INSHORE CONSTRUCTION REQUIREMENTS FOR FLOATING WIND TURBINES

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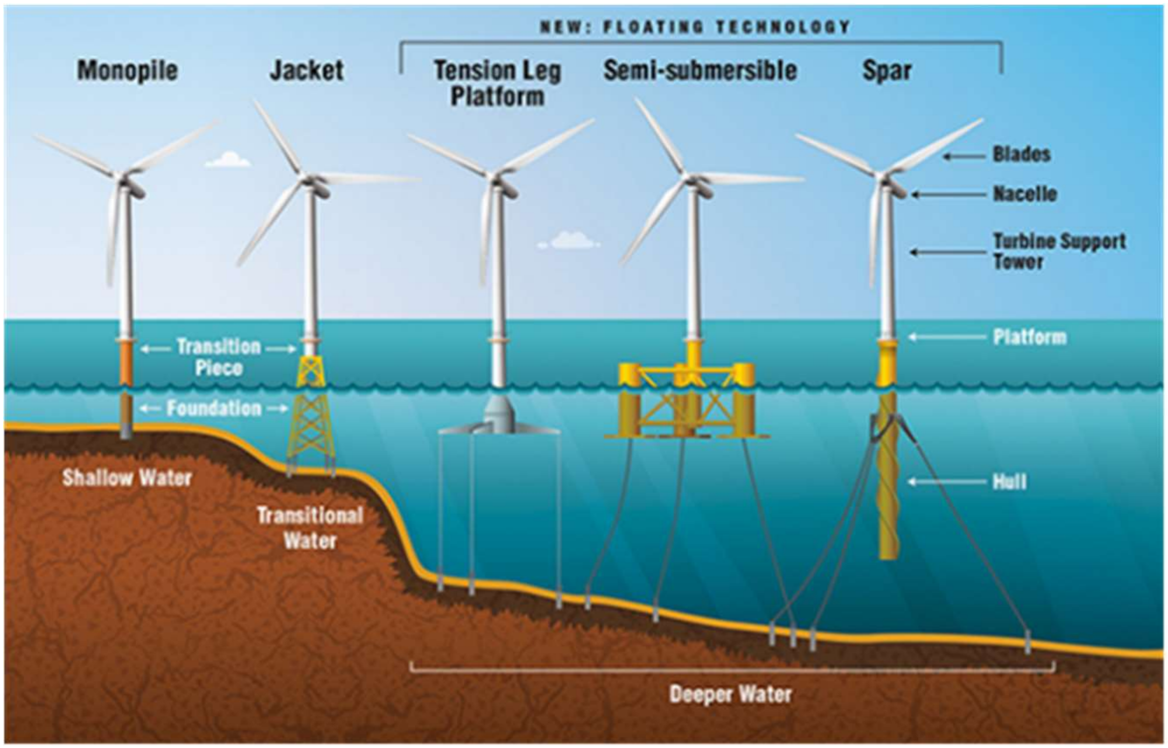
INTRODUCTION TO FLOATING OFFSHORE WIND TURBINES (FOWT)

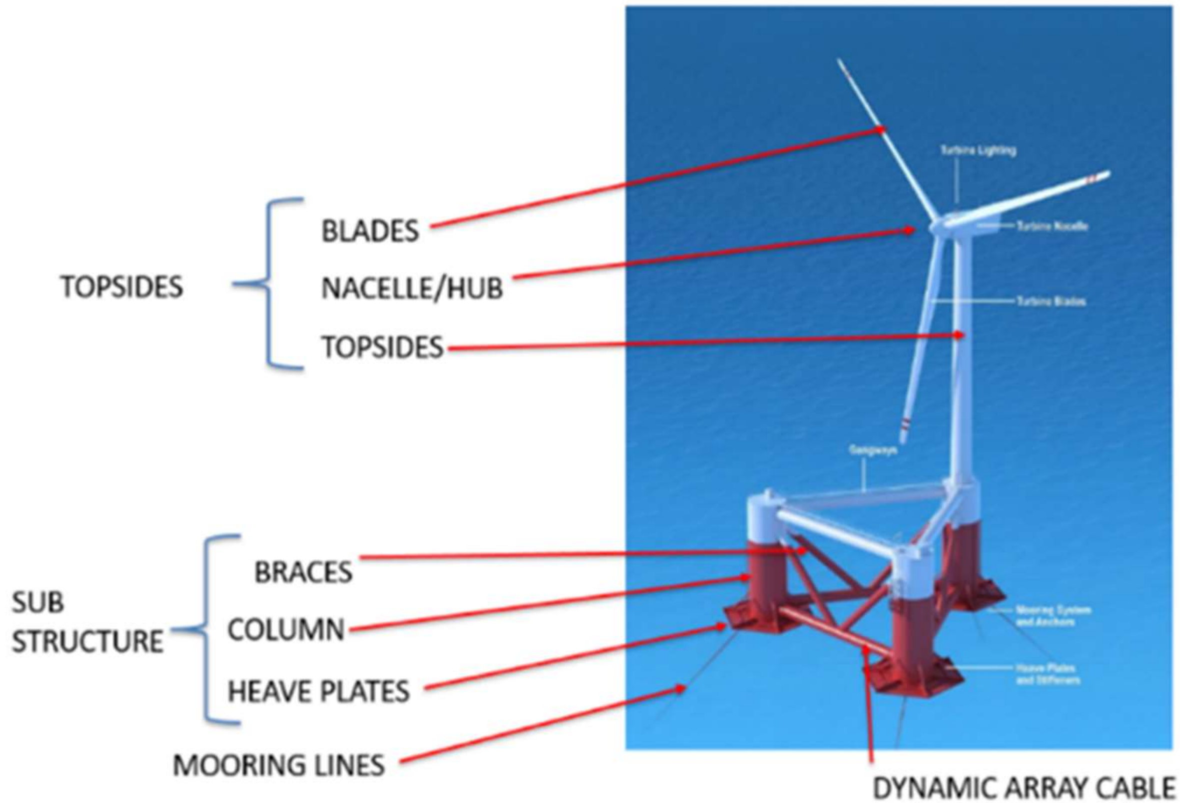
Offshore wind options, ref[1]



