for the Pico plant, in the context of a recovery project (national funding DEMTEC, EDP and Efacec); main contractors Efacec and Kymaner.

Ownership, operation and maintenance (O&M) until summer 2008: Wave Energy Centre (WavEC); from summer 2008 onwards O&M contract with consortium led by Kymaner.

Cost and Financing

The original project was financed largely by the European Commission; estimated total costs are €2-3M.

The recovery project (DEMTEC national funding, EDP & Efacec) had a total cost of approximately €1M, with the second refurbishment phase financed by EDP

Projected income will be generated by a favourable feed-in tariff of approximately 23 cEUR/kWh. Once the plant can operate autonomously at rated power, the revenue from electricity sale will most likely self-sustain the continuing O&M.

Further Information

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Sources:

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