Newsletter n. 3

October/2017

Introduction

The MAESTRALE project has come to an advanced stage. The purpose of this newsletter is to inform about the steps that have taken place in recent months. In particular, this issue of the MAESTRALE Newsletter illustrates the results of the three study visits that the project organized in Italy and Sweden, with a special emphasis on the feedback given by the project partners on the advantages and disadvantages of the Blue Energy (BE) technologies seen on the field. The second section of this newsletter presents the results of the analysis of the 45 case studies selected by the MAESTRALE partners, from which it is possible to deduce some preconditions for the creation of the LABs. Finally, we present in detail the two projects that raised the greatest interest from partners during the field visits in Gothenburg last July: the SeaTwirl moored floating wind mill project and the Seabased wave energy converter project.

HIGHLIGHTS OF THE 2ND AND 3RD MAESTRALE FIELD VISITS

On 5th – 7th July 2017 the MAESTRALE team flew to Gothenburg and Kristineberg to attend the 2nd and 3rd Field Visits in order to be updated on the most advanced BE technologies applied in Sweden. In particular, the morning of 5th July was dedicated to the visit of the Minesto company located in Västra Frölunda (Gothenburg) and to the presentation of the Deep Green prototype for the exploitation of the slower tidal waves and sea currents. The afternoon was dedicated to visiting the Waves4Power company (Västra Frölunda) and meeting the work-team to understand the converter technology based on buoys. The following day has been dedicated to the visit to the Sven Lovén Centre for Marines Sciences (Kristineberg), a newly established research centre within the University of Gothenburg, whose team explained the new project based on the cultivation of algae and sea micro-organisms as source of biogas production. Then followed the visit to the SeaTwirl's prototype test-site located in Lysekil, an innovative mooring floated windmill with blades turning around tower's vertical axis, and the visit to the Seabased AB headquarter, a world leading company for the design, production and instalment of wave energy converters.

THE THREE STUDY VISITS AND THE FEEDBACK OF THE MAESTRALE PARTNERS

Following the three study visits, each MAESTRALE project partner was engaged in giving a detailed feedback, highlighting the advantages (*Pros*) and the disadvantages (*Cons*) of the technological solutions seen on the field. The results of this exercise are summarized in the following table.

REWEC 3 – Wave Energy (Port of Civitavecchia – Rome, Italy)	
Advantages	**Disadvantages**
▪ *Low additional investments (UNISI, GOLEA,IRENA)*	▪ *High visual impact (UNISI, MIEMA, INFORMEST)*
▪ *Integration into an existing structure (IRENA, UNISI)*	▪ *Noise of the turbine (UNISI, IRENA, CEEI, AUTH, UAlg, MIEMA)*
▪ *Technical solution with high replicability potential (IRENA)*	▪ *Difficulties/very high costs of implementation in existing breakwaters (CEEI, OC-UCY)*
▪ *Limited costs grid connection (CEEI)*	▪ *Risk of negative impact on port areas of touristic interest (CEEI)*
▪ *Good solution but only on new port infrastructures, if planned during the designing phase (AUTH, MIEMA)*	
▪ *Small wave amplitude required (IRENA)*	
▪ *Easiest and costless maintenance (OC-UCY)*	
SeaTwirl – Offshore wind energy (Lysekil – Sweden)	
Advantages	**Disadvantages**
▪ *Simple technological system (UNISI, INFORMEST)*	▪ *Still many aspects have to be tested (UNISI)*
▪ *Installation in deeper locations (IRENA, CEEI, OC-UCY)*	▪ *Cabling, interference with other industries and marine environment (IRENA)*
▪ *Low installation costs (IRENA, UAlg, MIEMA, INFORMEST)*	▪ *No data on the effective capacity of electricity production (INFORMEST)*
▪ *Easy installation and maintenance (UAlg, MIEMA, GOLEA, INFORMEST)*	▪ *The device is still in a demonstration phase and environmental impacts are yet to be verified (UAlg)*
▪ *The device does not affect the seabed except for the mooring system (MIEMA)*	
▪ *Reduction of the loads induced by the turbine (CEEI)*	
▪ *Floating device and only moored to the seabed (GOLEA, OC-UCY)*	
▪ *Low starting wind speed regardless of the wind direction (GOLEA, INFORMEST)*	
▪ *Good technical solution for Southern Adriatic and remote island communities (IRENA)*	
▪ *Vertical axis wind turbine is good for Adriatic Sea (IRENA)*	
Seabased - Wave Energy (Lysekil - Sweden)	
Advantages	**Disadvantages**
▪ *Simple technological system (UNISI, CEEI)*	▪ *Fatigue life of some elements of the device (CEEI)*
▪ *Easy installation and maintenance (UNISI, OC-UCY)*	▪ *limitations for the positioning area of several devices (AUTH, INFORMEST)*
▪ *All operations can be made on-shore (UNISI)*	▪ *Installation and/or maintenance costs (MIEMA, OC-UCY)*
▪ *Low cost of the system (CEEI, UAlg)*	▪ *No data available on the effective capacity of electricity production (INFORMEST)*
▪ *System can work in low waters (UNISI, GOLEA)*	
▪ *System can work with waves of 1-3 meters (CEEI, MIEMA, GOLEA)*	
▪ *System can placed closer to the shore (IRENA, MIEMA)*	
▪ *Transferability in the Mediterranean Area - low waves with high frequency (UNISI, IRENA, GOLEA)*	
▪ *Low visual disturbance (AUTH, OC-UCY)*	
▪ *Safety of sea navigation (AUTH)*	
▪ *Excellent utilization per MW installed (UAlg)*	
▪ *Minimal impact on environment (MIEMA, OC-UCY)*	

