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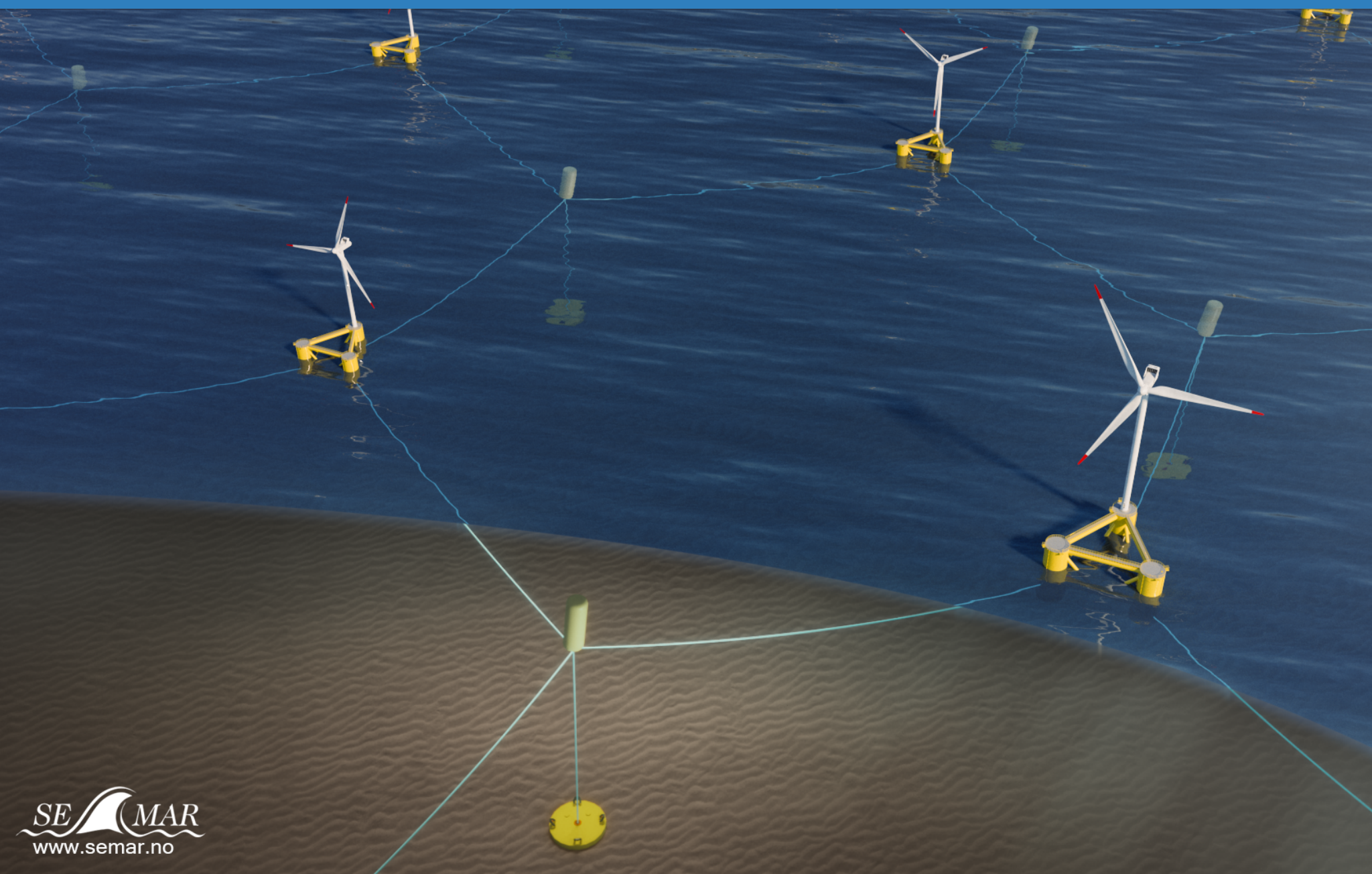
A quick guide to Honeymooring:

The 7 main benefits that make Honeymooring the best choice for future floating wind farms



About the authors

Finn-Christian W. Hanssen

Finn-Christian W. Hanssen is currently the manager for the hydrodynamics department in Semar. Previously he has worked with floater design in Moss Maritime, as a consultant in DNV, and as a researcher at NTNU. Finn-Christian holds a Ph.D. in marine hydrodynamics from NTNU, where he developed numerical methods for nonlinear wave-structure interactions.

