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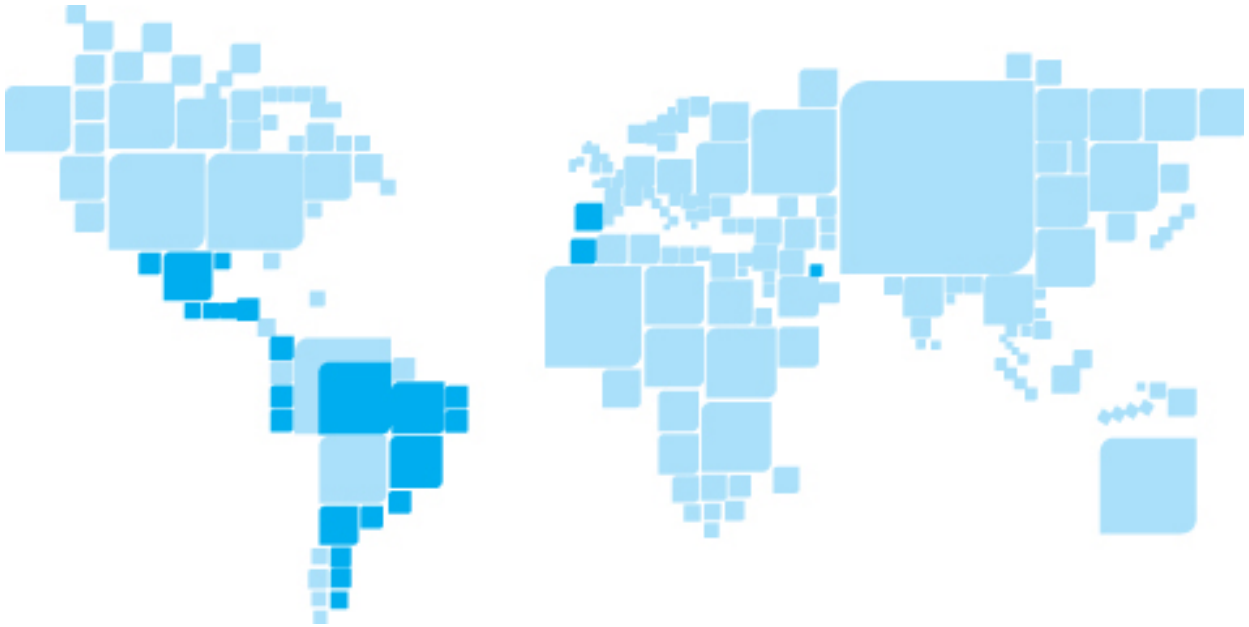
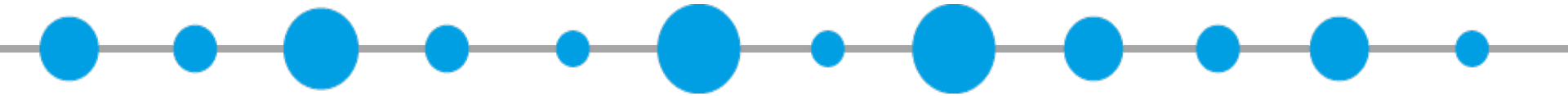


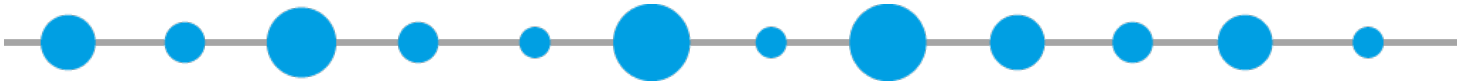
SATH®

Swinging
Around
Twin
Hull

saitec engineering



Introduction



State of the art

01 HIGH CONSTRUCTION COST

02 HIGH TRANSPORT AND INSTALLATION COSTS

03 HIGH MAINTENANCE COSTS

04 DEEP DRAUGHT -> NEED OF DEEP WATERS

Challenges

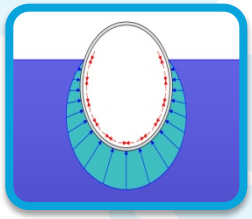
- Providing a competitive solution in terms of both capital expenditures (CAPEX) and operational expenditures (OPEX).
- Providing a solution suitable for any kind of seabed whose mooring system has as low an impact on cost as possible.

