Highlights of the 1st MAESTRALE Transnational Meeting

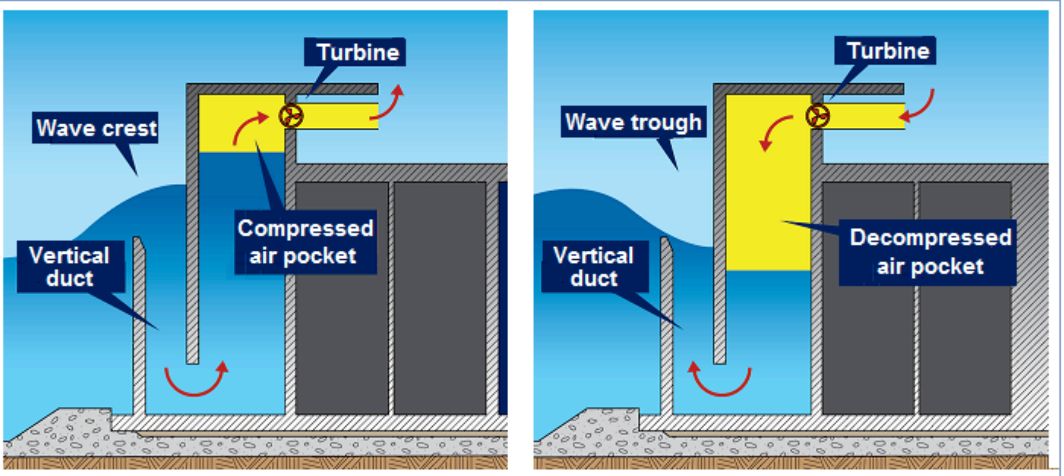
On 4-6 April 2017 the MAESTRALE team met in Rome to attend the 1st Transnational Meeting. It was a very fruitful discussion on the "State of the Art" of marine energy among the partners. We also had an interesting field visit to Civitavecchia Harbor, where we had the opportunity to see the REWEC3 power plant in action. Prof. Felice Arena gave a very clear and exhaustive explanation on how it is possible to implement a power plant based on wave energy in an extension of a Port. It has been emphasized that the best economic performance of such a plant occurs precisely if its realization takes place within an already existing port extension project (i.e. improvement of port safety). The following two days have been dedicated to the "Launch of the Blue Growth Community in the Mediterranean" organized by the Horizontal Project InnoBlueGrowth. It was an amazing experience of networking with the other Modular Projects referring to InnoBlueGrowth: speed dating exercises, round tables and plenary presentations were the ingredients that will help integrate knowledge and experiences between (among others) MAESTRALE project and key stakeholders in the Mediterranean.

Buon vento!
Simone Bastianoni - University of Siena

The REWEC3 Device in the Civitavecchia Port: A description of the project

Wavenergy.it Ltd has been working in the 1st full-scale realization of the innovative technology of the Resonant Wave Energy Converter 3 (REWEC3, known as U-OWC too) integrated into the breakwater of the Port of Civitavecchia (The Port of Rome, Italy), which covers an overall length of 524m. The REWEC3 is a wave energy converter belonging to the family of Oscillating Water Columns (OWCs) incorporated into a traditional vertical breakwater of monolithic reinforced concrete structure type. The REWEC3 may be considered as a strong improvement in the OWC technology, removing several important limitations of past applications and demonstrating to be a very cost-effective and resource-efficient plant.

At present, a fully developed REWEC3 wave energy converter is under testing in real world condition at the port of Civitavecchia, where there is the potential for having an installed power of about 2.2-2.5 MW over 124 independent absorbing chambers, each equipped with a turbo-generator set of about 18-20 kW. This device, as any OWC, is composed by a chamber containing a water column in its lower part and an air pocket in its upper part. The air pocket is connected to the atmosphere via a small duct hosting a self-rectifying turbine. In addition to that, a REWEC3 includes a small vertical U-shaped duct for connecting the water column to the open sea. The working principle of the system is quite simple: by the action of the incident waves, the water inside the U-shaped duct is subject to a reciprocating motion. This motion induces alternately a compression and an expansion of the air pocket, which generates an air flow in the air duct. A turbine coupled to an electrical generator, installed into the air duct, is driven in this way to produce electrical energy.



