
# Floating Wind Turbines – Construction and Installation Considerations

# Floating Wind Turbines – Construction and Installation Considerations

by

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# INDEX

# Types of floating wind

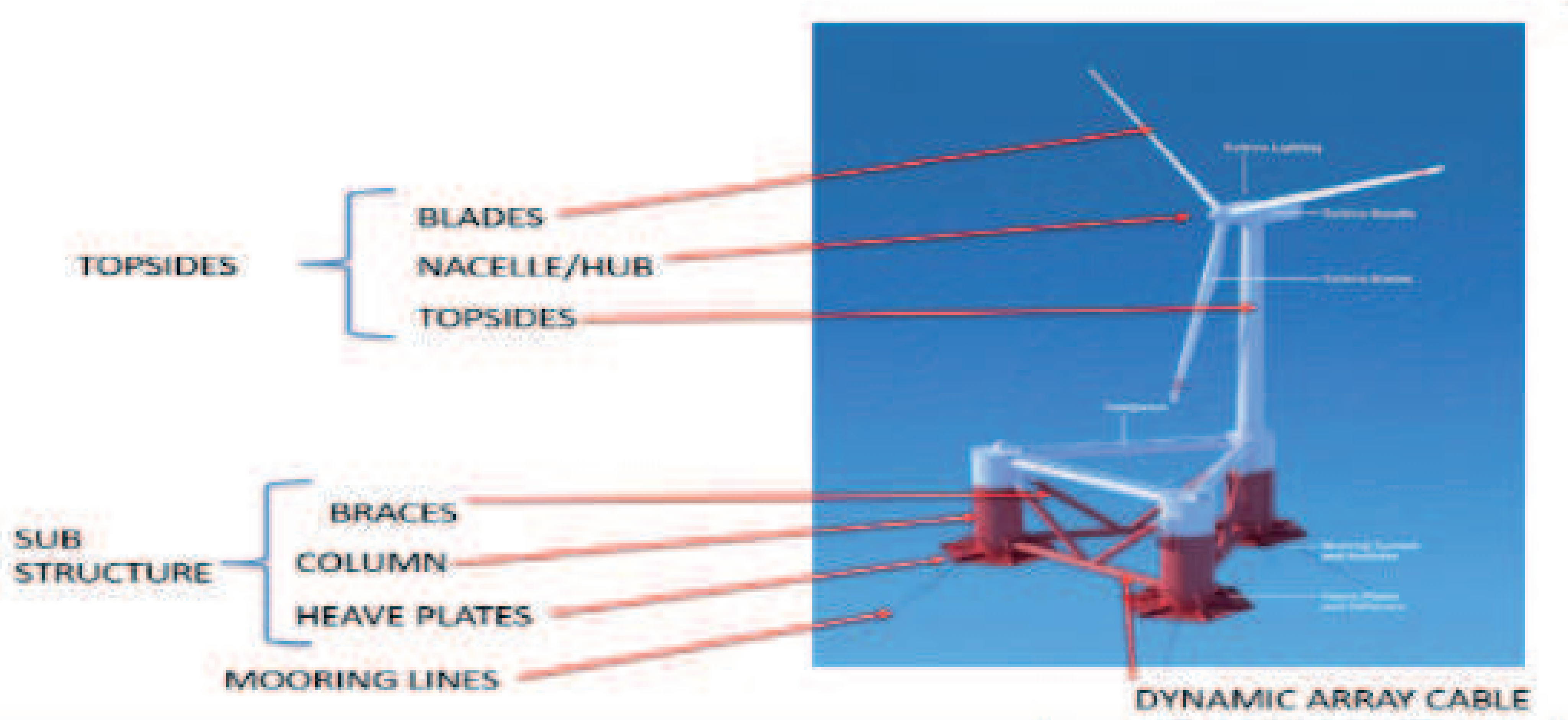
# FLOATING WIND TYPES, [6] (CREDIT DNV)

# FLOATING WIND OPERATING AND IN CONSTRUCTION

| Name | Type | Sub Structure Built | Sub Structure Material | Turbine Outfitting | Final location | Status |
|---|---|---|---|---|---|---|
| Wind float | Semi sub | Spain | Steel | Portugal | Portugal | Operating (3 * 8.4MW) |
| Wind float | Semi-sub | Spain | Steel | Netherlands | UK Kincardine | Operating (5 * 9.6 MW) |
| Hywind Scotland | Spar | Spain | Steel | Norway | UK Hywind | Operating (5 * 6MW) |
| Hywind Tampen | Spar | Norway | Concrete | Norway | Norway oil and Gas | Operating (11 * 8.8MW) |
| Barge | Damping pool | France | Concrete | France | France | Demo (1 * 2MW) |
| Barge | Damping pool | Japan | Steel | Japan | Japan | Demo (1 * 3MW) |
| Suspended ballast Spar | Stiesdal TetraSpar | Denmark | Steel | Denmark | Norway | Demo (1* 3.6MW) |
| Grande Large | TLP | France | Steel | France | France | Installed (3*8MW) |
| Wison | Semi-sub | China | China | China | China | Connected (1*5MW) |

