Exploring the FOWT mooring system landscape through generative design

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All-Energy/Dcarbonise
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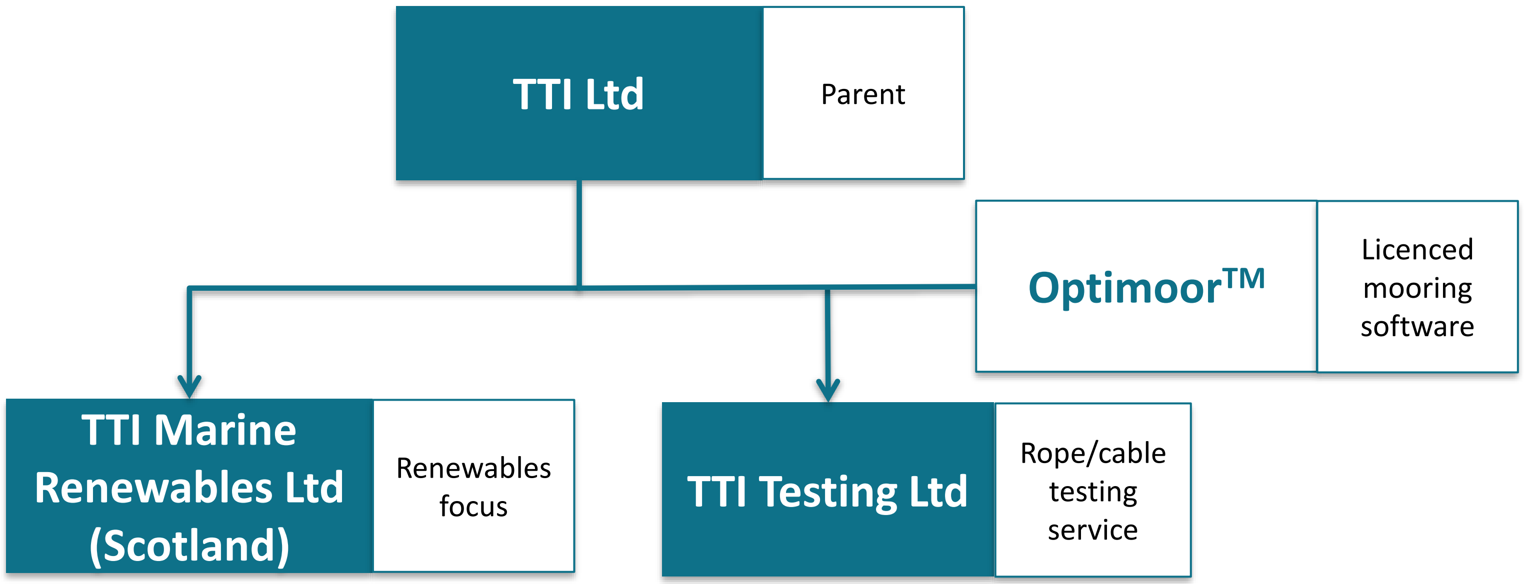
TTI Marine Renewables
A SUBSIDIARY OF TENSION TECHNOLOGY INTERNATIONAL LTD.