Deployed FOWT
- 2 barges
- 7 spars
- 9 semi subs.
- 0 TLPs

Fixed bottom
- 4000+ Monopiles (limit 50m)
- 300+ Jackets (limit 75m)

Principal parts of FOWT, ref[2]



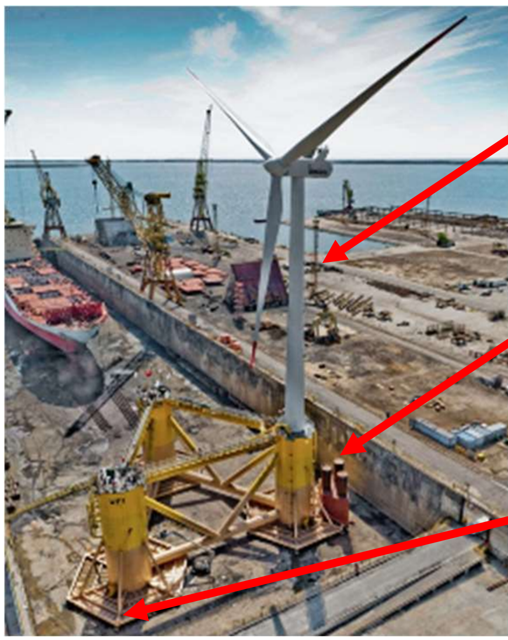
What is slowing growth of FOWT deployment

- No fixed design
- High capital cost
- High maintenance cost
- No mass production
- Limited number of large onshore cranes for fit out
- Lack of shipyard facilities for substructure fabrication
- Lack of ports with land area, strong quays, water depth for fit out

This presentation is about steel semi submersibles

SUBSTRUCTURE CONSTRUCTED IN DRY DOCKS

Small Semi submersible, ref[2]