| | | | | | | |
|---|---|---|---|---|---|---|
| *BW Ideol* | *Damping pool* | *France* | *Steel* | *France* | *France EolMed* | *in construction (3* 10MW)* |
| *Wind float* | *Semi-sub* | *France* | *Steel* | *France* | *France Golfe du Lion* | *in construction (3* 10MW)* |

# MAIN COMPONENTS OF FLOATING WIND [7] (CREDIT PRINCIPLE POWER)



# EXISTING UK FLOATING WIND CAPABILITIES

| Item | Existing UK production | Comment |
|---|---|---|
| | | |
| Towers | None | UK does not produce the required steel |
| Blades | Isle of Wight. Teeside | Restrained by high inflation, increased turbine size |
| Nacelle | None | Unlikely investment |
| Floating substructures | None | Port Talbot, Ardesier possible site for construction |
| Cables | limited | no HVDC cable manufacture in UK |
| Installation Vessels | None | Installation vessels overseas constructed and operated |


Steel Semi Submersible[7]


Concrete Damping Barge[14]


Steel Spar[15],[16]


Steel TLP[11]


Steel Submerged Ballast[12]


Concrete Single Point Mooring[13]

# Job creation

# Industrial Growth from Floating Wind

In the UK it is estimated that 10,000 new jobs are created in offshore wind annually but requires investment in:

- Develop Construction ports
- Fit out ports to be modified
- Doubling Research and development

# CELTIC SEA

New research from the Crown Estate reveals up to 5,300 new jobs could be created from the development of new floating wind farms in the Celtic Sea. The research also estimates a £1.4bn economic boost could be generated from the sites. The Celtic Sea Blueprint has determined the minimum supply chain and infrastructure requirements for the trio, announced by the Crown Estate in December 2023. It also examined the gaps, such as ports deep enough for handling the giant turbines, vessels to service the sites, and export cables to transport electricity to land.

Three wind farms off the south-west coast of England are expected to generate up to 4.5GW of electricity. The windfarms will require 260-plus turbines on a floating platform. More than 1000 anchors to secure the floating machines to the seabed, with at least 300km of mooring lines will also be needed. Nearly 900km of cables.

# Chains, anchors, AHTS

# CHAINS, [6] (CREDIT ACTEON)

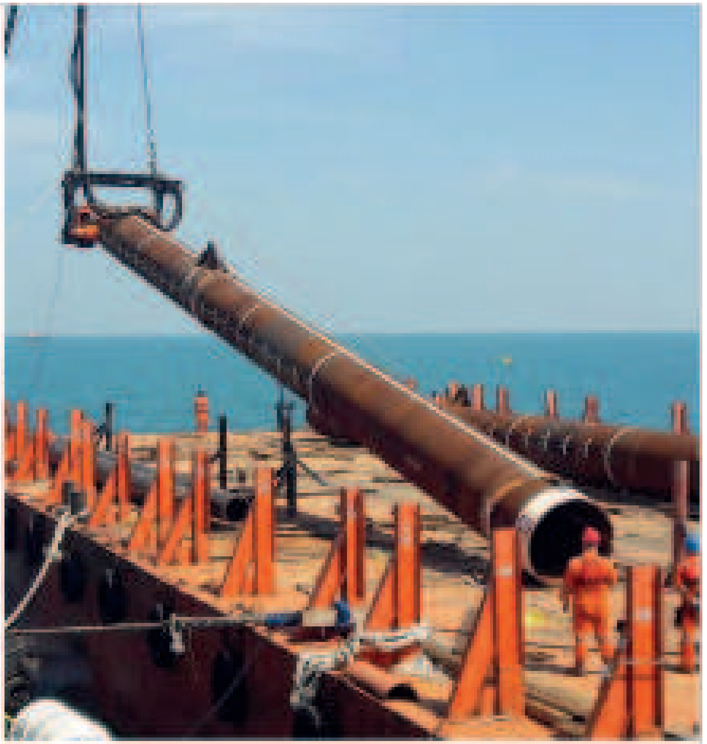
THE CHALLENGES
In floating wind, the mooring chain is 220mm in diameter; each link weighs 946kg. Loading and discharging may not be possible with ships' cranes, and load-bearing surface capability on the quayside and in-port storage areas, must be significantly higher.

