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Posidonia Ποσειδώνια
The International Shipping Exhibition

4th International Seminar on Energy and Shipping, June 8, 2018

OFFSHORE SUSTAINABLE ENERGY INFRASTRUCTURE AND ITS IMPORTANCE IN ENHANCING THE SHIPBUILDING INDUSTRY IN GREECE

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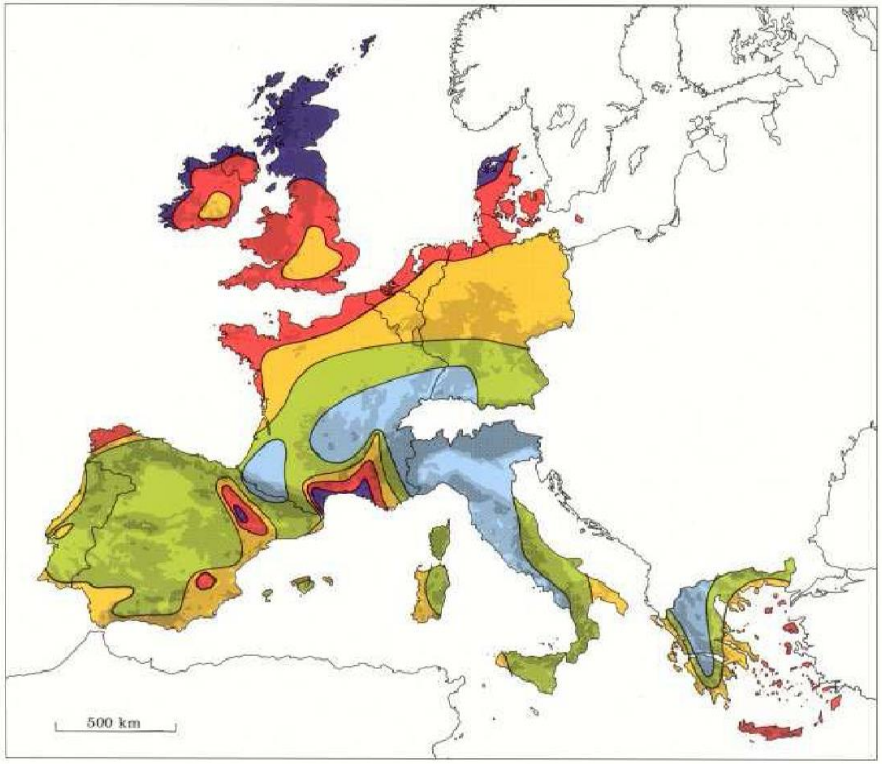
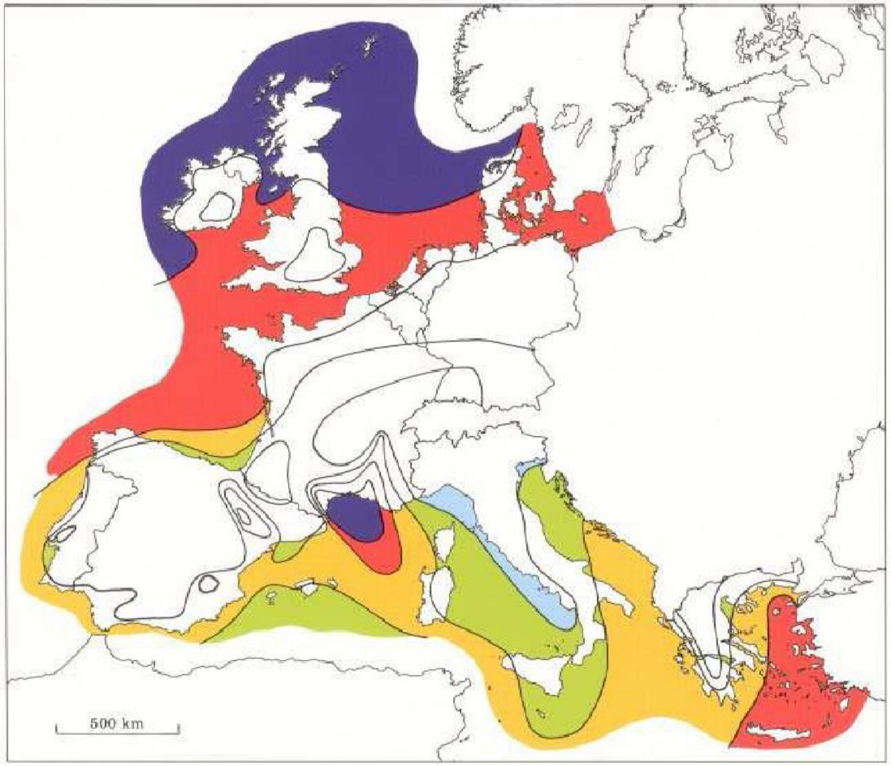
WIND RESOURCE IN EUROPE