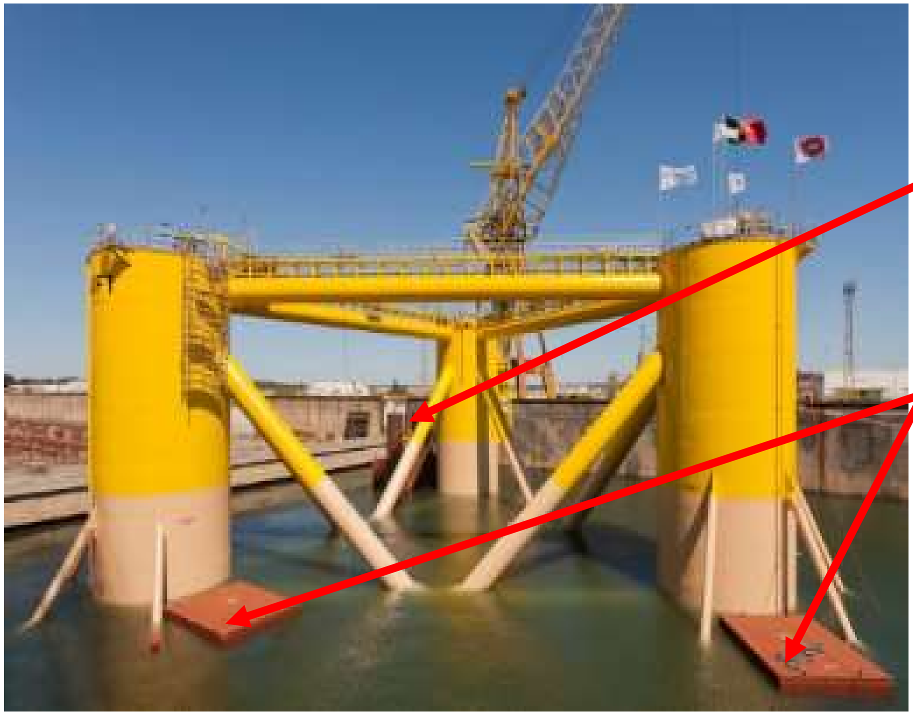


Turbine in corner, not central, to maximise onshore crane capacity.

Large temporary buoyancy tanks at the turbine corner

Note very large diameter of the heave plates
Which increases the width and effects dock width
and channel access to the open sea

Medium Semi submersible, ref[2]



Large temporary buoyancy tanks at the turbine corner

Small temporary buoyancy tanks at the other corner

FOWT too big to fit turbine in the dock

Drydock advantages

- Semi submersible barge not required
- No SPMT required

Drydock disadvantages

- Costly to hire
- Float out draft limitation, probably need to add temporary buoyancy
- Limited by width of dock gate
- Limited crane capacity to install turbine

SUBSTRUCTURE CONSTRUCTED ON LOADOUT QUAY

Loadout by SPMT, ref[2]