TTI Group

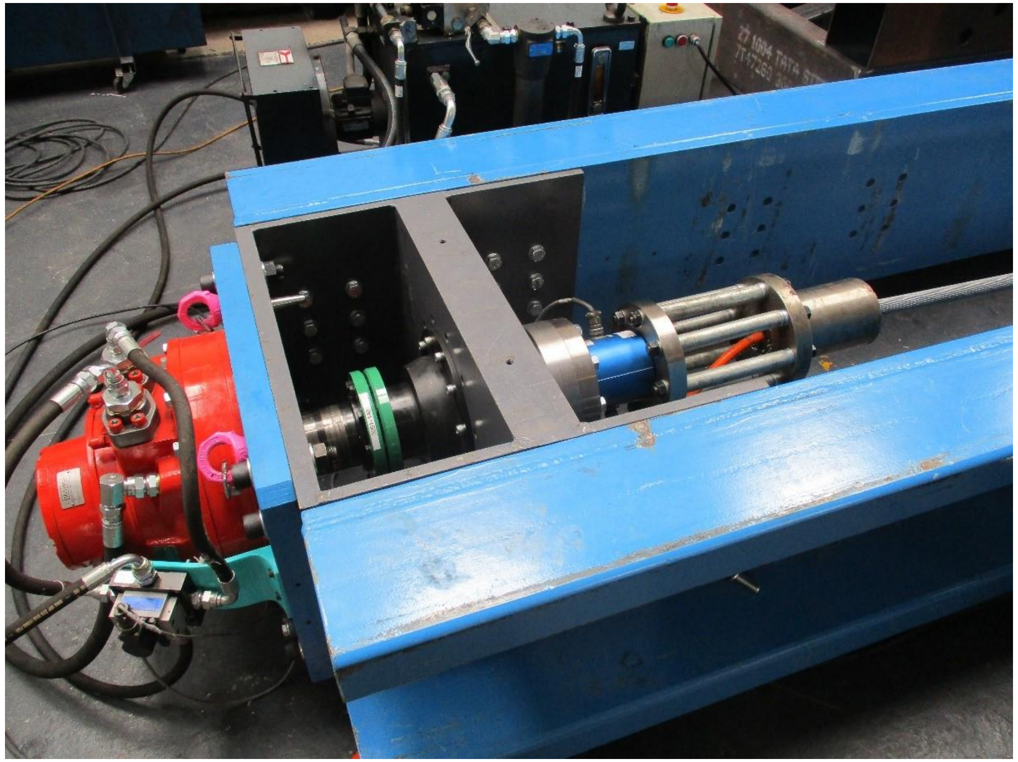
- Founded in **1986** and headquartered in the UK
- Global experts for designing and specification of ropes and textiles for marine systems
- Comprises three subsidiaries, including a world-leading component test facility

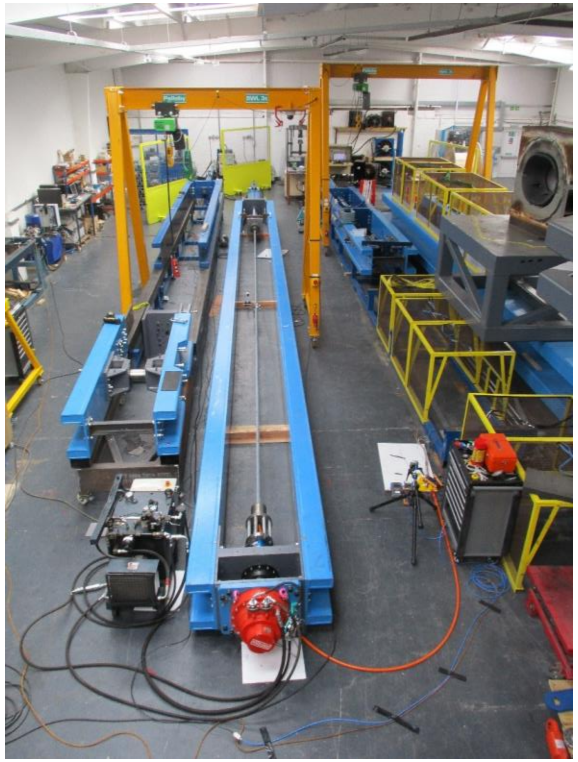


Basis


We provide specialist **through-life** technical support for metallic, synthetic and elastomeric based systems, subsystems & components:
Design
Installation
Decommissioning
Manufacture
O&M

TTI Testing Laboratories (Wallingford, UK)

