LIFES50+ Final Event Bilbao, 03 April 2019

Session: Floating substructure design
Topic: IDEOL concrete floater

William Jones and Thomas Choisnet
(Ideol)

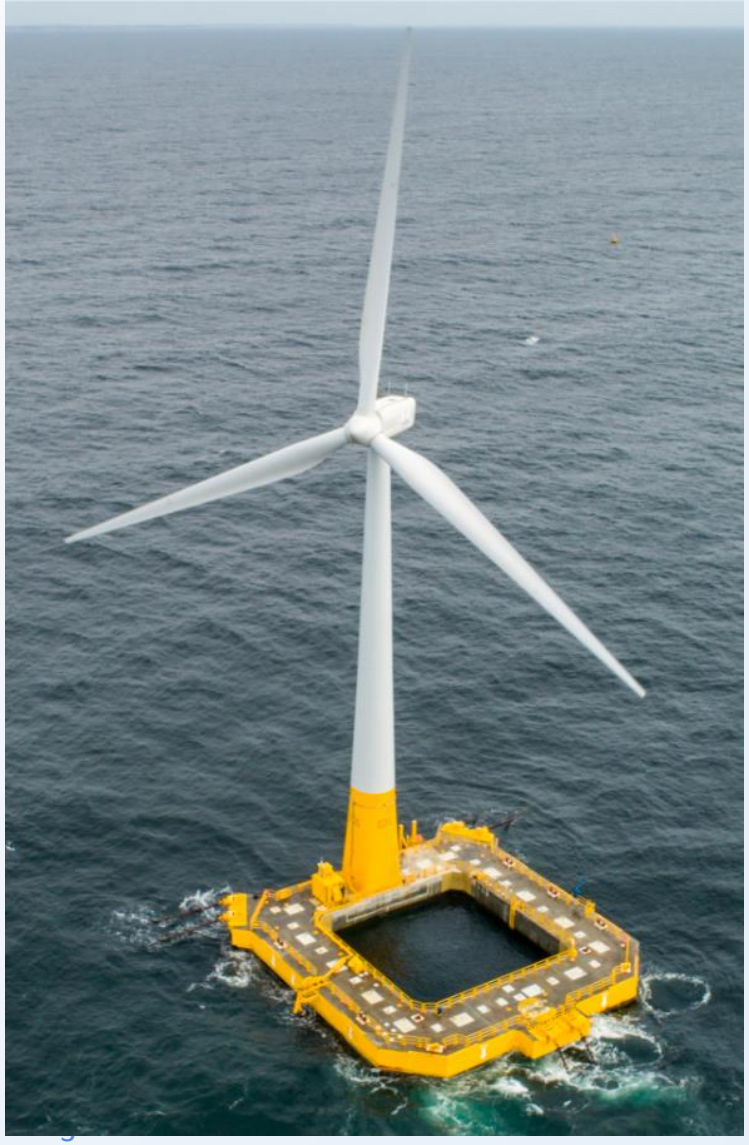
Qualification of innovative floating substructures for 10MW wind turbines and water depths greater than 50m

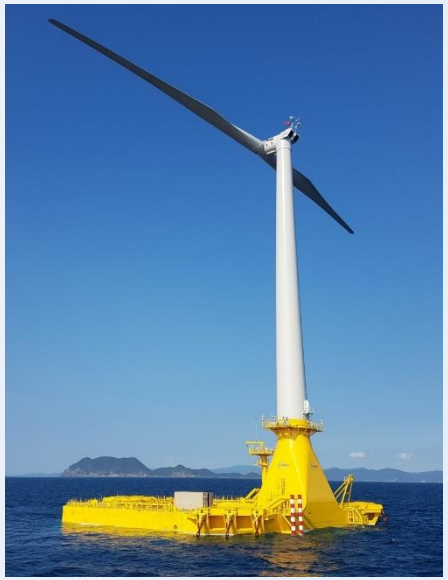
The research leading to these results has received funding from the European Union Horizon2020 programme under the agreement H2020-LCE-2014-1-640741.

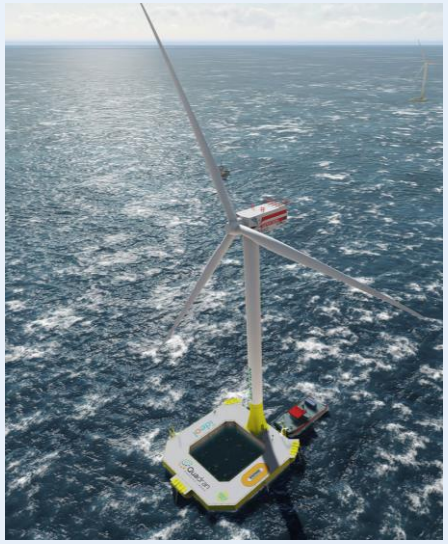
INTRODUCTION TO IDEOL

Introduction to Ideol

- Founded in 2010
- Fully dedicated to Floating Wind
- 50+ Employees
- Demonstrators in France and Japan:
  - 2MW FLOATGEN (Concrete)
  - 3MW Hibiki (Steel)
- 24MW EolMed Pilot Farm in Engineering Phase.
- Further projects in development globally.
- Multiple R&D projects.



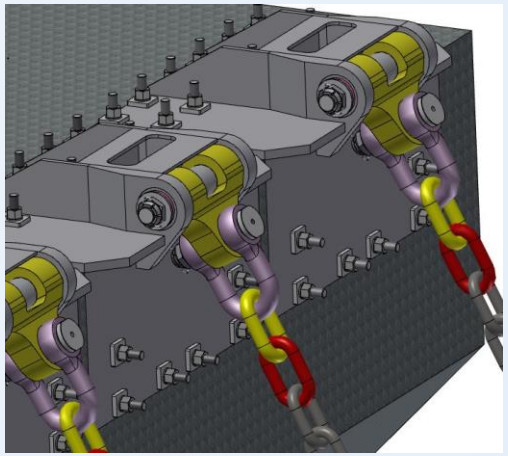


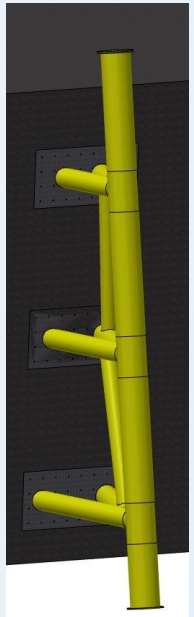


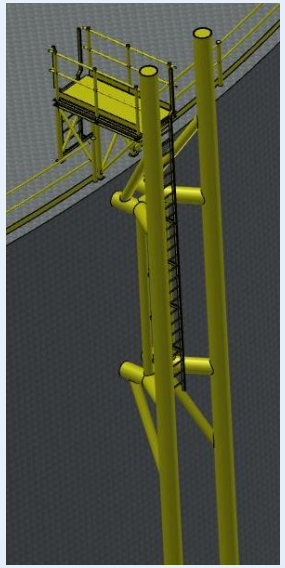
LIFES50+ IDEOL CONCEPT DESIGN

Concept for Lifes50+

- 3 Similar designs for each of the 3 Sites
- Experimental design with circular hull and centrally mounted tower.
- Patented Damping Pool at hull centre.
- Concrete hull construction.
- Damage stability and mooring line redundancy.
- Steel tripod transition piece.
- Horizontal skirt at keel level to reduce motions.
- Light weight synthetic rope mooring lines.