Source: www.wavenergy.it

The REWEC3 technology has been adopted by the Port Authority of Civitavecchia (PAC) in the works of enlargement of the port of Civitavecchia (Rome, Italy) as an innovative solution to the problem of improving port safety in comparison with traditional vertical breakwaters. Specifically, 17 REWEC3 caissons are under construction and 8 are about completely built. This configuration was designed with the objective of maximizing the energy harvested by a single absorbing cell. Specifically, each REWEC3 caisson is 33.94 m long and includes 8 independent absorbing cells (vertical duct and pneumatic chamber) 3.87m wide. The vertical duct is 1.60 m wide and the U-duct opening is located 2.00 m below m.w.l., so that the opening is not always below the free surface, while the pneumatic chamber is 3.20 m wide. The passive part of the REWEC3 reminds the classical vertical breakwaters, thus based on the associated construction techniques. The lowest part of the active cells of the caissons is filled with concrete in order to ensure both the overall stability and a monolithic behaviour of the structure, while the cells of traditional caisson are filled with sand and concrete. The total cost to build the REWEC3 caissons have been fully covered by APC via funds of the Italian Government (CIPE, "Legge Obiettivo"). From a strict economic perspective, it is mentioned that the extra-cost for building a REWEC3 caisson with respect to a traditional breakwater caisson has been estimated about 5-7%. This relates to the fact that the REWEC3 is built with the same construction techniques of a traditional breakwater (pre-built reinforced concrete caisson, in dry docks, which is sunk in situ by filling sea water).

The Port of Civitavecchia and the new dock — *The new dock* — *The new dock and the REWEC3 Caissons* — *The REWEC3 Caissons*

Source: Port Authority of Civitavecchia

Highlights on Blue Energy status in Italy

Tidal and Wave energy represents the two most advanced types of ocean energy technologies. In the EU, the aim is to reach 100 GW of combined wave and tidal capacity installed by 2050. In order to achieve these targets the sector needs to overcome a series of challenges and barriers with regards to technology readiness, financing and market establishment, administrative and environmental issues and the availability of grid connections especially in remote areas. Currently these barriers are hindering the sector's progress; its ability to attract inwards investments and to engage with the supply chain to unlock cost-reduction mechanisms. A number of policy initiatives and mechanisms have been put in place to ensure that ocean energy technologies could become cost-competitive in the short term, in order to exploit the benefits that these technologies could provide to the

EU. Despite the increased interest demonstrated by political initiatives, such as the above mentioned EC Communication on *Blue Energy*, ocean energy deployments are proceeding at lower pace than expected and the ocean energy market is still to be established.

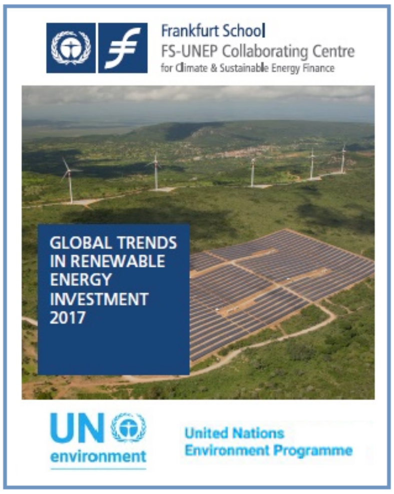
On the Mediterranean Sea there are notable differences in development of *Blue Energy* sector compared to Atlantic Ocean and northern Europe and existing projects in Mediterranean are on initial stage of development. Mediterranean Sea is characterized by more or less suitable areas for the development of the *Blue Energy* exploitation, considered in all its sources - waves, tides, currents, salinity and temperature gradients along with other alternative energy forms related to the use of off-shore wind farms and the use of marine biomass. In the case of Italy, to date, the Blue Energy use in the Adriatic, Ionian and Tyrrhenian Seas is still in an embryonic phase when compared to the situation in other seas/oceans and is headed by single and experimental projects.

Wave energy: the annual and monthly average offshore wave power, varies between 1.6 kW/m and 9.05 kW/m. The Adriatic sea shows an average value around 2 kW/m, the smallest value around Italian coasts, as expected. The Ionian, North and Middle Tyrrhenian seas are a bit more energetic reaching a value of about 3 kW/m whereas the South Tyrrhenian is characterized by a value of 4 kW/m. A completely different behaviour is highlighted for the Alghero buoy (north-west Sardinia island) where the estimated power reaches the value up to 9 kW/m. The site is subject to direct approach of swells from distant storms of one of the most perturbed region of the Mediterranean Sea. In fact, it is influenced by rapid change in currents caused by winds from the east and north Europe. Here the estimated power reaches the value up to 9 kW/m. The high energy potential for West Italian offshore (Sardinia) is also showed from wave climate registered around the west coast of Sicily Island. Sicily has mid-Mediterranean location, positioning at the end of the passage formed from Sardinia and Tunisian coast. This configuration creates a localized weather system that encourages the coming of the wave energy resources from the far field. However, the data set of the buoy operating in Mazara del Vallo provides point wave power assessment of 4.75 kW/m, which is only half of the power reached in Alghero. It is important to note that Mazara del Vallo wave buoy is located offshore of the south-western coast, in a naturally sheltered site, so that its primary and secondary fetch sectors result quite reduced. The south facing shores, in fact, experience more gentle swell conditions associated with weaker seas generated by damped winds passing through the Tunisia and Sicily island. Hence, greater energetic conditions are expected for the Sicilian western coast.