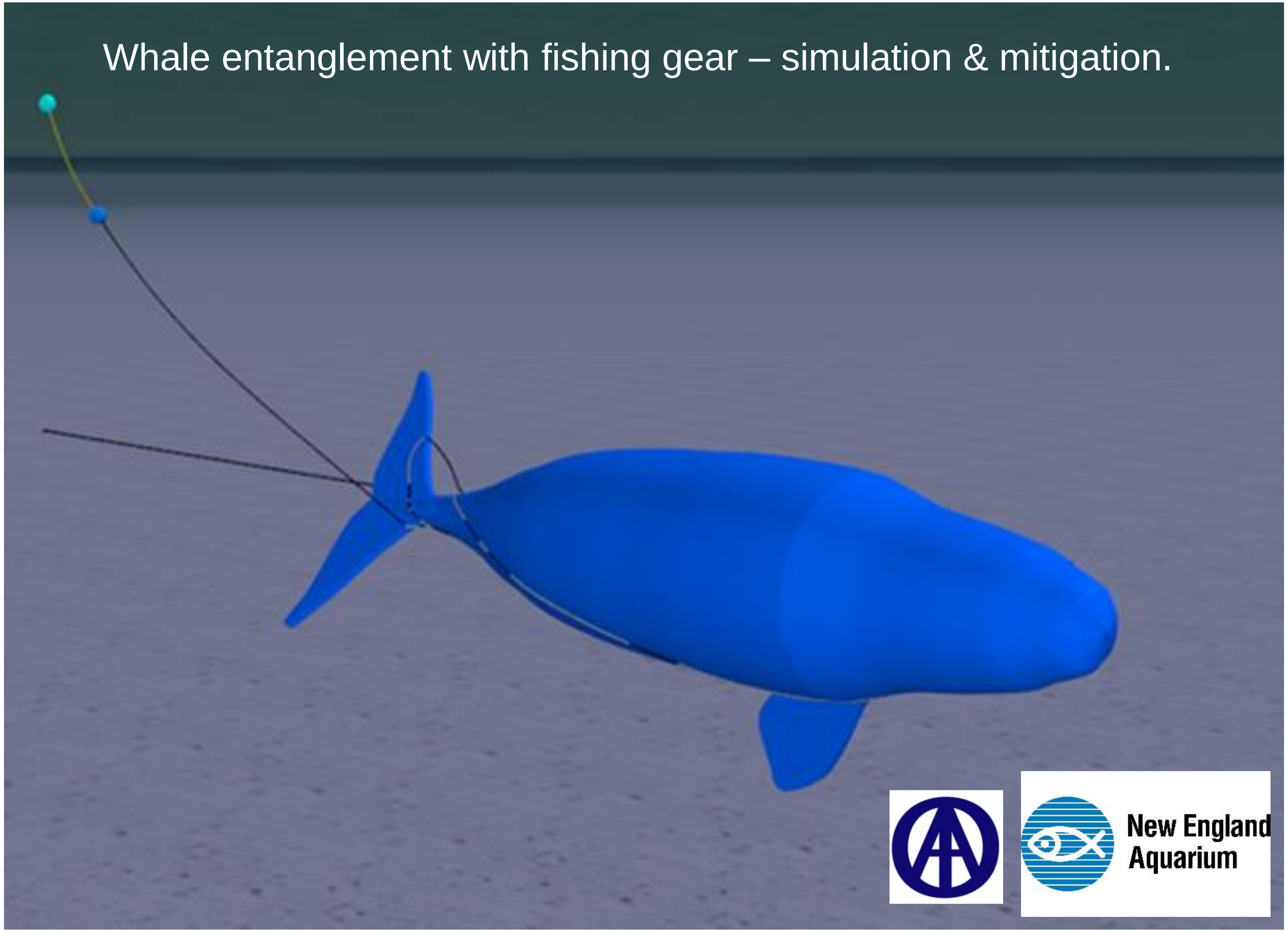


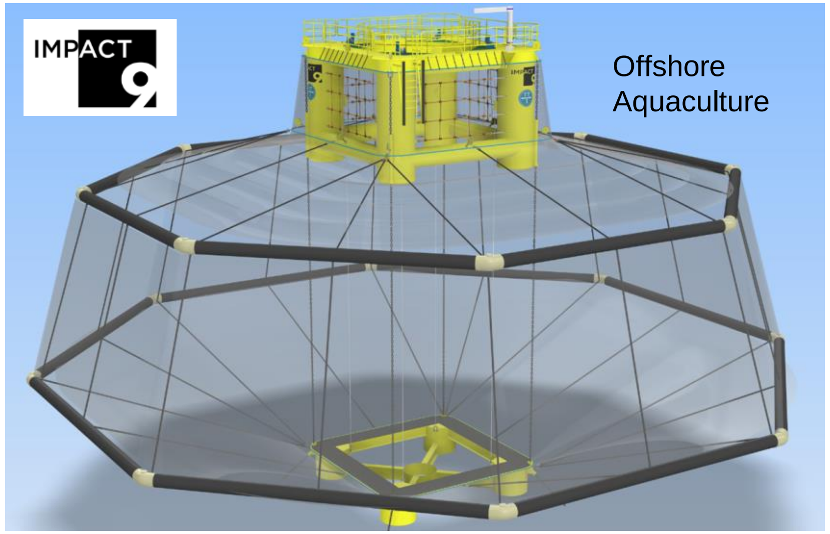


TTI Testing offers a full range of consultancy, research, development and forensic analysis in fields related to the design, inspection, operation, testing, appraisal and discard of tension elements.