Offshore, the chain is so heavy that it cannot be winched onto an installation vessel. Instead, it must be lifted. The current fleet of anchor handling vessels few of the fleet today can accommodate this larger chain size. The vessels' chain lockers also cannot store the chain so it must be loaded onto the deck.

# ANCHORS, [6], [7] (CREDIT ACTEON)

However, the handling challenge comes from anchors needed for station keeping for floating wind structures.
Suction piles might be 4 to 6 m in diameter and 15 to 20 m in length
Driven piles can be 2.0-3.0 meters in diameter and up to 20 to 30 m in length, again difficult to transport and store.





# Large AHV [6] (Credit Acteon)

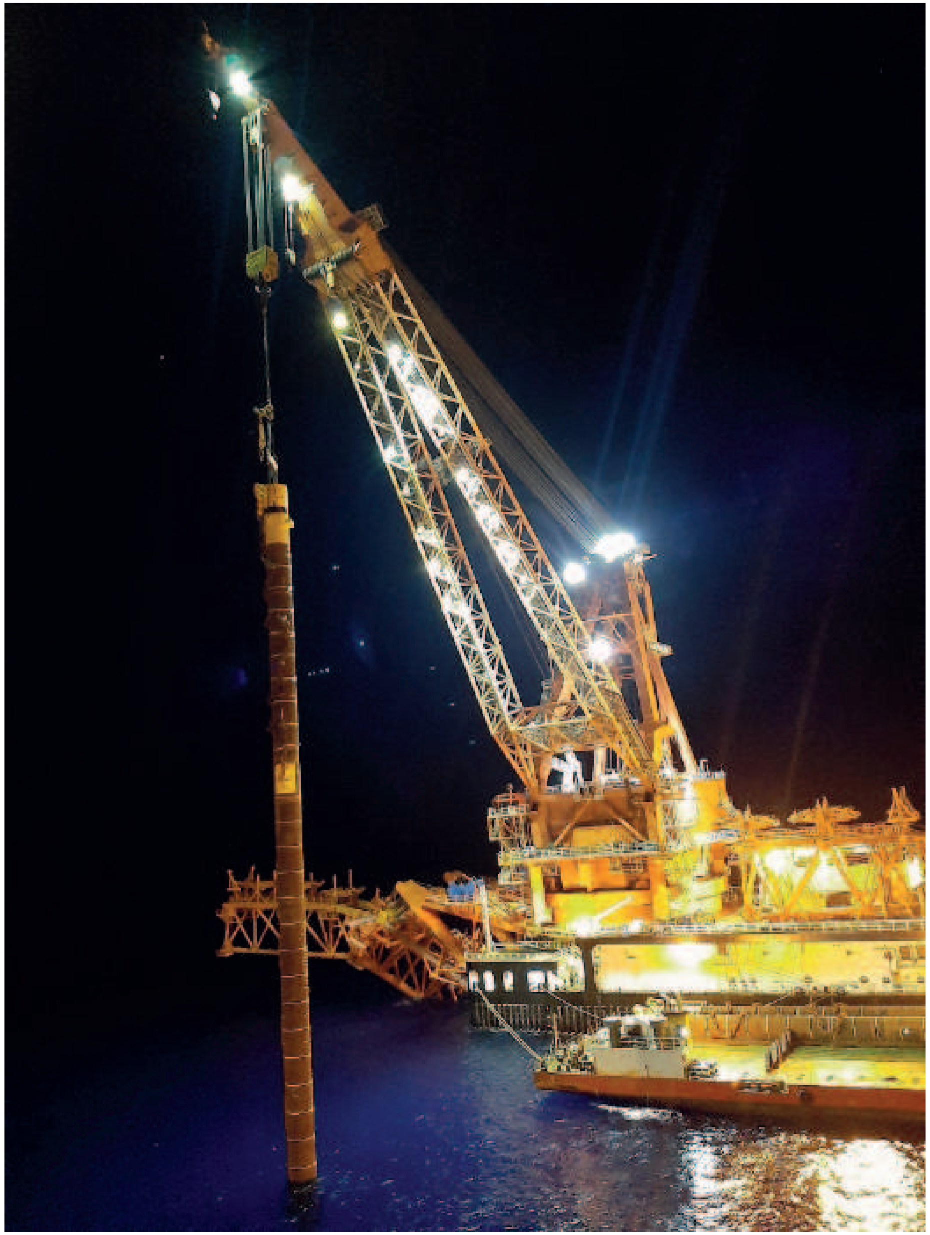
# SUCTION PILE [18] (CREDIT SPT)