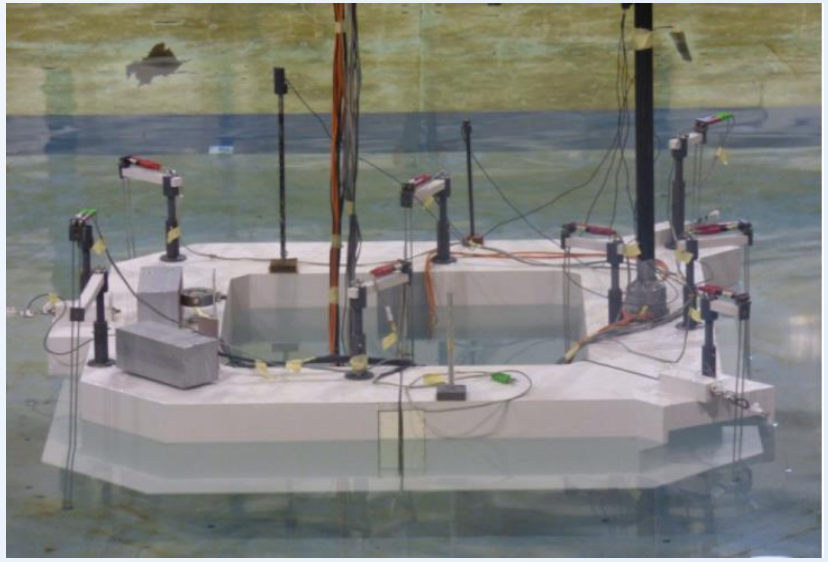






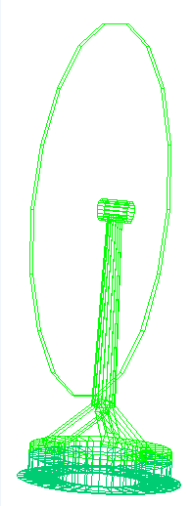
Key Reference Test Data for Design

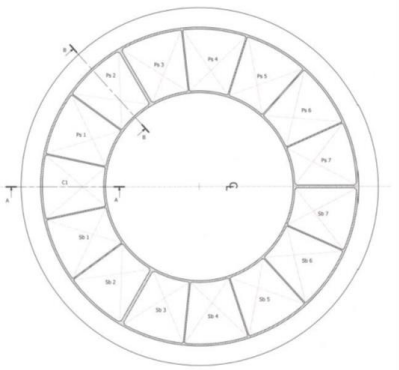
- Ideol basin test results for square and Octagonal damping pool Hulls
- Previous experience within Ideol of circular CALM Buoy basin tests and operations.
- Nylon Mooring Rope Stiffness and Elongation testing.

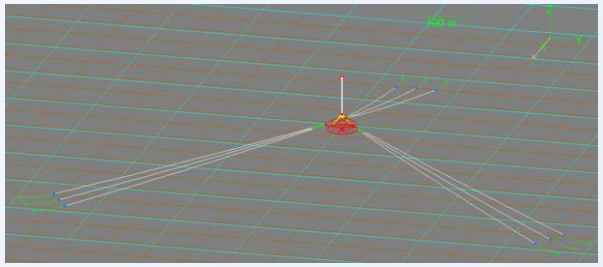


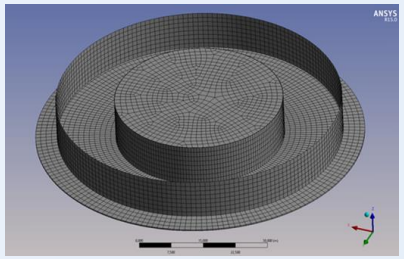
Design Activities

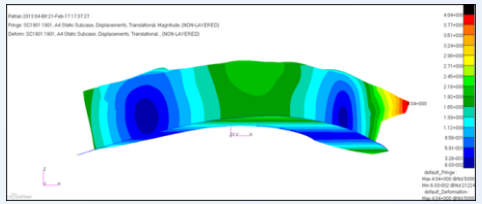
- Completed to DNVGL standards
- Stability Analysis including intact and compartment damaged cases.
- Mooring Strength and Fatigue Analysis.
- Hull Structural Finite Element analysis
- Tower and Transition Piece Design
- Coupled Aero-Hydro-Servo-Elastic Analysis with FAST.
- Specification of Inter Array Cable and optimisation of layout for CAPEX, losses and installation.
- Planning series construction, integration, installation and commissioning.