We have internationally recognised expertise in wire and fibre ropes, chains, electromechanical cables, hoses and related interface components in the onshore, industrial and offshore markets and can also offer a full range of additional industrial mechanical testing.

Other Interesting Work!





Floating Offshore Wind Projects

We are experienced across many technologies. Our roles in recent projects shown include:

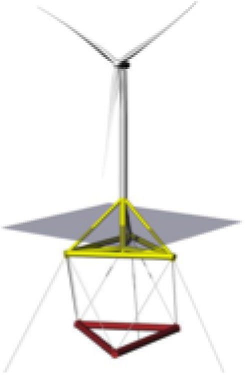
- Site selection.
- Validation of coupled aero/hydrodynamics model.
- Mooring design & anchor specification, including multi-objective optimisation.
- Design support for mini-turret mooring.
- Connector design.
- Procurement of hybrid synthetic/chain mooring.
- Specification of anchors.
- Marine operation analysis.
- Cost of energy and market studies.


TODA CORP.


IDEOL


MPS


ENEROCEAN


STIESDAL


EOLINK

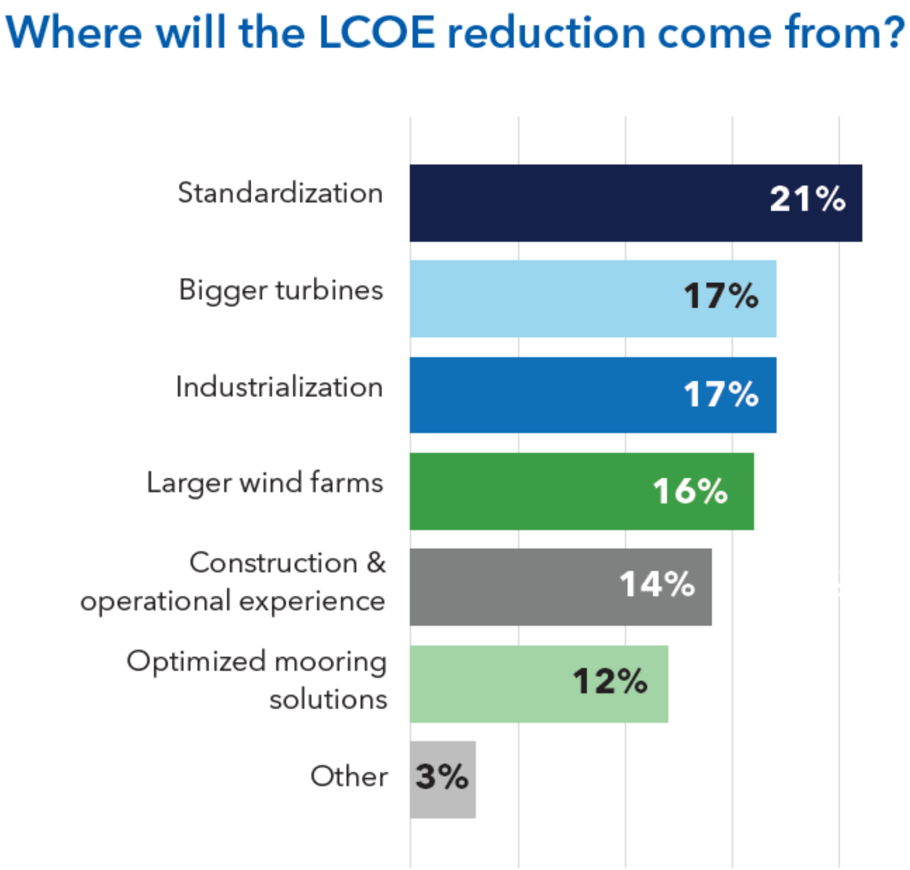

FRONTIER TECHNICAL

Forecast

DNV's Energy Transition Outlook forecasts that by 2050, 15% of all offshore wind installed capacity will come from floating offshore wind. This means that approximately 300 GW of floating offshore wind will be installed globally in the next 30 years, requiring around 20,000 turbines, each mounted on top of floating units weighing more than 5,000 tonnes and secured with so many mooring lines that if they were tied end-to-end they would wrap around the world twice.

[DNV, 2023 Floating Wind: Turning Ambition Into Action]

…approximately 4km of mooring lines per turbine are required over different sites, environmental conditions, platform topologies etc.….



