Interreg North-West Europe
Marine Energy Alliance
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Conceptual design of the Waveco self-positioning observation platform

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Conceptual design of the self-positioning platform

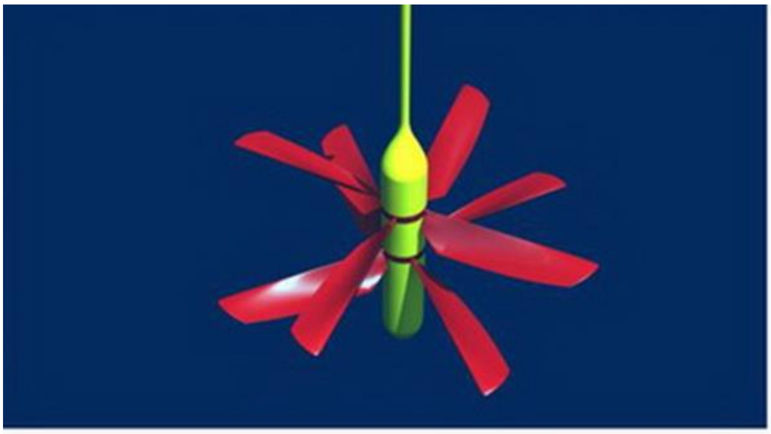
Introduction

Waveco is developing a self-positioning platform, that can be stationed at a certain place at sea and keep its position by a propeller that is driven with wave energy. DMEC has performed calculations to determine the shape of the platform and the energy production and consumption for different weather, wave and current conditions.

Subwave turbine

The Subwave turbine is a double rotor wave turbine. Hanging on a cable it will be positioned 100 m below the self-positioning platform. At such a depth there is hardly any wave motion anymore. The two rotors will spin in opposite directions by the vertical up and down movement induced by the self-positioning platform under wave conditions. So the platform moves up and down with the waves and pulls the Subwave turbine through the water. The cable pulls the turbine up and an added weight pulls it down again. See the YouTube video: "Subwave 2403 2015 eng" for a clear explanation:

https://www.youtube.com/watch?v=uz1Y7DsCIQo



Dimensioning

The station keeping force that the propeller has to deliver is equal to the drag force on the platform by waves, current and wind. So the first thing to study is the options to reduce these drag forces to as low as possible values. From the calculations it became clear that the wind drag force during extreme storms is the main drag force on the system. Therefore the platform has to have a very low frontal area and a low wind load shape factor. After consideration the catamaran type of construction (7 m long and 4 m width) seems the most interesting, since it has a very low frontal area. This is a preliminary choice that could change based on further analysis. The catamaran can be driven by a propeller at the front (see figure 1). In this way the structure can automatically yaw to the lowest drag position, while there is no obstruction in the wake of the propeller.

All the parts of the catamaran can be given a low drag airfoil shape fairing, including the instrument compartment. About 100 m below the platform there is the Waveco Subwave turbine. Turbine and platform are connected by an electrical and mechanical cable, which should also have a low drag shape fairing.

The turbine itself will have a high horizontal drag in ocean and tidal currents and there is not much possibility to reduce this drag. Therefore the maximum current in which the platform can operate is limited to about 1 m/s of constant current.

See figure 2 for a rendering of the self-positioning platform.