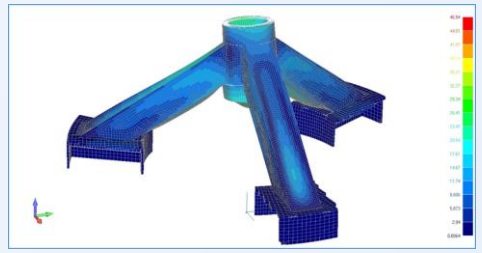


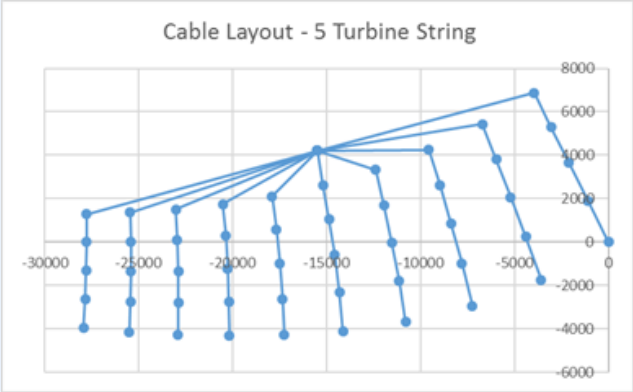






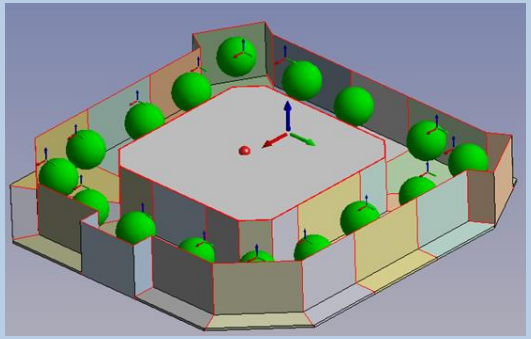
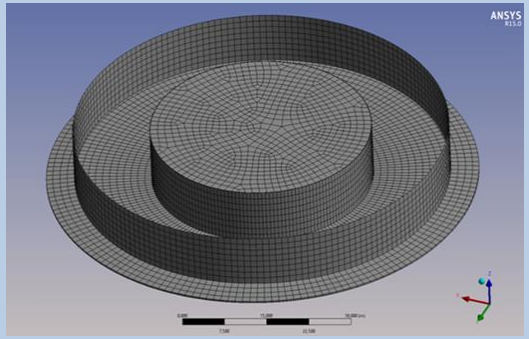
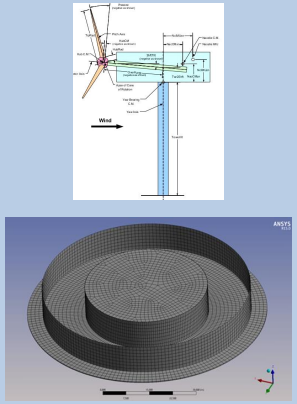
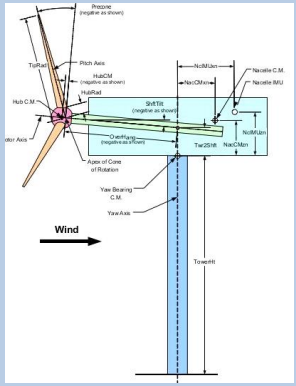






Coupled Analysis Models

Increasing Turbine Fidelity

Orcaflex Simplified Turbine		FAST Aero-Servo-Elastic Turbine	
			
Orcaflex Multibody Hull	Orcaflex Monobody Hull		FAST Hydrodyn Hull
Finite Element Mooring - Line Dynamics			Quasi-Static Mooring

Increasing Floater Fidelity

Coupled Ana

LIFES50+
Mooring Analysis
Hull Structure Loads

LIFES50+
Turbine, Tower and Transition Piece
Mooring Fatigue

I easing Turbine
F ity

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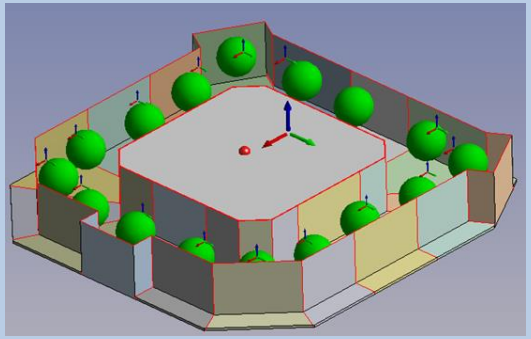	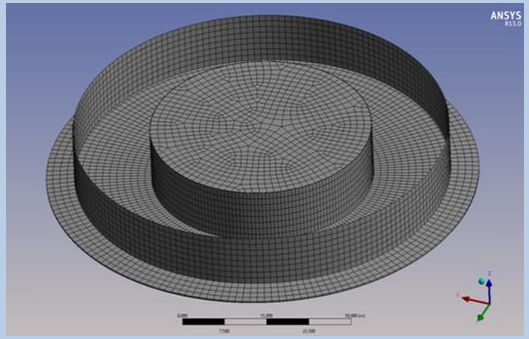	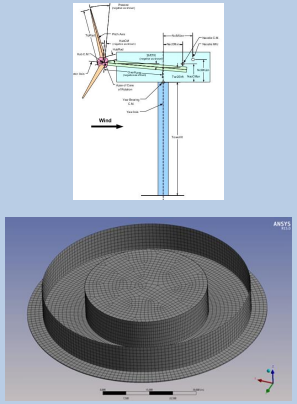	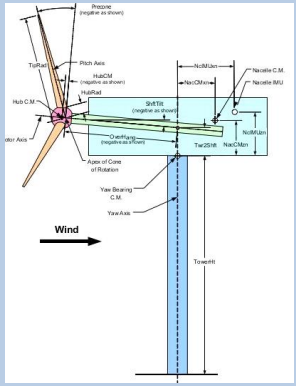
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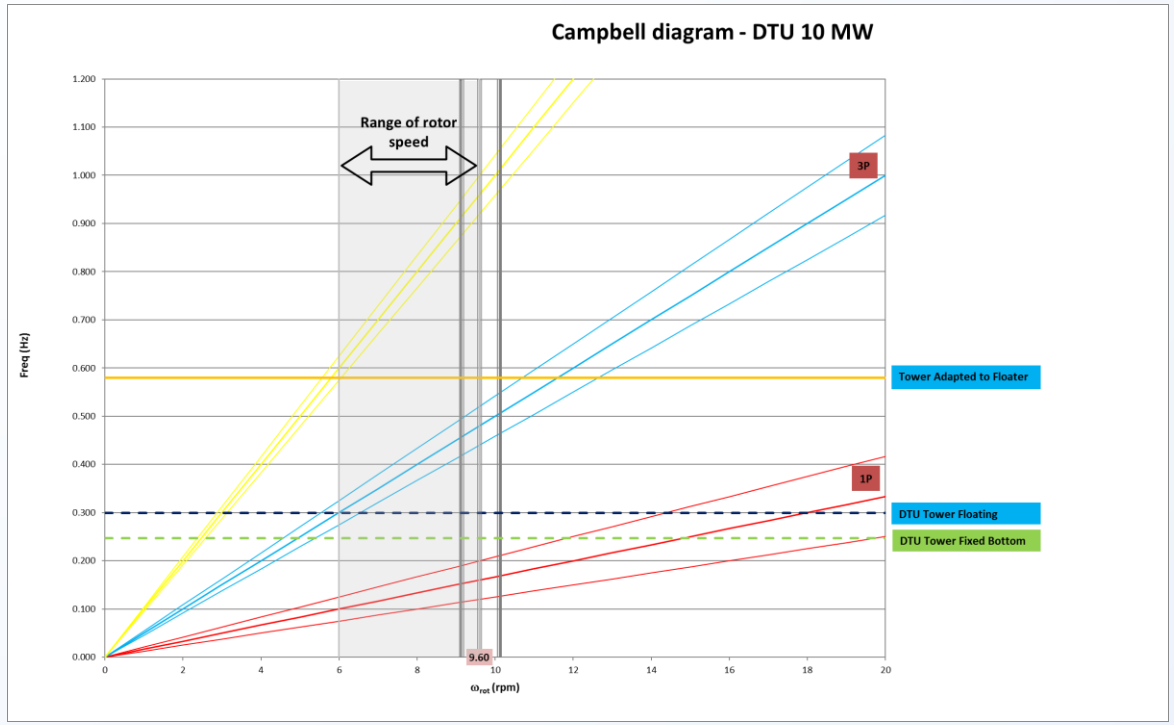
Increasing Floater Fidelity

Adapting Turbine For Floating Structure

- Main changes: Tower and Controller Tuning.
- Controller tuned to avoid excitation of platform pitch mode while limiting loads and maintaining power curve. Filter frequencies updated for new tower.



