Intro for lunch colloquium 23 November 2015 @ TU-Delft

By Fred Gardner

The symphony wave energy converter

"a continuing story."

Teamwork Technology developed several sustainable energy technologies. Amongst them is wave energy. Until 2009 they were responsible for, The Archimedes Waveswing, a project that was started in 1993. It was installed at full scale in Portugal.

Recently we renewed our interest in wave energy. By introducing the Symphony wave power technology, a new project is started.

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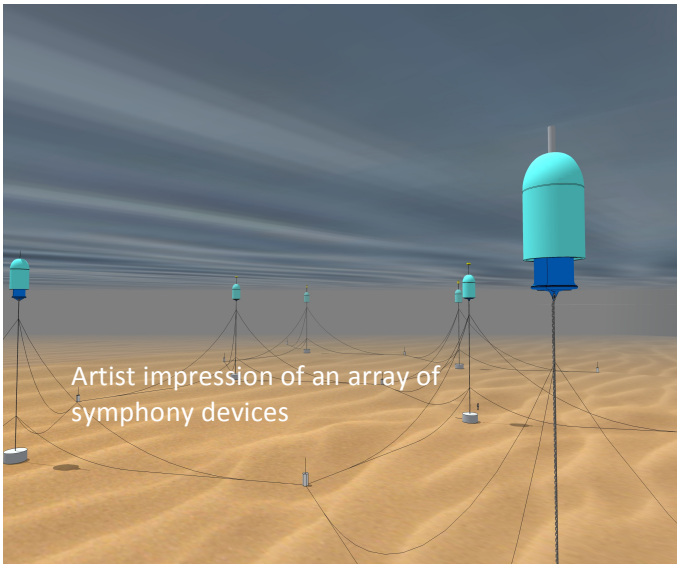
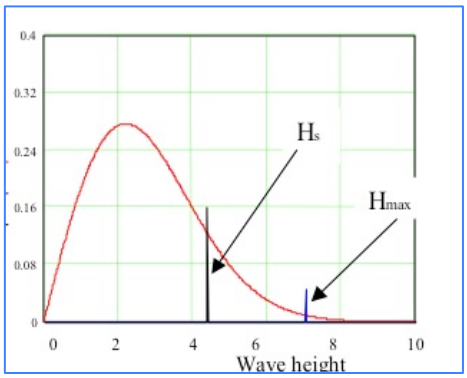
Archimedes Wave Swing being towed from the shipyard

With 22 years of history on wave energy, Teamwork Technology bv is an experienced developer in this field. Recently, after two years of concept development, the decision is made to work towards a new prototype. And first finance is secured.

This step follows a strategic plan. Business development is always connected to technology development. Therefor in the presentation the TU, this link is made as well.

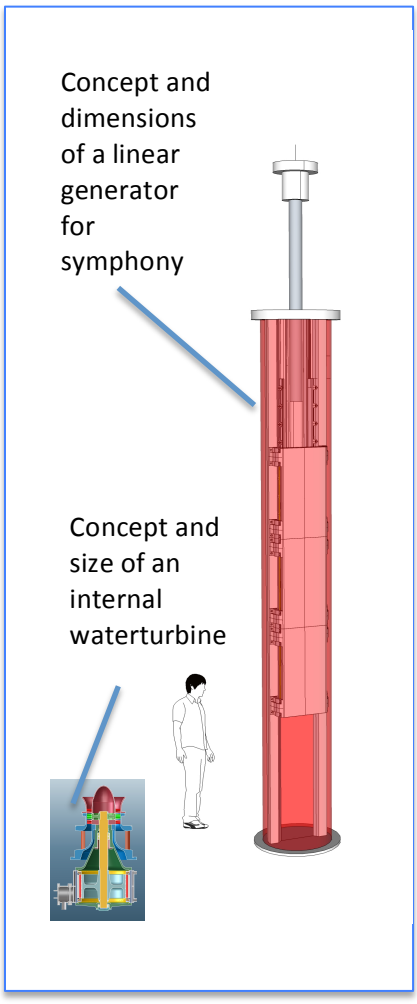


Artist impression of an array of symphony devices



Starting a new wave energy project at a moment that all kind of wave technology companies that are testing at full scale in the ocean, are abandoned by their investors, because commercial results are delayed, is businesswise, at least, a challenge. Important for this challenge, is that one understands "the economics of wave power".