# CONSTRUCTION MITIGATION

# AIR BUBBLE CURTAIN

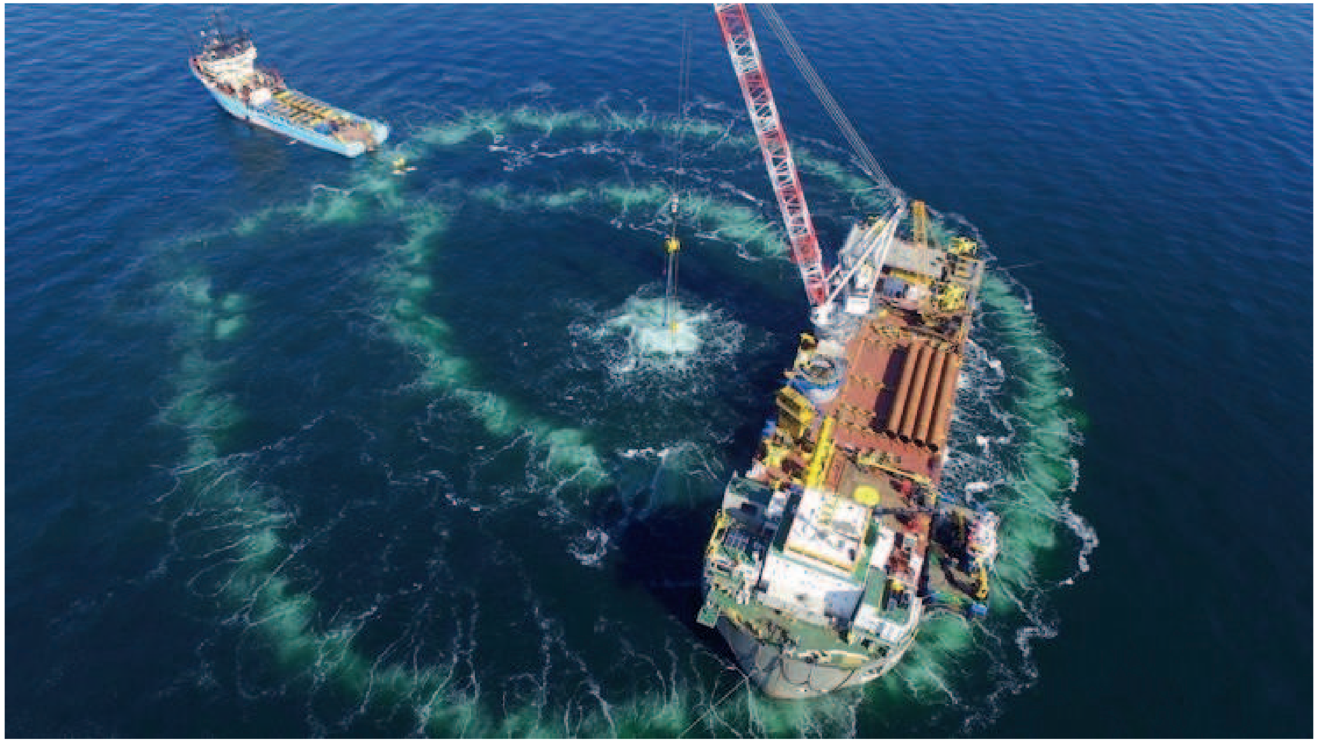
# Driven pile, [6] (Credit Acteon)

**Marine pile driving at large construction sites produces considerable noise and high pressure underwater.** These conditions can be lethal to fish and can harm marine mammals. To reduce sub-aquatic sounds generated by work sites, projects now employ air bubble curtains. **These air bubble curtains** provide an effective barrier to sound propagating through water, because of the difference in density between air and water.



