

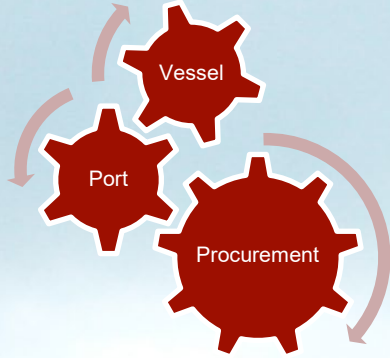
Subsea Expo 2024

Bharath Kumar – Global Technical Lead - Floating Wind

Scaling Floating Wind Demos to Commercial Scale



Supply Chain Constraints



The offshore floating wind sector is on the brink of significant expansion, shifting from demonstration to multi-GW commercial projects, accompanied by numerous challenges and supply chain constraints

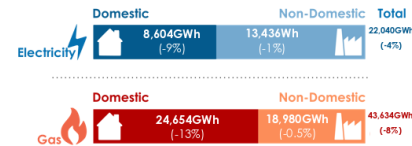
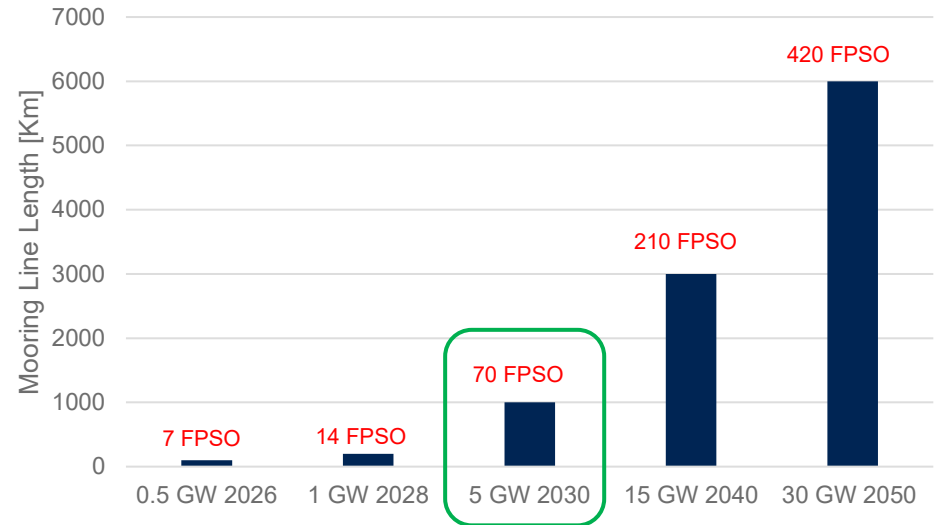
Installation Challenges



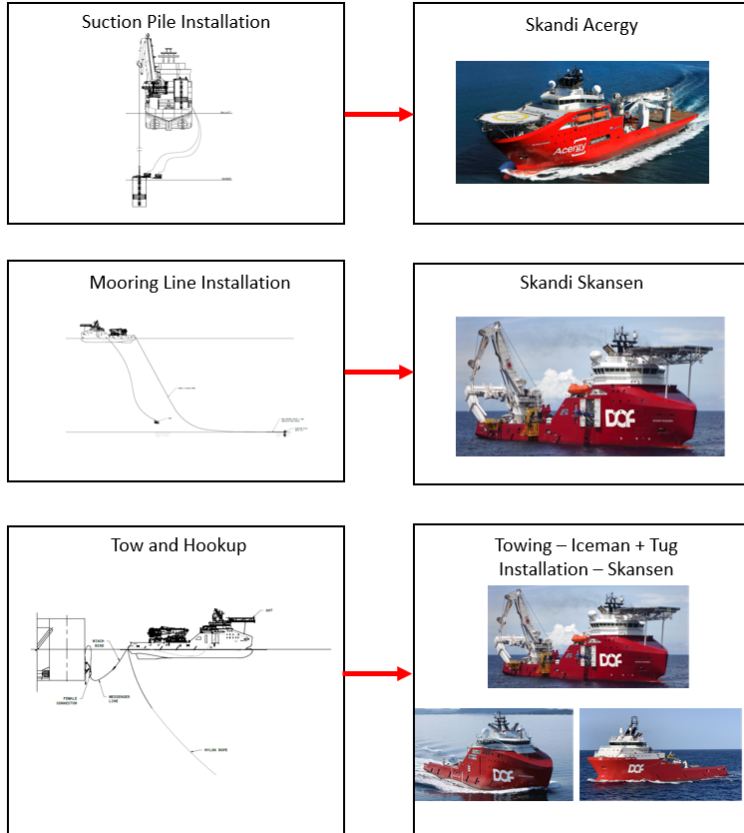
Mooring Procurement in Terms of Oil and Gas

