PORT AND INSTALLATION CONSTRAINTS OF TENSION LEG PLATFORMS (TLP) FLOATING WIND TURBINES

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PURPOSE OF PRESENTATION

The presentation will review the port and installation requirements of TLPs as floating wind substructures.

INDEX

INTRODUCTION

Question

The methods for constructing and installing semi-submersibles, barges and Spars are well developed. However the installation requirements for floating wind tension leg platforms are at an early stage of development

Method

This TLP installation review is based on industry websites and basic naval architecture input

MOORING TYPES

CATENARY

- Barges, Semisubmersible, Spar
- Use drag anchors, suction piles, drilled/driven piles

TURRET MOORING

- Semi submersible port/tow-out
- Tension mooring in operation
- Use drilled/driven piles (suction piles might be possible)

TENSION LEG

- Use drilled/driven piles

TLP ADVANTAGES

Advantages:
- Low steel weight in substructure
- Low motions during operations
- Small area on the seabed for moorings

Disadvantages
- Low intact stability during tow out
- High cost of moorings
- Installation of moorings is weather dependant
- Turbine in the centre of the structure limiting available cranes for turbine installation
- Difficult to return to port for heavy mantenance

To overcome the disadvantages
- May require temporary buoyancy
- May require use of dynamic positioned crane vessel offshore

TLP POSSIBLE INSTALLATION METHODS

- Temporary buoyancy
- Offshore dynamic positioning crane vessels
- Inshore construction
- Variable draft
- Tow out mooring with substructure hull

BLUE H Ref [5]

The Blue H Prototype (small scale TLP with a 80 kW turbine)
The engineering, manufacturing, assembling and demonstration of a prototype, a 300 metric ton scale model placed in the Adriatic Sea with a depth of 113 meters, 22 kilometers from the coast, the world's first floating wind turbine. Removed after 1 summer.

STIESDAL OPTIONS Ref[9]

TetraTLP: Tension Leg Platform. Suited for 100-500+ m water depth

The assembly involves no Welding
Spar Type

Fitting topsides
Spar Type

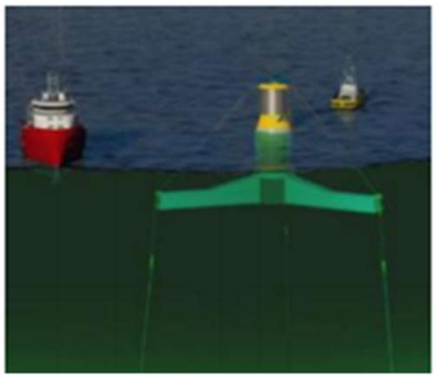
TLP TEMPORARY BUOYANCY STIESDAL Ref [2]

Tow out with temporary buoyancy

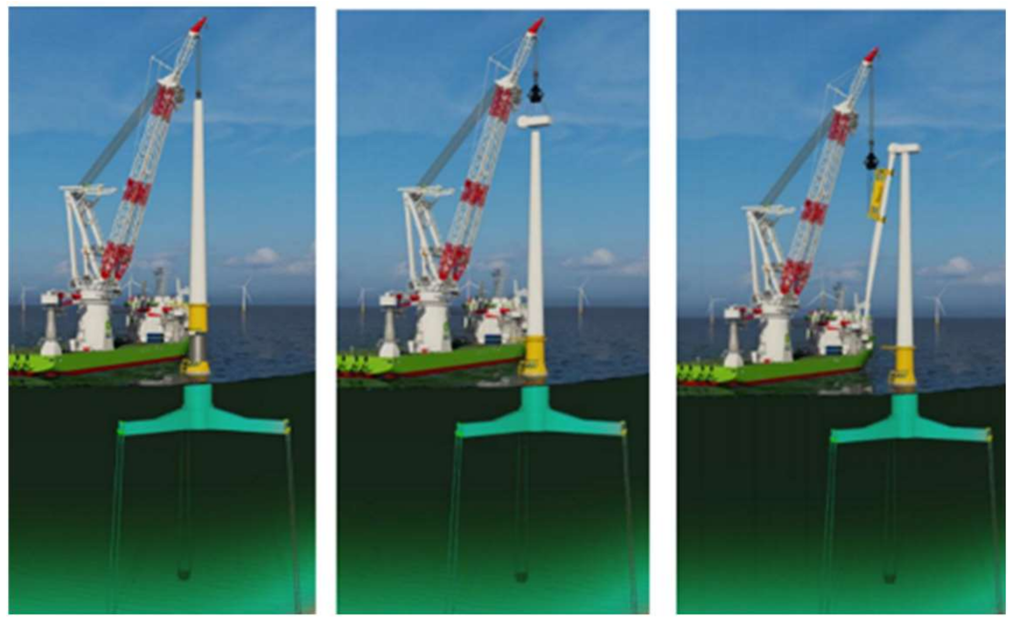
Remove temporary buoyancy after
Connecting tendons