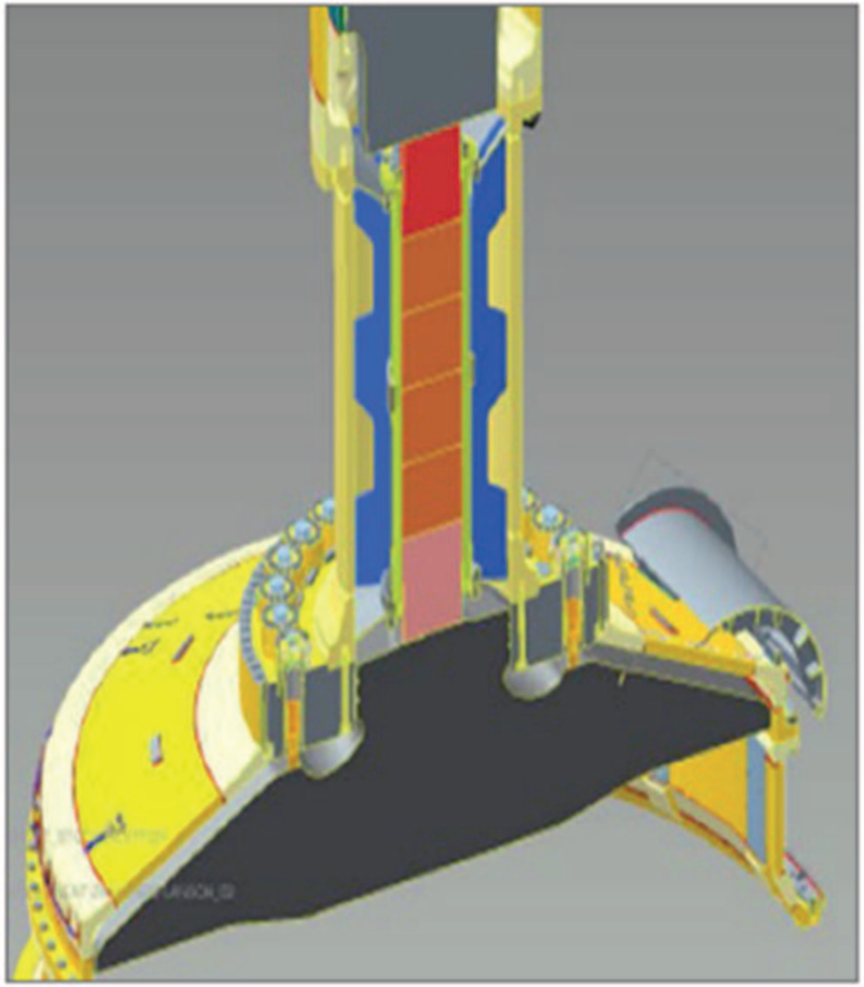
# MITIGATION - Bubble curtain [6] (Credit Acteon)

**Multiple lines of air bubble curtains** can increase the efficiency of the attenuating effects of the bubbles. A series of Bubble Tubing® rings around the pile generates denser bubble curtains. Bubble Curtains are a potential strategy as a mitigation measure to address acoustic impacts to marine mammals in the Noise Strategy Roadmap.



# NOISE REDUCTION HAMMER [20] (CREDIT MENCK)

Pile Hammer
Noise
Reduction Unit
(credit Menck)