Minesto Deep Green - Tidal and ocean currents energy (Västra Frölunda – Sweden)	
Advantages	**Disadvantages**
▪ No visual impact (UNISI, AUTH, INFORMEST, OC-UCY)	▪ High density traffic in Adriatic (IRENA)
▪ Transferability in the Mediterranean Area and remote islands (UNISI, IRENA, MIEMA, GOLEA)	▪ Risk of negative impact on the marine life (IRENA, CEEI, AUTH, MIEMA, OC-UCY)
▪ Adaptability to large number of location scenarios (IRENA)	
▪ Device works with lower tidal flows (UAlg, MIEMA, GOLEA, OC-UCY)	▪ Fatigue life of some elements of the device (IRENA, CEEI)
▪ Simplicity of the device and easy installation (INFORMEST)	▪ Limited areas in the Mediterranean for the installation (CEEI)
	▪ Possibility of problems in the installation procedures (UAlg)
	▪ Need of sea-depths of at least 90 m. (MIEMA, GOLEA)
	▪ No data on productivity (MIEMA, INFORMEST)

Wave4Power - Wave Energy (Västra Frölunda - Sweden)	
Advantages	**Disadvantages**
▪ Limited visual impact (IRENA, OC-UCY)	▪ Device and mooring system to be redesign to scale down for the adaptability in the Mediterranean (UNISI)
▪ Device made by a network of well established companies (UNISI)	▪ Limited power output (IRENA, CEEI)
▪ Top quality technology (UNISI)	▪ Financial problems fro grid connection (IRENA)
▪ Components/device already tested (UNISI CEEI)	▪ Installation procedures and costs (MIEMA)
▪ Durability of the device (IRENA, AUTH, GOLEA)	▪ Device still on test phase, no data on productivity (INFORMEST)
▪ Low and easy maintenance (AUTH, GOLEA)	▪ Need of wide areas of sea free from ship traffic (INFORMEST)
▪ Possibility to create a complete system connected to the grid (UAlg)	
▪ Involvement of local actors for management/maintenance (MIEMA)	
▪ Possible integration with offshore fish farms and desalination plants (MIEMA)	
▪ All connection are placed in a dry environment (MIEMA)	
▪ Technology allows optimization for smaller wave heights for some Mediterranean areas (GOLEA)	
▪ Maintenance must be performed offshore, increasing costs (OC-UCY)	

From the table above we can draw interesting conclusions. In particular, with regard to the advantages and/or disadvantages offered by these technologies, the MAESTRALE partners emphasize some aspects, such as the size of installation/network connection costs, the easiness or stiffness of maintenance, the possible impact on the marine environment, the possibility of installation in shallow waters, the possibility of operating even with low level of the waves and/or the less favorable currents, i.e. the typical conditions of the Mediterranean Sea, and so on. The latter aspect is the most interesting, being related to the transferability of these technologies to the Mediterranean sea waters:

REWEC3: is one of the most promising technologies for BE generation since it is applicable in other areas of Mediterranean basin were the wave height is low but wave frequency is high. However, the installation of this kind of device is suitable only on new port infrastructures, and only if planned during the breakwater designing phase.