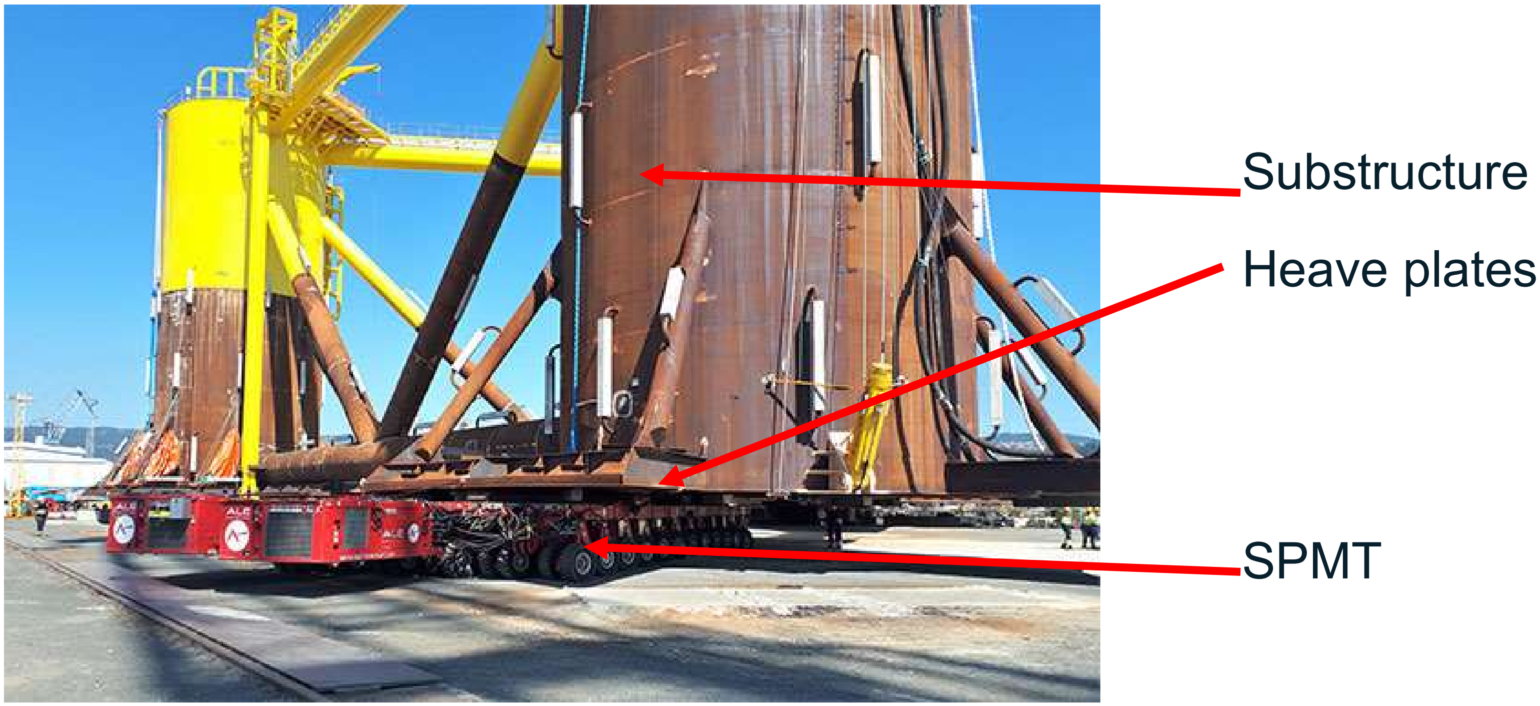
HTV/
Submersible
barge

Substructure,
With turbine
in one corner

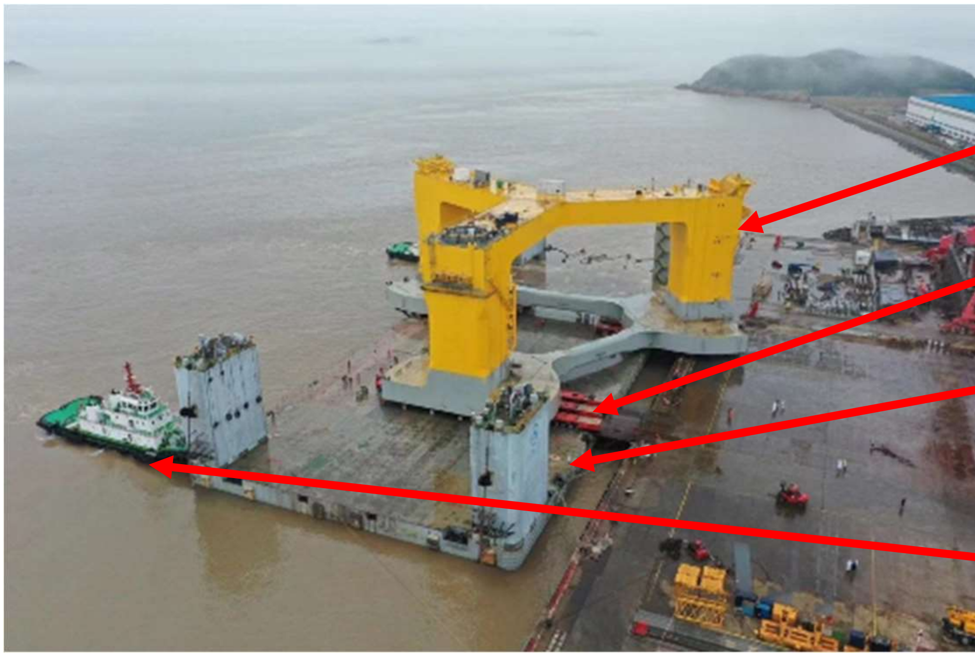
SPMT

Heave plates

SPMT, ref[2]



Loadout by SPMT, ref[3]



Substructure

SPMT Trailers

Submersible Barge

Harbour Tug

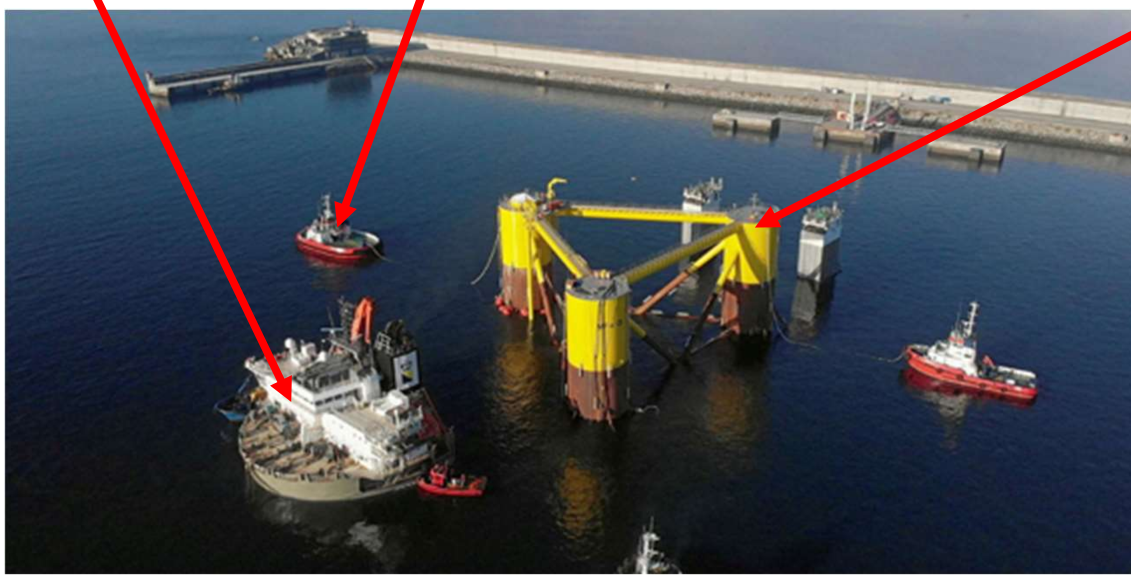
Loadout by SPMT, ref[3]