Wind resources[1] at 50 metres above ground level for five different topographic conditions										
	Sheltered terrain[2]		Open plain[3]		At a sea coast[4]		Open sea[5]		Hills and ridges[6]	
	$m s^{-1}$	Wm^{-2}	$m s^{-1}$	Wm^{-2}	$m s^{-1}$	Wm^{-2}	$m s^{-1}$	Wm^{-2}	$m s^{-1}$	Wm^{-2}
(purple)	> 6.0	> 250	> 7.5	> 500	> 8.5	> 700	> 9.0	> 800	> 11.5	> 1800
(red)	5.0-6.0	150-250	6.5-7.5	300-500	7.0-8.5	400-700	8.0-9.0	600-800	10.0-11.5	1200-1800
(yellow)	4.5-5.0	100-150	5.5-6.5	200-300	6.0-7.0	250-400	7.0-8.0	400-600	8.5-10.0	700-1200
(green)	3.5-4.5	50-100	4.5-5.5	100-200	5.0-6.0	150-250	5.5-7.0	200-400	7.0- 8.5	400- 700
(light blue)	< 3.5	< 50	< 4.5	< 100	< 5.0	< 150	< 5.5	< 200	< 7.0	< 400

Wind resources over open sea (more than 10 km offshore) for five standard heights										
	10 m		25 m		50 m		100 m		200 m	
	$m s^{-1}$	Wm^{-2}	$m s^{-1}$	Wm^{-2}	$m s^{-1}$	Wm^{-2}	$m s^{-1}$	Wm^{-2}	$m s^{-1}$	Wm^{-2}
(purple)	> 8.0	> 600	> 8.5	> 700	> 9.0	> 800	> 10.0	> 1100	> 11.0	> 1500
(red)	7.0-8.0	350-600	7.5-8.5	450-700	8.0-9.0	600-800	8.5-10.0	650-1100	9.5-11.0	900-1500
(yellow)	6.0-7.0	250-300	6.5-7.5	300-450	7.0-8.0	400-600	7.5- 8.5	450- 650	8.0- 9.5	600- 900
(green)	4.5-6.0	100-250	5.0-6.5	150-300	5.5-7.0	200-400	6.0- 7.5	250- 450	6.5- 8.0	300- 600
(light blue)	< 4.5	< 100	< 5.0	< 150	< 5.5	< 200	< 6.0	< 250	< 6.5	< 300

OFFSHORE WIND ENERGY

EUROPEAN OFFSHORE WIND TARGET 2020

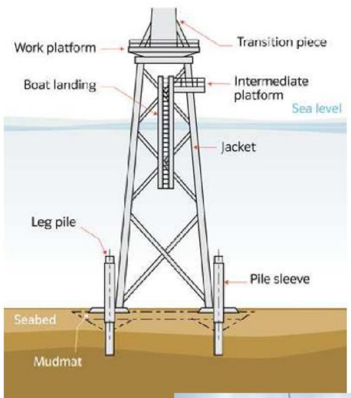
NREAP: National Renewable Energy Action Plan

OFFSHORE WIND DEVELOPMENT - MAIN STEPS

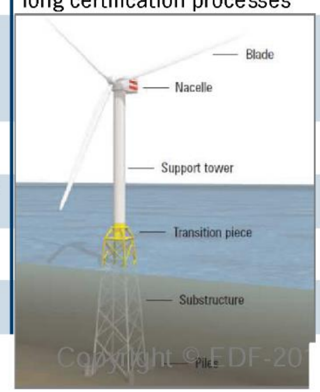
	Origination	Development	Construction	Operation
Milestones	• Initial screening of potential sites • Preliminary evaluation of seabed and wind conditions • Securing of project and property rights • Application for permission	• Wind Assessment/ Ground Survey • Environmental Impact Assessment (EIA) • Technical planning • Securing of grid connection • Receiving of construction permit	• Component contracts signed • Installation of foundations and wind turbines • Connection to onshore grid • Commissioning and start of operation	• Hands-on and pro-active operation • Regular check and maintenance of technical equipment • Repairs, overhauls and upgrades • At end of lifetime: decommissioning or repowering

JACKET

- Jacket : steel lattice structure (welded pipes Ø 0.5 – 1.5m) from Oil & Gas industry. ~ 1000tons (> 1km welding!).
- Structure suitable for deep water (< 50-60 m) with heavy turbines (> 5 MW). Small leg monopiles are driven in the seabed (Ø 1 – 2.5m).
- 1st offshore wind installation: demonstration site Beatrice in Scotland in 2006 (2 x REpower 5 MW – 45 m water depth).