- How much mooring is required?
 - UK Target for 2030 - 5GW
 - 5GW – 334 FWT x 15MW
 - 1 FWT – 3 x 1000m Mooring
 - 5GW – 1000Km of Mooring
- In terms of Oil & Gas
 - 1 x FPSO – 9 x 1.6Km Mooring
 - 5 GW - 1000Km – 70 FPSOs
- 175 FPSOs installed worldwide since 1977
- 65 FPSOs installed in West Africa and Northern Europe
- 5GW capacity can fulfill electricity needs for Scotland's domestic & non-domestic

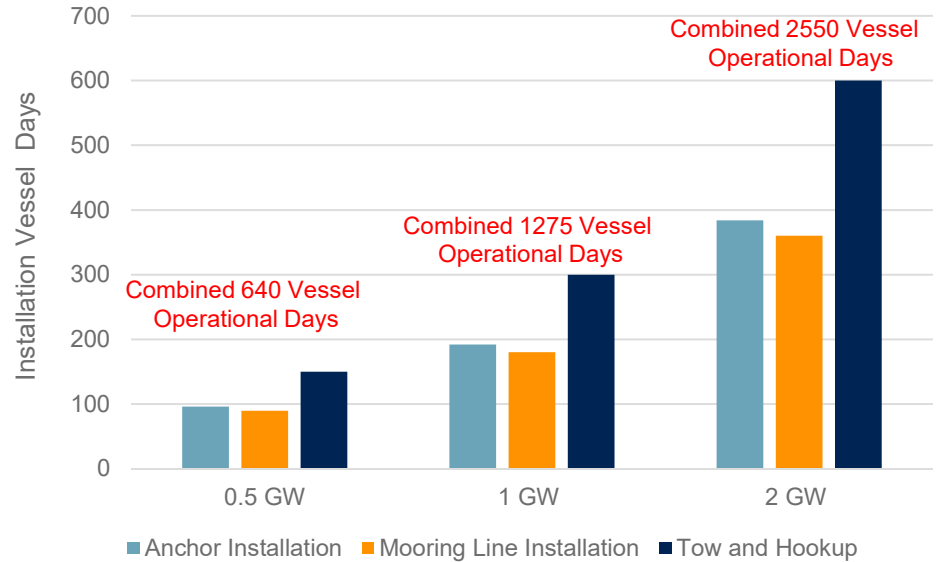
Floating Wind Ambition – UK



Installation Vessel Demand



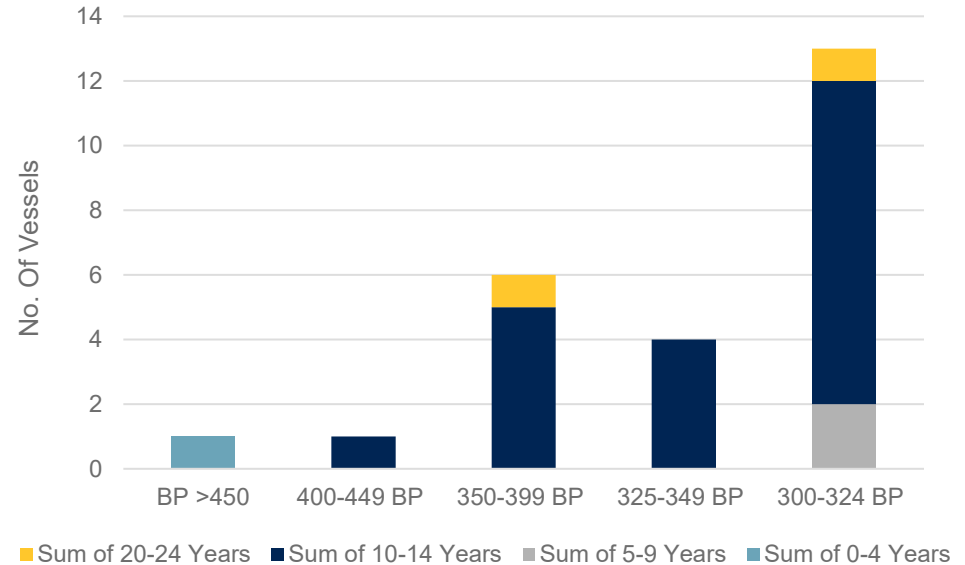
Installation Vessel Days



Installation Vessel Availability

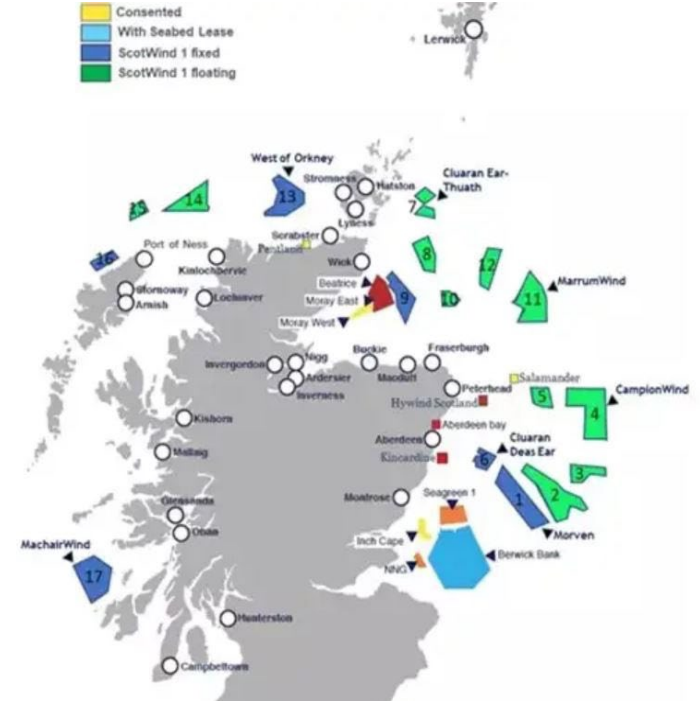
- CSV for pile installation
 - 1 x 400t Crane
 - 1 x 100t Crane
 - Deck > 2000m²
 - Accommodation > 75+
