

Final report

1.1 Project details

Project title	Effektivisering af bølgeenergi vha. Tryksatte cyklontanke
Project identification (program abbrev. and file)	J.nr. 64015-0030
Name of the programme which has funded the project	EUDP 2015-I
Project managing company/institution (name and address)	Wave Star A/S Park Allé 350E 2605 Brøndby
Project partners	Aalborg Universitet
CVR (central business register)	29838879
Date for submission	17. maj 2016

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1.2 Short description of project objective and results

English

The aim of the project was to develop, test and document a new, unique pressurized cyclone reservoir, which would simplify Wavestar's power take-off (PTO) system and help to increase efficiency and reduce the cost of the extracting of energy from the waves.

The project did not manage to develop a fully finished product before it unfortunately had to be abandoned. Wavestar was forced to giving up finding the self-financing to continue the business, and all activities were stopped by the end of April 2016. There has been made specifications, diagrams and drawings of the pressurized cyclone reservoir, which are all public and can be used by AAU and other research and development.

Danish

Formålet med projektet var at udvikle, teste og dokumentere en nyt, unik tryksat cyklontank, som skulle forenkle Wavestars power take-off system (PTO) og bidrage til at øge effektiviteten og reducere omkostningerne ved udvinding af energi fra bølgerne.

Projektet nåede ikke at udvikle et fuldt færdigt produkt, før det desværre måtte opgives. Wavestar blev tvunget til at opgive at finde den nødvendige egenfinansiering at fortsætte virksomheden, og alle aktiviteter blev stoppet med udgangen af april 2016. Der er udarbejdet specifikationer, diagrammer og tegninger på den tryksatte cyklontank, som alle er offentlige og kan bruges af AAU og andre til forskning og udvikling.

1.3 Executive summary

The aim of the project was to **develop, test and document** a new, unique pressurized cyclone reservoir, which would simplify Wavestar's power take-off (PTO) system and help to increase efficiency and reduce the cost of the extracting of energy from the waves.

The pressurized cyclone tank would simplify Wavestar's PTO system by eliminating the need for an energy-consuming active booster system and combine this with a pressurized cyclone, which removes impurities in the oil. This reduces the wave machine's internal electricity consumption, as it causes significantly less wear and maintenance, and increases the lifetime of the PTO system.

The pressurized oil reservoir could be transferred to other wave energy systems using hydraulic PTO, offshore industry, large construction machinery and others in need of large hydraulic efficiency.

The project was launched on 1/9 2015, and the project plan was implemented until 30/4 2016, when it was decided to stop all activities in Wave Star A/S.

According to the plan and the project's first two milestones was completed, including a simulation model, hydraulic diagram for a full-scale wave energy machine and specifications for manifold and accumulator design based on data for pressure variation in the system at different wave profiles. There is provided a graph for design

of the PTO system with the pressurized tank, which includes manifold, pressurized tank, pump and generator and high pressure and medium pressure accumulator.

At the beginning of 2016 was Wavestar granted a very large amount from the EU Horizon 2020 program for the construction of a 1 MW WEC in Belgium. The pressurized cyclone tank should have been implemented at this large plant and have contributed to reduced maintenance and increased efficiency.

Unfortunately, it proved impossible to find the necessary self-financing, and as a consequence of this, Wavestar decided to completely abandon all activities and close the company.

All specifications, diagrams and drawings of the pressurized cyclone reservoir are all public and can be used by AAU and other research and development.

1.4 Project objectives

The project was launched on 1/9 2015, according to the plan and the project's first two milestones have been completed.

During the period, there is developed a simulation model in Simulink / Matlab, which can extract data for flow and pressure variations respectively for low, medium and high pressure lines and data to calculate the accumulation / volume requirements for the pressurized tank. This should form the basis of only a simple model, and since more and more elaborate models, where the concept is routinely checked.

There have been studies of literature on cyclones and pressurized tanks. Finally, there has been developed a hydraulic diagram for a full-scale wave energy machine a plurality of pressurized cyclone tanks, as well as the work has been started with the definition of the number of generator units and the control of these.

Based on the calculations and the information collected in P1, was in P2 developed a complete model for the pressurized tank with specifications for manifold and accumulator design based on data for pressure variation in the system at different wave profiles (small to big waves) . There is provided a graph for design of the PTO system with the pressurized tank, which includes manifold, pressurized tank, pump and generator and high pressure and medium pressure accumulator.

There are finally collected quotations from subcontractors on the various components.

From 30/4 2016 it was unfortunately decided to give up the completion of the project.

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1.5 Project results and dissemination of results

Wavestar reached a long way down the road to meet the expectations of the project. The new pressurized cyclone tank was beginning to take form to contribute to the improvement of the COE, but a full finished physical tank was not produced.

The preparatory work has been done and all work has been made available for further research on the AAU for both university and third parties.

The preliminary results are made public through the university, but there is not yet published articles on the subject.

It was not possible to find a new partner to complete the project, but it is our hope that it lives on at university, and that others will continue the concept.

1.6 Utilization of project results

If Wavestar had continued its activities, the results of this project would had been essential for the commercialization process. Cost of Energy is the crucial challenge for wave energy in general, and the increased efficiency in maintenance and in the PTO system, would have contributed to improve the competitiveness.

Wavestar was selected by the EU Horizon 2020 for support of the construction of a 1 MW facility in an offshore wind turbine park. The goal was to show the combination of wind and waves in the future CO₂-free energy production.

Wavestar has over the years worked closely together with Aalborg University (AAU), which also includes in this project and the PTO development.

Wavestar and AAU has jointly installed a large and sophisticated test bench at the university, that students have access to and AAU retain afterwards. For the pressurized tank it applies to all materials, drawings and calculations will be available to the university and their partners.

1.7 Project conclusion and perspective

If it had been possible for Wavestar to provide self-financing for the EU Horizon 2020 project, this EUDP project would have had a decisive impact on the road to commercialization of wave energy.

The next necessary step was to increase efficiency and to test the technology on a larger scale and in a wave environment with bigger waves in the open sea.

Unfortunately, it was not possible to reach the last crucial piece of road. However, it is our firm belief that AAU and other wave energy inventors will be able to work further with the results obtained and the massive development that Wavestar has conducted and documented over the years.

Annex

Technical Report

Minutes of meeting from Steering Group 10/5/2016