Solution

HIGH CONSTRUCTION COST

Low construction cost

No maintenance cost

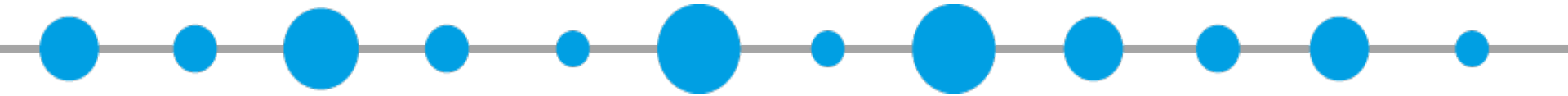


GEOMETRY OF FLOATERS: CYLINDRICAL WITH OVOIDAL CROSS-SECTION

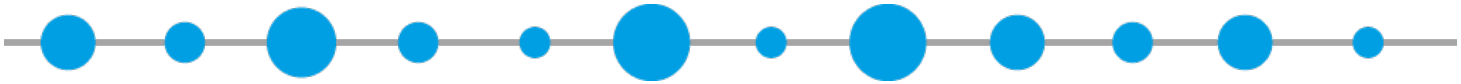
Compression stresses

LAYOUT: TWIN HULL

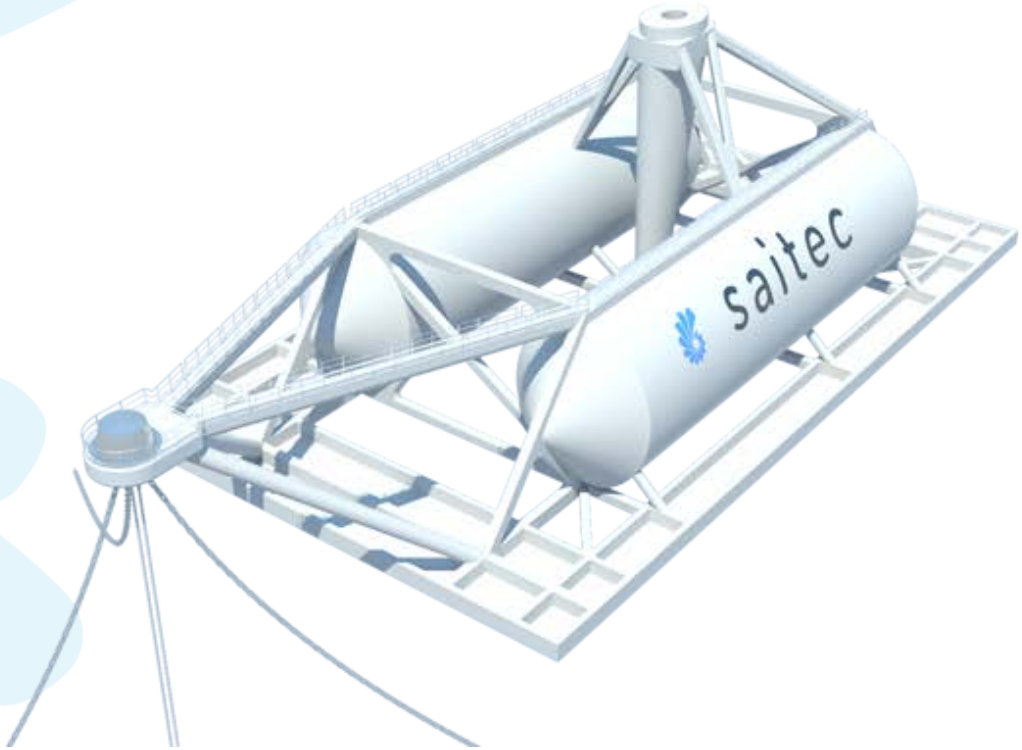