- AHV for mooring Installation
 - BP > 250t
 - Deck > 1000m²
 - Winch Storage - 5000m x 300mm dia rope
 - Chain Locker -1000m²
- Tow and Station Keeping Vessel
 - BP > 200t

Current AHTS Fleet Age and Capacity



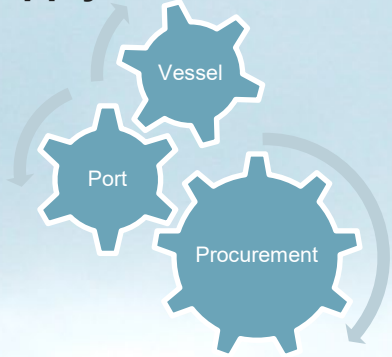
Requirement for Suitable Port

- Key Requirements for 500MW
 - 20 ha for lay down
 - 12 ha for wet storage
 - Quayside Length – 500m
 - Bearing Capacity – 40-100 t/m²
 - Water depth – 12-20m
- 25 Ports suitable for expansion
- Requires approx. £3.5bn Investment by 2030 to meet 5 GW of floating wind target



Source – Offshore Wind Scotland

Supply Chain Constraints



Installation Challenges



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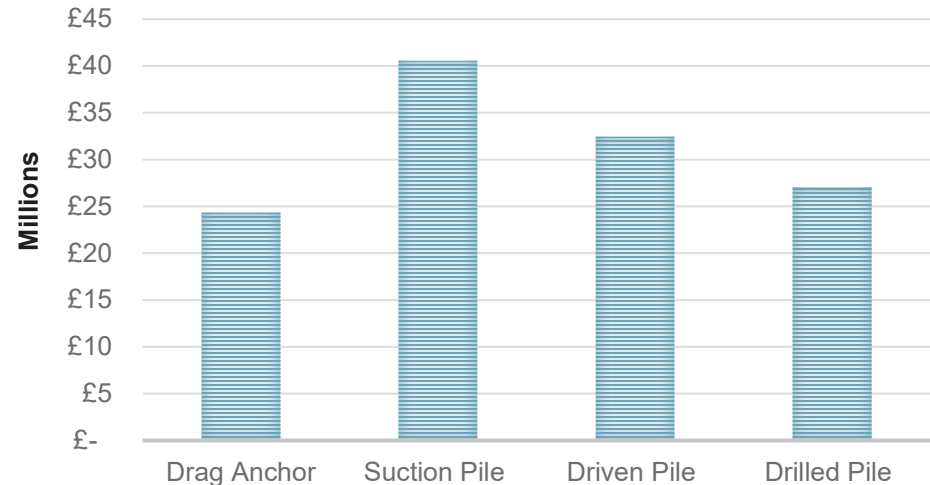