Advantages	Disadvantages
Lightweight and stiff structure	Complexity of fabrication
Better global load transmission compared to monopiles	Large number of joints required compared to other latticed structures
Large variations in water depth can be covered through cantilevering piles or modifying the geometry	Logistical issues due to the templates (pre-piling case)
No scour protection required	Complex connection to transition pieces
Structural redundancy	High manufacturing lead-times
Low soil dependency	No standardized design that leads to long certification processes
Good response to wave loads. Little sensitivity to large waves and limited dynamic amplifications of loads due to high stiffness	
Limited storage area compared to GBF	
Faster fabrication compared to GBFs (serial production)	
Better quality control	
Easy decommissioning	



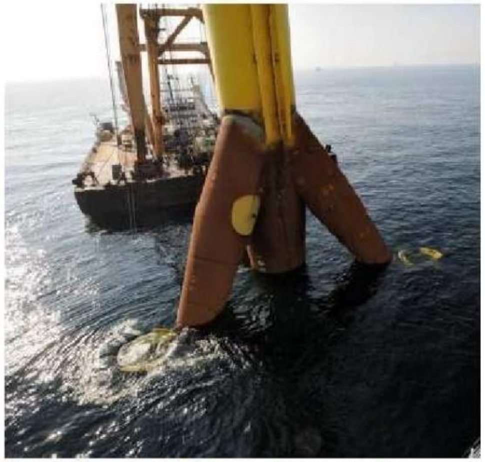
TRIPOD INSTALLATION (ALPHA VENTUS)


Tripods being welded


Tripod up-ended for shipping


Tripods arriving at Wilhelmshaven port


Heavy-lift crane ship on site


Tripod foundation lowered to seabed

Installation complete

INSTALLATION – HEAVY OFFSHORE VESSELS

JAPANESE PROJECTS : SEA ANGEL (2015)

Fukushima
7 MW (MHI)

Items	Scopes
Turbine	· Verification of 7MW hydraulic turbine.
Floating	· Development of V-shape semi-sub floating. · Development of the reduction of floating motion by turbine control and O&M program.
Mooring	· 8 pieces catenary.

· Rotor diameter	164m
· Hub height	105m (ASL)
· Height of the floater	32m

Installed summer 2015

FUKUSHIMA-FORWARD Project

ADVANCED SPAR 5 MW (2016)

- **Last part of Fukushima forward project**
  - 5MW Turbine
    - Hitachi
    - Downwind type
  - Advanced-spar concept
    - Japan Marine United
    - Low draft solution (30m)
    - Large sections (50m)

➡ Japan is still working on prototypes

Full shape

Built in the dockyard of Hitz

Carried to Sumoto port on 2 May

The floater lost control and leaned on 9 May

The floater recovered stability again on 14 May

JAPANESE PROJECTS : SEMI-SUB AND SPAR (2013)

Fukushima (Mitsui/Hitachi)

- Design for use with a 2MW turbine
- Width 58 m
- Total column length 32 m of which 16 mwill be submerged
- Hub height 60 m

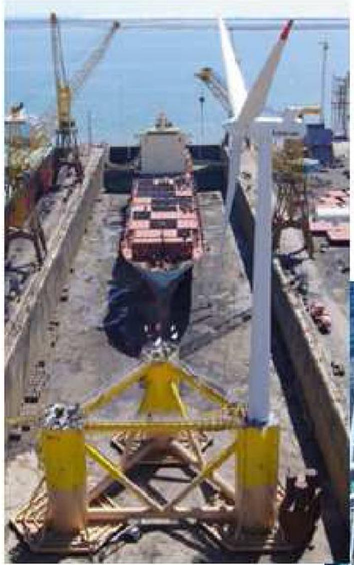
GOTO OWT (Toda/Hitachi)