Semi submersible float off, ref[2]

Submersible Heavy Transport Vessel

Harbour Tug

Substructure Floatoff



Loadout quay advantages

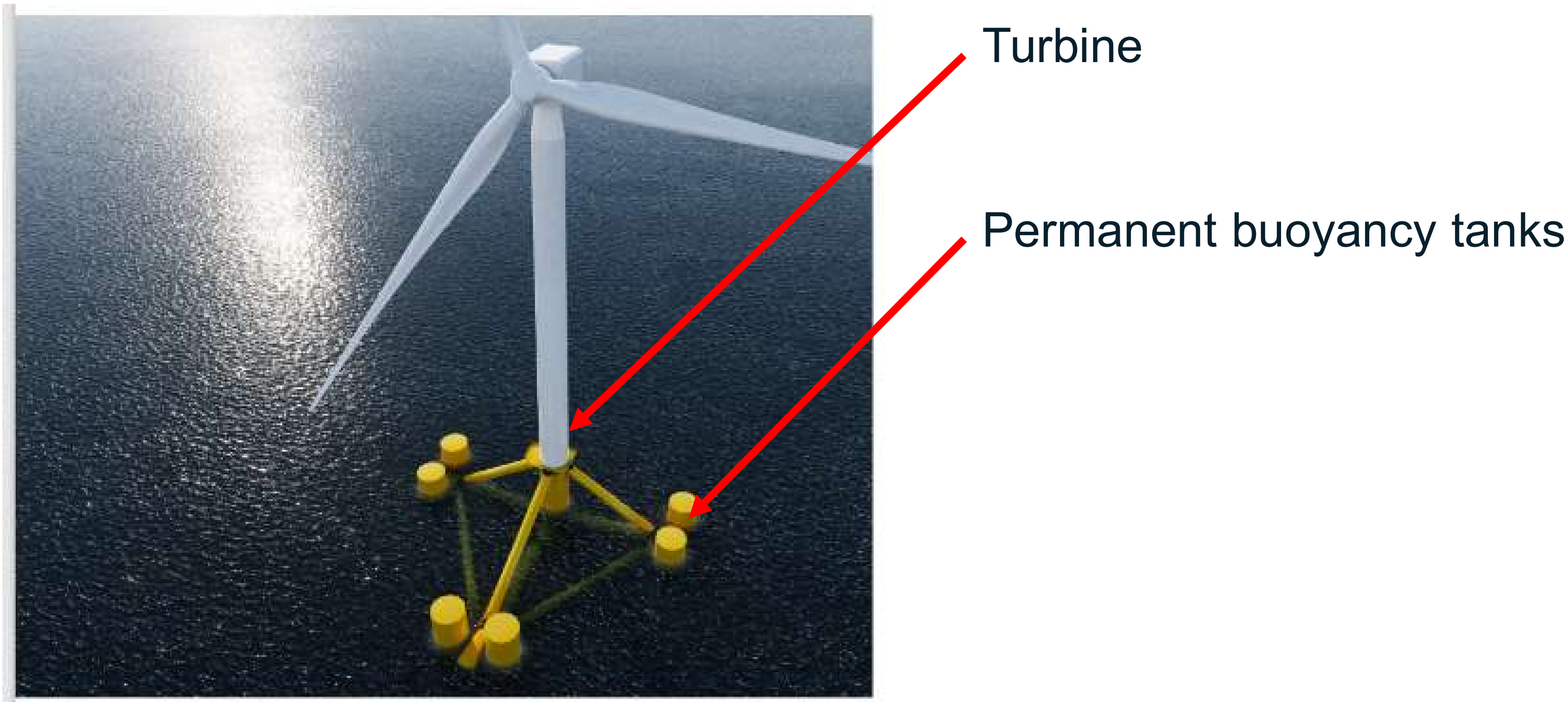
- Uses existing shipyard facilities
- Technique is well understood

Loadout quay disadvantages

- Semi submersible barge is required
- SPMT required

DESIGN FOR MASS PRODUCTION

Tetra Semi Submersible, ref[7]



Tetra Sea Tranport, ref[7]

Sea transport
of substructure
components

Tetra construction, ref[7]

Fast and robust assembly takes place in the port of embarkation. Port requirements are limited to a flat, level area at quayside for component delivery and assembly.