- The floating condition increases the frequency of the 1st Tower mode which could result in excessive excitation from the blade passing loads.
- This frequency change may be calculated using FAST (or equivalent) software which accounts for the hydrostatic stiffness and hydrodynamic added mass of the hull.
- For LIFES50+ the towers were stiffened to place the 1st mode above the 3P blade passing frequency: a ‘Stiff-Stiff’ tower design.

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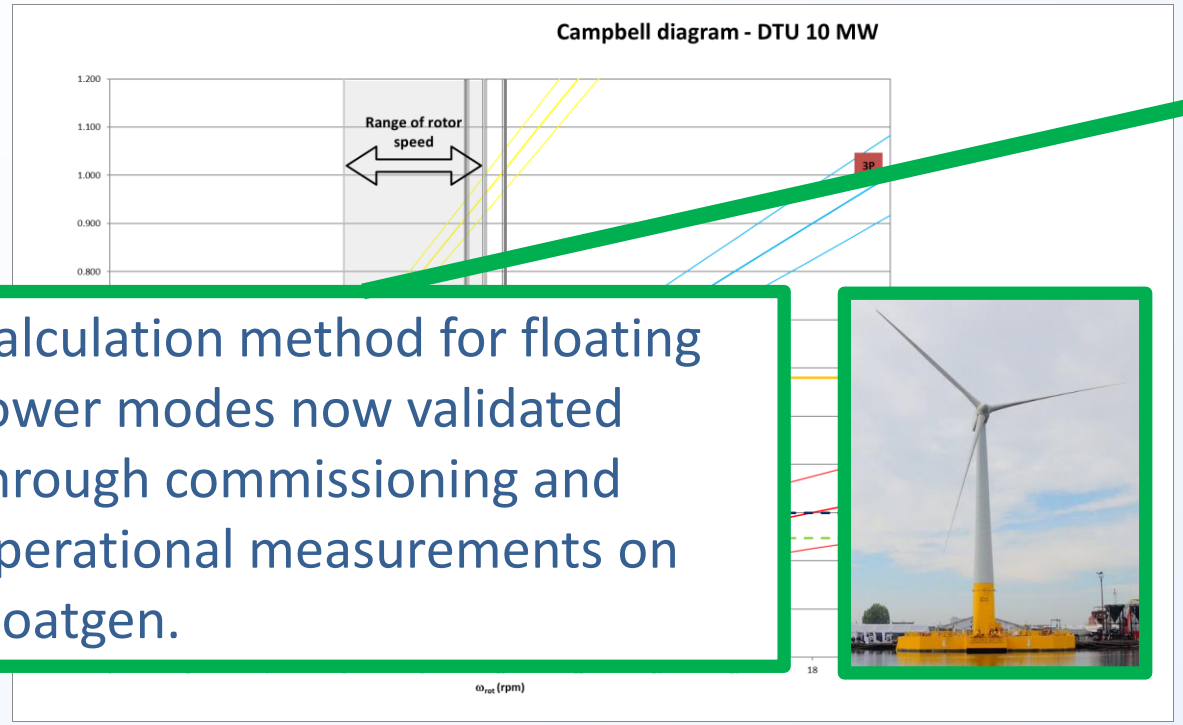

Calculation method for floating tower modes now validated through commissioning and operational measurements on Floatgen.

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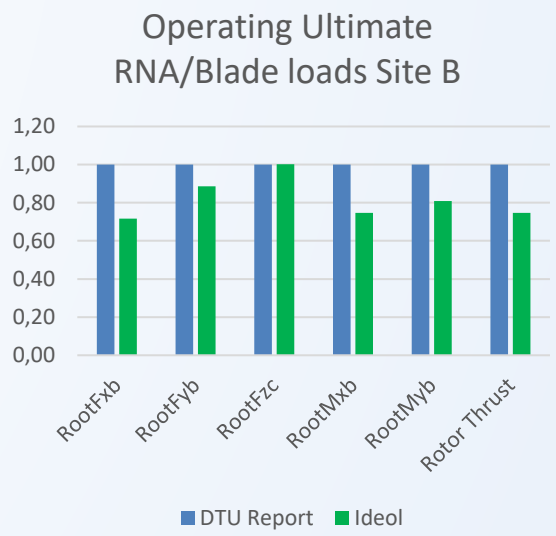
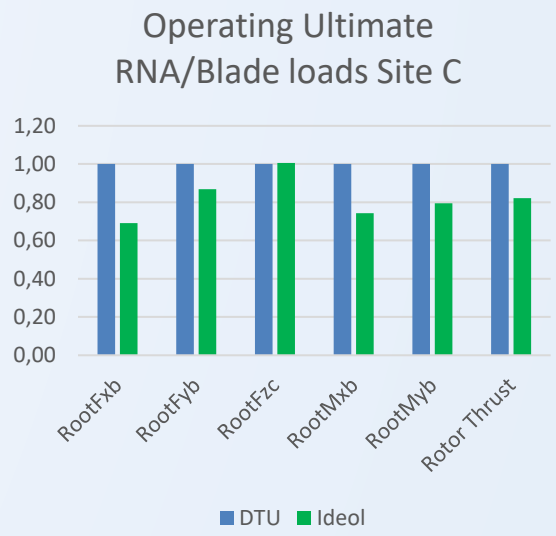
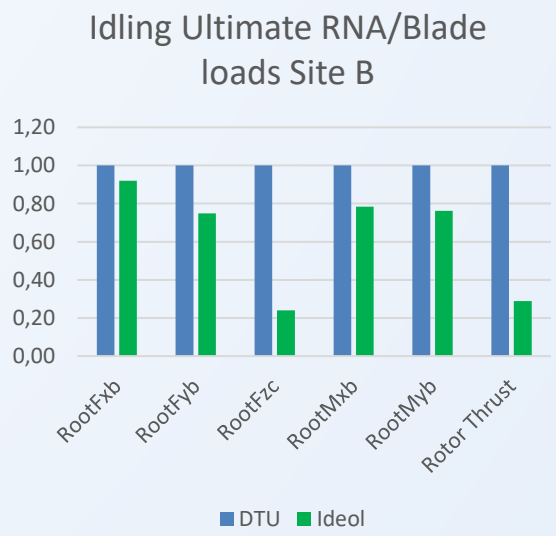
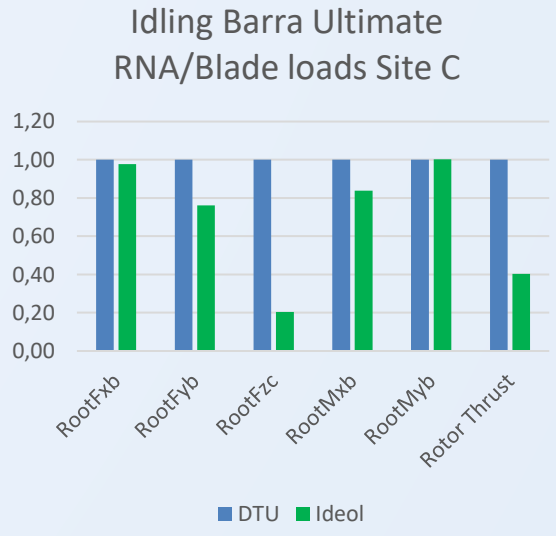
Verification of Turbine Loads Envelope