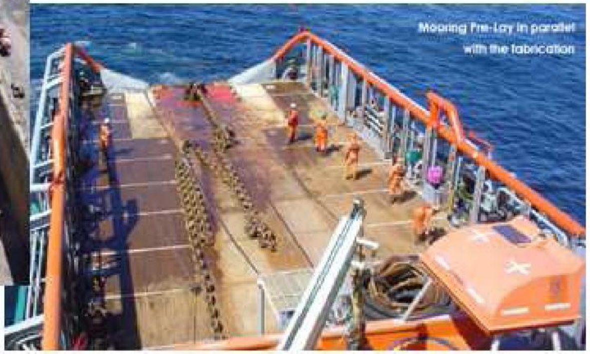
Full Scale:

- 2MW downwind turbine with 80m rotor diameter
- Total spar length 172m
- Total weight incl. Turbine 3,400 t
- Steel with pre-stressed concrete
- Steel chain mooring, 3 points, catenary, attached to drag anchors

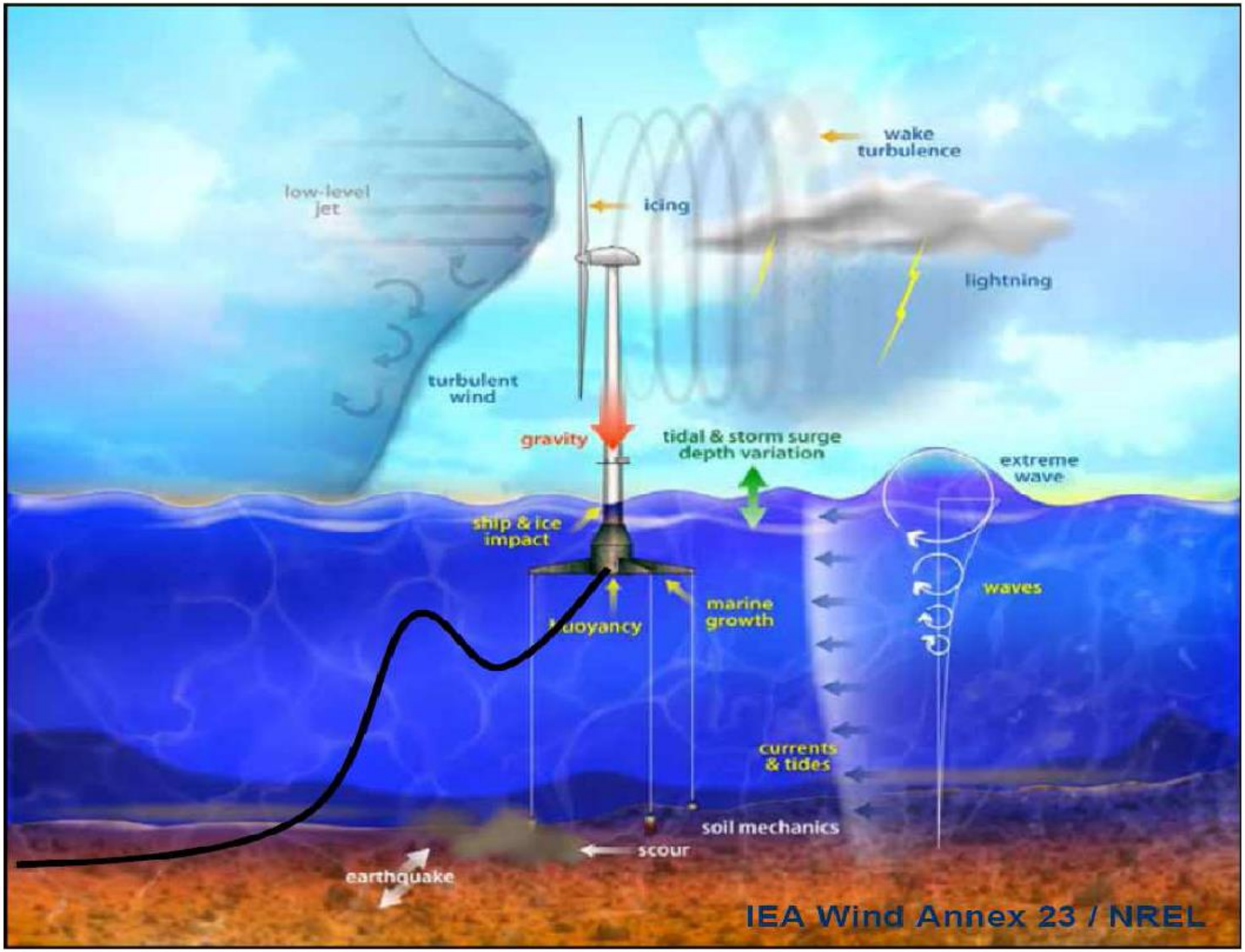
Image Source: Kyoto University

INSTALLATION - SEMISUBMERSIBLE



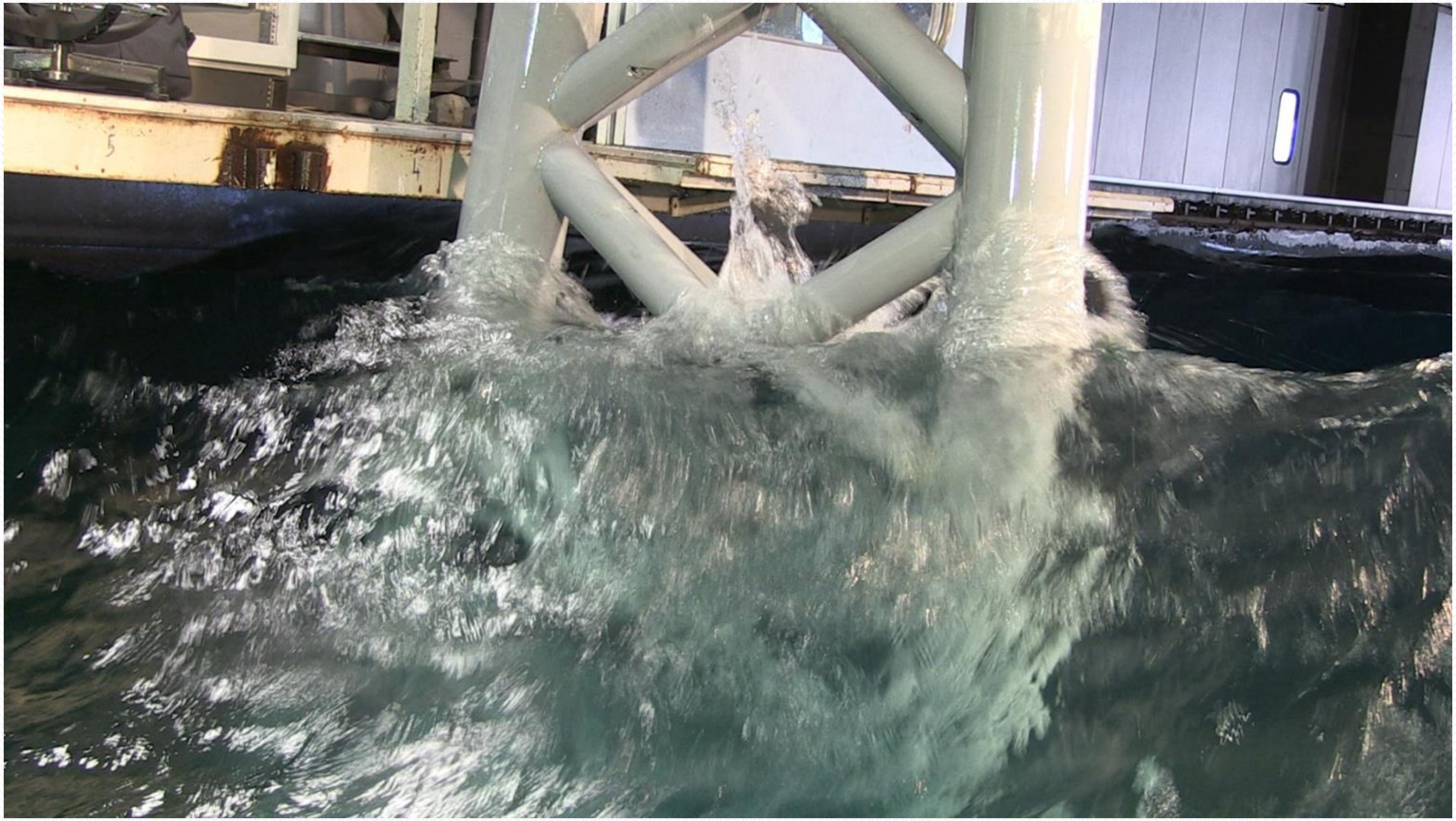


CHALLENGES TO BE ADDRESSED



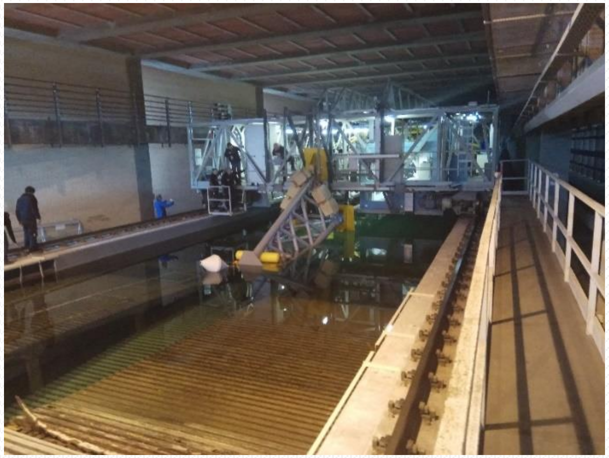
WAVE ENERGY CONVERSION CONCEPTS - LOOKING AT THE FUTURE