DNV report survey results

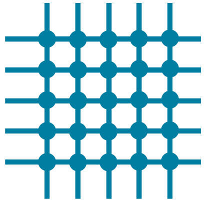
Challenge

Floating offshore wind turbines (FOWTs) are complex systems which require cost effective mooring system solutions.

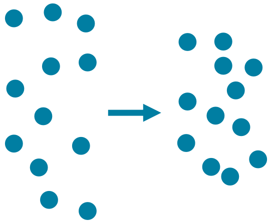
The mooring designer is often faced with many avenues which can be explored, i.e., a large parameter space, as well as competing objectives and constraints. For example, the LCOE of each turbine will be influenced by two potentially competing factors; CAPEX and AEP

An iterative approach based on a different project may result in a sub-optimal design.

A brute force approach can require a large number of simulations.

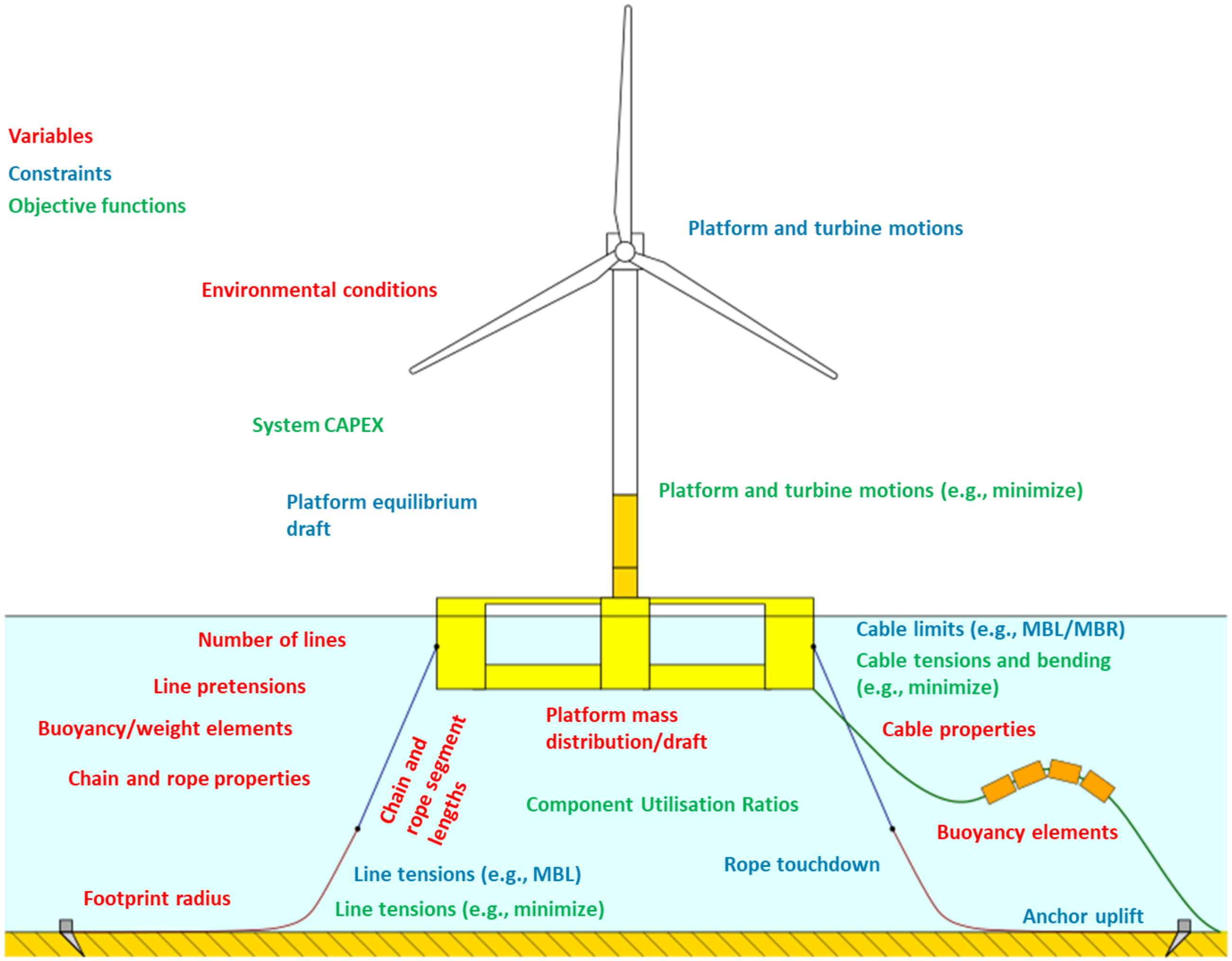


Heuristic search techniques, are highly efficient at exploring parameter spaces.