Low construction cost



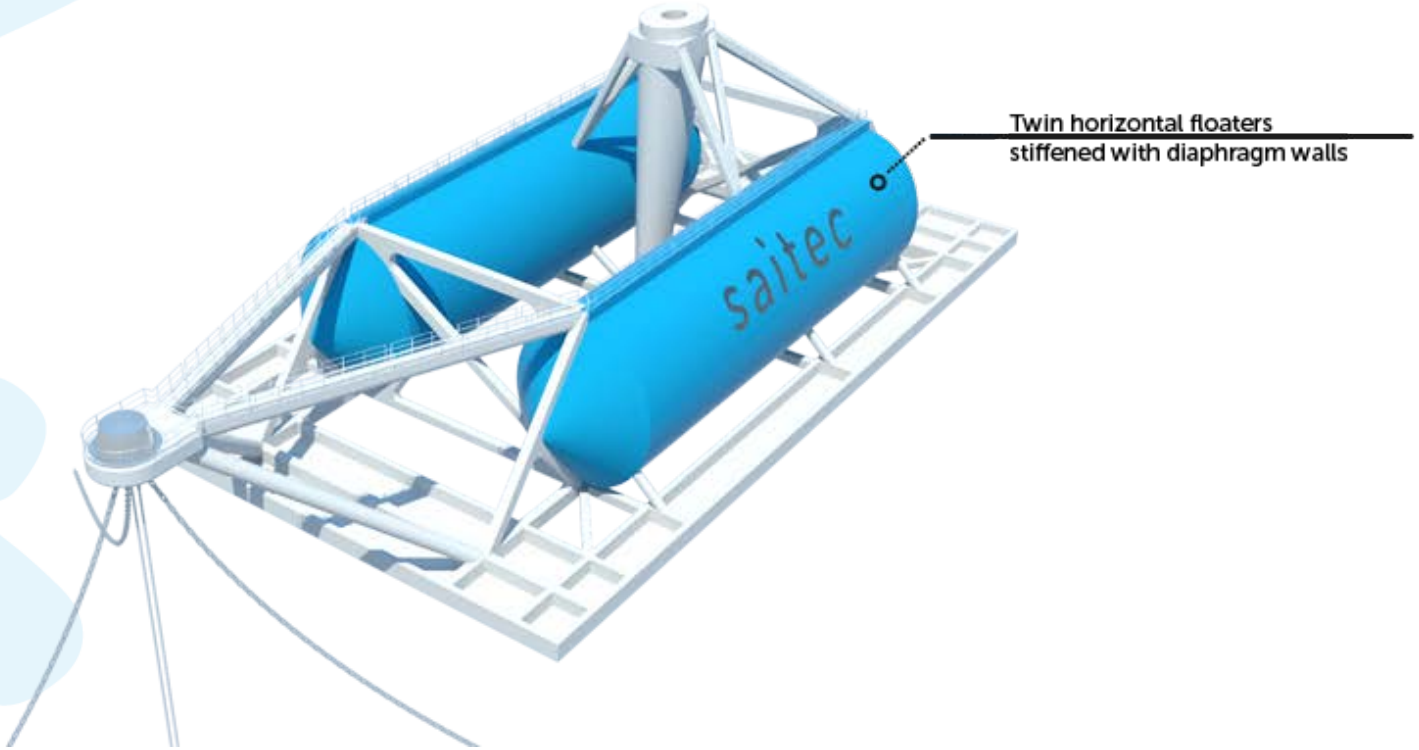
Concept



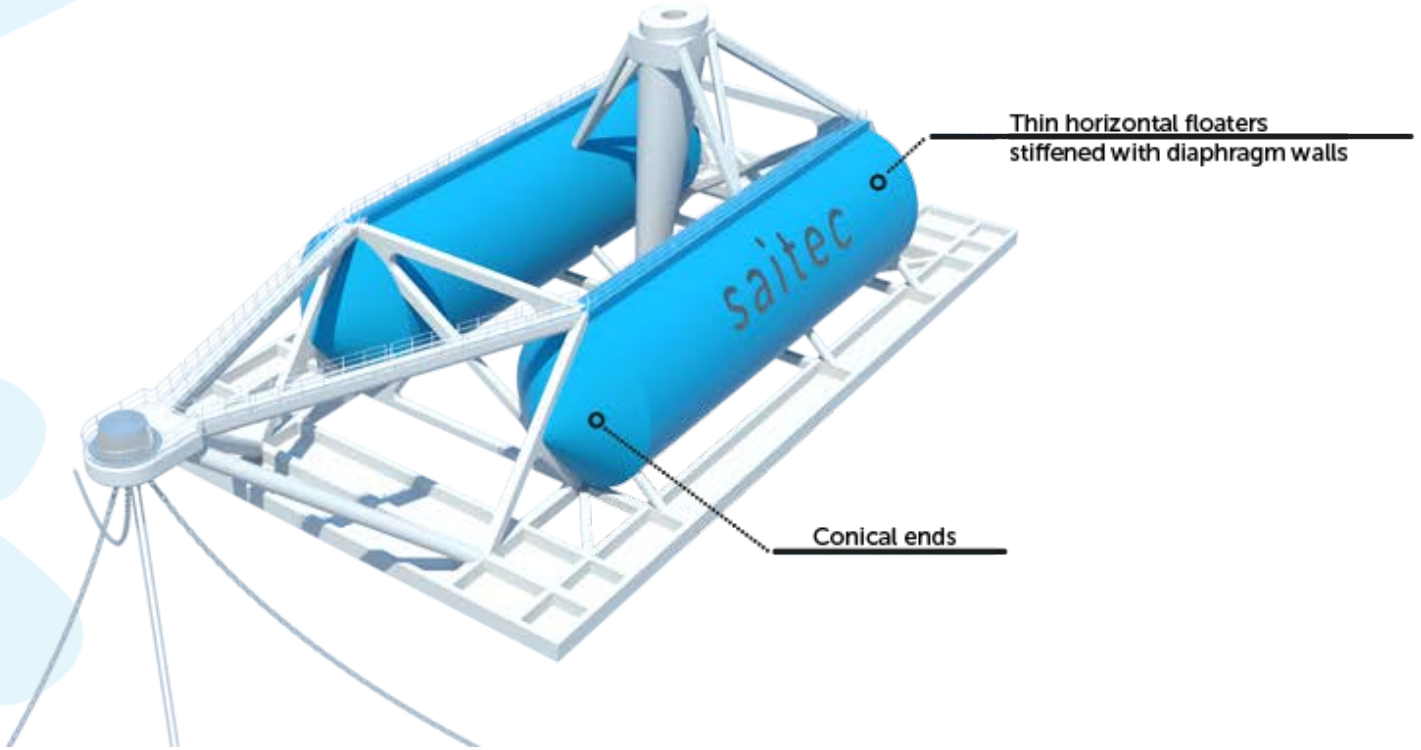
Platform Concept



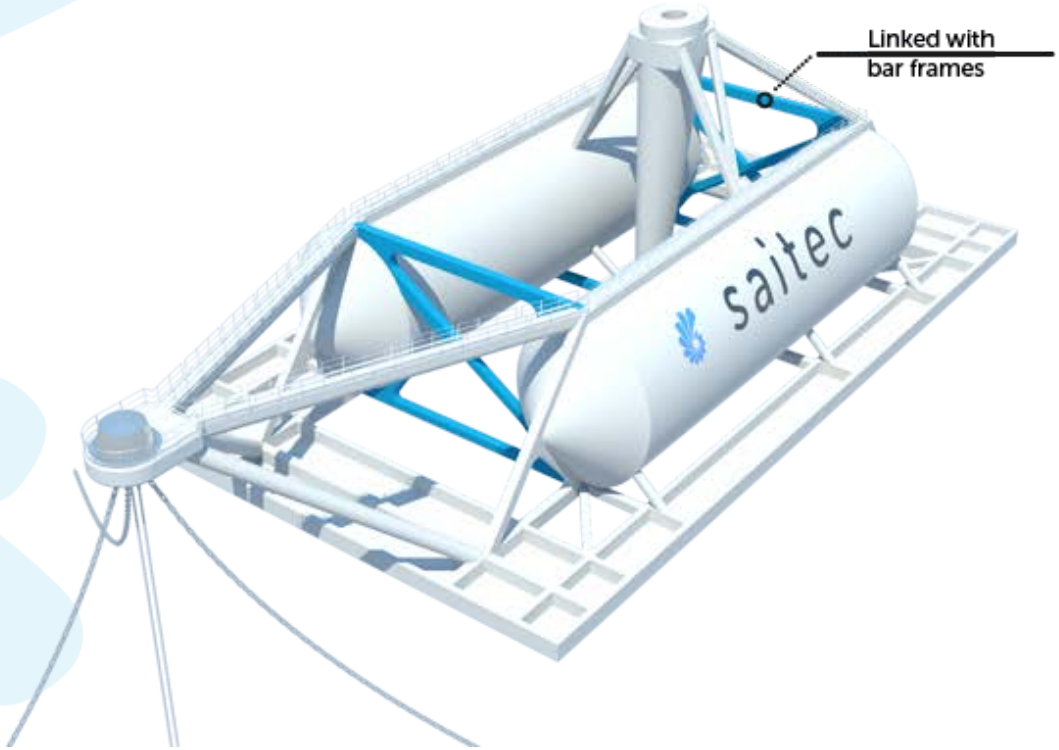
Platform Concept



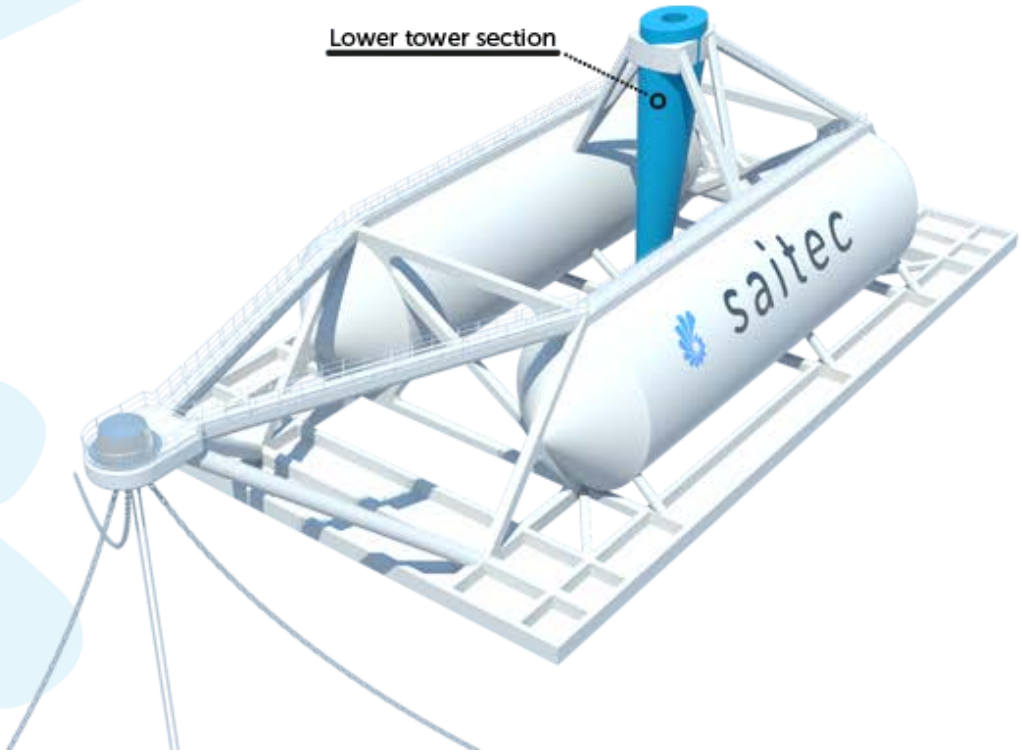
Platform Concept



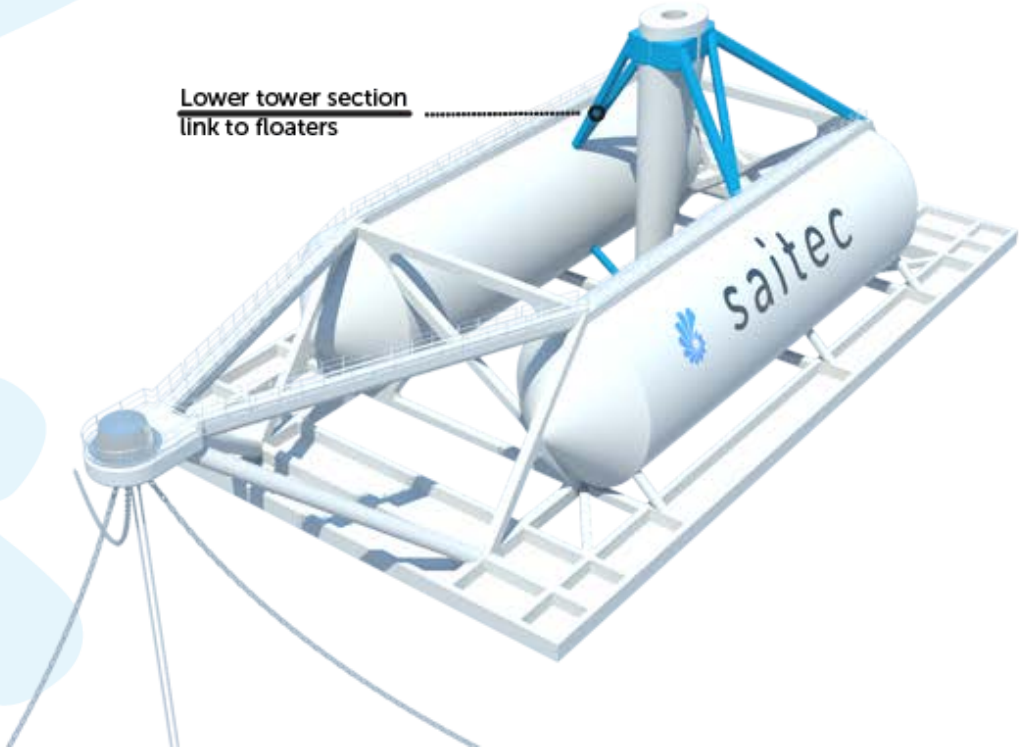
Platform Concept