SeaTwirl: thanks to the relative simplicity of the technology, the low installations costs, the low environmental impact and the low starting wind speed, this device could be transferred to Southern Adriatic and several remote islands (mainly the islands of the Croatian Archipelago), were the wind speed is generally low and constant, but could be sometimes very high.

Seabased: devices can be easily installed in clusters close to the seacoast and with low sea depth and flat seabase. The possibility to customize size and power of the device according to wave energy potentials make it easily applicable in the Mediterranean.

Waves4Power: one of the most promising technologies for BE generation in ocean environments. Transferability into the Mediterranean basin has to be investigated, however it seems to be applicable in some areas of the Southern Adriatic.

Minesto Deep Green: the device can produce electricity in seas with slower sea currents (1.2 m./sec.), like the Mediterranean, but transferability into this basin has to be investigated.

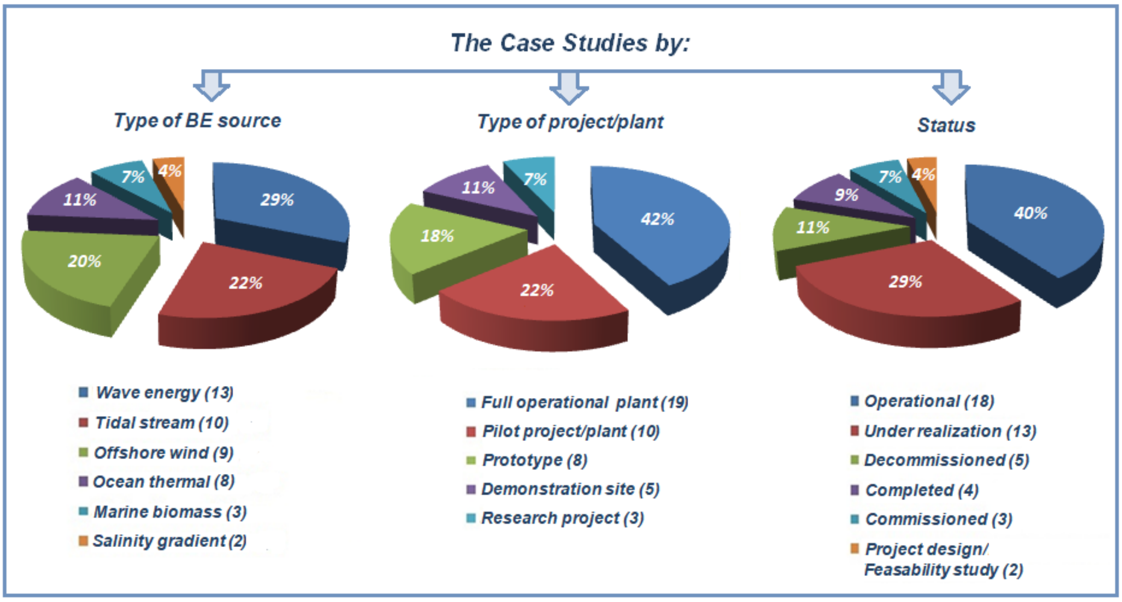
THE CASE STUDIES ANALYSIS: KEY FINDINGS

The analysis of the 45 case studies selected by MAESTRALE project partners brings out very interesting data, especially in view of the creation of the Blue Energy Labs (BELs) and the transferability in the Mediterranean area of the chosen technologies. In particular, considering the type of EB source, most of the 45 case studies consist of projects/devices to exploit In particular, considering the type of EB source, most of the 45 case studies consist of wave energy projects/devices to exploit tidal currents, offshore wind and ocean thermals. tidal currents, offshore wind and ocean thermals. However, their use or increased diffusion in Mediterranean waters, apart from isolated cases, is still to be verified.