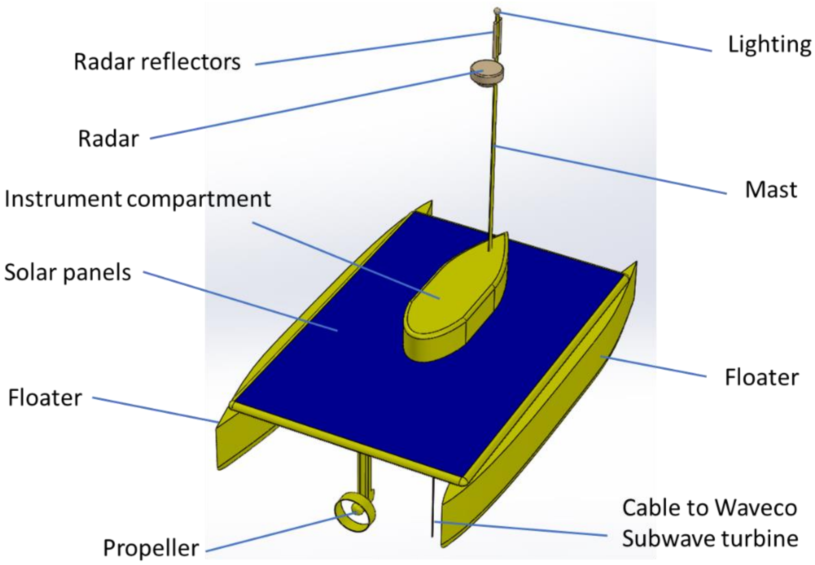


Figure 1: Scheme of the catamaran type of self positioning platform

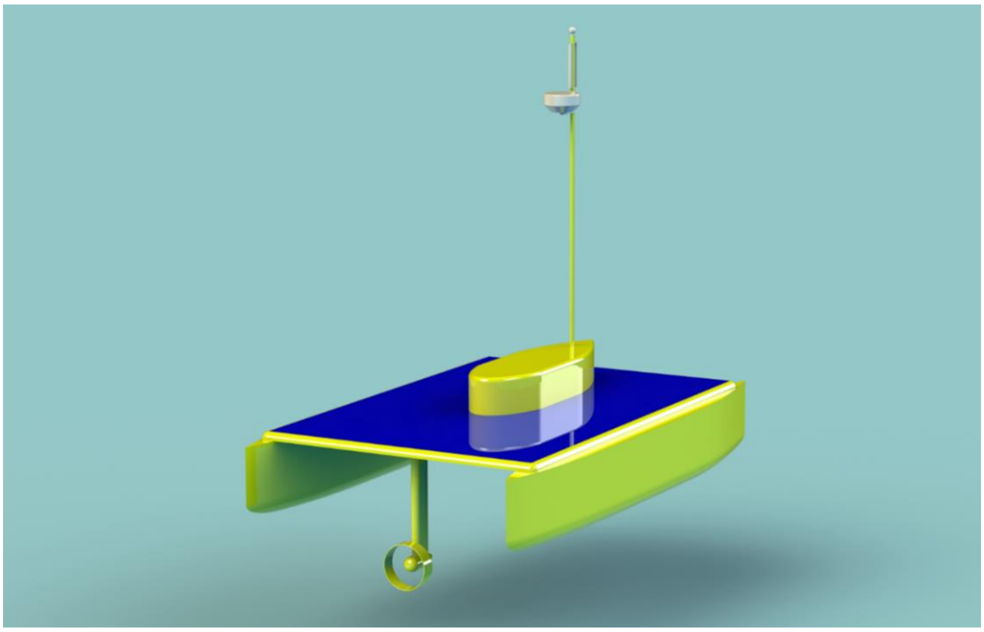


Figure 2: Rendering of the self positioning platform

The solar panels are optional for areas where there can be long periods of low wave energy. A relatively big area of solar panels is needed to produce sufficient power to counteract the current drag on the catamaran, the cable and the turbine.

There can also be periods of low wave energy combined with low solar energy. Then the system is consuming more energy than it produces. Therefore a relatively big battery is needed to overcome this situation. With a battery capacity of 60 kWh (comparable to a modern electrical car battery), the platform can hold its position for around 5 days at an average current of 1 m/s and for around 15 days at an average current of 0.7 m/s, if there is no electricity production by solar or waves.

Specifications of the self-positioning platform

The table below gives the main specifications of the platform. All specifications are preliminary and open for discussion.

Table 1: Conceptual specifications of the self-positioning platform

Conceptual specifications		
Length of floaters	7	m
Length of platform	6	m
Width of platform	4	m
Freeboard height platform	0.5	m
Draft	0.5	m
Length instrument compartment	1	m
Height instrument compartment	0.5	m
Width instrument compartment	1	m
Hull width	0.6	m
Maximum average current	1.0	m/s
Max. significant wave height	16	m
Wave period	16	s
Wave length	220	m
Maximum wind speed	40	m/s
Depth of Subwave turbine	100	m
Diameter of cable to turbine	10	mm
Diameter of the Subwave rotors	2	m
Subwave rotors efficiency	35%	
Electrical efficiency Subwave	80%	
Weight of the rotor (submerged)	800	kg
Solar panels number (optional)	12	
Solar panel area	1.6	m^2
Solar panel efficiency	20%	
Payload weight of instruments	200	kg
Power consumption all instrumentation (max continuous)	150	W
Battery storage capacity	60	kWh

Of course the dimensions of the instrument compartment can be customized. The Subwave rotor efficiency is for the power of both rotors added.