Seabed Challenge – Anchor Cost

- Drag Anchor and Driven Pile are more versatile compared to others
- Procurement cost of drag anchor is half of the suction pile
- Drilled piles are cost-effective compared to other pile types because of their smaller dimensions contributing to less weight
- Other anchors such as Gravity, SEPLA, VLA, and Torpedo anchors not included in the study
- All costs are based on building 1 GW floating wind farm

Anchor Type	Clay	Sand	Hard	Rock
Drag	3	3	2	0
Suction	3	1	0	0
Driven	3	2	3	0
Drilled & Grouted	1	1	3	3

Anchor suitability for different soil types [3-best, 2-better, 1-fair, 0-not suitable]

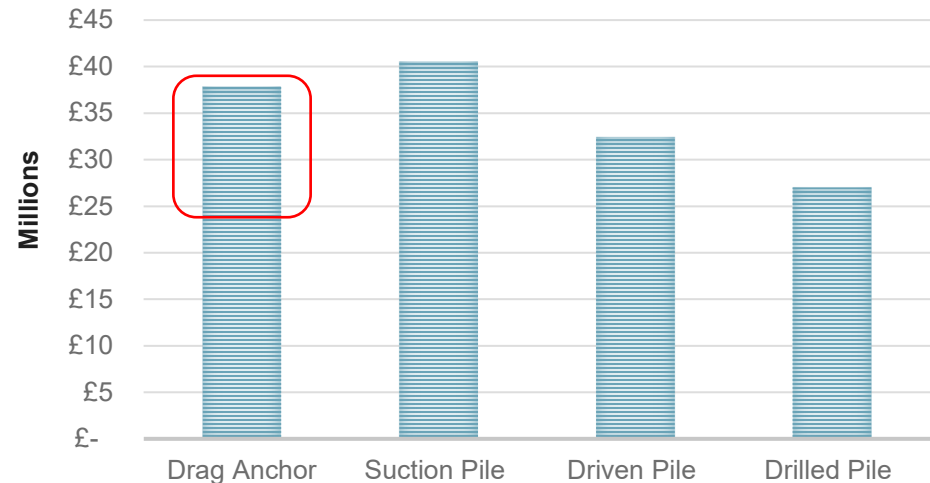


Seabed Challenge – Revised Anchor Cost

- A 3-leg drag anchor necessitates a larger mooring chain
- A 6-leg drag anchor mooring is practical but requires twice the quantity of anchors.
- Procuring a 6-leg drag anchor is slightly more cost-effective than procuring 3 suction piles
- Procuring drilled piles is cost-effective compared to all other types of anchors

Anchor Type	Clay	Sand	Hard	Rock
Drag	3	3	2	0
Suction	3	1	0	0
Driven	3	2	3	0
Drilled & Grouted	1	1	3	3

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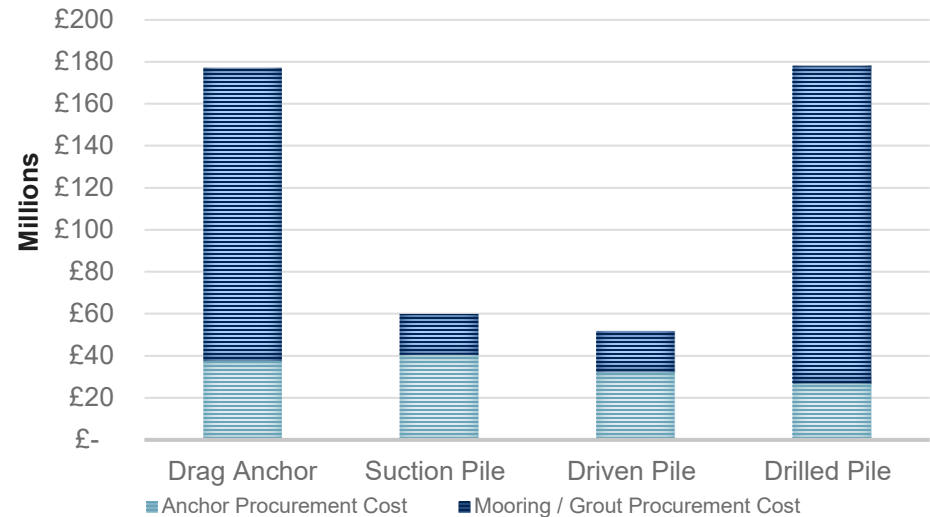