ORIGINAL BLUEWATER TLP INSTALL CRANE VESSEL Ref [2]

Tugs



Active Heave Compensation Of Hook of DP2 crane vessel



BLUEWATER FLOATING WIND TENSION LEG PLATFORM Ref [2]

The modular floater can be assembled quickly and pre-commissioned at the quayside. The offshore installation is executed in two steps, firstly the TLP followed by the wind turbine generator (WTG). An innovative slip joint allows a direct lift of the WTG on the TLP

SBM **Ref[3]** Substructure construction

PROVENCE GRAND LARGE, July 2022, ref [3]

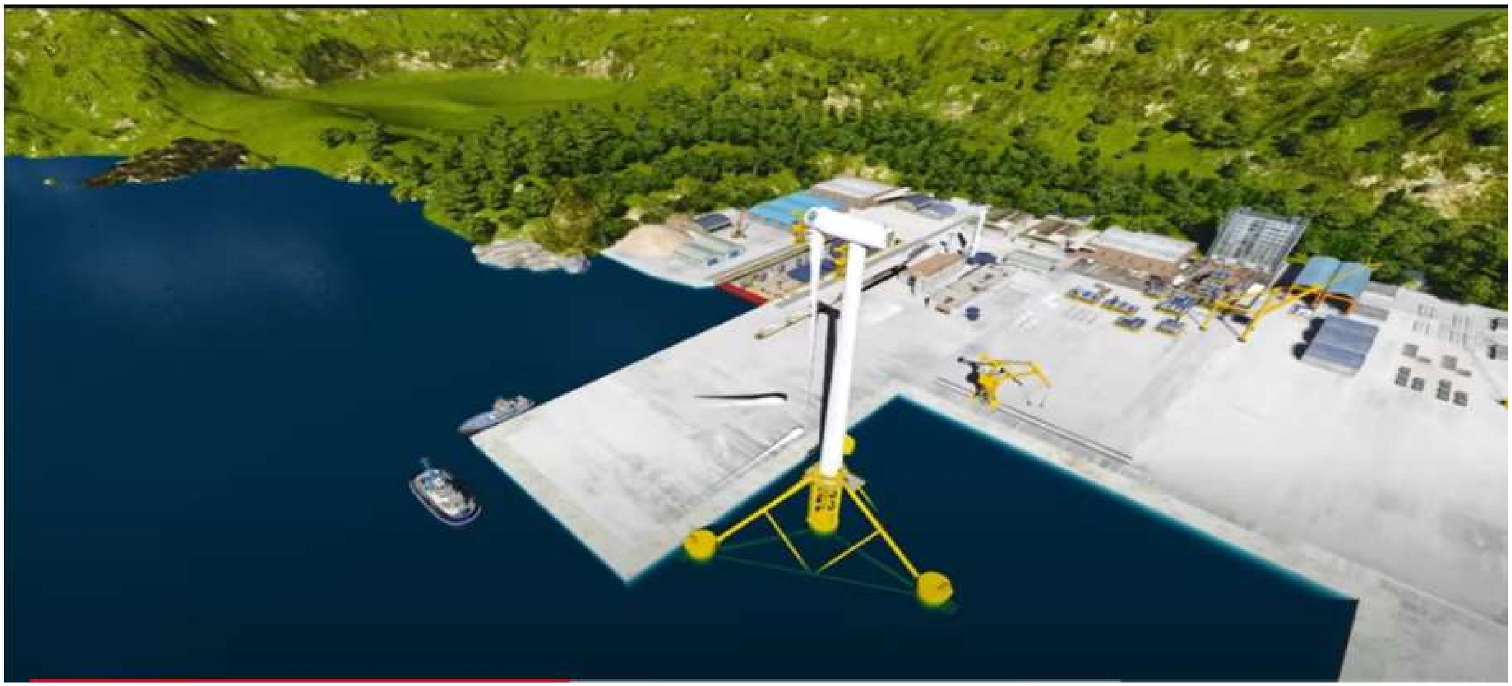
Eiffage Métal's site in Fos-sur-Mer, where the assembly of the structures is being carried out by the French company and Smulders, its Belgium-based subsidiary