Tidal energy: in Italy there are only few locations with an existing exploitable resource of current energy and one of them with a significantly greater potential is Messina strait. On that location, many test devices have been implemented and few of them even went to full scale. The main example is The Enermar pilot plant. The installation site was offshore near Messina, by the Sicilian coast, where the average speed of the tidal current is between 1.5 e 2 m/s, although there are points, in the Strait of Messina, where the velocity peaks can reach more than 3 m/s.

Offshore Wind: the highest wind speeds, between 6.5 and 7.5 m/s, appear in the south-western parts of Sardinia (Sardinia Sea) and Sicily coasts (Sicily Strait). The absolute minimum (between 3.5 and 4.0 m/s) appears at the corner facing the border between Italy and Slovenia (Northern Adriatic). Other secondary minima can be found near the coastal areas of Liguria (between 3.5 and 5.0 m/s), Lazio (between 5.0 and 5.5 m/s), and Marche (between 5.0 and 5.5 m/s). In particular we consider a typical 1.5 MW turbine with hub height of 60 m and a typical 2.3 MW turbine with hub height of 85 m. As is evident, a hypothetical distribution is similar to that of the wind speed, with maximum values (up to 6500 MWh to 60 m up to 10000 MWh to 85 m, corresponding to about 4000 hours of work equivalent of the turbine at its rated power) in the parts southwestern coasts of Sardinia and Sicily.

THE NEW UNEP REPORT ON "GLOBAL TRENDS IN RENEWABLE ENERGY INVESTMENTS 2017": KEY FINDINGS ON MARINE ENERGY



According to the Report of the *United Nations Environment Programme (UNEP)* on the new trends in renewable energy investments, in 2016 global new investment in renewables[1] fell by 23% to $241.6 billion (312.2 in 2015), the lowest total since 2013, but there was record installation of renewable power capacity worldwide in 2016. A major reason why installations increased even though money invested fell was a sharp reduction in capital costs for solar photovoltaics, onshore and offshore wind. Wind, solar, biomass and waste-to-energy, geothermal, small hydro and marine sources between them added 138.5 GW, up from 127.5 GW in 2015. Offshore wind was the "star sub-sector" in 2016, its record asset finance total of $30 billion including the go-ahead for the biggest project yet, the 1.2GW Hornsea array off the UK coast. The smaller sectors of renewable energy had mixed fortunes in terms of investment last year. Among them marine energy edged down 7% to

[1] The following renewable energy projects are included: all biomass and waste-to-energy, geothermal, and wind generation projects of more than 1MW; all hydropower projects of between 1MW and 50MW; all wave and tidal energy projects; all biofuel projects with a capacity of one million litres or more per year; and all solar projects, with those less than 1MW estimated separately and referred to as small-scale projects, or small distributed capacity.

$194 million (of which, nearly $ 100 million in Europe). However, considering the 2004-2015 period, although taking into account the low-base level of investment base compared to other renewable sources, the annual average growth rate for the marine sources is 16%.

New Investments by sector

Data in $ bln.	*2004*	*2006*	*2008*	*2010*	*2012*	*2014*	*2015*	*2016*	*Δ% 2015/2016*	*CAGR (**) 2004/2016*
TOTAL of which:	47.0	112,7	181.4	243.6	255.5	274.2	312.2	241.6	- 23	+ 15
Solar	11.2	21.9	61.3	103.6	140.6	143.9	171.7	113.7	- 34	+ 21
Wind (*)	19.6	39.7	74.8	101.6	84.4	106.5	124.2	112.5	- 9	+ 16
Biomass & W-t-E	8.3	12.8	17.5	16.6	14.4	10.8	6.7	6.8	0	- 2
Small Hydro	2.7	7.5	7.6	8.1	6.4	6.4	3.5	3.5	0	+ 2
Geothermal	1.2	1,4	1.7	2.9	1.6	2.9	2.3	2.7	+ 17	+ 7
Biofuels	4.0	28.8	18.4	10.5	7.2	5.3	3.5	2.2	- 37	- 5
Marine	*0.0*	*0.8*	*0.2*	*0,2*	*0.3*	*0.3*	*0.2*	*0.2*	*- 7*	*+ 16*