Approach

TTI has developed an optimisation tool which rapidly identify candidate mooring solutions for a given set of parameters, objectives, constraints and design load cases. These work alongside Orcaflex and can be implemented in many different ways (i.e., most model objects can be manipulated). A few example parameters are shown below.



Approach

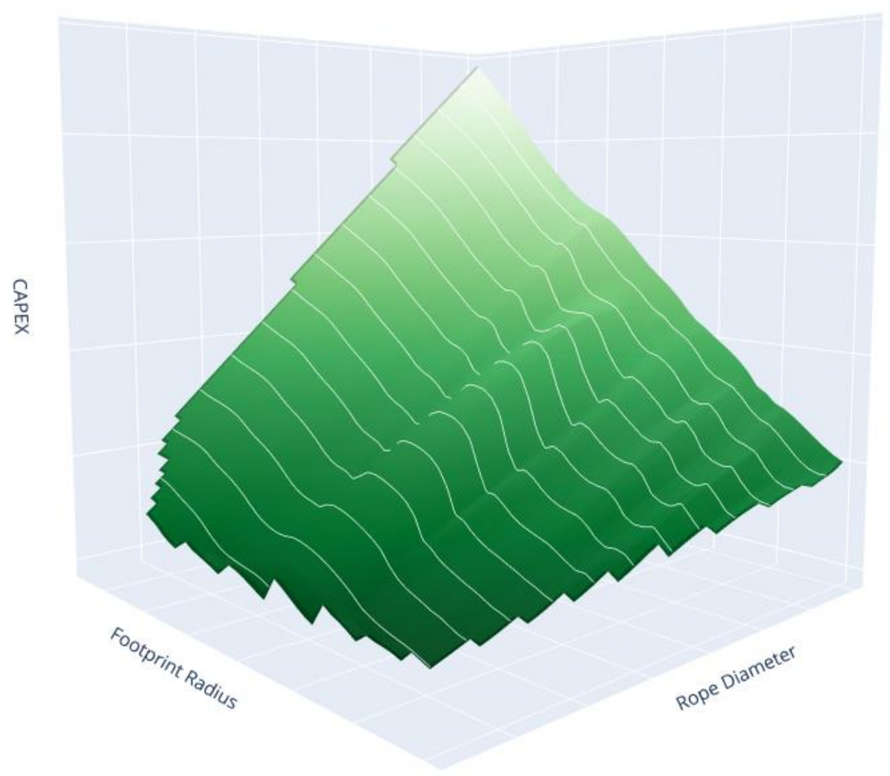
Multi-objective optimisation can be utilised to reduce the computational burden of mooring system scoping when dealing with large parameter spaces. It enables:

- Optioneering towards a manageable set of potential candidates that can taken forward to detailed design.

- A compromise of competing objectives to be reached (e.g., CAPEX, array density, installation requirements etc.) to optimise LCOE.

- Identification of trends in terms of input parameters and results.

This technique, as outlined in a forthcoming White Paper, has been successfully applied to a number of MRE and FOWT projects including two FOWT mooring systems deployed near Goto Island, Japan.



Landscaping

The tool has been used for the ongoing ORE Catapult **MA02 *Cost, Risk and Failure Implications of Different Mooring Spreads and Number of Mooring Lines*** project.

Input parameters

Identify mooring systems and generate BoMs

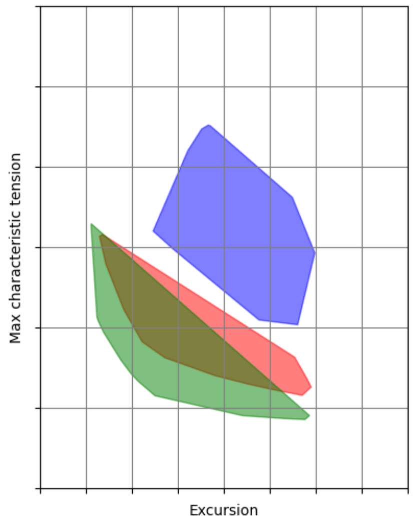
Determine consequences of failure

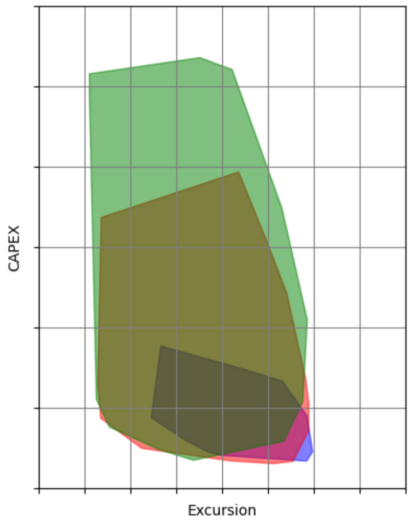
Carry out reliability and lifecycle cost assessments