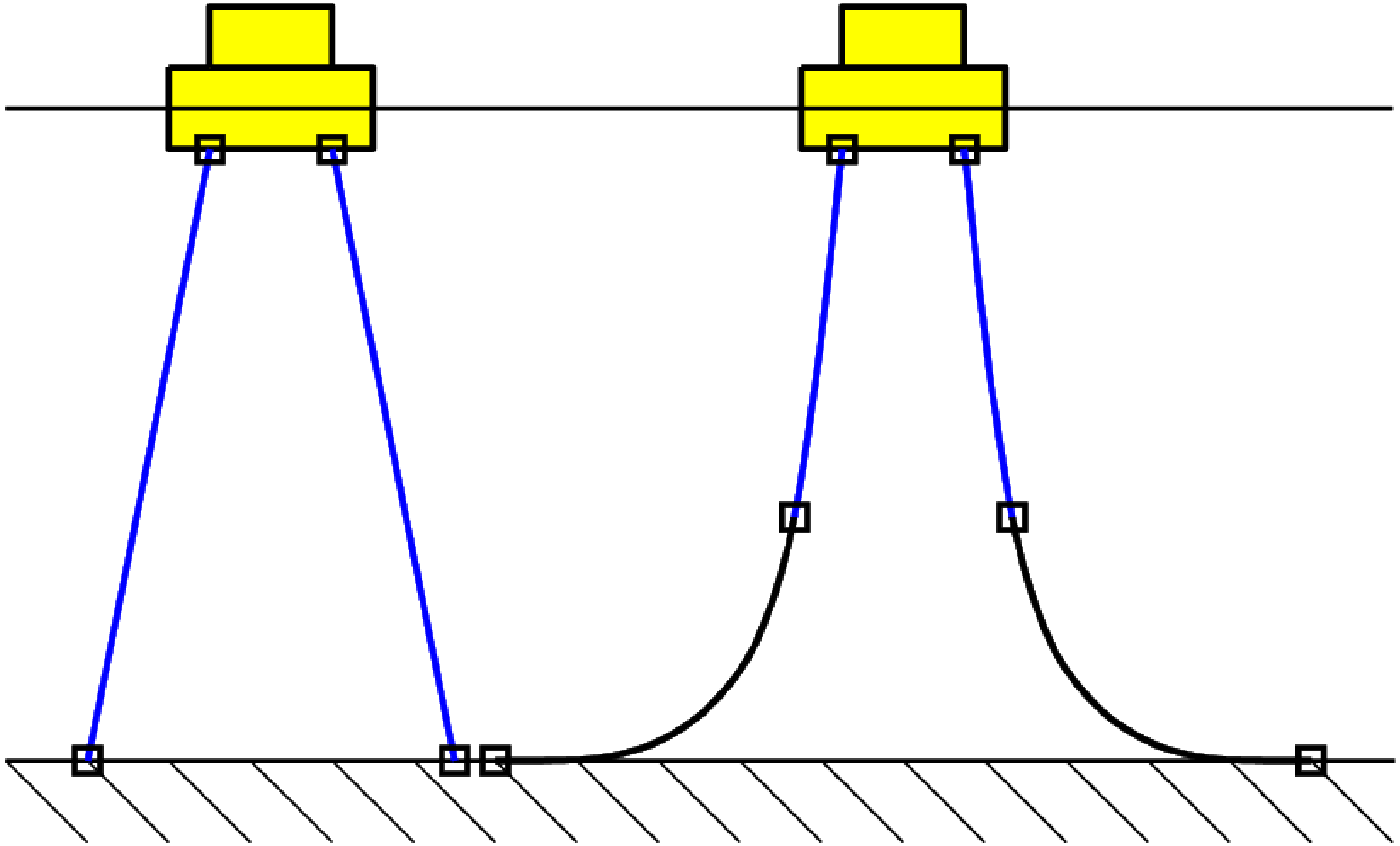


The EQ-Piling® technology is an innovative pile driving solution that uses the **deceleration of a large water column** to deliver a long-duration blow to the pile. The technology reduces noise at the source during installation without the need for hands on deck, ensuring a safe and environmentally friendly installation.

# TAUT MOORING

# TAUT MOORING VS CATENARY MOORING [8]

**Taut mooring**
**- no chain on seabed**
**- reduced area for mooring**



# HYWIND TAMPEN

# CONCRETE SUBSTRUCTURES IN DRY DOCK [15] (CREDIT EQUINOR)

# SOLID BALLASTING, TOPPED WITH WATER [15] (CREDIT EQUINOR)

# LAYDOWN AREA [15],[17] (CREDIT EQUINOR)

# Substructures in wet storage [15],[17] (Credit Equinor)

# BLADE LIFTING [15],[17] (CREDIT EQUINOR)

## Fitting Blade. FOWT wet storage [15],[17] (Credit Equinor)

# TOW OUT. Large tug to pull, others for steering At least 3 tugs are required during the mooring up [15] (Credit Equinor)