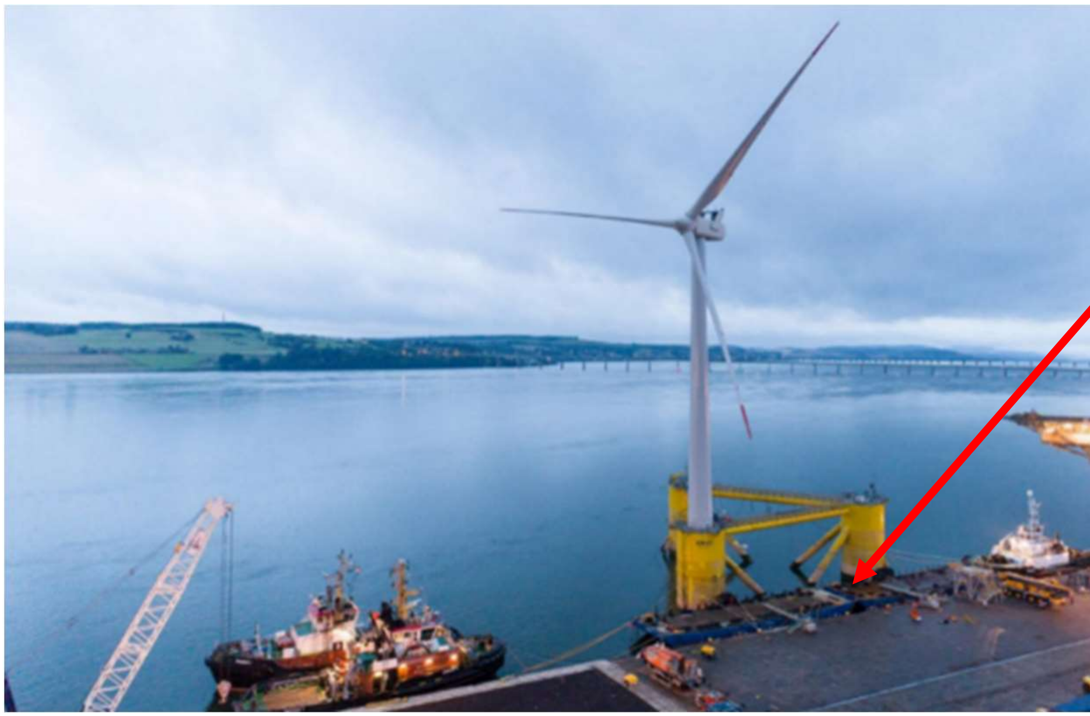
NACELLE AND BLADE - FIT OUT QUAY

107m long Haliade-X 12 MW turbine blade, ref [6]

The nacelle of GE’s Haliade-X 12 MW, ref[6]

The tower of GE's Haliade-X 12 MW, ref[6]

Spacer barge, ref[2]



Spacer Barge To Keep Semi Submersible Off The Fit Out Quay

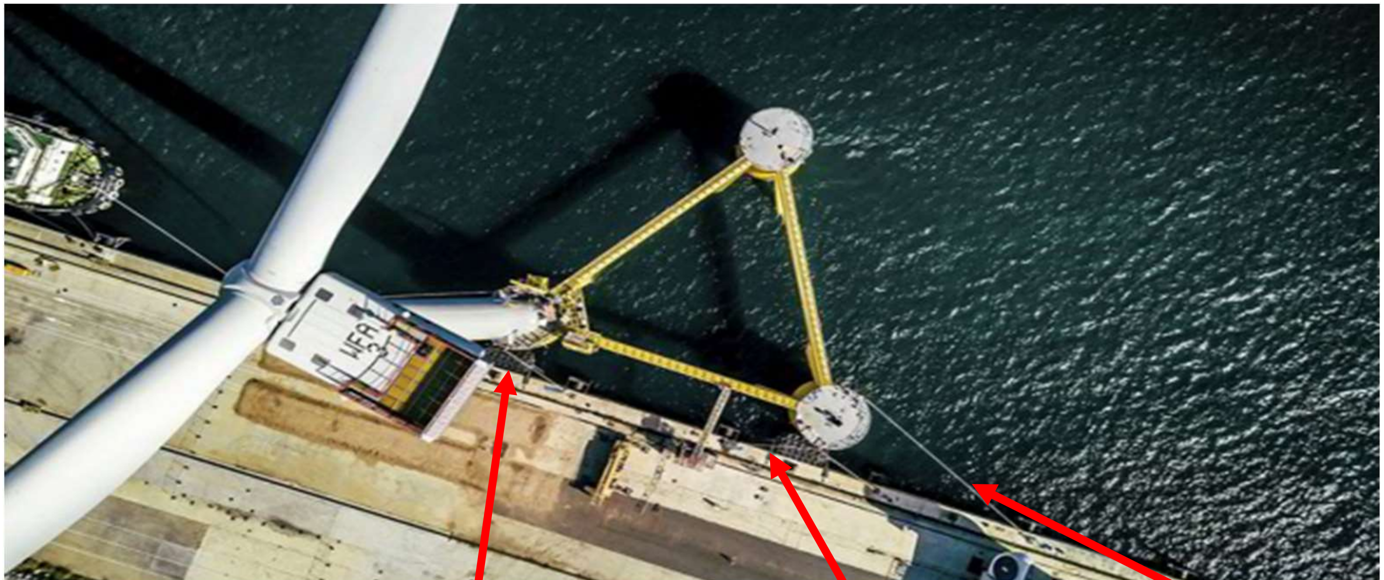
Note Underwater Heave Plates Mean Large Fenders Or Spacer Barge Is Required