Niklas Norman

Niklas Norman has had faith in the development of floating wind since he chose it as the theme for his master's thesis in applied mathematics in 2008. After a few years with concept developments and floater design in Dr. Techn. Olav Olsen, Niklas has worked with analysis of marine operations and mooring in Semar, where the idea of Honeymooring has been developed.

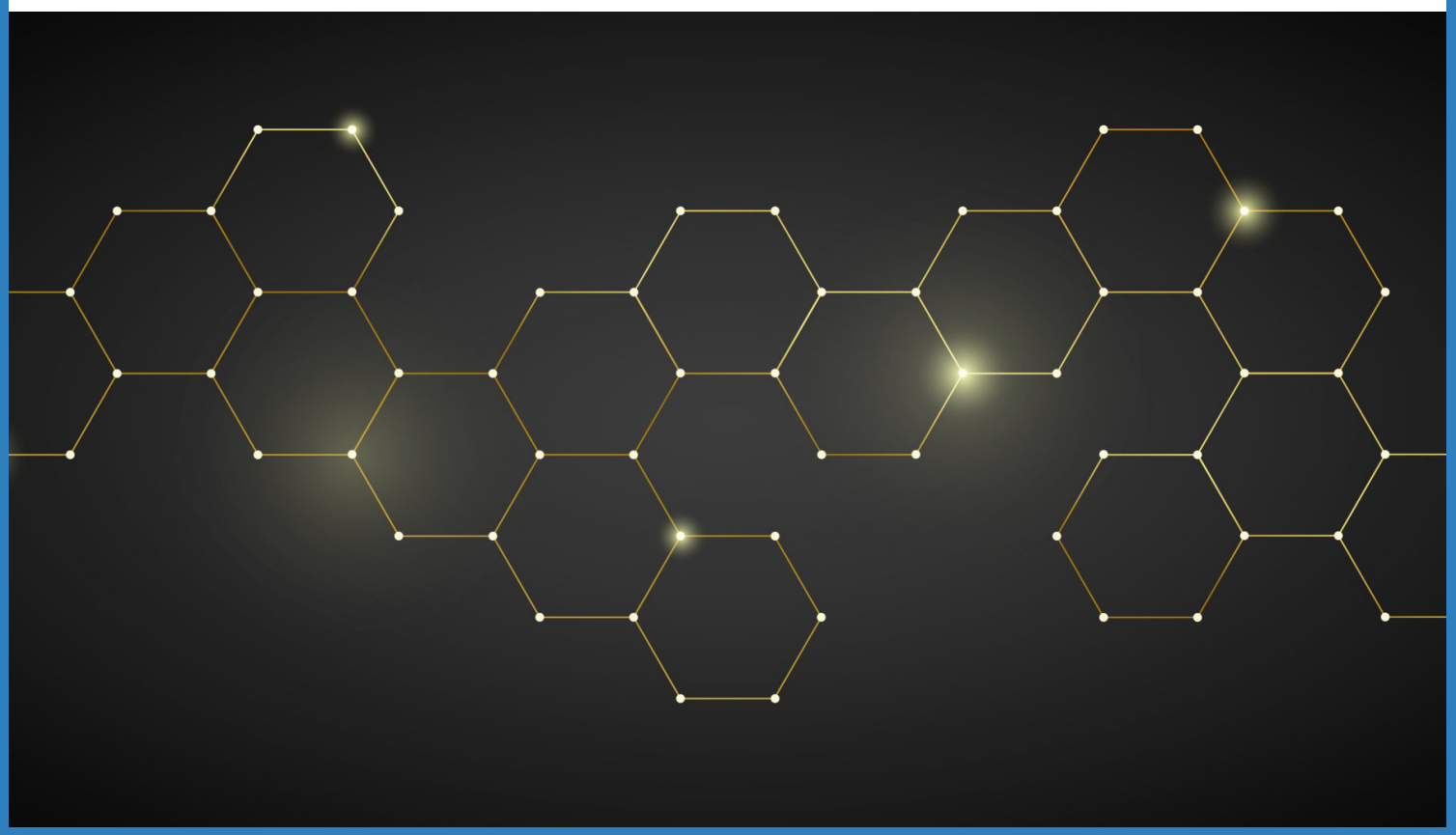
Per Sørum

Per E. Sørum is the Senior Vice President for business development at Semar AS. He focuses on GoToMarket-activities, international business development, and operational sales of advanced technologies - within offshore oil & gas and the Floating Offshore Wind (FOW)- business.