LAUNCHING
USING

A BARGE
OR

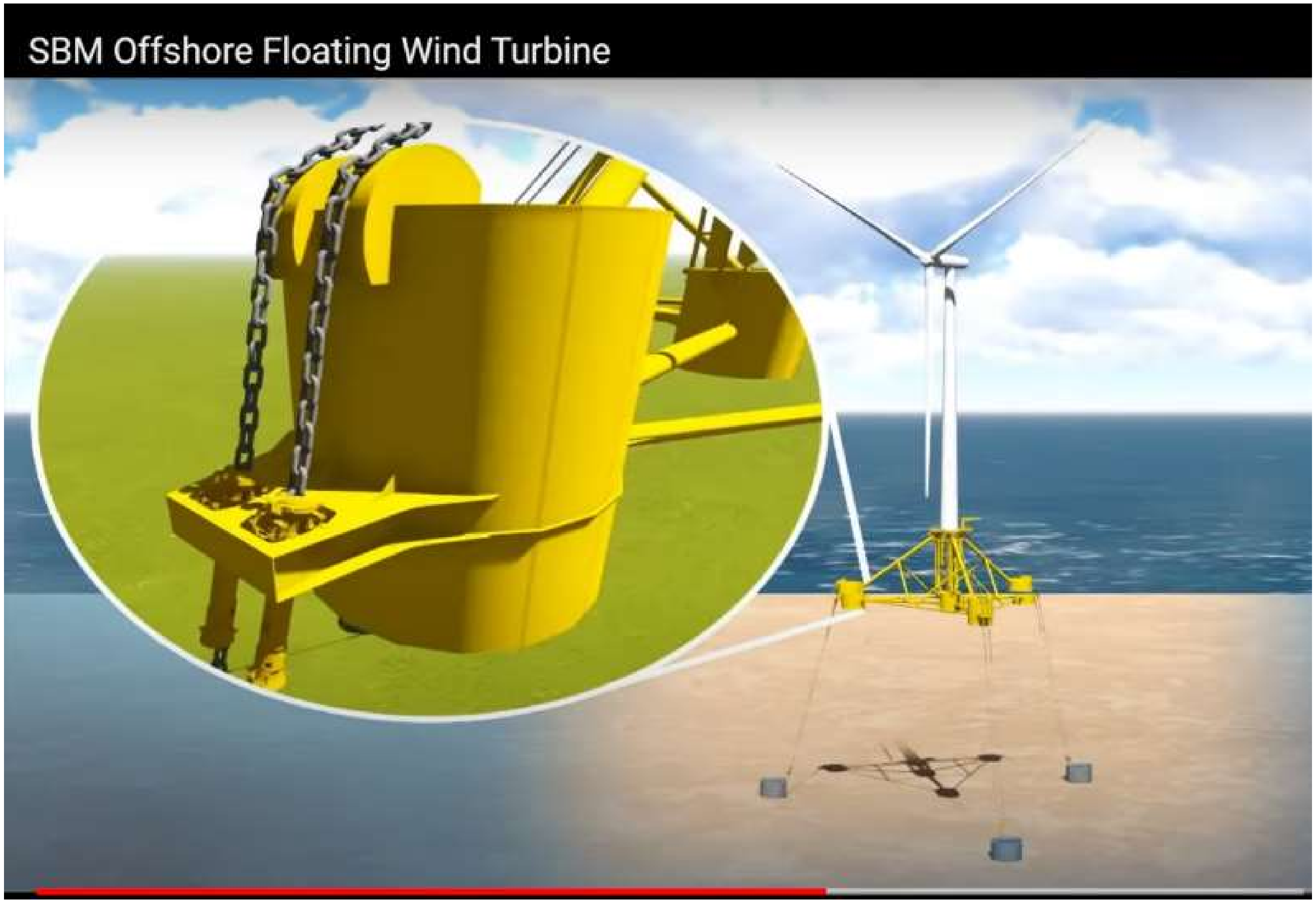
A SLIPWAY

FIT OUT TOPSIDES ALONGSIDE A QUAY



SBM **Ref[3]**

Tow out shallow draft
Large 2nd moment of
Water plane area

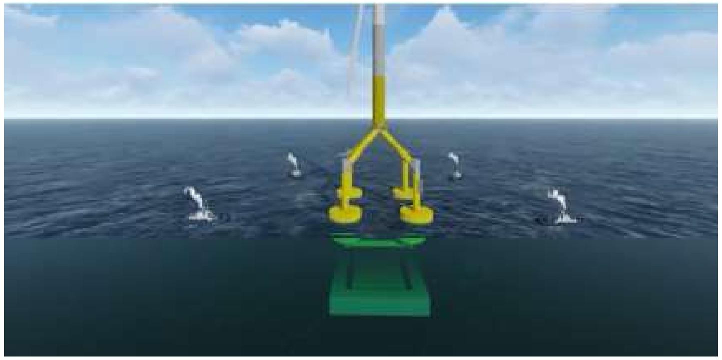

SBM Offshore Floating Wind Turbine

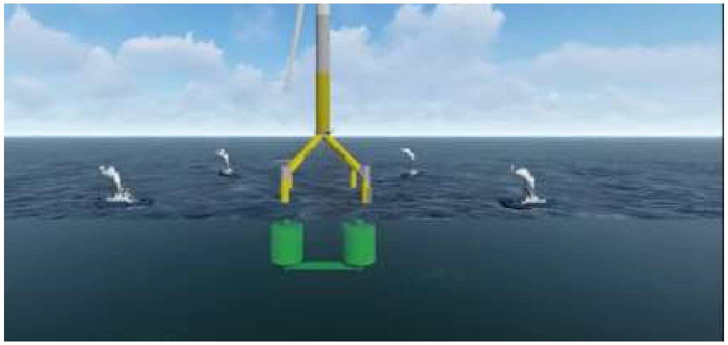
SBM Ref[3]

Tension (chain) tethers, ballast down and re-tension

GICON ref[4]

https://www.youtube.com/watch?v=t7cIcBYRs5Q





ECO TLP Ref[7]

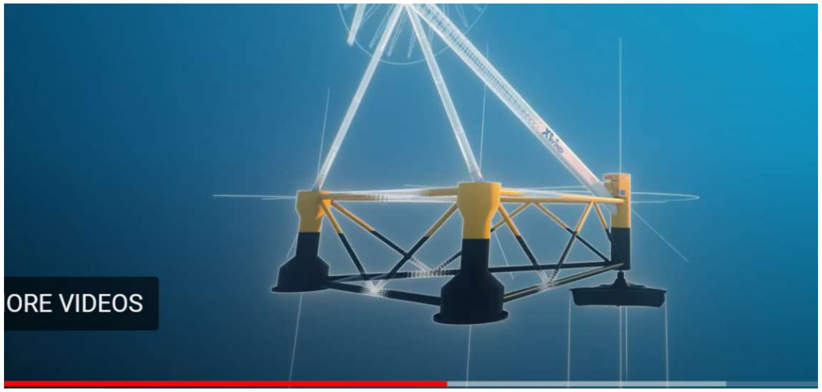
ECO TLP is a patented deep water Tension Leg Platform that for 100-3000m water depths that scales with next generation Floating Offshore Wind Turbines (FOWTs).

JAPANESE COMPANIES

JERA, MODEC ref [6], Toyo Construction, and Furukawa Electric

TLP mooring lines reduce the space occupied under the sea.
Larger diameter columns means better intact stability during tow-out, but higher surge and sway motions during operations.

X1 PART SEMI-SUBERSIBLE, TENSION MOORING



The X1 Wind FOWT concept is based on a Tension Mooring system , with a weather vaning system and a downwind turbine. The design allows for a lighter floater design with a significantly reduced steel requirement and for a more efficient and restricted mooring system minimizing the impact on seabed. It is scalable for turbines of 15+ MW, facilitating cost-effective deployment for large-scale offshore wind farms.

CONCLUSIONS

To facilitate the installation process and minimize costs, the main installation aspects have to be considered:

> What type of TLP is being used

> Shipyard location
> Substructure shipyard can be anywhere
> Distance from fit out port to offshore wind farm site (3 day tow)

> Minimise weather downtime during installation
> Number of anchor handling vessels (3 or 4)
> Whether an offshore crane vessel is required

THANK YOU FOR YOUR ATTENTION