# OFFSHORE NEXT TO OIL PLATFORM, [15] (CREDIT EQUINOR)

# La Grande Large TLP

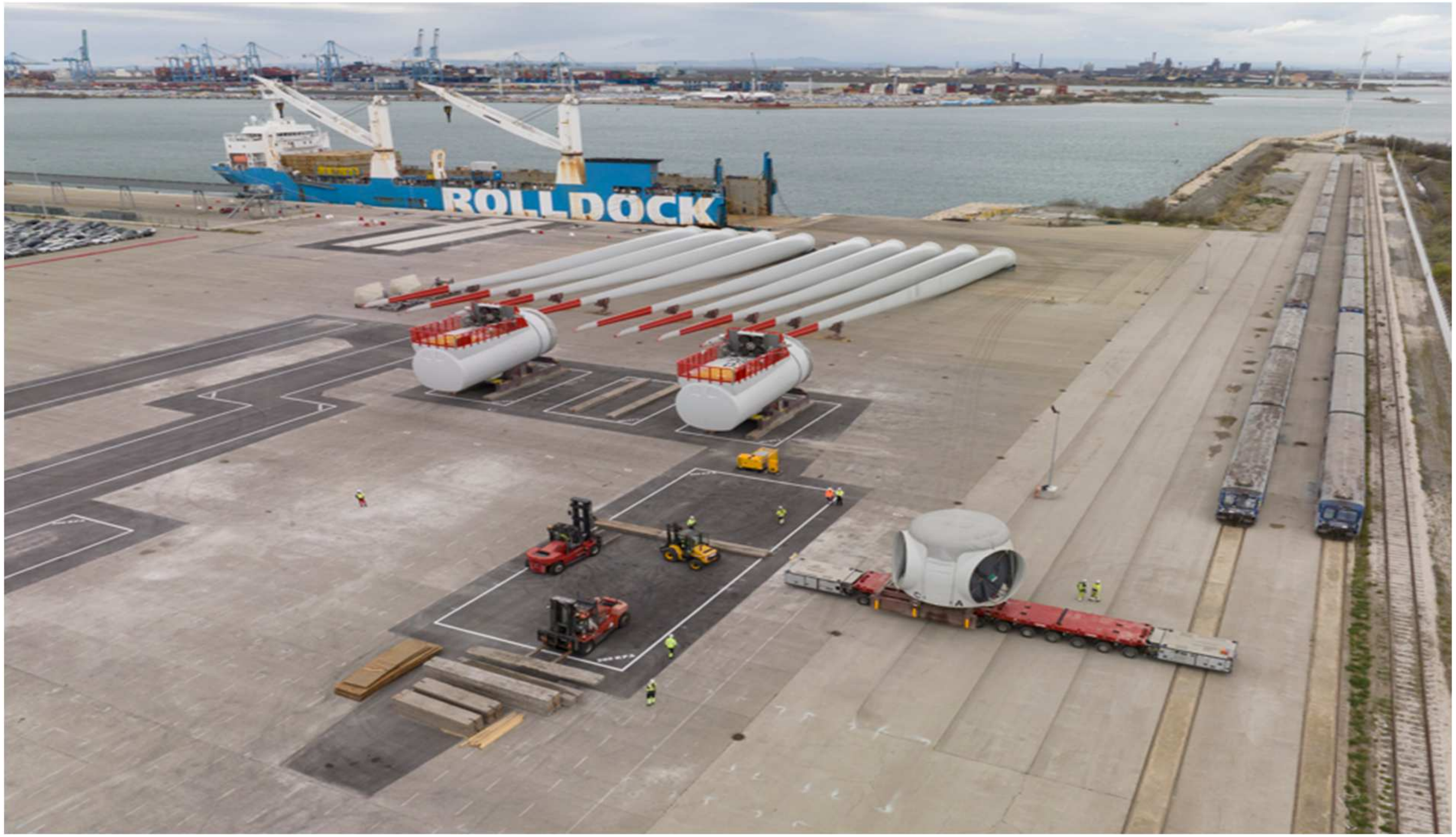
# LARGE AREA FOR CONSTRUCTION, [3], [4], [5] (CREDIT SBM)

# Submersible Barge Land to Sea [3], [4], [5] (Credit SBM)

# HARBOUR TUGS MOVE SUBSTRUCTURE [3], [4], [5] (CREDIT SBM)

# OFFLOADING BLADES AT FIT OUT QUAY [1], [2] (CREDIT SBM)

# LAY DOWN TOPSIDE COMPONENTS [1], [2], [3], [4], [5] (CREDIT SBM)



# BIG CRANES LIFT TOWER FROM FIT OUT QUAY [3], [4], [5]

# Big cranes at the fit out quay [3], [4], [5] (Credit SBM)

# INSHORE CABLE LAYING [3], [4], [5] (CREDIT SBM)

# Tow Out [3], [4], [5] (Credit SBM)

# INSTALLATION[3], [4], [5] (CREDIT SBM)

Float-off | Provence Grand Large by SBM Offshore - YouTube

# INSTALLATION[3], [4], [5] (CREDIT SBM)

# FUTURE OF JOBS

Floating wind, which uses turbines located at sea but not attached to the ocean floor. Floating wind has the potential to make a huge contribution to filling the installed capacity gap in renewables and represents a game changer for the energy sector globally. “Floating wind” has the potential to make a huge contribution to filling the wind energy gap and represents a game changer for the energy sector globally.

The concept is fairly simple: floating wind uses turbines located at sea but not drilled into the ocean floor to generate clean electricity. The floating wind turbines are towed out to sea after being erected at sheltered ports. The possibility to float turbines regardless of sea depth is a game changer in terms of capacity, and the potential for standardised manufacturing (compared to offshore fixed-bottom wind power) will reduce cost.

Floating wind has several key advantages compared to traditional onshore or fixed-bottom wind parks. Onshore wind is often seen by local communities as an eyesore, and planning permission for new sites is becoming increasingly difficult to obtain. Bottom-fixed offshore wind sites are limited by both water depth and existing maritime infrastructure, meaning turbines are limited to water depths of up to 60 metres. Floating wind on the other hand can be installed regardless of sea depth, opening up vast tracts of ocean which could be used for energy generation. It is estimated that floating wind has roughly double the potential capacity of bottom-fixed offshore wind, and this is only taking into account areas located up to 200 kilometres from shore. Floating wind can minimise effects on local communities and wildlife,

Floating wind could facilitate the standardised design and production of turbines, which could bring costs down dramatically. Currently, different soil types and different sea currents mean each offshore wind park needs to be designed separately, driving up capital expenditure costs significantly. Standardisation would reduce these upfront costs, and facilitate scale for production and maintenance, as well as the use of secondary materials, and recycling and reuse at the end of turbines' lives. This level of scale will be key to cost reduction.