System availability and LCoE for different mooring layouts

The study is an investigation on how mooring design choices can influence FOWT availability and LCoE, focusing on:

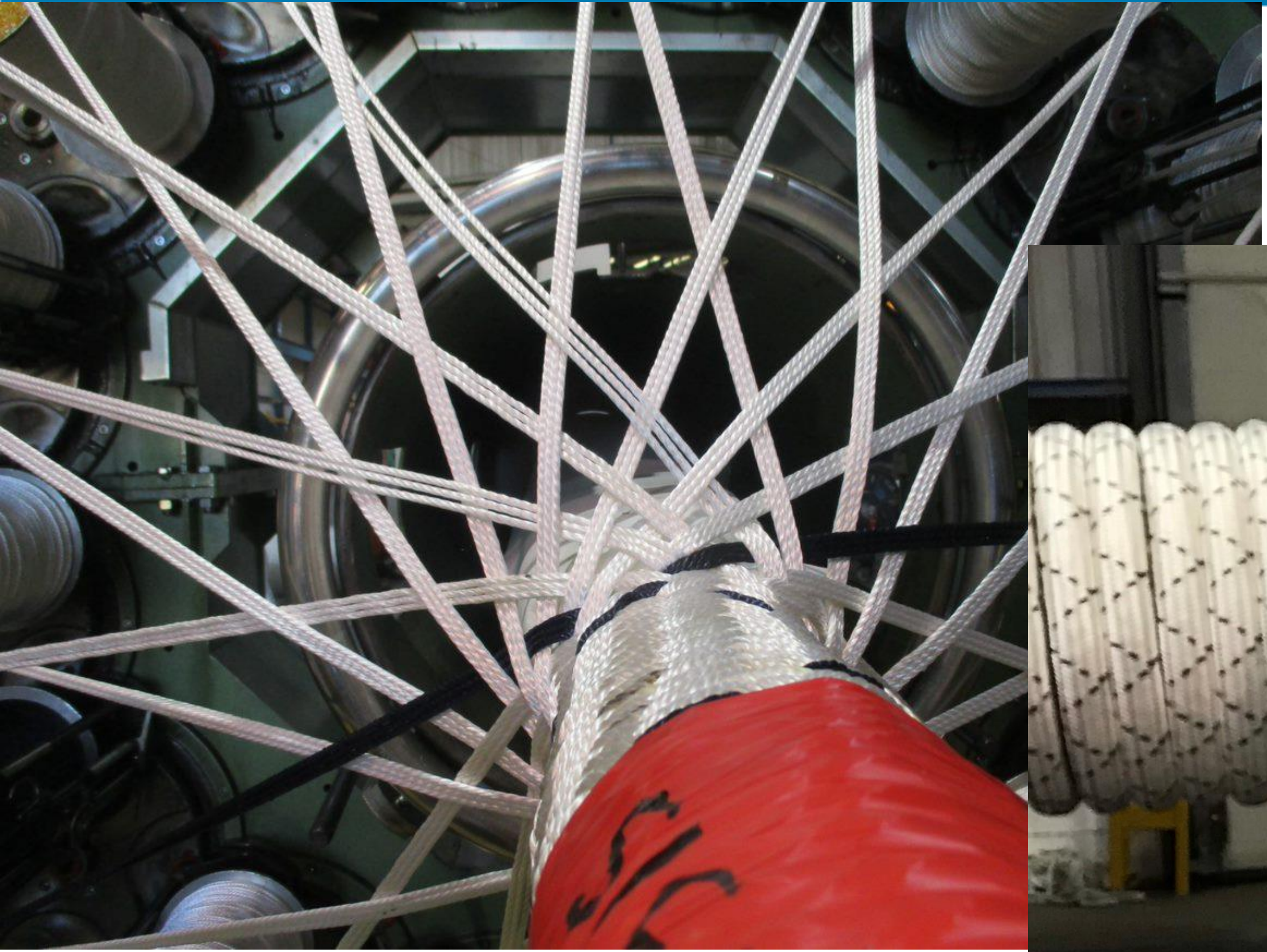
- Chain catenary, semi-taut and taut mooring topologies
- 3, 6 and 9 line systems
- 100m and 500m deployment sites