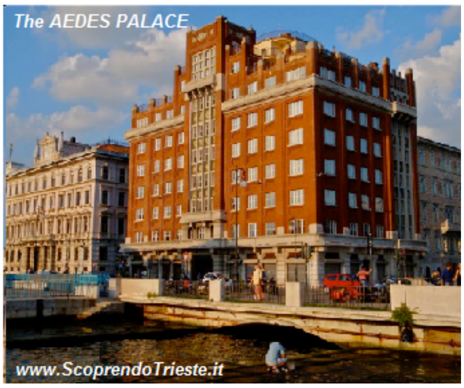
(*) – Onshore and Offshore
(**) - Compound Average Growth Rate

Source: UN Environment, Bloomberg New Energy Finance

In marine energy, recent years have seen a series of upsets, particularly for wave technology developers. Several leading players went out of business in 2013-15, and the remaining, depleted field has found it hard to raise fresh venture capital funding. Nevertheless, in 2016 Finnish company *AW-Energy* raised €10 million in loans from the European Investment Bank to develop further its *WaveRoller* technology, currently being demonstrated off the coast of Portugal. Australian companies *Carnegie Wave Energy* and *BioPower Systems* have been awarded government grants to develop demonstration projects off Western Australia and Victoria respectively. The other fledgling, in marine energy technology, tidal stream, has progressed further, with the first multi-MW demonstration projects being installed at *MeyGen*, off the north coast of Scotland, and at Paimpol-Brehat, off the French Brittany coast (the Paimpol-Bréhat park is a hydro-turbine farm created in 2008, managed by EDF and it is the 1st farm in France and in the World of hydro-turbines connected to the national electricity distribution network). During 2016, *Atlantis Resources*, the company behind *MeyGen*, raised £ 6.5 million via a share issue on *London's Alternative Investment Market*, while *OpenHydro*, involved at Paimpol-Brehat, raised £ 47 million from its shareholders, led by French engineering group *DCNS*. Another turbine maker, *Scotrenewables*, was awarded a € 10 million grant from the European Commission's Horizon 2000 programme, in February 2016. Marine energy saw almost no asset finance in 2016, but the potential remains for it to feature in some significant projects in the future, and efforts were underway to finance larger projects in UK, Irish and French waters.


Hydro-turbine immersion off the Bréhat coast 29/05/2016

SEA ENERGY IN DOWNTOWN! THE CASE OF TRIESTE



From the end of 2017, the Aedes Palace of Trieste, known as the "Red Palace" and owned by the Assicurazioni Generali group (AG), will be heated and cooled with Sea Water. The palace (9 floors, 50 meters high), a sort of mix of Art Deco aesthetics and Italian rationalist architecture and built in 1928 by architect Arduino Berlam, is home of the headquarters of the Generali Academy, the School of Excellence created to develop the skills of managers worldwide. Following the "green" line that the AG group has already applied in other Italian locations, instead of the gas heat plant and large air conditioning units, a system with heat pumps will be installed in the underground floor of the building, exploiting the seawater temperature - taken as said by the nearby “Canal Grande”- will heat or cool the rooms of the big palace. This system will result in considerable economic savings (no gas use and cut in energy consumption around 50-60%) and an important contribution to the reduction of greenhouse gases due to the use of a renewable source. The plant, designed by *SIMM* (*Società di Ingegneria Masoli Messi*) in Trieste, will not only exploit the seawater temperature but also that of groundwater, which will be taken at a depth of about 30 meters, just a short distance from the building. The 18°C groundwater will be mixed with sea water to comply with the temperature limits set by the law for the re-immersion of water in the environment. The entire plant and heat pumps will not come into direct contact with sea water, which could create a lot of problems because of the microorganisms present in the water itself. The project has foreseen the installation of heat exchangers (titanium, for longer duration), which will transfer heat in and out between the external piping and the internal plant. In order to provide adequate maintenance, the system will be twofold: this can be done without interrupting the cooling or heating of the building

Next Steps

According to plans, the 1st relevant result of the project MAESTRALE is about to be released! It is the "International Catalogue of Best Practices and Case Studies" in the field of Blue Energy, that is going to be issued in the next weeks under the coordination of IRENA, the Istrian Regional Development Agency. The document will collect 100 best practices in Blue Energy plants from all over Europe and will be the most up-to-date picture of the state of the art of Blue Energy development in Europe, including the regulatory framework at EU and national level.

Direct experience on the field is important to get a clear view of what are the most promising solutions in the Blue Energy sector. The MAESTRALE team is planning two more field trips to visit the most interesting energy plants: we want to pick the best of the best practices and check where they could be applied in the Mediterranean area. Stay tuned!

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 the 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 investments for Blue Growth.

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Project partners

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