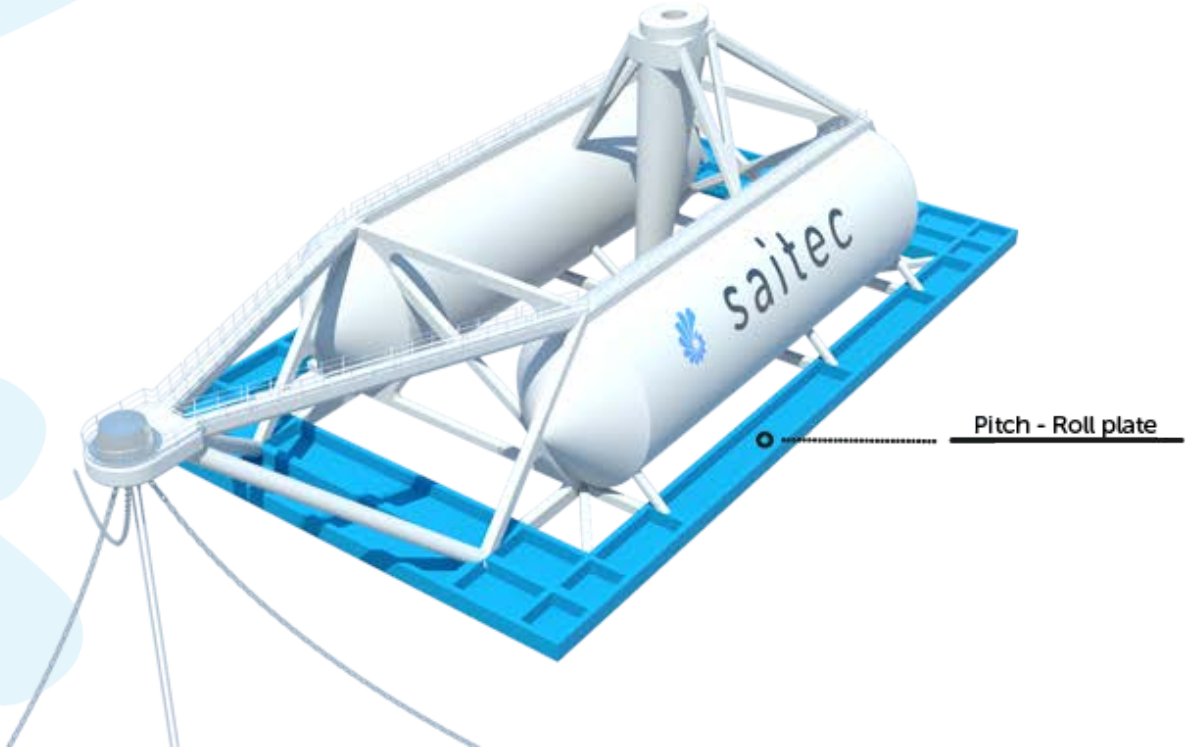
Platform Concept



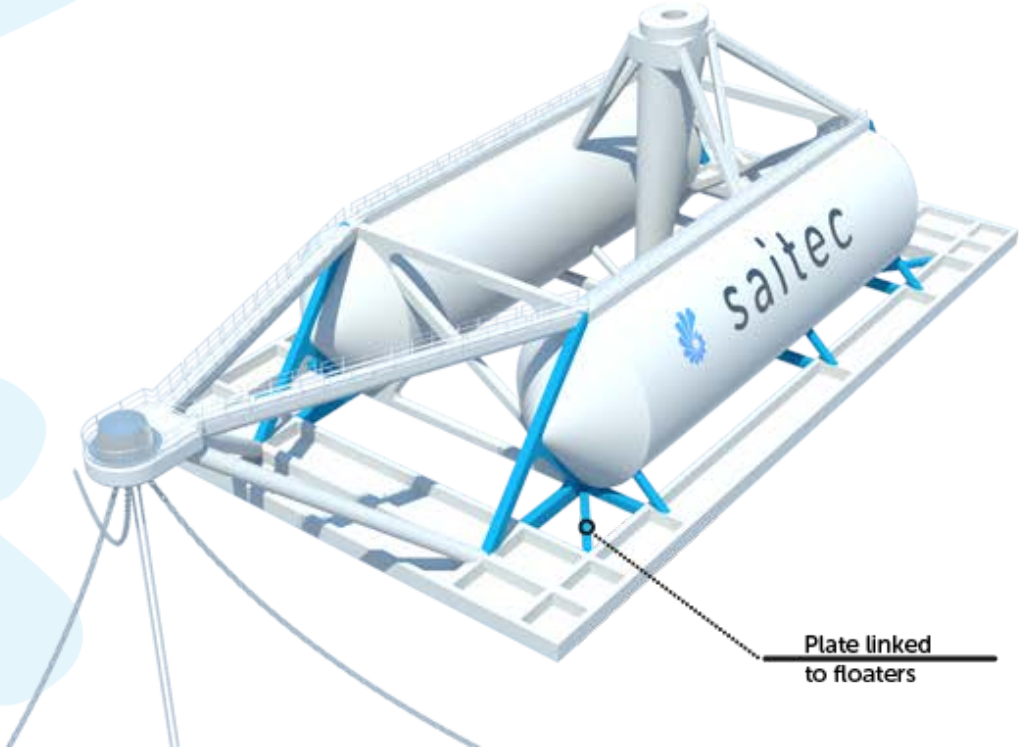
Platform Concept



Platform Concept



Platform Concept



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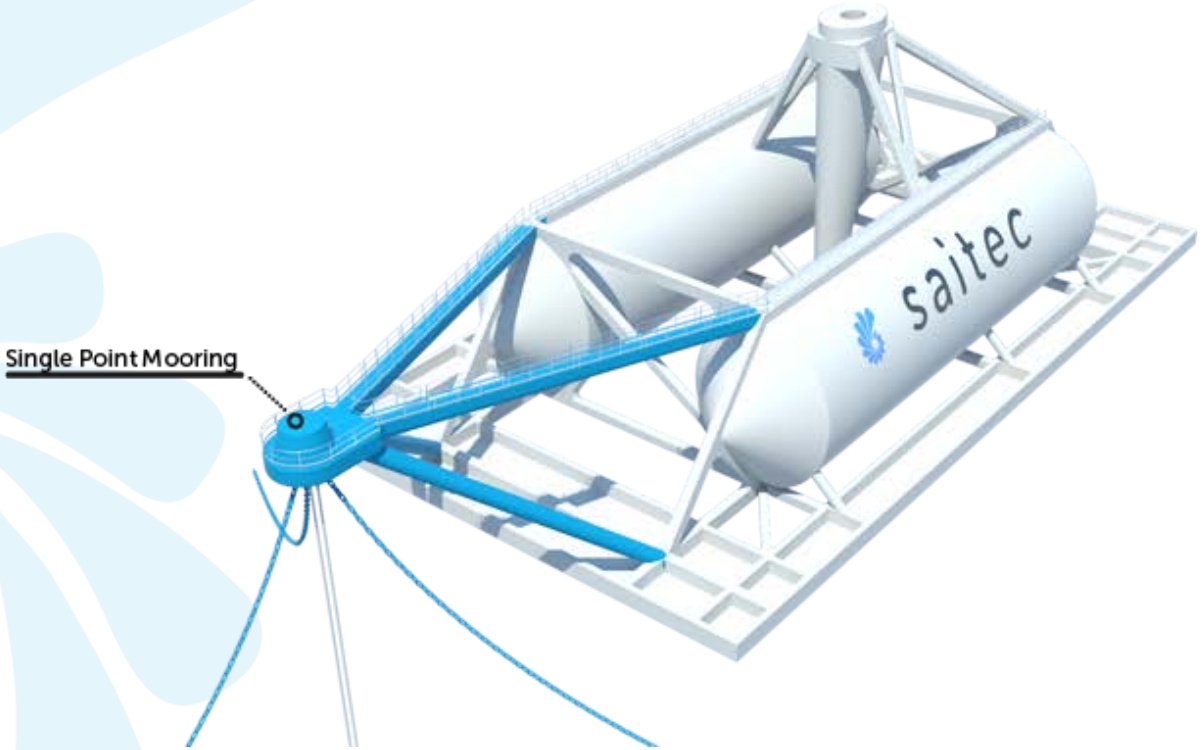
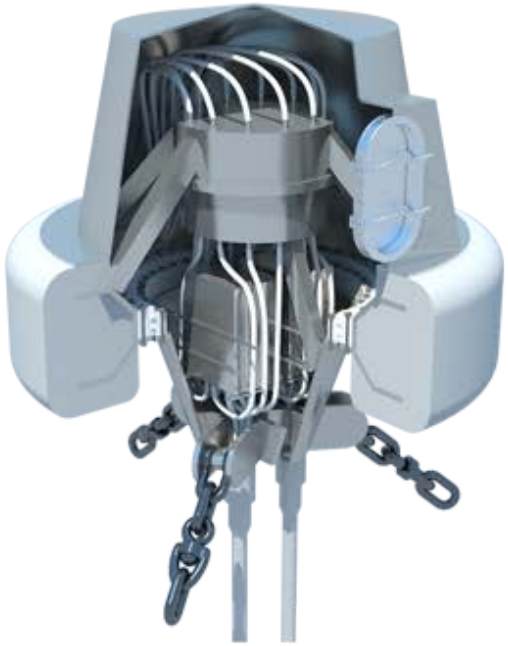