ANY QUESTIONS

Email ac1080@Exeter.ac.uk

ABBREVIATIONS

FOWT	floating offshore wind turbine
HTV	heavy transport vessel
SPMT	self propelled modular transporter (trailer)
TLP	tension leg platform
WTG	wind turbine generator

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ABSTRACT

Floating offshore wind needs to go from pre commercial phase to full commercial use if it's full benefits are to be realised. The port and installation requirements for barge, semi submersible and Spar substructure types are understood, though more research is needed to reduce cost. Floating Wind Tension Leg Platforms (TLPs) have constraints on tow out intact stability and complications in installing the tension moorings. The paper will review the port and installation requirements of TLPs as floating wind substructures. The TLP has the advantages over other substructure types for low in place motions and minimum area taken up on the seabed. There is experience from the offshore oil and gas industry of TLPs which can assist in developing cost effective TLP designs for floating wind. The priorities are the turbine fit out port and the vessels required for TLP offshore installation. Cost reduction during the port and installation phases are based on the best techniques from the offshore oil and gas industry, from bottom fixed wind turbines and the installation of other floating wind types. Installation methods considered are: variable draft between tow out and operations, piece small installation offshore and fitting temporary buoyancy for the tow out phase. Design for installation includes expanding the weather window in which the TLP floating substructure can be transported to site and configurations to facilitate mooring. The simplification of installation methodology will reduce time spent offshore and will minimise risks to personnel.