- Through coupled analysis with FAST the turbine loads envelope was verified.
- A range of critical loadcases for the turbine in the floating condition were analysed in particular those with extreme seastates.
- The motion performance of the hull is adapted to ensure that the turbine loads in the floating condition remain within the original design limits.
- In this way modification of the turbine is avoided.



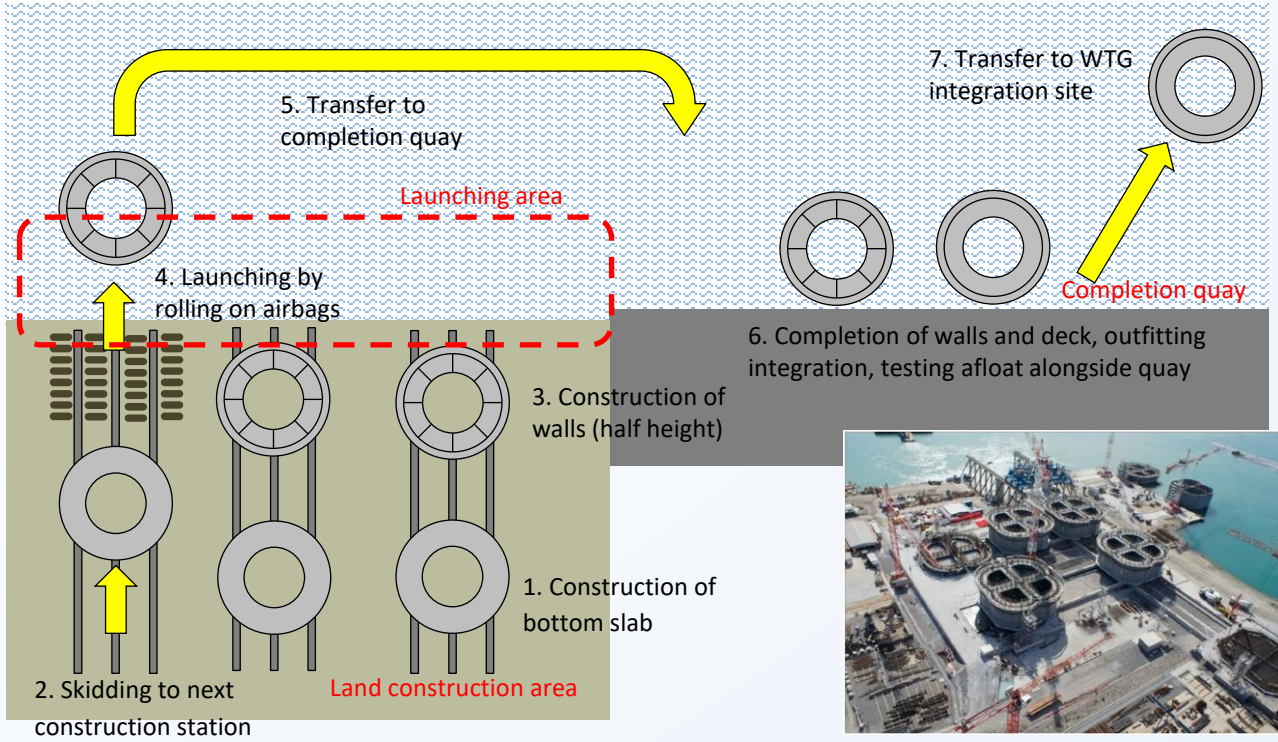




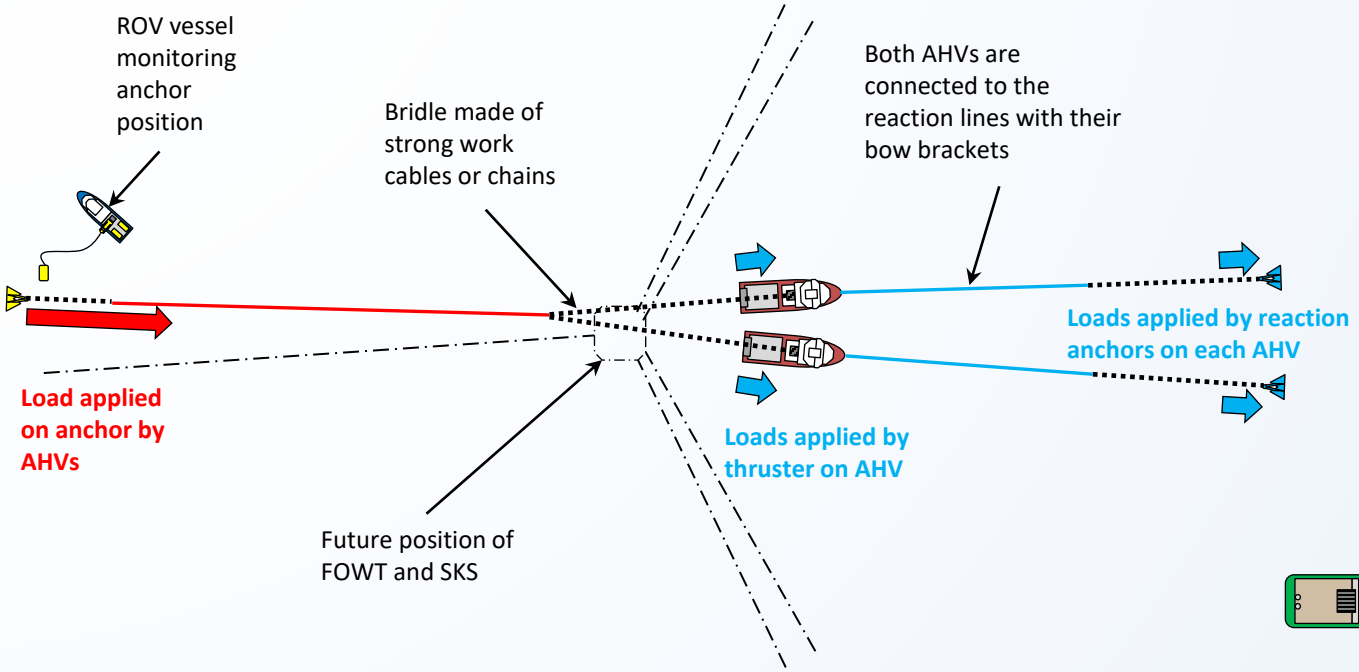


Series Production and Quayside Integration