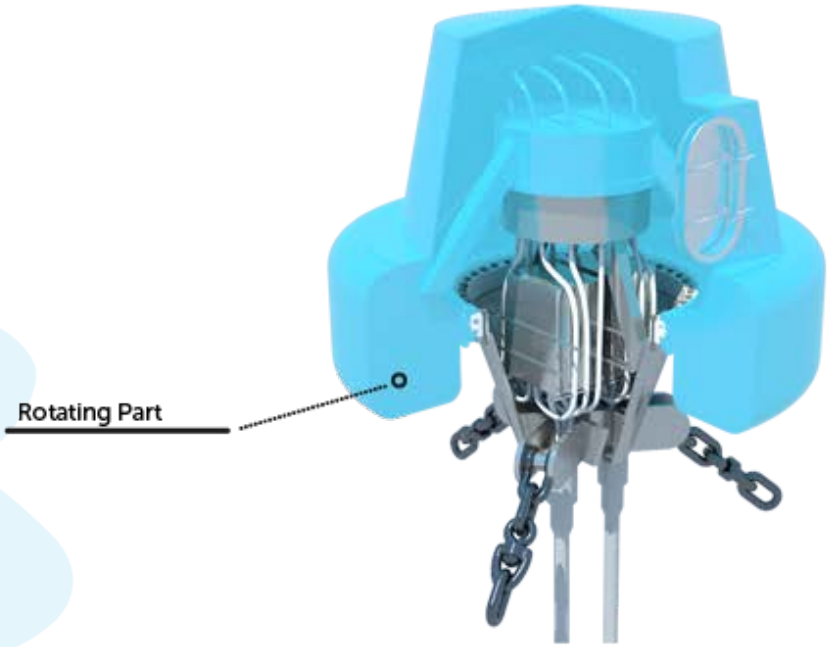

WILSON


RATU SONGKHLA

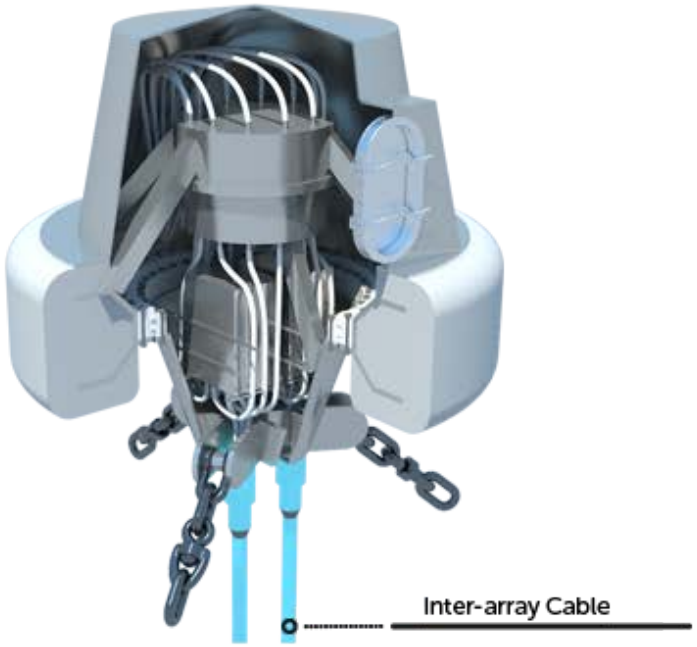
SPM Concept



SPM Concept



SPM Concept



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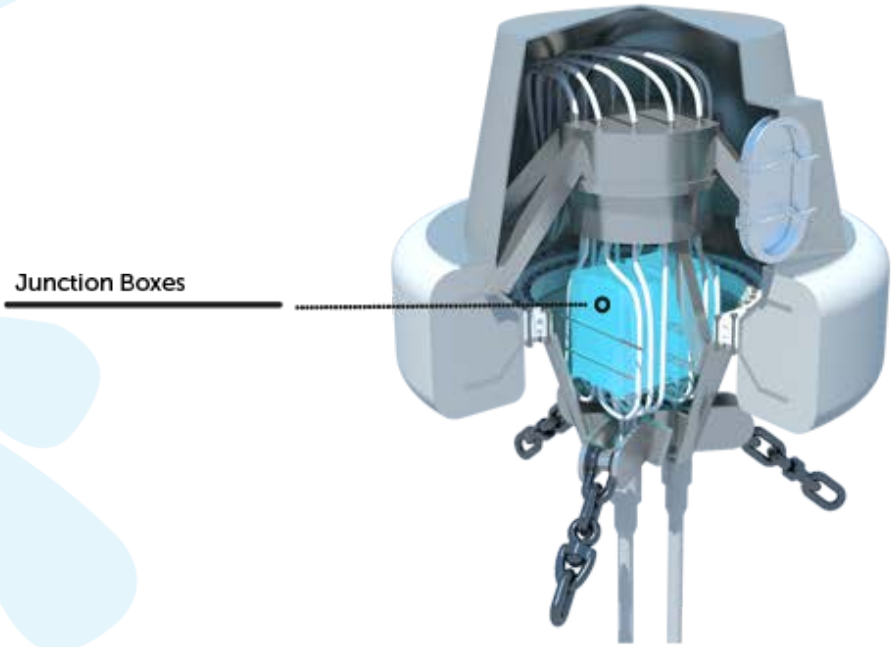

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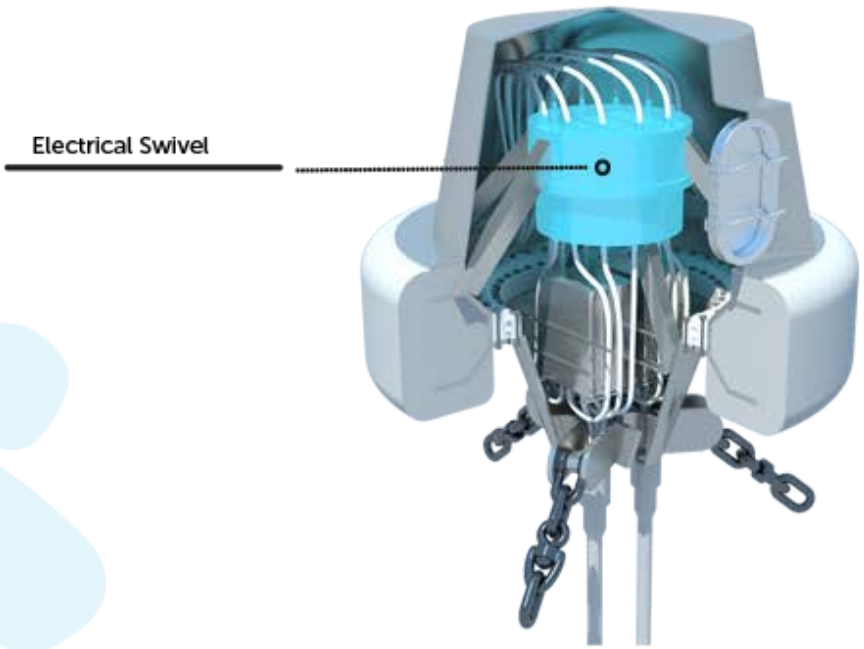

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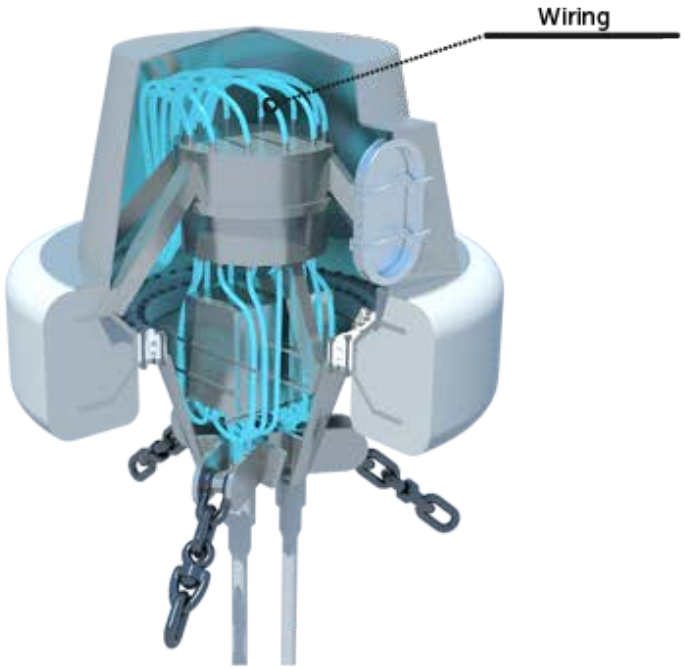

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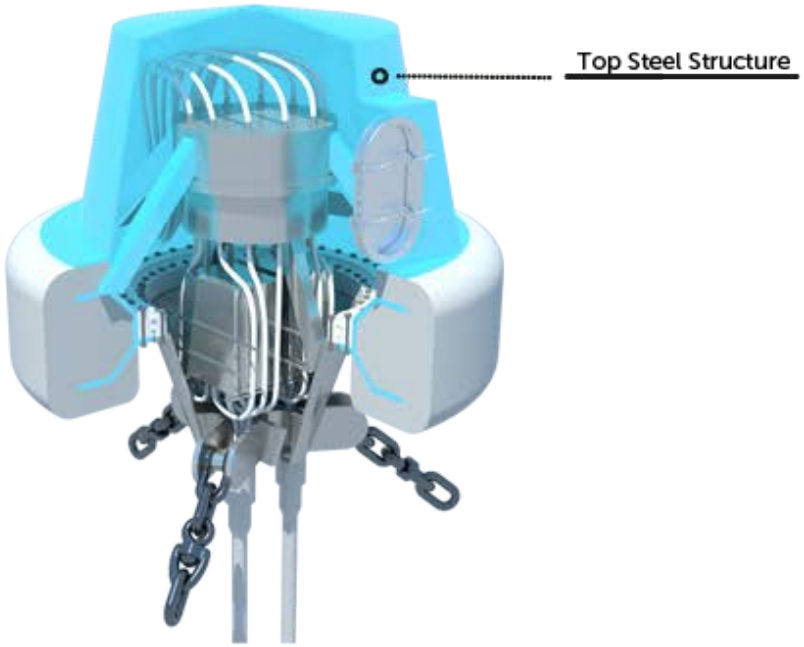

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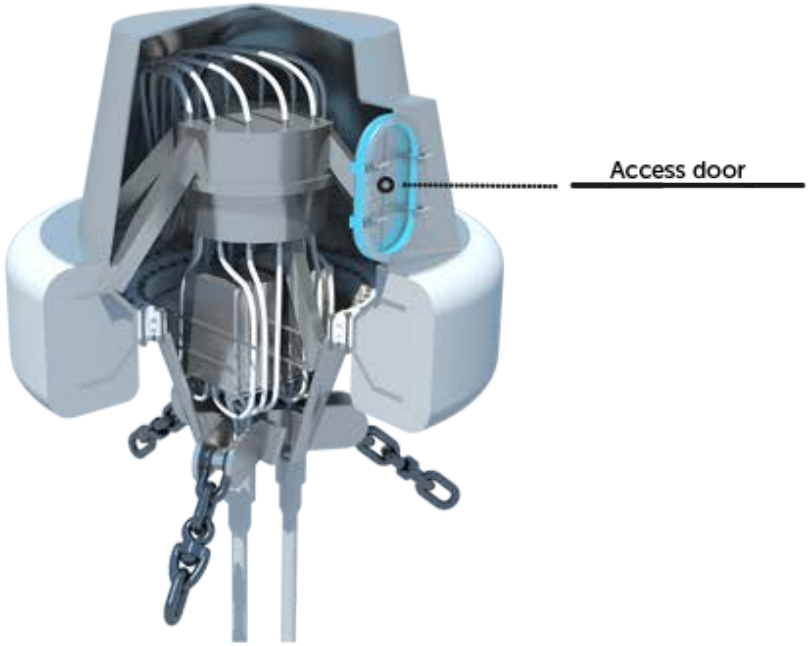