As well as generating electricity the opportunity to leverage floating wind technology to produce green hydrogen (i.e. hydrogen produced using renewable energy) exists.

The outlook for jobs is also bright for floating wind. The oil and gas offshore sector has traditionally been a large employer in many regions across the world (e.g. North Sea, Gulf of Mexico, Persian Gulf). For years, workers trained in offshore oil and gas have developed skills and expertise in a challenging environment: these same skills are directly transferrable to floating wind, e.g. equipment inspections, staffing supply boats etc.

Ensuring a socially just energy transition is key to its social acceptance: floating wind can ensure that some of those hardest hit by the shrinking oil and gas sector will benefit directly from new jobs created by the scale-up of renewable energy. Floating wind will also bring local jobs: ports will need to be upgraded, turbine maintenance will be done locally, and production of turbines and support structures could also take place close to new wind farms. All of this will mean that local communities benefit not only from clean energy, but also from the economic benefits in its wake.

Obstacles ahead
The path ahead for floating wind is not obstacle-free, however. Floating wind remains a new technology, and not all investors are willing to bet on it. Costs remain higher than fixed-bottom wind currently, with high costs for cables and connection to the grid required. Indeed, in some situations, connecting to local grids may not be feasible, requiring alternative measures to bring energy to the shore, such as green hydrogen. Huge and highly developed port facilities will also be required to service turbines effectively, infrastructure which cannot be built overnight.

To jump start investment, subsidies will initially be required (unless carbon externalities are adequately priced for), until standardisation, learning and scale brings floating-wind costs below those of comparative methods.

There is a big task ahead to turn the surge in renewable power into a jobs for the UK. It may mean Government making investments that private sector companies on their own won’t necessarily make - the obvious example of this is investment in our ports. There needs to be a plan for the skilled workforce.

# Discussion

Despite this massive growth forecast, in floating wind there is only about 180MW deployed. **Significant barriers to full commercialisation still exist.** There are challenges that must be overcome before floating offshore wind will realise its full potential. These issues include:

- Floating wind **more expensive** than fixed-bottom wind
- Covid caused **supply chain** problems
- Recent high inflation = high interest rates = **higher cost of financing**

Most ports do not have the required area to deliver commercial scale floating offshore wind components without significant investment. To reduce draft of FOWT add temporary buoyancy.

Floating substructures (semi submersibles and barges only) are currently towed back to port for maintenance and repairs. However, this will not remain feasible or economical as wind turbines are located further offshore and the distance to O&M ports increases.

# Conclusions

Floating wind developers in the first instance will use existing ports, cranes, installation vessels.
There are moves to improve existing ports.
Large onshore cranes are being developed and deployed

Existing anchor handling tugs have been successful. But more are required.
Very large anchor handling tugs are under development, with more storage for chain
Different methods of using existing large crane vessels are being considered

THANK YOU FOR YOUR ATTENTION

ANY QUESTIONS

Email: ac1080@Exeter.ac.uk

# ABBREVIATIONS

FOWT = Floating offshore wind turbine
HVAC = High voltage alternating current
HVDC = High voltage direct current
KV = kilovolt
M = metre
MW = megawatt
O&M = operations and maintenance
T = (metric) tonne

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# Abstract

As the floating offshore wind turbine industry continues to develop and grow, the capabilities of established port facilities and installation vessel need to be assessed as to their ability to support the expanding construction and installation requirements. This presentation reviews current infrastructure requirements and projected changes to port facilities that may be required to support the floating offshore wind industry.

The capabilities of established shipyard facilities to support floating wind farms are assessed by evaluation of size of substructures, height of wind turbine with regards to the cranes for fitting of blades, distance to offshore site and offshore installation vessel characteristics.

The ability to assemble Floating Offshore Wind Turbines equipment in a port means minimising highly weather dependent operations such as offshore heavy lifts and assembly, saving time and costs and minimising safety risks for offshore workers.

The presentation will provide information on previous and current floating offshore wind turbines under construction. Information is included on

- Job Creation,
- Construction Mitigation
- People requirements.
- Physical requirements of constructing and installing floating wind turbines
- Training and industrial relations, considerations
- How to minimise effects on the environment with noise mitigation during pile driving and reducing the effect of damage to the seabed