Fenders at fit out, ref[2]

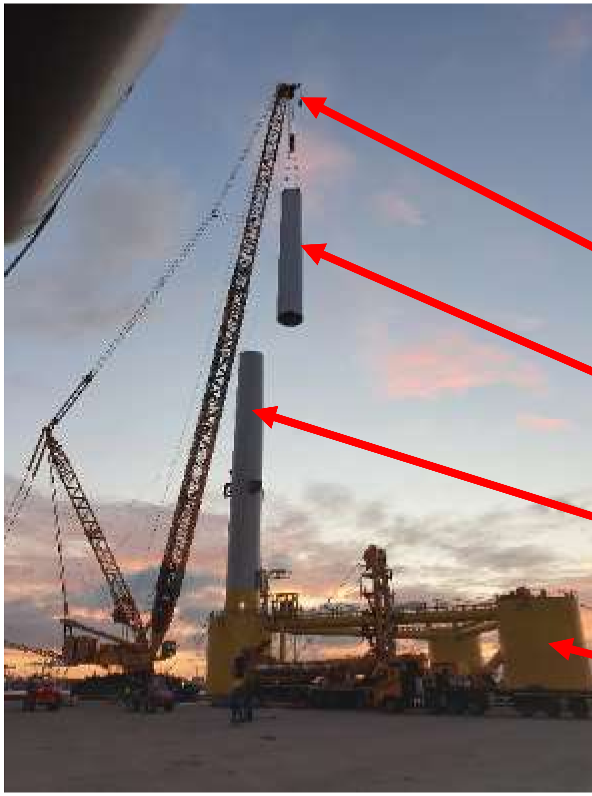
Fenders To Keep Semi Submersible Off The Fit Out Quay

Mooring Lines

Fit out Quay, ref[2]



Fenders Breasting Lines Mooring Lines



Lifting tower Sections by onshore crane at the Fit out quay Ref[2]

Large onshore crane

Upper tower

Lower tower

Substructure

Lifting nacelle by onshore crane at the fit out quay, ref[2]