- *Wave*: 13 plants have been chosen, mainly located in Spain (3 plants), Italy (3), United Kingdom and Portugal (2 each). The average of the nominal power of the selected plants is about 213 KW, excluding the decommissioned big project PELAMIS on the northern coast of Portugal (40 devices with an unitary capacity of 750 kW). Among the operational plants (many plants are decommissioned or under realization) the highest nominal capacity is that of the Mutriku Wave Power Plant located at Bay of Biscay in the Spanish Basque Country (296 kW).
- *Tidal stream*: 10 plants were selected, of which 6 located off the coast of the United Kingdom (mainly of Scotland) and 2 in Italy (but with a very low nominal power). The nominal average productive capacity shows marked differences depending on the individual plant (for example, from the 150 kW of the R115 WEC device located in Castiglioncello - Tuscan Archipelago/Italy, to the 320 MW of installed capacity – nominal rate 240 MW – of the under realization project Swansea Bay Tidal Lagoon - UK);
- *Wind offshore*: out of 9 plants, 6 are located in the European coasts of the Atlantic Ocean and in North Sea (4 in United Kingdom and 2 in Portugal), or in the best locations for the exploitation of this kind of source. The nominal power ranges from the 2 MW of the under realization Portuguese DEMOGRAVI3 project to the 630 MW of the London Array wind park (175 turbines located 20 km off the Kent coast in the outer Thames Estuary in the United Kingdom);
- *Ocean thermal*: 8 plants mainly located on the Eastern Adriatic Countries - Slovenia Croatia and Montenegro -, with a nominal average capacity of 3.47 MW, but with marked differences depending on the individual plant (for example, from the 15 kW of the Duindorp plant (The Hague) to the 19 MW of the Thassalia plant - Marseille).

Considering the type of project/plant out of the 45 case studies chosen by the MAESTRALE Partners, 42% are full operational plants mainly in ocean thermal energy (private hotels and public buildings in

Slovenia and Croatia) and tidal stream energy (mainly in United Kingdom and Scotland in particular). Pilot projects/plants cover the 22% of the case studies and are concentrated mainly in the wave, tidal and offshore wind sub-sectors, especially in Italy and Portugal. Finally, concerning the status of the projects/plants a share of 40% is related to operational plants that exploit ocean thermal, wave and tidal energy (mainly located in Italy and United Kingdom).



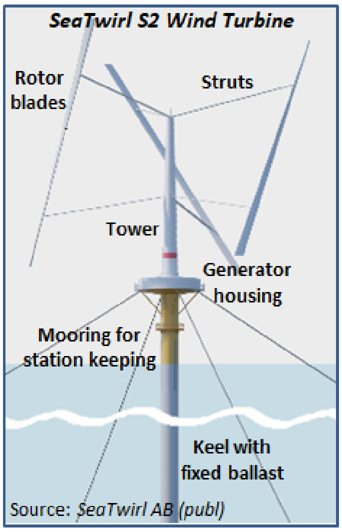
THE SEATWIRL PROJECT IN LYSEKIL (SWEDEN): A DESCRIPTION OF THE PROJECT

SeaTwirl S1 is the first built prototype of a moored floating windmill. *SeaTwirl AB* deployed the 30kW floating wind turbine off the coast of Lysekil Municipality in July 2015. The *S1* engine has been connected to the grid and tested according to plan since its deployment. *SeaTwirl*'s technology uses a vertical-axis wind turbine with a tower connected to the sub-sea structure, consisting of a floating element and a keel. As the energy of the wind causes the turbine to rotate, the structure maintains its stability by using the keel and the counter turning moment, similar to the function of a keel on a sailboat. *Twirl* turbines can be sited in areas that are currently out of reach for conventional offshore wind turbines (that are limited to a depth of about 50 meters). In other words, *SeaTwirl* turbines can be anchored much deeper than 50 meters (unlike any other wind offshore turbines on the market today). This means that *SeaTwirl* can be sited where winds are stronger and more reliable.