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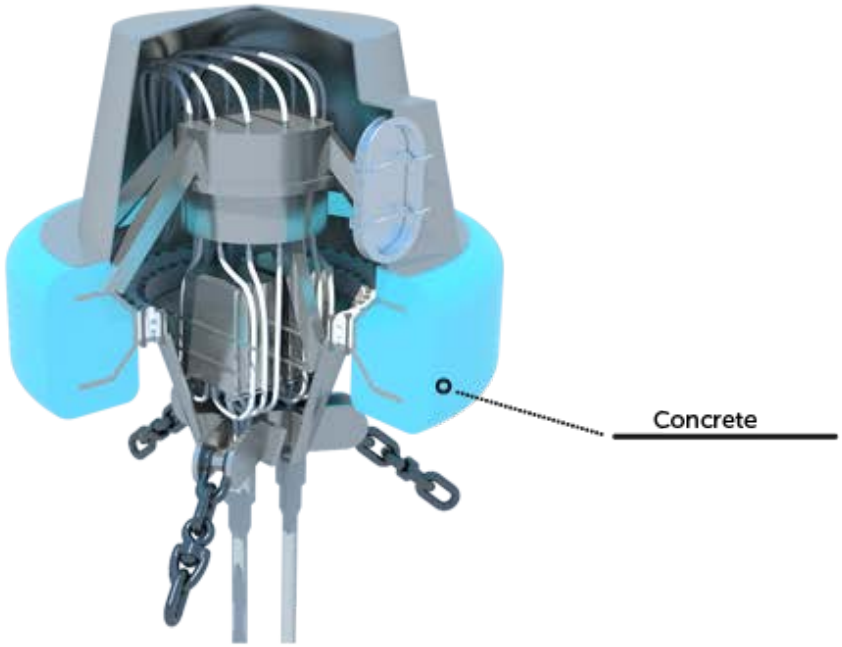

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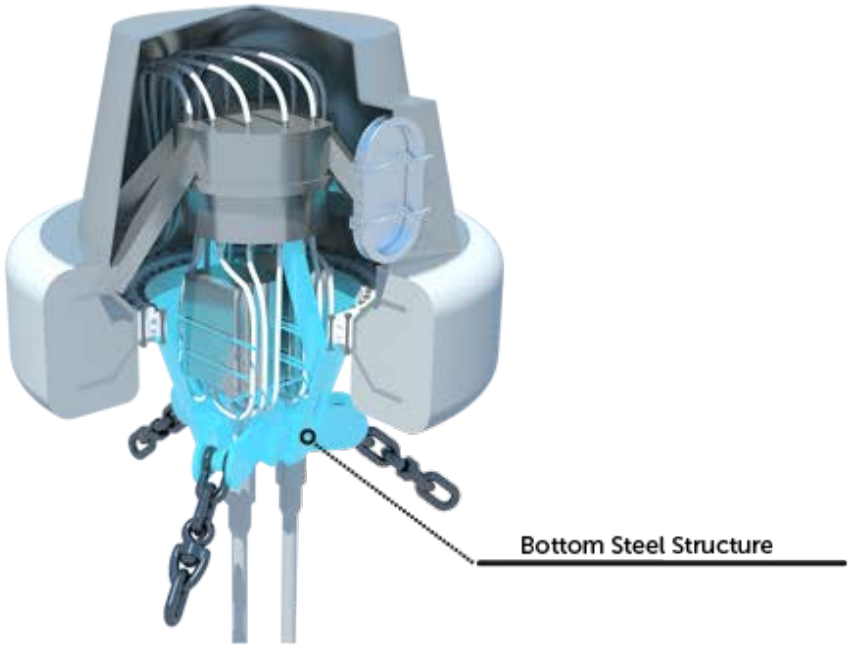

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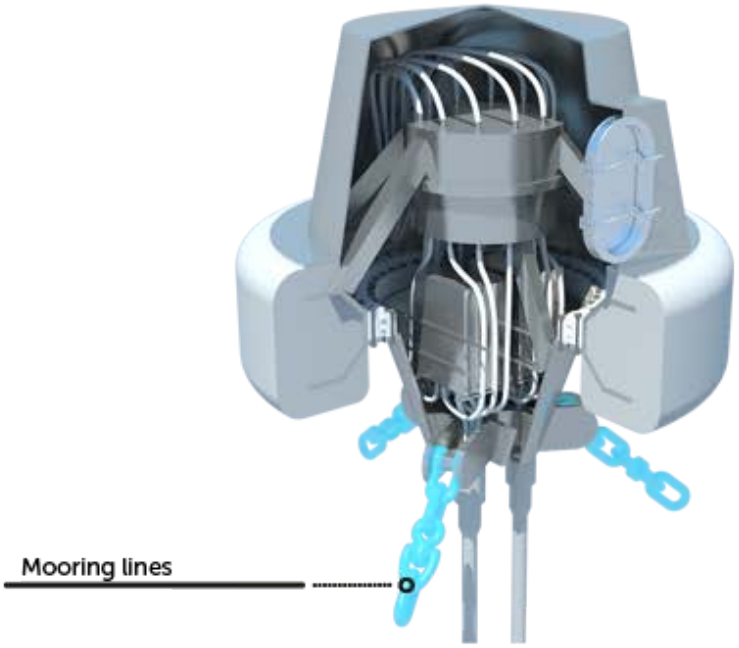


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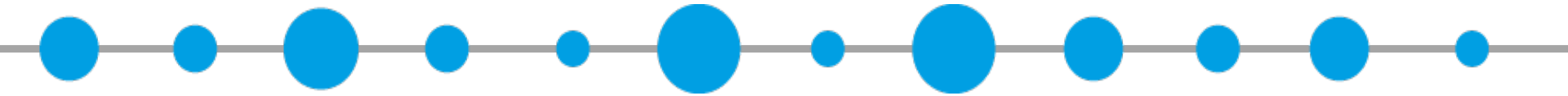
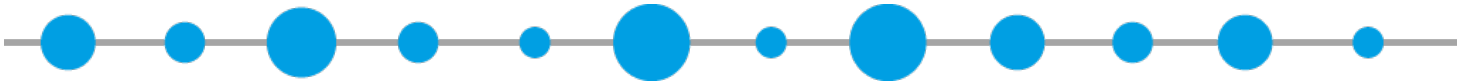


Sath design for a hawt of 5 mw



Introduction

The design has been tailored to support a 5MW wind turbine and its performance has been proved in **operational and extreme environmental conditions** by numerical calculations and through intensive testing with a scale model in the water tanks at I.H. University of Cantabria.

Enviromental conditions

- Operating scenario :
  - Wind velocity:
    - V=3 m/s (Cut-in)
    - V=11,4 m/s (Rated)
    - V=25 m/s (Cut-out)
    - Expected Significant Height: Hs=6,0 m.

Enviromental conditions

- Extreme scenario :
  - T=1 year

    V1 (Zhub)=40 m/s (10min)

    Ve1 (Zhub)=56 m/s (3sec)

    Hs1 =11 m (spectral significant wave)

    H1=20 m (deterministic wave)
  - T=50 year

    V50 (Zhub)=50 m/s (10min)

    Ve50 (Zhub)=70 m/s (3sec)

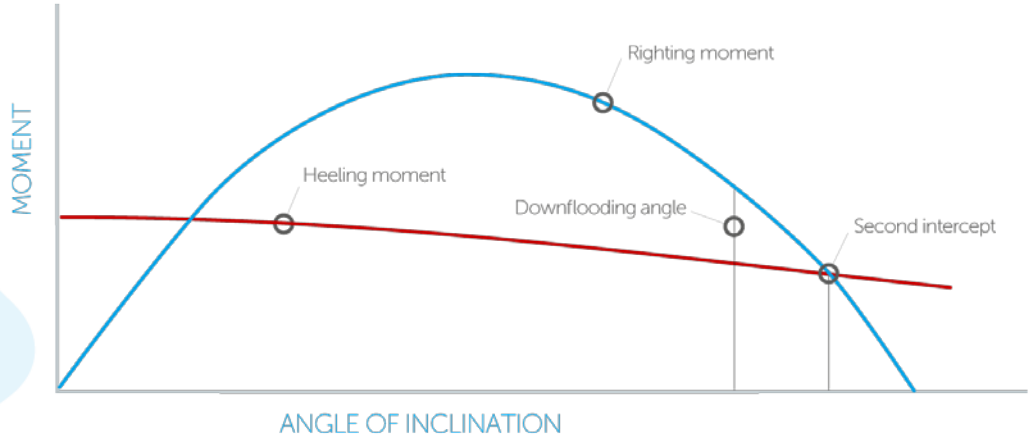
    Hs50 =14 m (spectral significant wave)

    H50=26 m (deterministic wave)

Basic requirements

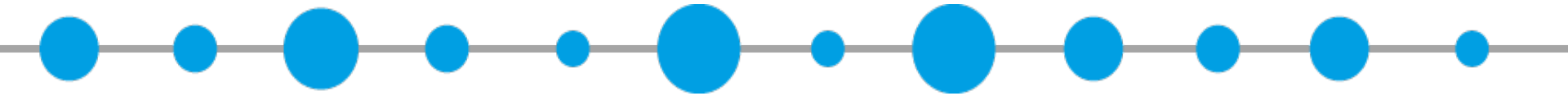
Stability

The area under the ringhting moemnt curve to the second intercept or down-flooding angle،whichever is less، shall be equal to or greater than 140 % of the area under the wind heelingmoment curve to the same limiting angle.