Seabed Challenge – Anchor + Mooring Cost

- Drag anchor system requires long anchor chain
- Drilled piles demand a substantial amount of grout, which is five times more expensive than the pile itself
- Piles utilize a shorter chain and long fibre rope, contributing to a reduced mooring procurement cost.

Anchor Type	Clay	Sand	Hard	Rock
Drag	3	3	2	0
Suction	3	1	0	0
Driven	3	2	3	0
Drilled & Grouted	1	1	3	3

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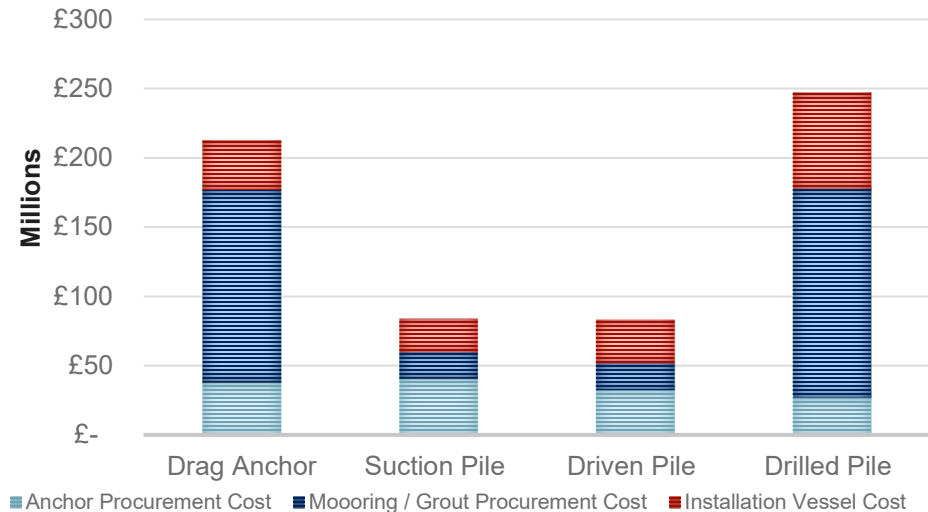


Seabed Challenge – Mooring + Installation

- Drilled pile takes 3 times longer than suction pile
- Re-setting of drag anchor could significantly increase schedule risk
- Suction piles are the quickest to install, followed by driven and drag anchor

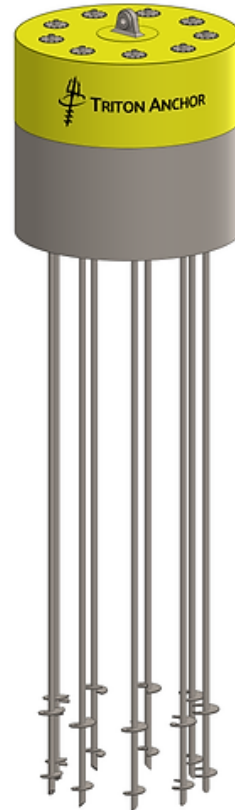
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Anchor suitability for different soil types [3-best, 2-better, 1-fair, 0-not suitable]



Seabed Challenge – Solutions

- Early assessment of Seabed
- Compliant 3-leg drag anchor system
- Reduce drag anchor test tensioning
 - Conduct tank tests to lower test tensioning needs.
 - Reduce the number of anchors for testing.
- Avoid drilled and grouted piles or explore alternatives
 - Triton Anchor
 - SCHOTTEL – Self-Drilling Groutless Anchors
- Enhance drilled pile installation efficiency with Bauer technology



Installation Challenge – Mooring

- Handling bigger chain
 - Max capacity 185mm chain
 - 6-Leg mooring design
 - Use of Nylon Rope
 - Load Reduction Devices
- Fibre rope storage capacity
 - Reels on deck
 - Potential use of CSV
- Stretching of fibre rope
 - Traditional stretching up to 40% MBL is not practical
 - JIP to comprehend requirements
 - Address stretching by incorporating re-tensioning capability