What is Honeymooring?

In simple terms, Honeymooring is a system for mooring floating wind turbines in a honeycomb network without using a steel chain. Every floating wind turbine (FWT) is individually connected to shared buoys using near-horizontal and lightweight fiber ropes or alternatively wires. Every buoy is moored vertically to the seabed using a taut fiber rope. Honeymooring enables sharing the anchors and the main “flexibility-giving-element” (the air-filled buoy) scalable across different water depths. The steel chains or steel-clump-weights are the “flexibility-giving elements” for traditional gravity catenary systems. Thus, phrased in a slightly populistic way: Honeymooring replaces individual steel with shared air.

A successful pre-study
Semar performed a pre-study supported by Innovation Norway, TotalEnergies Norway, and Equinor Energy, confirming that Honeymooring offers significant cost savings compared to traditional mooring systems. The technical part of the pre-study did not identify any critical technical obstacles.



1. Honeymooring reduces the cost of mooring hardware and installation

By eliminating steel chains and clump-weights, Honeymooring reduces capital expenditures by lowering procurement and installation costs. Although actual savings will be site-specific, the innovative mooring solution is estimated to minimize mooring hardware costs by 50% compared to traditional catenary mooring systems. By significantly reducing the mooring line pretension, Honeymooring simplifies installation processes enabling installation using smaller and cheaper vessels.

As opposed to traditional ways of sharing anchors, Honeymooring is highly scalable over a broad range of water depths. It significantly reduces mooring-related hardware costs by using cheaper, more standardized (mass-produced), and fewer mooring components in a chainless system. The number of FWTs in the system is easily adjustable, and any FWT can be disconnected for inshore maintenance in a straightforward, low-cost manner.

In total, Honeymooring reduces the overall capital expenditure for future wind farms by around 10%, reducing the Levelized cost of energy (LCOE) dramatically. Honeymooring opens up new possibilities for guiding inter-array power cables through the water in-between the FWT-s. This possibility might lead to significant cost savings from the power-cable budget.

2. Honeymooring eliminates seabed damage

Honeymooring minimizes the seabed footprint and reduces seabed erosion to a fraction of catenary mooring systems. As used in existing wind parks like Hywind Scotland, a catenary mooring system and the upcoming Hywind Tampen field require long lengths of chain resting on the seabed to avoid uplift on the anchor in extreme conditions. When the floater moves, the chain will therefore erode the seabed. This may threaten local marine life and coral reefs and release CO2 into the atmosphere.

It is well-known that steel chains resting on the seabed represent an environmental challenge in mooring systems used for one-of drilling units in the oil and gas industry. Installing a wind farm with tens or even hundreds of units is thus difficult to defend. Compared to a catenary system, Honeymooring reduces the seabed damage to a fraction. This means that Honeymooring can be utilized in areas unavailable for traditional mooring systems, which may significantly enable floating wind farms on a large scale.

3. Honeymooring improves safety for marine operation crew and eases installation, maintenance, and repair

Traditional mooring systems' high pretension and high component weights mean high potential energy. The high potential energy involved increases the possibility of severe accidents involving installation crew or employees in other complex marine operations.
Since the Honeymooring system has low pretension levels and primarily lightweight components, crew safety is improved. Furthermore, the low pretension levels and light features allow for the use of lower-cost installation vessels. Moreover, to obtain the correct pretension in the system, a very high precision- level is needed when installing a traditional mooring system. Honeymooring is possible to install with more generous tolerances.

If a wind turbine must be towed away for inshore maintenance, it is possible to replace it with a dummy buoy. The dummy buoy ensures that the mooring system's horizontal restoring characteristics remain intact while the wind turbine is away. Since the system has low levels of pretension, replacing a wind turbine with a buoy can easily be facilitated by slacking the lines one by one. You do this by pulling the buoys that connect to the wind turbine.