Maximum pitch/roll inclination (0C) ≤ 15º

Maximum hub acceleration (0C-EC) ≤ 0،3g



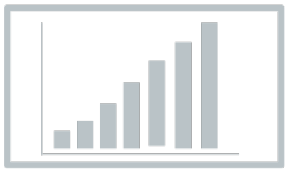
Analysis Process

Analysis stages

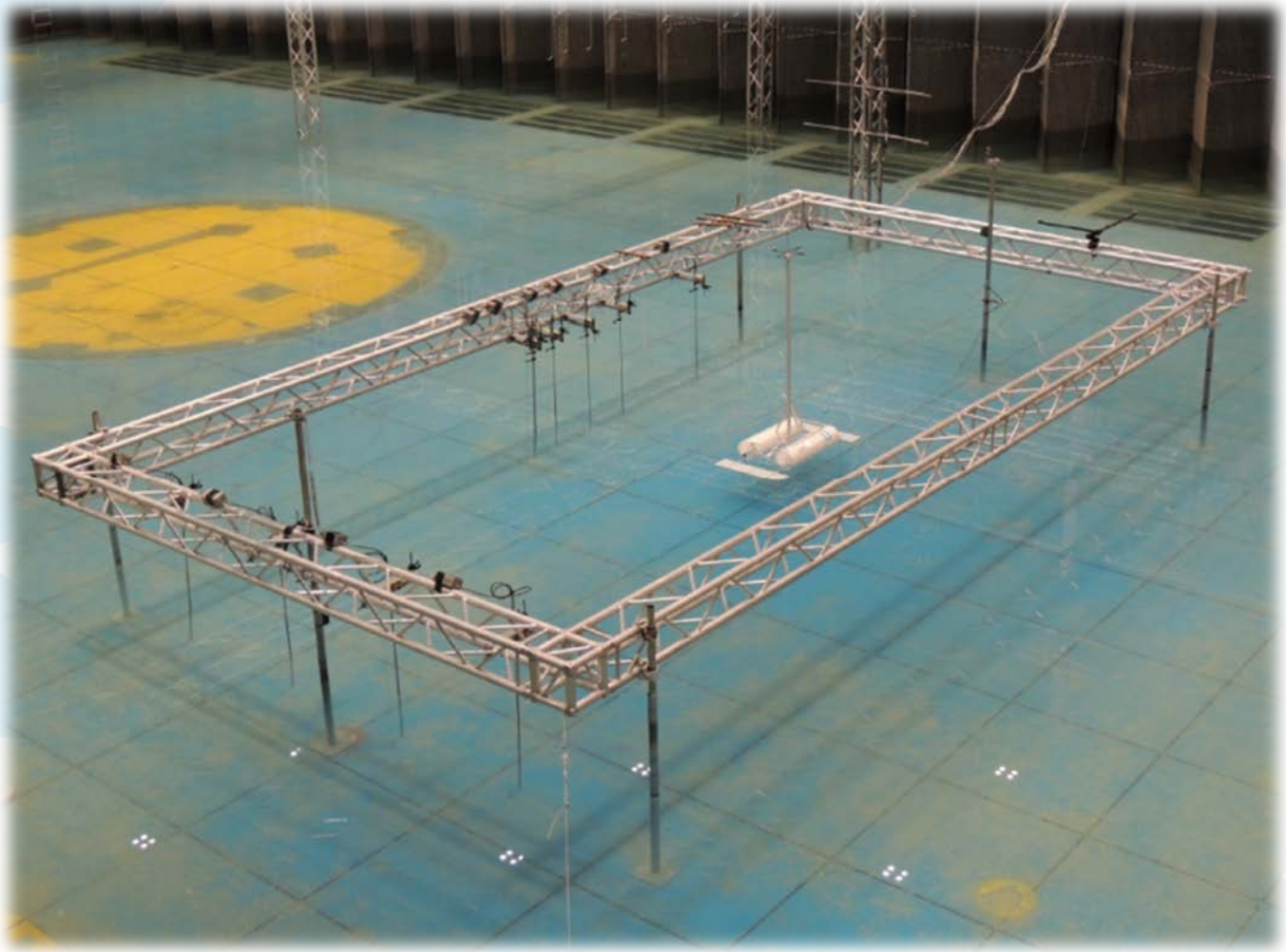
01 SOFTWARE ANALYSIS & PRE-DIMENSIONING

02 SCALE MODEL TEST

03 SOFTWARE CALIBRATION & MODEL OPTIMIZATION

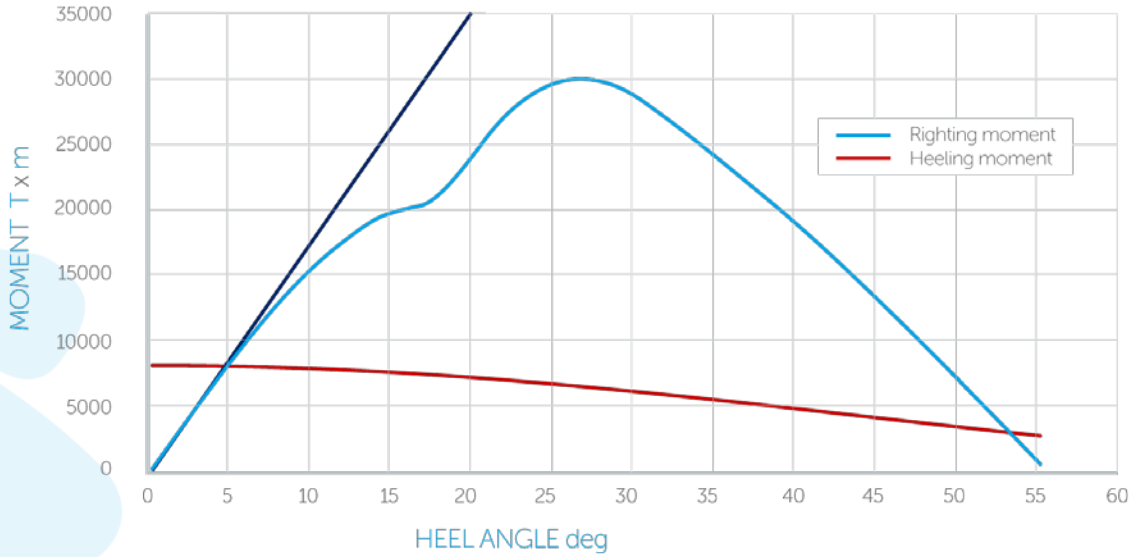


Scale model testing



Scale model testing (Results)

Stability



Heeling area > 334.268 T*m

Righting area > 941.215 T*m

SF > 2,82

Scale model testing (Results)