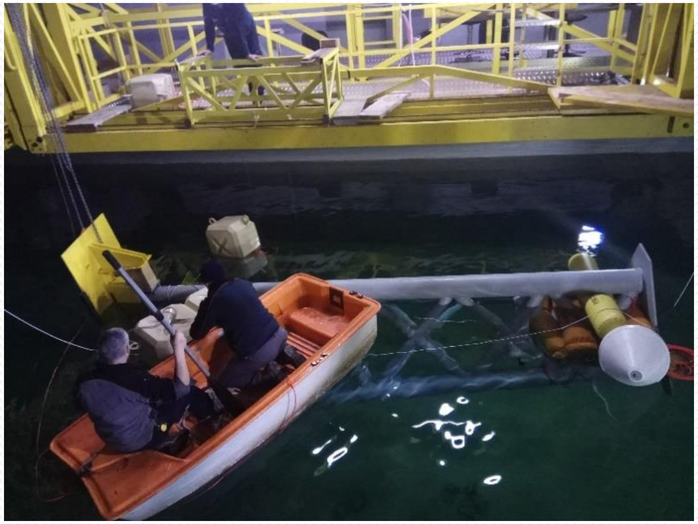
RESEARCH IN GREECE

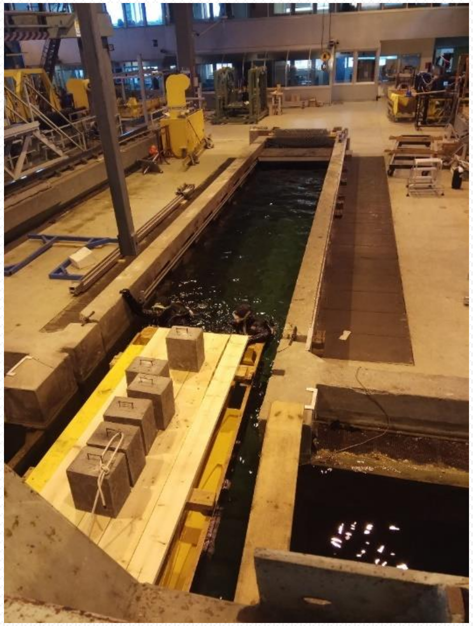


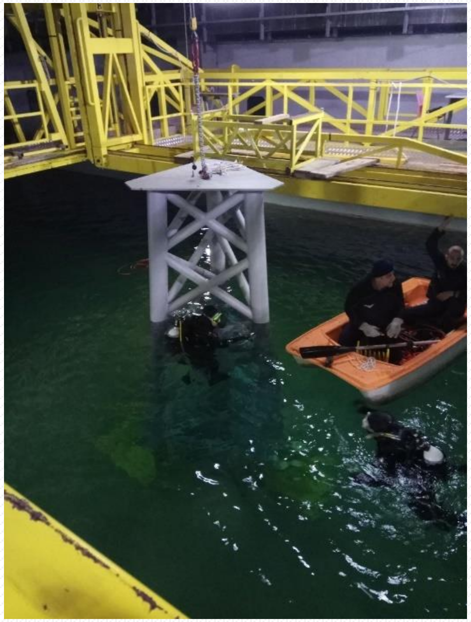
VIHYDRO & VIHYDRO II

A three-legged jacket foundation for large power OWT is intermediate water depths