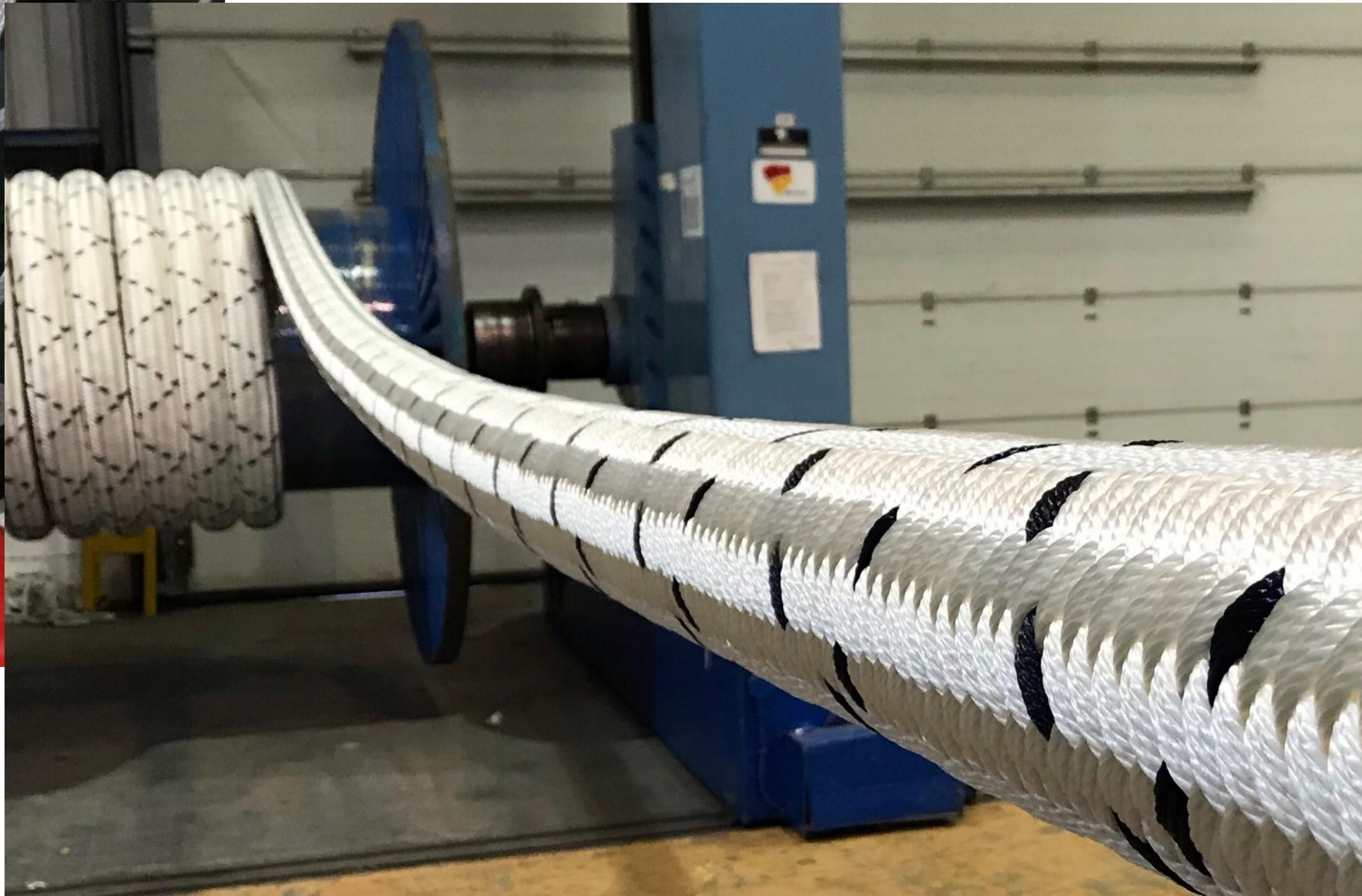




CATAPULT Offshore Renewable Energy

Informing Rope Design





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Thanks for listening

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