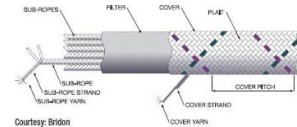
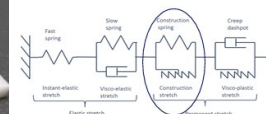


DOC – Dublin Offshore

TFI Marine – Sea Spring



Construction stretch

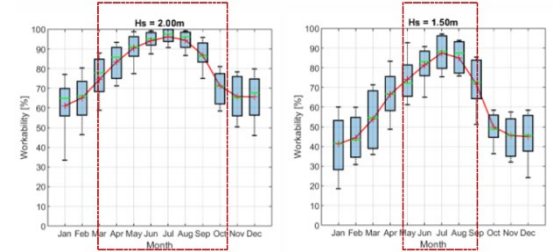
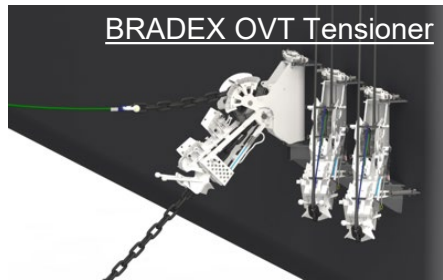


Installation Challenge – Mooring Hookup

- Personnel Transfer
 - W2W Floating to Fixed, Floating to Floating is challenging
 - Weather Sensitive
 - Reduced workability - 4 months
 - Vessel operability and personnel transfer are not aligned
- Tensioning - Tensioner at floater or water column or seabed or at pile?
 - Floater
 - Onboard winch for messenger
 - Challenging to re-tension
 - Water column
 - Water depth restriction
 - Clump weight in catenary
 - Seabed
 - Longer chain
 - Pile
 - Enhanced pile size



BRADDEX OVT Tensioner



In-Line- Tensioner



Flintstone Tensioner at Pile



Installation Challenge – Hookup Solutions

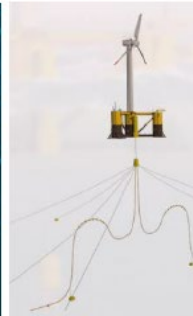
- Eliminate Personnel Transfer
 - Tow using mooring lines
 - Develop Quick connection system
- Choose ILT location wisely
- Dry mate / wet mate subsea cable connection
 - Avoid stripping cable on the floater
 - Eliminating complex termination on floater