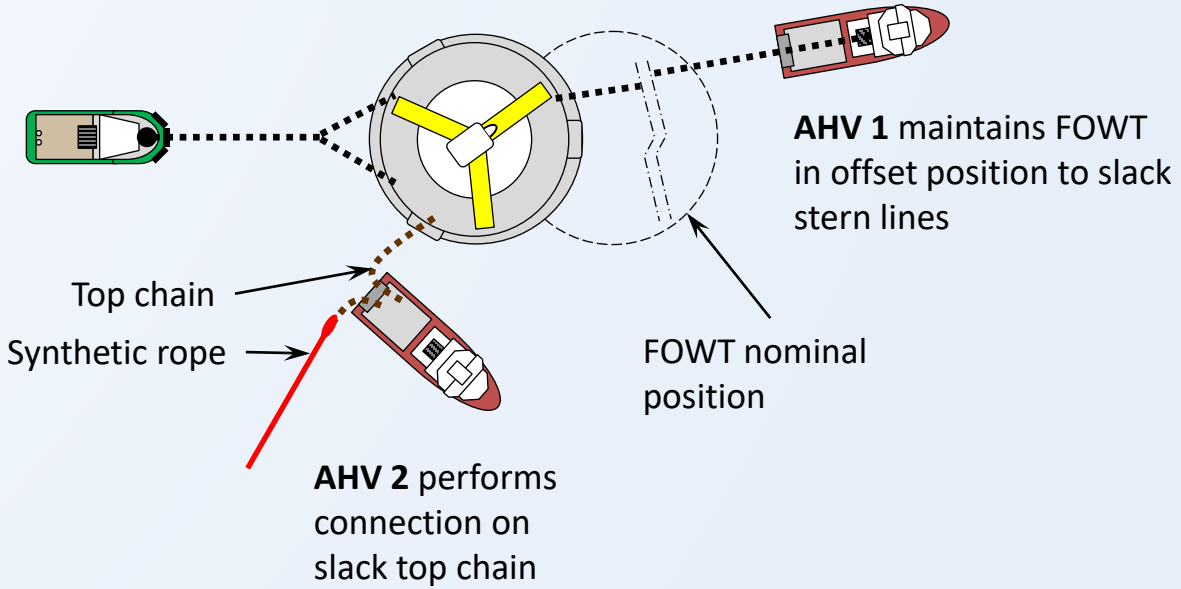
- 3 lines of production
  - Hull construction in yard + afloat
  - 1 Floater completed every 10 days
  - 50 Floaters in 2 years
- Full integration and pre-commissioning of turbine at quayside
- Offshore installation in batches of 5 to bring forward production revenue



Mooring Pre-Installation and Hookup

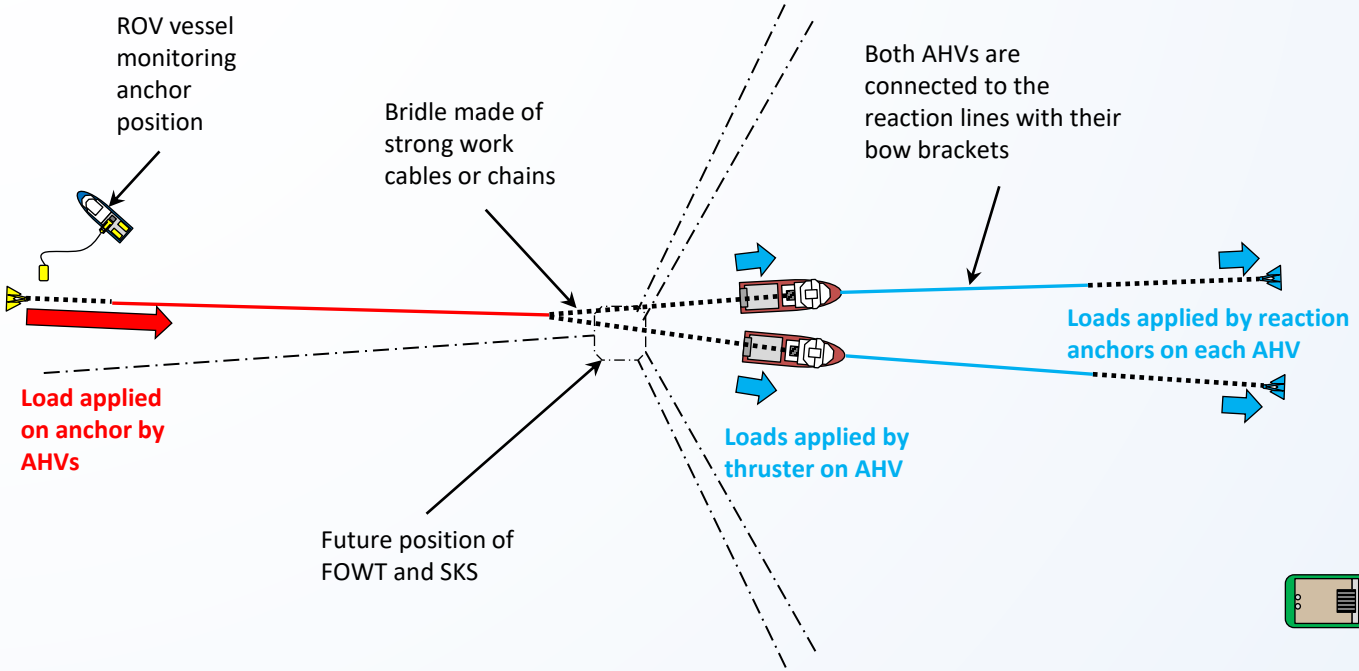


- Mooring Top chains pre-installed on floater.
- Final connection on deck of AHV
- Assisting vessel pulls floater to reduce tension in line being connection.