- **Natural Periods :**

  Pitch: T=25,22 s

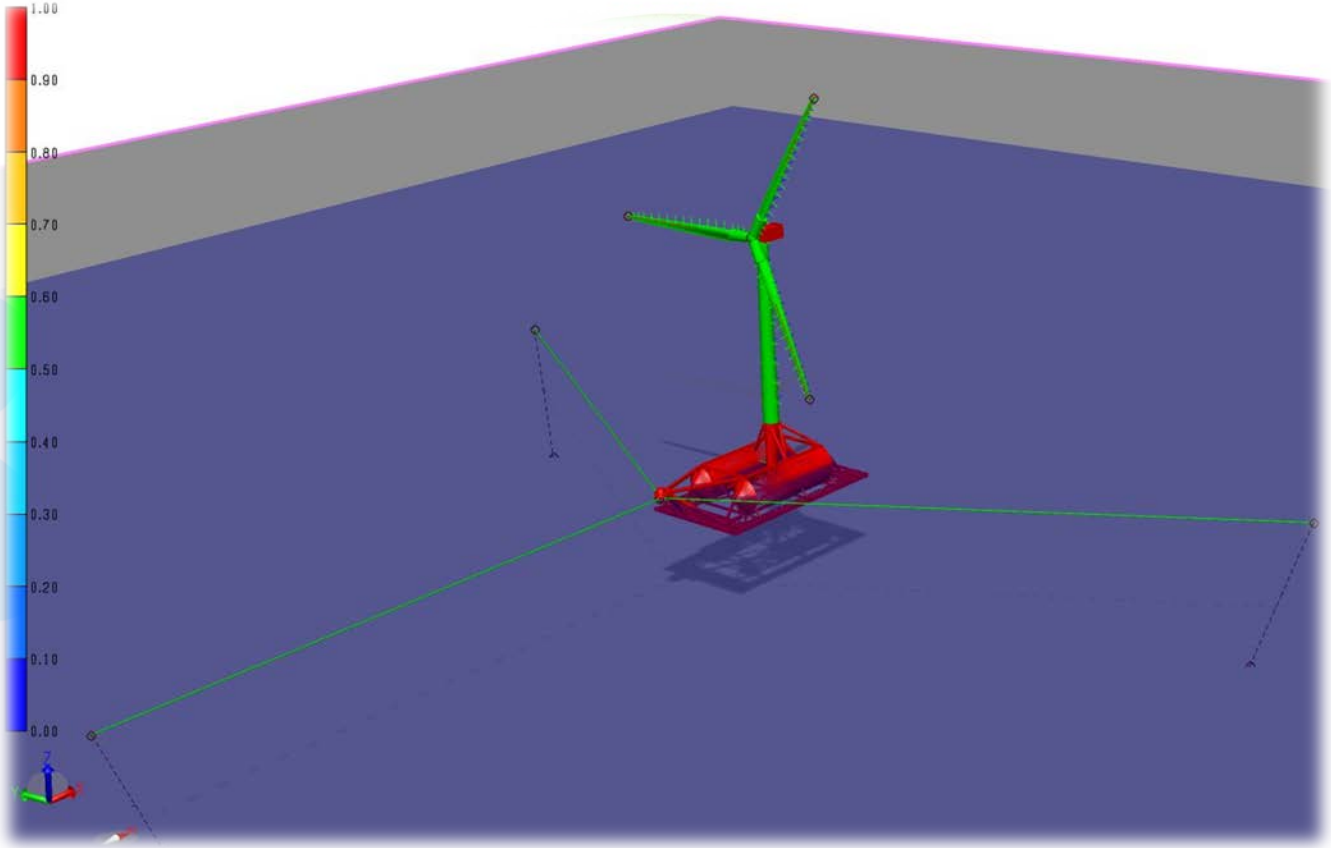
  Roll: T=21,94 s

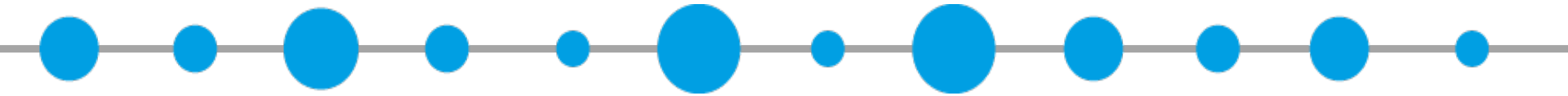
  Heave: T=9,18 s

- **Oscillations and Accelerations :**

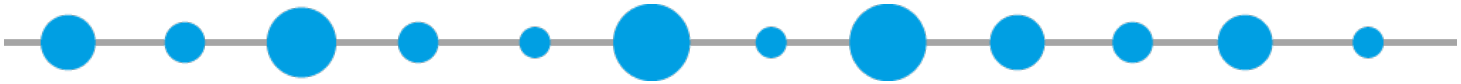
	Cut-in	Cut-out	Rated	Extreme
V(m/s)	3.00	25.00	11.40	50.00
Hs(m)	2.85	6.04	2.85	14.00
T(s)	6.90	17.63	6.90	17.63
Max_A(deg)	0.33	2.98	0.33	6.63
Max_a(m/s2)	0.28	1.02	0.28	2.48
Static_α(deg)	0.58	1.78	5.09	1.76

Software calibration & model optimization





Construction

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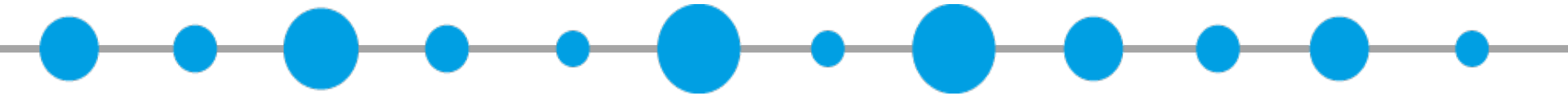
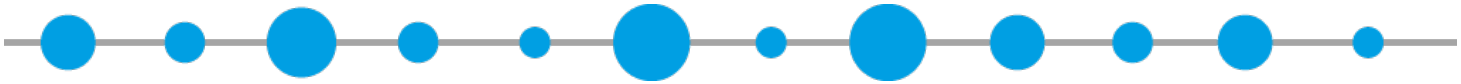


Cost analysis



Industrial production CAPEX

	INDUSTRIAL PRODUCTION	
	Cost [€/MW]	Cost [€]
Balance of the System	**1 631 790**	**8 158 952**
Development	120 000	600 000
Engineering & Management	80 000	400 000
Platform	541 254	2 706 272
Site access staging & Port	100 000	500 000
Electrical infrastructure	367 202	1 836 010
Assembly & Installation	423 334	2 116 670
Financial costs	**621 419**	**3 119 987**
Insurance	74 064	370 321
Decommissioning	111 096	555 481
Contingency	325 162	1 625 811
Construction finance	111 096	555 481
Turbine costs	**1 450 000**	**7 250 000**
TOTAL	**3 703 209**	**18 516 046**

On a 500 MW Wind Farm (50m deep) basis and 5 MW WTG

Industrial production CAPEX Sath dependent

		INDUSTRIAL PRODUCTION	
		Cost [€/MW]	Cost [€]
Development		**120 000**	**600 000**
Engineering & Management		**80 000**	**400 000**
Platform		**541 254**	**2 706 272**
	Platform material & labour	231 099	1 155 496
	Construction yard and	121 615	608 076
	Mooring	130 390	651 950
	Electrical swivel	50 000	250 000
	SPM Bearing	5 000	25 000
	SPM Steel Structure	3 150	15 750
Assembly & Installation		**100 158**	**500 790**
	Installation of Mooring	28 158	140 790
	Platform´s Transport &	72 000	360 000
TOTAL		**841 412**	**4 207 062**

On a 500 MW Wind Farm (50m deep) basis and 5 MW WTG

Offshore Wind OPEX Cost Reduction

Considering average values :

11.1 m€/year x 20 years= 222.0 m€reduction of more than 20 % OPEX

ACTIVITY	Base 5 MW Monopile (20 - 30 m) Average (€/year)	Base 5 MW SATH (40 m) Average (€/year)
Onshore logistic	778.227,49	778.227,49
Workboats	3.537.397,70	3.537.397,70
Aviation	3.183.657,93	3.183.657,93
Crane barge services	11.319.672,64	0,00
Offshore accommodation / base	21.224.386,20	21.224.386,20
Turbine maintenance	7.074.795,40	7074.795,40
Turbine spare parts	6.367.315,86	6.367.315,86
Offshore substation maintenace	176.869,89	176.869.,89
Export cable surveys and repairs	176.869,89	176.869.,89
Onshore electrical	84.897,54	84.897,54
Array cable surveys and repairs	495.235,68	495.235,68
Scour and structural surveys	565.983,63	188.661,21
Foundation repairs	495.235,68	247.617,84
Lifting, climbing & safety equipment inspections	212.243,86	212.243,86
SCADA adn condition monitoring	848.975,45	848.975,45
SAP and arine co-coordination	848.975,45	848.975,45
Weather forecasting	91.972,34	91.972,34
Administration	495.235,68	495.235,68
Total Cost (€/Mw)	57.977.948,30	46.033.335,40
Cost Reduction (%)	20,60 %	

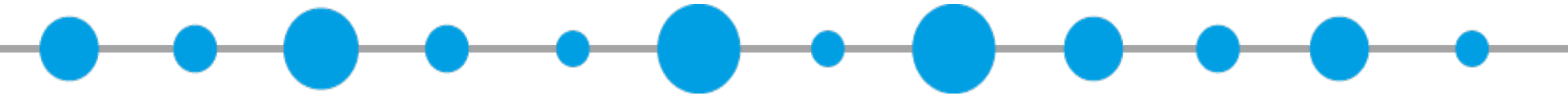
On site dependent

Source : IHS EER; Project Finance; Erneuerbare Energien; Handelsblatt; Roland Berger

SATH vs Monopile

Saitec made a comparison between a 500 MW monopile wind farm (20m depth) vs a 500 MW SATH© wind farm (40 to 50 m depth):

- CAPEX -> Overall cost reduction: **10.12 %**
  -> Foundation related: **33.59 %**
- OPEX -> more than **20 %** cost reduction
- LCOE -> cost reduction of about **13 %**



Conclusions

Conclusions

Saitec has developed a floating platform solution made of prestressed concrete that responds to the challenges brought :

- **Low draught** (<10m)
- **Plug & Play** solution.
- **Low mooring stresses.**
- **Low movements and accelerations**
- **Reduced costs**

Conclusions

- SATH is a competitive solution with offshore fixed-bottom wind turbines in shallow waters (30-40 m)
- SATH's performance has also been proved for both 8 & 10 MW wind turbines

This project has also been financed by E.E.A. Grants

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