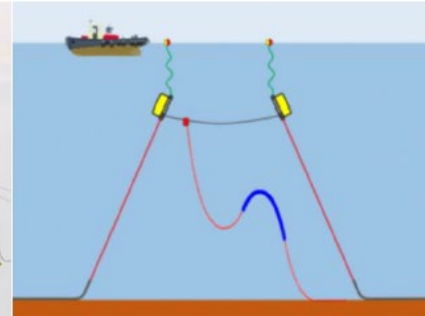
PALM QCS



SQUID



Disco Buoy



Q-Connect



Lessons Learned from Floating Wind Projects



1. Early Engagement

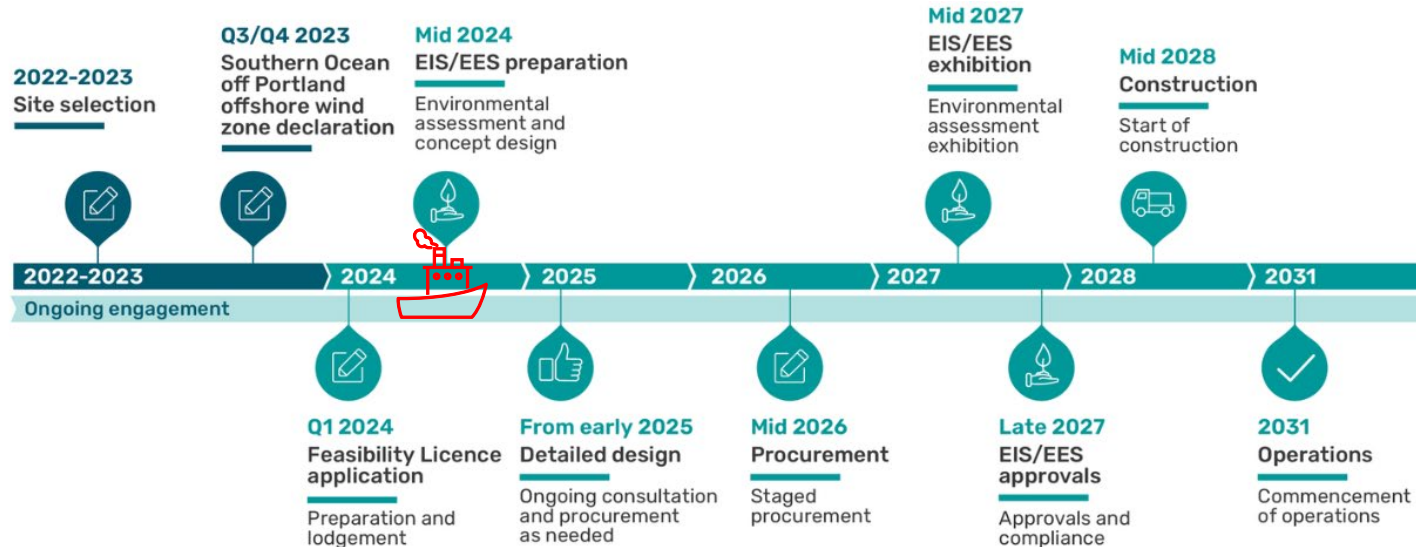


2. Understand Seabed



3. Transfer of Personnel

How early should you engage?



A trusted partner for offshore operations

Positioned globally

- Operating from 6 continents
- 20 offices near key O&G markets
- 54 vessels (7 on management / chartered in)
- Head office in Norway

Total of 4,022 employees *

- Offshore 3,177
- Onshore 845

Vessels & subsea equipment *

- Subsea 29
- AHTS 14
- PSV 11
- **Total fleet 54**
- ROV / AUV 74

* All totals as of 30.09.2023

“No matter where DOF operates in the world, safety is held as the highest priority.”

Marine services

Bringing award-winning capability to the offshore sector.



Subsea services

Integrated subsea services; wherever, whenever you need them.



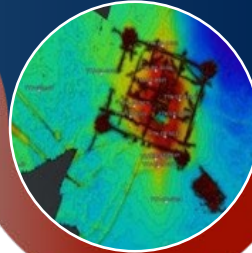
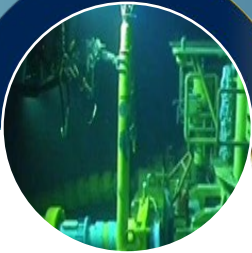
Integrated Subsea Solutions

Our comprehensive range of services encompasses a vast spectrum of subsea and marine operations, setting the standard for excellence and innovation in the industry.