SeaTwirl S1 Wind Turbine

Source: SeaTwirl AB

Thanks to the floating sub-sea structure of the wind turbine, the bearings inside the generator housing do not need to carry the weight of the turbine. This is unique to *SeaTwirl* and means that the bearings are subjected to less loads than in other wind turbines. *SeaTwirl*'s wind turbines have a lower centre of gravity and a more stable design than horizontal-axis wind turbines, because the generator and all parts that require maintenance can be placed under the turbine and above the water. *SeaTwirl S1* has an height of 13 meters from the sea level, (below sea level: 18 metres), a turbine diameter of 10 meters, and a rated power of 30 kW. Multiple SeaTwirl S1's can be placed in a dense pattern for increased output. SeaTwirl wind turbines are easily accessed which reduces service costs.



The Company's innovative system ensures lower manufacturing costs, lower life-cycle costs (i.e. reduced need for service and maintenance) and thus a lower overall cost. This is especially important for offshore structures. In addition, the technology of *SeaTwirl AB* bypasses the extensive (and expensive) seabed survey. *SeaTwirl*'s technology is primarily intended for use in offshore commercial wind farms, but there are other interesting areas of use too, or: Islands and remote locations where supplies of power are uncertain and demand for locally-produced power is rising; off-grid fish farms that require power on a smaller scale to deliver electricity to feeders and pumps.

The Company is developing the 1 MW rated capacity *SeaTwirl S2* engine, which is scheduled for completion by 2020. *SeaTwirl S2* has an height of 55 meters from the sea level, (below sea level: 70 meters), a turbine diameter of 50 meters and an height of the rotor blades of about 40 meters. The optimal operating depth for *SeaTwirl S2* is 90-120 metres, but it can be sited at much deeper and extreme wind speed locations (50m/s with a cut-off wind speed 25 m/s). The rated power is 1 MW per single unit, however several SeaTwirl S2 engines can be used in an extensive wind farm. *SeaTwirl AB* plans to sell the first commercial unit to a leading energy company and then establish a floating offshore wind farm in 2025.

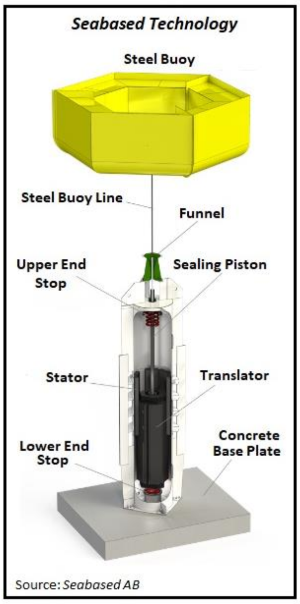
Milestones of the SeaTwirl AB activity

2009: *Inventor and founder of SeaTwirl Daniel Ehrnberg successfully tests the first prototype*
2012: *SeaTwirl AB is founded and raises its initial investment*
2015: *SeaTwirl S1 is successfully commissioned in the sea outside of Lysekil, Sweden*
2016: *SeaTwirl raises capital and begins trading on Nasdaq First North under the ticker STW*
2020: *A full-scale SeaTwirl S2 (1MW) is commissioned*
2025: *The first SeaTwirl Wind farm is commissioned*
2030: *SeaTwirl is a leading player in the floating wind power market*