- All activities using standard vessels.
- Pre-installation of anchors and lines ahead of FWT arrival
- Stretching of synthetic lines to ensure length stability during life.

Mooring Pre-Installation and Hookup



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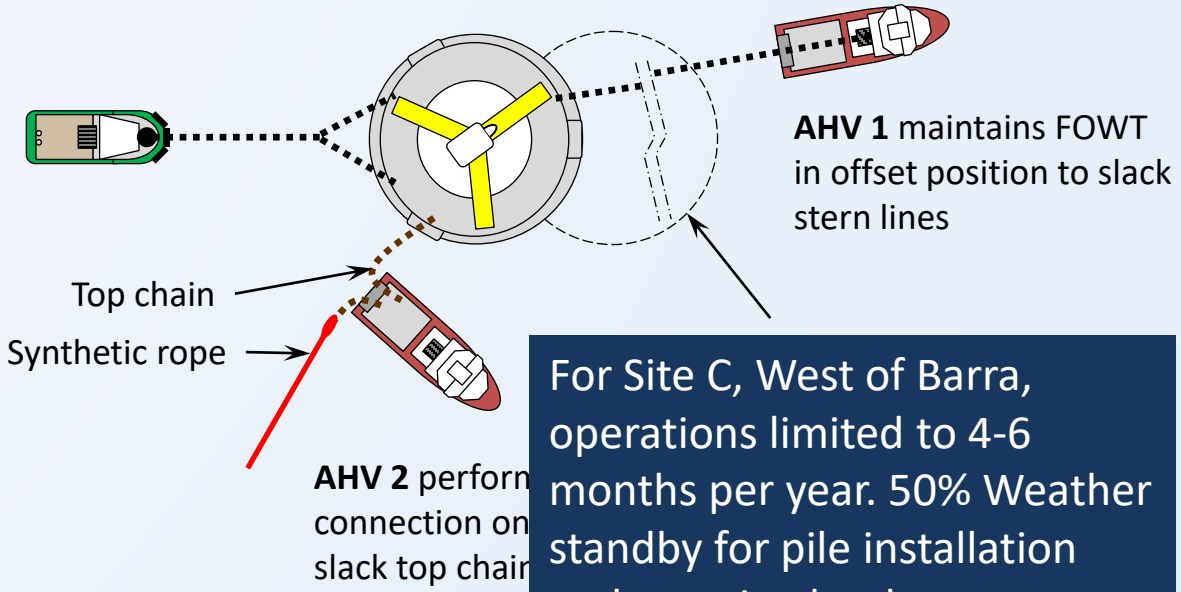

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For Site C, West of Barra, operations limited to 4-6 months per year. 50% Weather standby for pile installation and mooring hook-up.

Ideol Conclusions for Lifes50+

- Upscaling to 10MW
  - Motions verified for acceptable loads envelope with a 10MW turbine.
  - Upscaling significantly reduces the cost of the hull and mooring system per MW of energy production.
  - Going from 2 to 10MW halves the volume of concrete required per MW.
- Commercial Scale Floating Wind Farm
  - Series production, integration and installation scenarios assessed.
  - Optimisation and industrialisation key to reducing hull cost further.
  - More detailed Metocean data key to substantial mooring system cost savings and reduction of number of lines.
- Circular Hull
  - Mooring and Motion characteristic of a circular FWT with Damping Pool defined.
  - Tripod type structure not cost effective compared to direct connection with offset tower - Return to Offset tower for further projects.

WHATS NEXT?

LEADFLOAT:

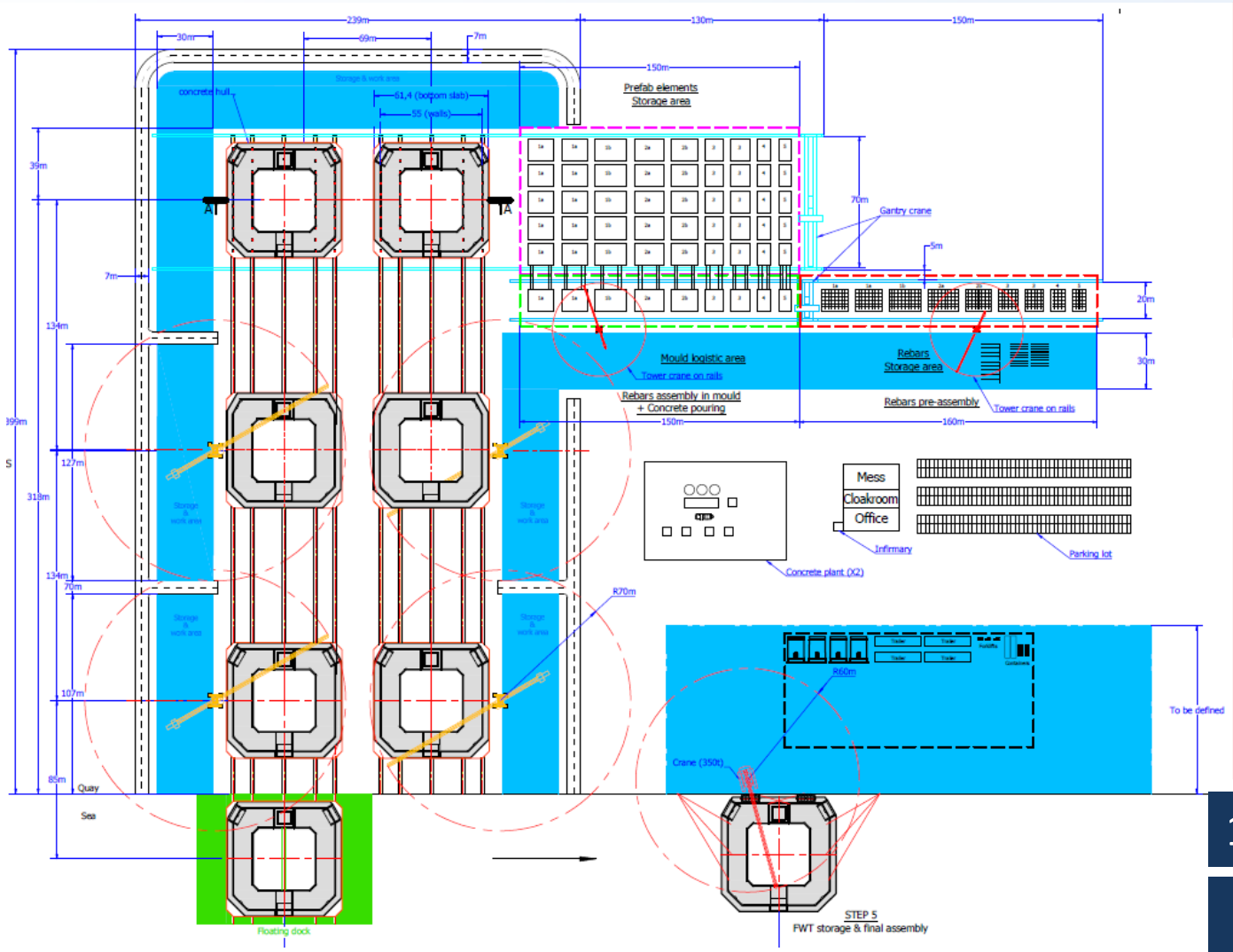
- O&M Optimisation
- Adaption for other markets.
- Commercial Scale Mass Production