Decommissioning

SURF

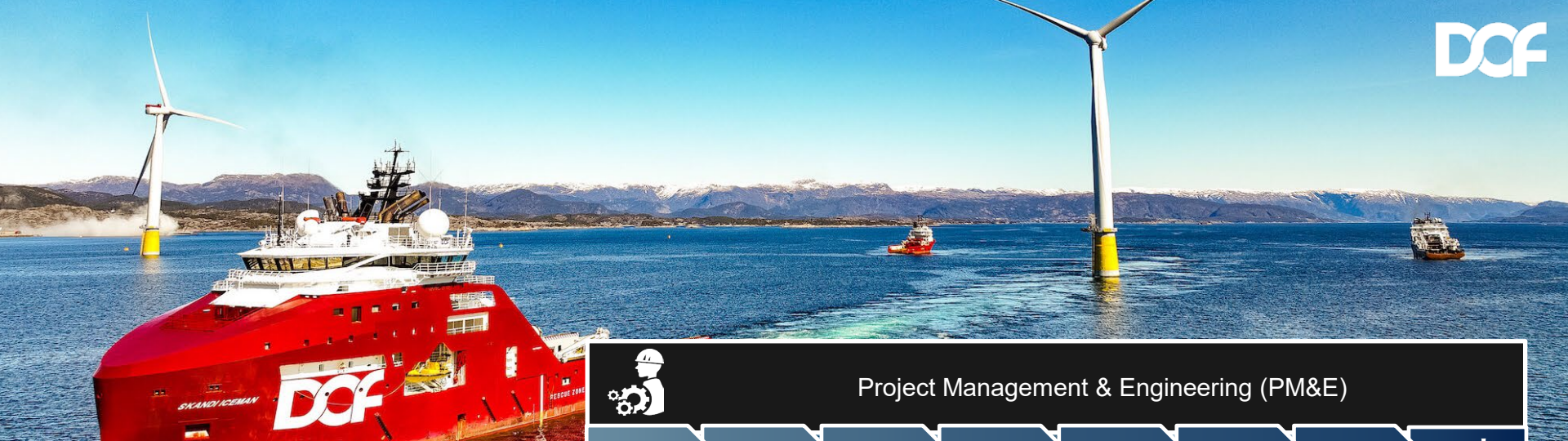
Survey



Construction

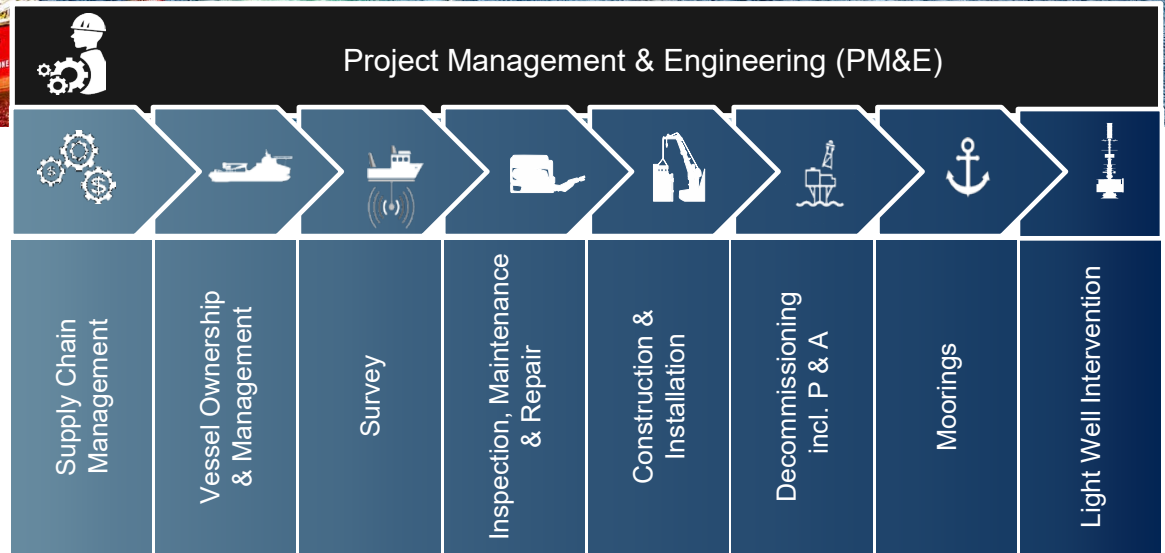
Moorings

IMR



Turnkey Solutions for the Offshore Energy Sector

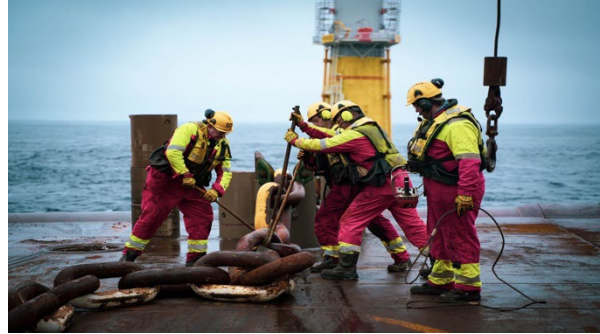
Consolidating resources through the combination of DOF's comprehensive operational subsea expertise, project management and engineering solutions with DOF Group owned & operated assets to deliver a single-source execution solution



Early Engagement



- **Operational Expertise:** Incorporate practical insights for enhanced operational efficiency.
- **Cost Optimization:** Identify cost-effective solutions and streamline logistics.
- **Risk Mitigation:** Assess and mitigate operational risks to prevent delays and unexpected costs.
- **Regulatory Compliance:** Understand and comply with regulatory requirements from the outset.
- **Technology Alignment:** Ensure project designs align with available technologies to minimize modifications.
- **Efficient Installation:** Optimize installation processes to reduce time and enhance efficiency.
- **Relationship Building:** Foster strong partnerships for collaborative success in current and future projects.
- **Timeline Management:** Coordinate early for efficient scheduling and adherence to project timelines.





Presented by

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