THE SEABASED PROJECT IN LYSEKIL (SWEDEN): A DESCRIPTION OF THE PROJECT

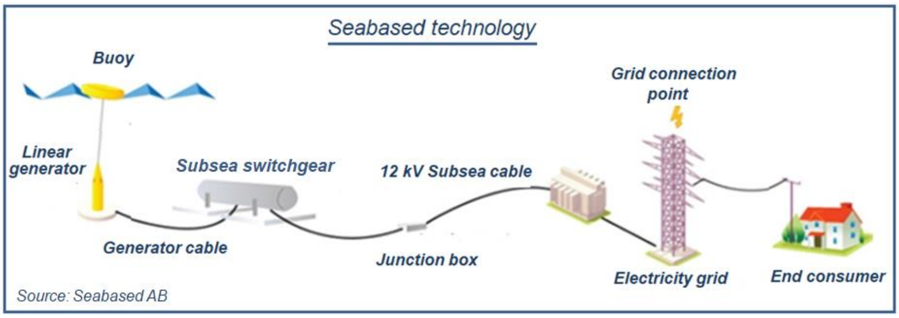
The company *Seabased AB*, also hosted in Lysekil, is a leading actor for developing solutions in the wave energy sector and it designs, builds and installs complete, grid-connected wave parks. These wave parks produce electricity using wave energy converters (WECs), which consist of buoys connected to linear generators placed on the seabed. The buoys move with the waves, and this motion generates power. A subsea WEC makes the electricity suitable for grid use, and sea cables deliver it to the grid. The linear generator, the *Seabased WEC S2.7*, is very efficient at extracting power from the 1-3 meter high swell waves. The encapsulated generators are anchored to the seabed using concrete bases plates, designed and dimensioned according to wave loads and seabed conditions. Seabed preparations

in the form of blasting or excavations are not necessary. Deployment of the WECs on the seabed protects them from extreme conditions that may occur at the surface of the sea and helps minimize required maintenance. From the point of view of maintenance operations, an individual WEC can be disconnected and replaced without affecting the function of other parts of the wave park, which simplifies controls, on-going repairs and maintenance. As the Seabased solution is modular, power units can be placed as single units or in groups, taking into consideration installed power, seabed conditions and other factors. Furthermore, due to the scalable system wave parks can be expanded in phases, to meet the requirement of the customers possibility to invest.



The generators are deployed in formations aligned against the prevailing wave direction and spaced about 20 m. apart. Distance between formations is about 50 m. The total area of a wave energy park is expected to be 1 km2 per 1000 units. *Seabased* built wave energy park in the Municipality of Sotenäs (Västra Götaland County on the Swedish West coast), which is connected to the national electric grid. The Sotenäs project was a joint effort between *Seabased*, the Finnish company *Fortum* (electricity generation), and the *Swedish Energy Agency - SEA*. The *SEA* awarded an investment grant to *Fortum* and *Seabased* for the Sotenäs project in February 2010.

On 13th December 2015, *Seabased* and *Fortum* connected the Low Voltage Marine Substation (LVMS) to the Nordic grid in Kungshamn (Sotenäs). Thereafter, on 14th January 2016 the Sotenäs park generated electrical power to the Nordic power grid for the first time. Phase 1 of the Sotenäs project is now complete, and all the equipment included in it has been manufactured and installed. This includes 36 WECs, a subsea switchgear (LVMS) and an almost 10 km long transmission link between the wave park and the mainland grid. Seabased also assumed responsibility for all permits, including environmental permits. The actual generation results were significantly higher than anticipated at the start of the project, in part due to generator redesign. Because of the increased efficiency of the new generators, the 36 WECs suggest an installed capability up to 3 MW.



Seabased has been also the supplier of a WEC to the WESA project (*Wave Energy for a Sustainable Archipelago*), a joint effort between Uppsala University (Lead Partner), Ålands Teknikkluster and University of Turku, a pioneering wave energy conversion project in the waters of Åland Islands. The project ran from May 2011 until the end of 2013 and was 75% financed by the EU, through the ERDF, and the remaining 25% by national governmental bodies.

Next Steps

The different technologies applied to the BE plants and/or studied/developed by the scientific bodies visited during the field visits have been included in the MAESTRALE Catalogue of Best Practices and Case Studies, among the most promising BE technologies. Furthermore, the transferability of these technologies to the Mediterranean area will be deeply investigated and they will be especially considered among possible solutions to implement Pilot Projects during regional Blue Energy Laboratories. Stay in tune!

Our Communication Activities

In order to disseminate the project development and a more comprehensive understanding of *Blue Energy* on various aspects: actual potential, existing regulations, availability of innovative technologies, a Facebook page and a Twitter account have been created. We are going to share all important updates of the project, news and research articles on Blue Energy and the practices that have been successfully implemented in that field. Moreover, we aspire to create a virtual community where scientists, policy makers, entrepreneurs and citizens can contribute with their knowledge and ideas with regard to prompt effective actions and in-vestments for Blue Growth.

We are on-line !

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