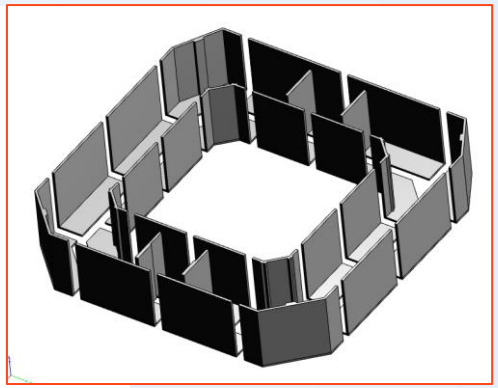
SQUATINA: Optimisation, industrialisation and cost reduction of a 12MW FWT

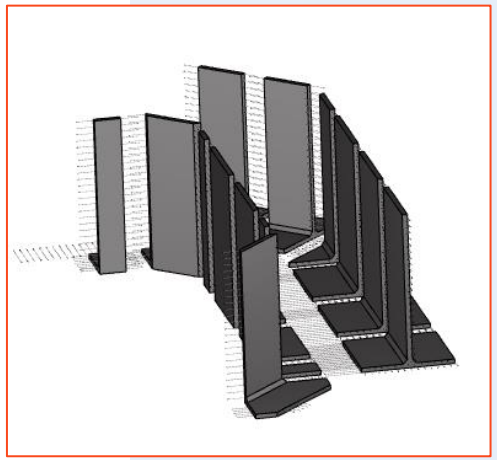
OPTIFOT: Floating Substation

Series Production with Prefabrication

12MW Turbine







1 floater every 2 weeks

With two assembly lines and prefabrication

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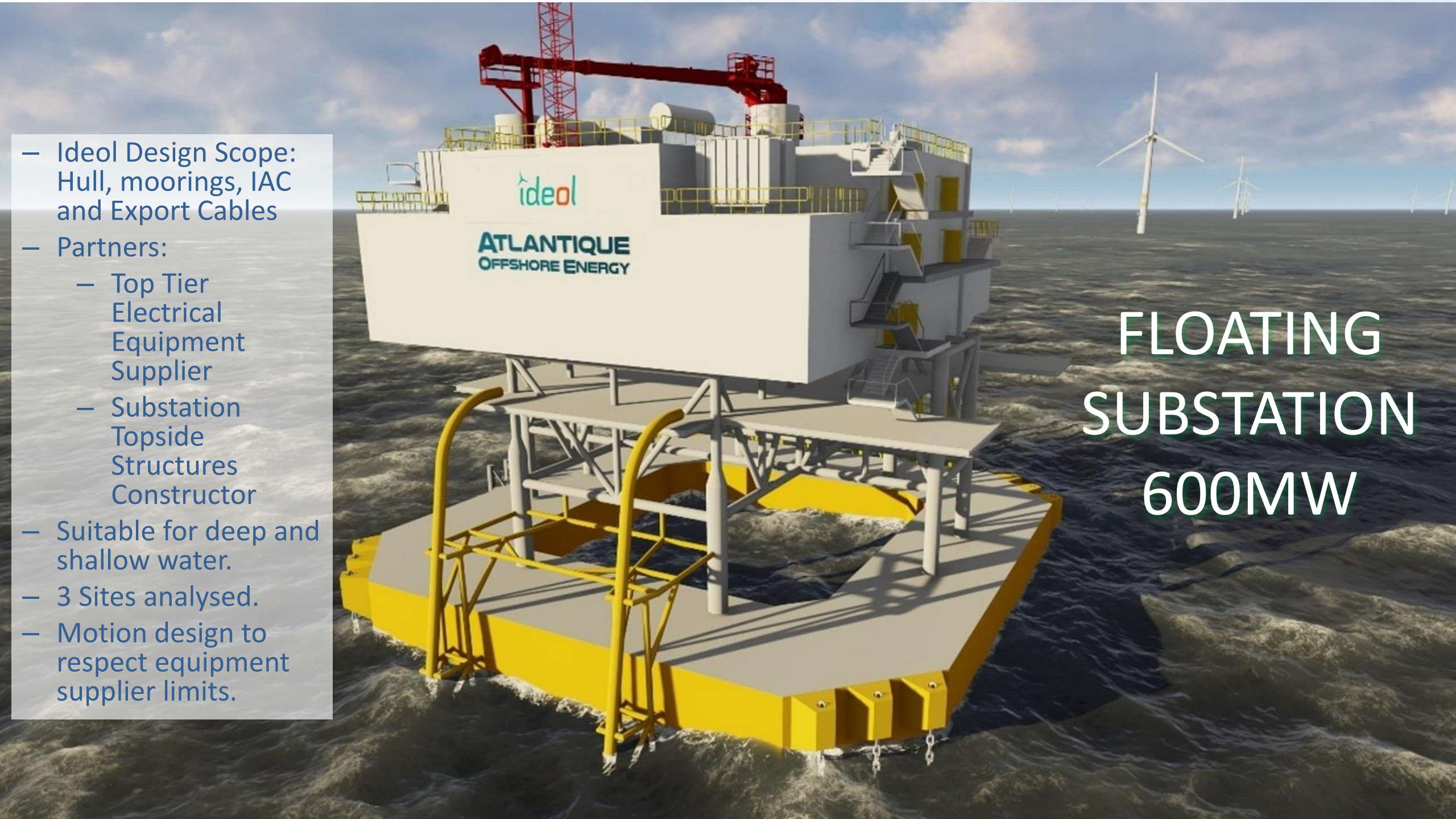
FLOATING SUBSTATION 600MW



- Ideol Design Scope: Hull, moorings, IAC and Export Cables
- Partners:
  - Top Tier Electrical Equipment Supplier
  - Substation Topside Structures Constructor
- Suitable for deep and shallow water.
- 3 Sites analysed.
- Motion design to respect equipment supplier limits.

THANK YOU!

www.lifes50plus.eu

The research leading to these results has received funding from the European Union Horizon2020 programme under the agreement H2020-LCE-2014-1-640741.