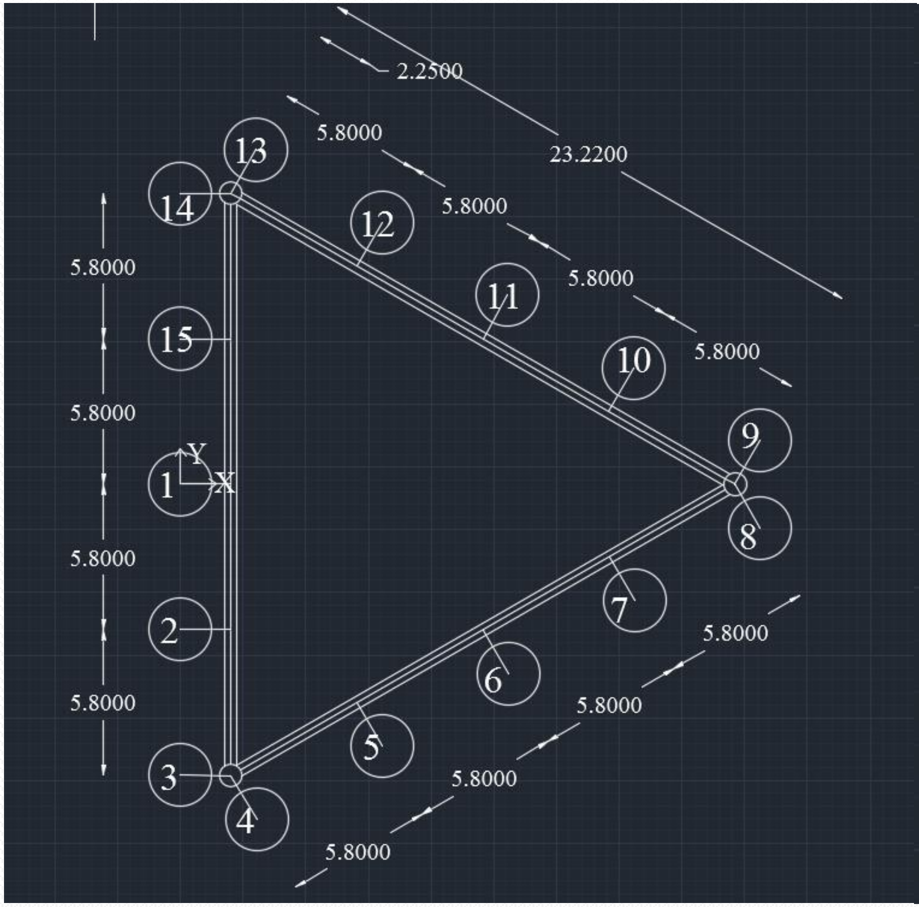


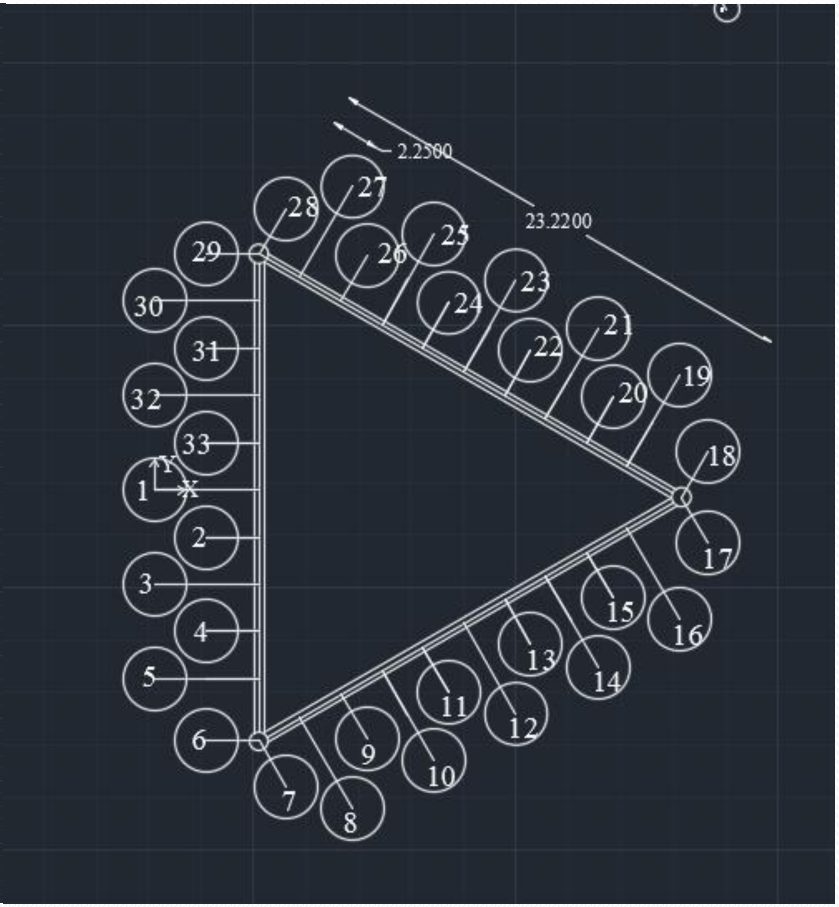






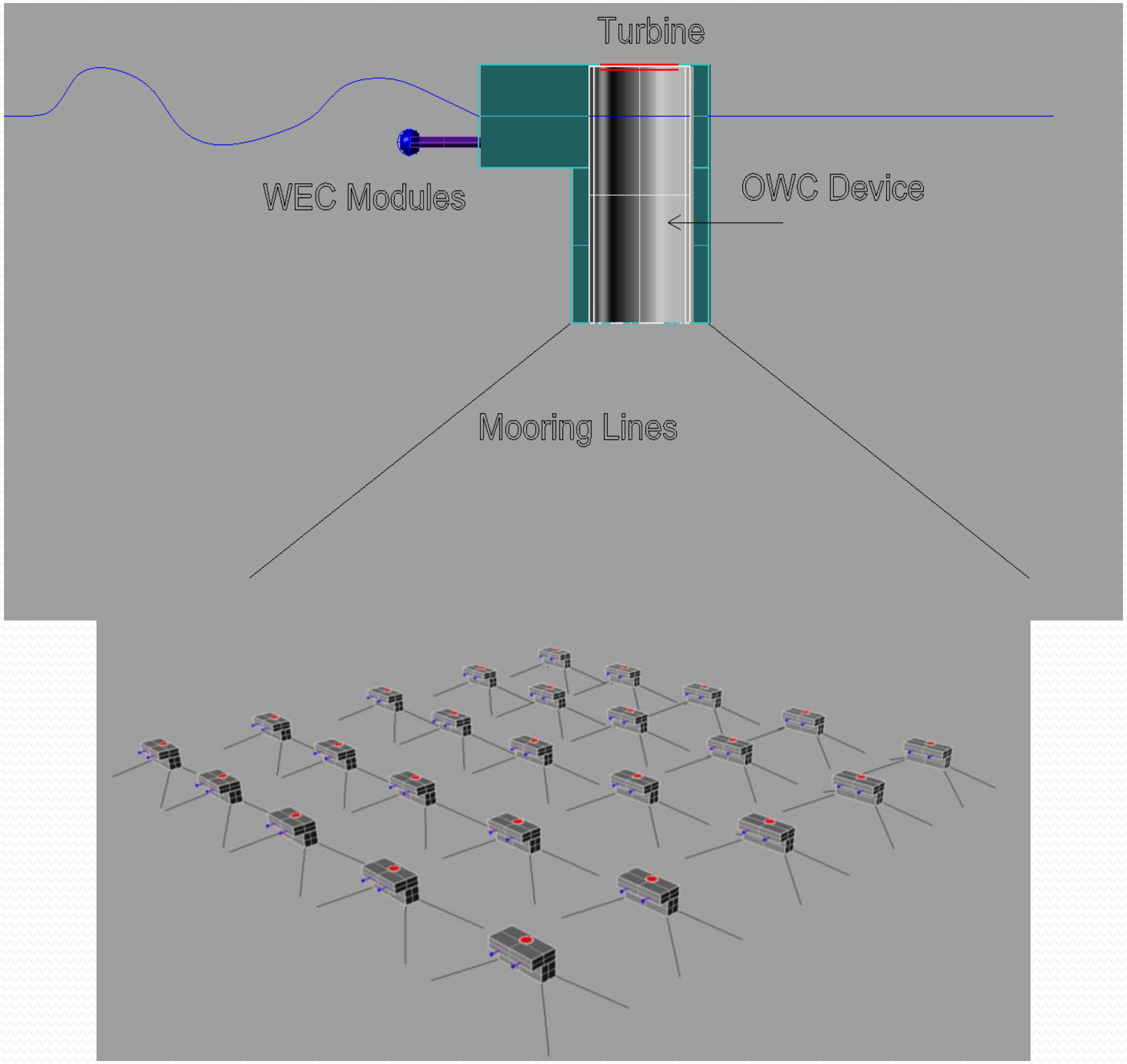
EXTENSION TO A HYBRID PLATFORM





A MULTI-TASK HYBRID BREAKWATER

In cooperation with Harbin Engineering University – China



JOIN THE FUTURE IN THE SEA