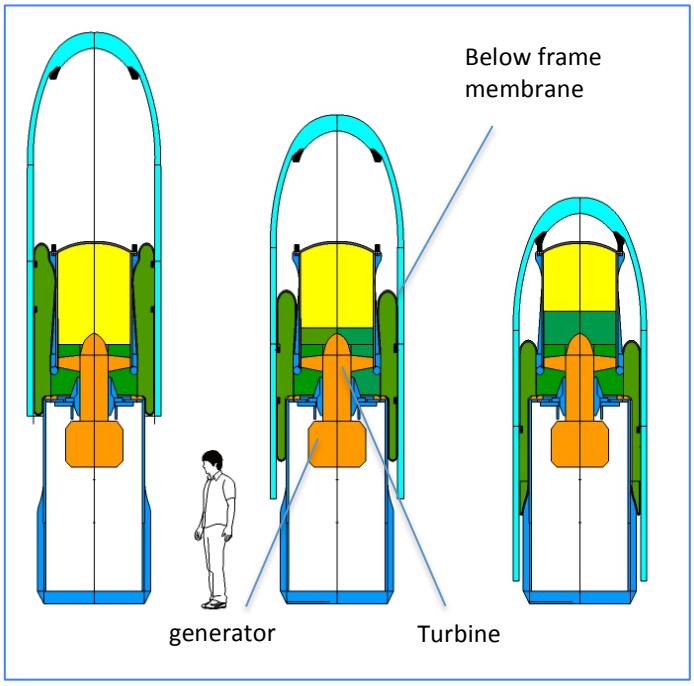
Pressures and currents in a wave are constantly changing. Not only during the wave cycle. Also the occurrence different wave heights is extremely variable. During one hour the ratio between the average and highest wave height is about 4. In an annual season this is about 16. Depending on the location, the average wave can be ca. 2 m while the highest is about 30 meters. So the challenge is to combine reliability and survivability within the design of a wave energy converter design. This is a real cost benefit challenge. Especially since the total power production of a single (large) device is moderate and maximized to a few GWh/y at the most. The second challenge for a point-absorber is the resonance behaviour. Concepts like AWS and the new Symphony device are based on this principle. They are attenuators. They work as antennas for ocean waves. They are resonating to the wave frequency. The small symphony (1,5 m in diameter) will move in its full motion with a stroke of 2m at only 20 cm waves. Resonance occurs since there is a spring inside the system. The acceleration forces from both the mass of the moving parts and the added mass of the water, reacts against the spring force inside. During each cycle all kinetic energy of the mass transfers into potential energy of the spring twice. This cyclic motion process is powered by the pressure in the wave as a wave passes. If waves are larger than 20cm the systems motion should be damped to slow it down and prevent it from touching the end stops. This damping is tapping the energy from the system and transferring it into electricity.



Much study was done in the last 30 years on systems like AWS and the theory is confirmed by model testing. The theory of transforming energy from the waves into mechanical energy of a device like symphony (point absorber) is well studied and can be calculated at a high level of reliability and accuracy.
The challenge starts when the energy captured in the device needs to be transformed into useful energy like electricity. In the past for the AWS a linear generator was developed as a power take off. Together with Henk Polinder from the TU-Delft, a prototype was build and tested in the AWS that was installed in Portugal. For symphony such a design is made as well. The drawing (right) gives an example of such a design for the (small) symphony prototype. Although possible, it will be large and expensive.

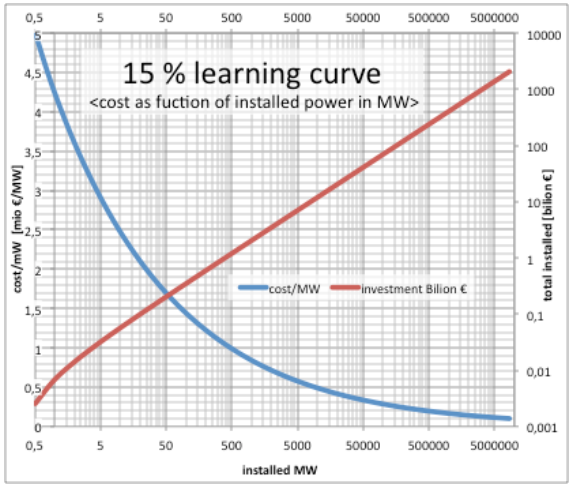
Therefor within the Symphony project, research for simplicity, low cost and reliability is done. This combination is found by combining many functions into a few critical components.

One component is the “below-frame membrane”. It combines a function of a seal, a bearing, end-stop and a PTO. As the upper membrane overlaps a larger gap than the lower, a liquid flow through the turbine as the outer cylinder moves down. Ones the liquid is passed the turbine, it flows into a resonance chamber filled with highly compressed air. The air in this chamber gets more and more compressed as more liquid enters and creates a counterforce that functions as a spring.



If everything works out well, the only two remaining complicated parts are the below frame seal and the turbine

In the presentation at the TU Delft an animation will be shown and the operation will be explained in detail. Also the challenge and business strategy behind such a development will be discussed. Much has to do with developing a new product in a developing market and the effect of cost reduction when industrialisation starts. Universities and small companies are natural Partners in the first stage developments; Teamwork is working with Universities around the world and looks forward to partner with TU Delft again in this challenge.



The mix of new business development and technology development is the core business of Teamwork Technology bv. For the last 22 years new buisiness and startups in the field of renewables were developed. (www.teamwork.nl). Fred Gardner was the founder of the company and of many new technologies and is now also partly invoveld at Inholland (university of applied science), where he assists the research group on renewable energy, and tries to create a better connection between the organisation in the field