CAPEX of the self-positioning platform

The CAPEX of the self-positioning platform is estimated at about 400 keuro (see the table below).

Development	**Hours**	**euro/hour**	**euro**
R&D hours	5000	80	400000
Prototype insourcing components:			
catamaran with compartment and mast			100000
solar system			30000
drive train			40000
battery system			30000
subwave turbine complete			60000
controls			50000
instrumentation			30000
Tests and demontration			80000
Certification			70000
Total development investment			***890000***
Product (small series)	**Number**	**euro/hour**	**euro/product**
Series production	20		
Insourcing all components:			
catamaran with compartment and mast			30000
solar system			10000
drive train			25000
battery system			22000
subwave turbine complete			15000
controls			15000
instrumentation			25000
Assembly	300	60	18000
Total production cost price			***160000***
Selling price of Product		**Percentage**	**euro/product**
Production cost price			160000
Marketing		25%	40000
Service		15%	24000
Financing		10%	16000
Insurance		10%	16000
Overhead (all other company costs)		30%	48000
Margin		30%	48000
R&D costs			44500
Total sales price			***396500***

This is a first estimation of the sales price of the self-positioning platform.

Some topics for further study:

This is a conceptual design of the platform. Most choices can be adapted after further analysis. Some topics for further study are:

- The drag forces by ocean currents. More detailed calculations will be necessary as well as optimisation of the shape of the parts of the whole system.
- Single or double hull. The double hull has less wind drag, but the propeller (as sketched) could collect floating debris. Two propellers could be integrated in the two hulls, or we could choose for a single hull and try to reduce the wind drag.
- The power production of the Subwave turbine and the forces it exerts on the system, as well as the added weight to the turbine, to keep tension in the cable.
- Wind lift forces on the deck at storm conditions (see below).

To avoid that storm wind lift forces can pull the platform out of the water, the PV panels can be mounted in such a way that there are openings between the PV panels to relieve these forces (see figure 3). The angled mounting position of the PV panels will also help to reduce the lift forces, as long as the bow is kept into the wind. Care should be taken that the PV panels do not induce too much drag, so the optimal angle and the dimensions of the openings should be assessed.

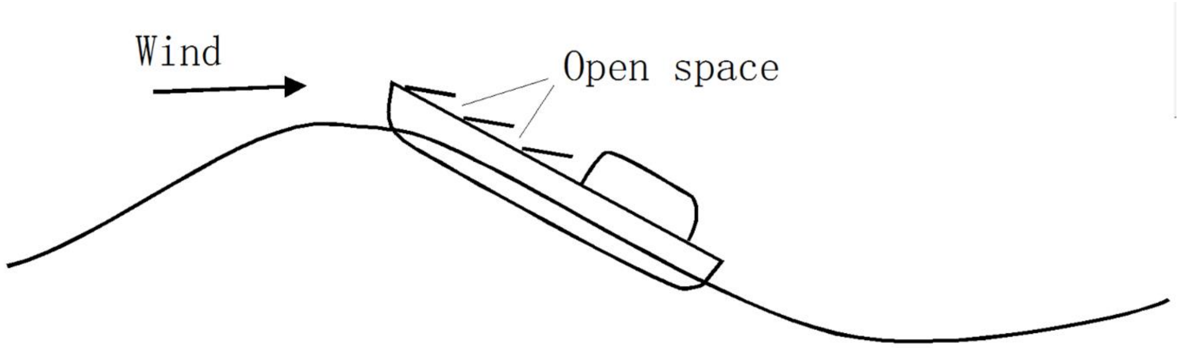


Figure 3: The PV panels can be mounted under an angle, so that the storm wind lift forces can be decreased