Large onshore crane

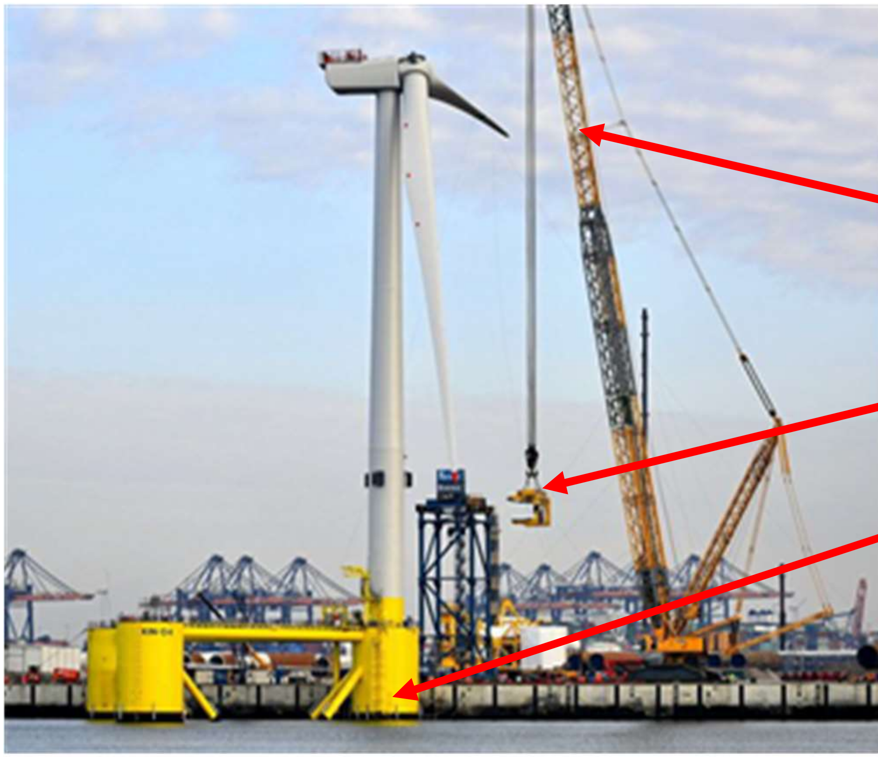
Nacelle

Substructure

Lifting nacelle by onshore crane at the fit out quay, ref[2]

People needed to make the connection between nacelle and tower

Lifting blades by onshore crane at the fit out quay, Ref[2]



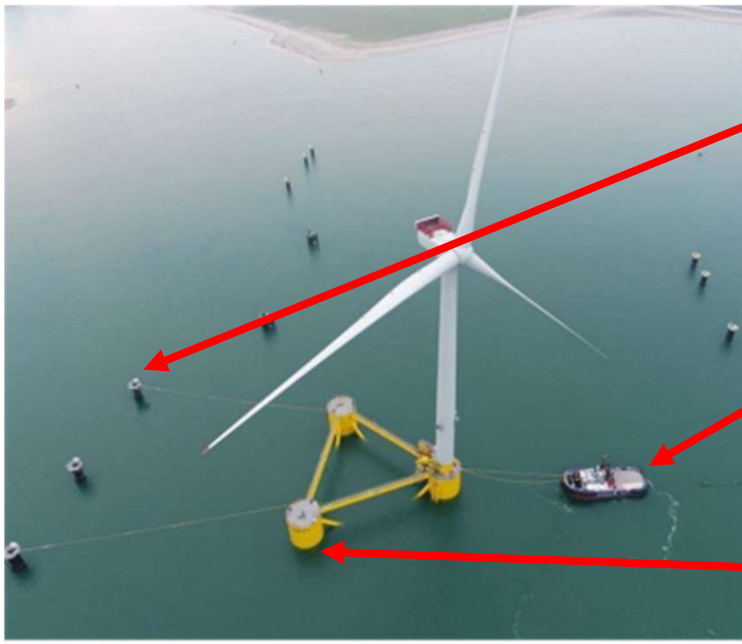
Large onshore crane

Blade handling tool

Substructure

Lifting blades by onshore crane at the fit out quay, Ref[2]

Wet storage, ref[2]



Temporary
Mooring
Piles

Harbour Tug

FOWT

CONCLUSION

Many ports will need to be upgraded in order to accommodate floating wind projects, ref[3], but facilities will need to see a reliable sequence of projects and the prospect of significant future work before they consider investing in the work required. Project-based upgrades that can deliver the required capabilities on a temporary basis may be preferred, ref[4]

Due to their size, large real estate areas, with ground reinforcement, plus with good maritime access and sufficient ground capacity will be needed.

For loadout from a quay is the current preferred option for fabrication

For fit out quays with very large onshore cranes are required

THANK YOU FOR YOUR ATTENTION

ANY QUESTIONS

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ABBREVIATIONS

FOWT	floating offshore wind turbine
CD	chart datum
SPMT	self propelled modular transporter (trailer)

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Questions

Q1. Which are the top three factors which could help reducing costs the most in the near future?

Reply1. The factors that would reduce cost are:

a. Mass production. This may need to be done in low cost centres for semi substructures, such the Far East or the Middle East

b. Ports close to the offshore wind farms need to be developed with sufficient water depth (12 to 15m), and a strong quay (15t/m2)

c. Need more large onshore cranes.

Questions

Q2. Are there any access ports in the UK with 20 m water depth ?

Reply 2. There are some deep water ports on the UK that are offering facilities for semi submersible fit out which require 12 to 15m water depth at the fit out quay:

- Cromarty Firth (Invergordon with Nigg fabricators)
- Kishorn
- Hunterston
- Scapa Flow
- Ardesier, with upgrades and dredging
- Seaton, Hartlepool, with quay upgrades and some dredging
- Belfast, with dredging
- Port Talbot

Questions

Q3. Very interesting thank you. Is increased motions, compared to fixed, a new challenge for materials and or fatigue design?

Reply 3. Fatigue during ocean transport is low compared to the in-place condition However the fatigue issues in operation will lead to heavier or more expensive fabrication of the substructure.