4. Honeymooring reduces the CO2 footprint

Production of steel chain requires a vast amount of energy, and this energy often comes from fossil sources associated with significant CO2 emissions. On the other hand, producing fiber ropes result in significantly smaller CO2 emissions. Due to their lightweight, the environmental impact of transporting fiber ropes is less than that of heavy steel chains.

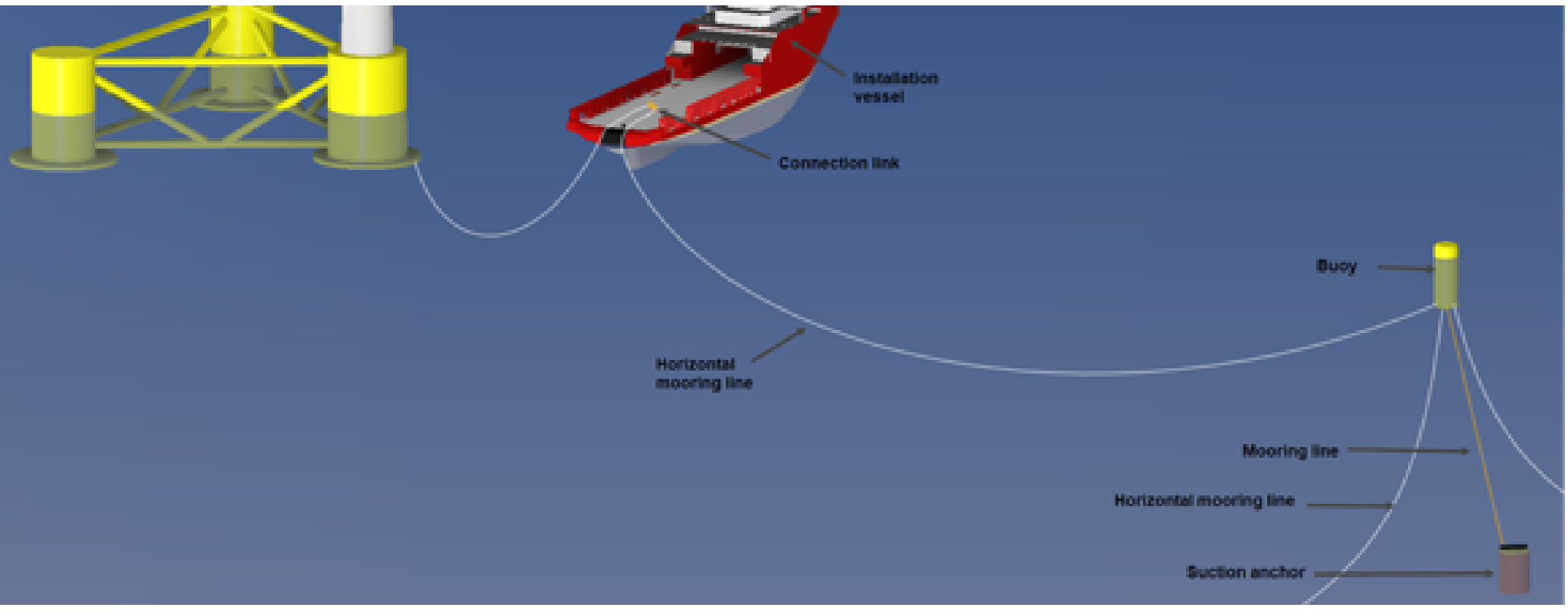
Using smaller-than-traditional vessels, which leads to more efficient marine operations during installation, also has a favorable environmental impact. By reducing the bottom footprint, Honeymooring avoids the release of CO2 into the atmosphere that may occur when mooring lines erode the seabed.

5. The scalability of Honeymooring is a formidable advantage compared to other mooring solutions

Mooring design, installation, and logistics are complex for systems relying on precise pretension levels, such as catenary systems. Due to varying bathymetry, each mooring line is often unique and requires installation in a specific sequence. Furthermore anchor-sharing will not be feasible in many waterdepths giving many anchors to be installed.

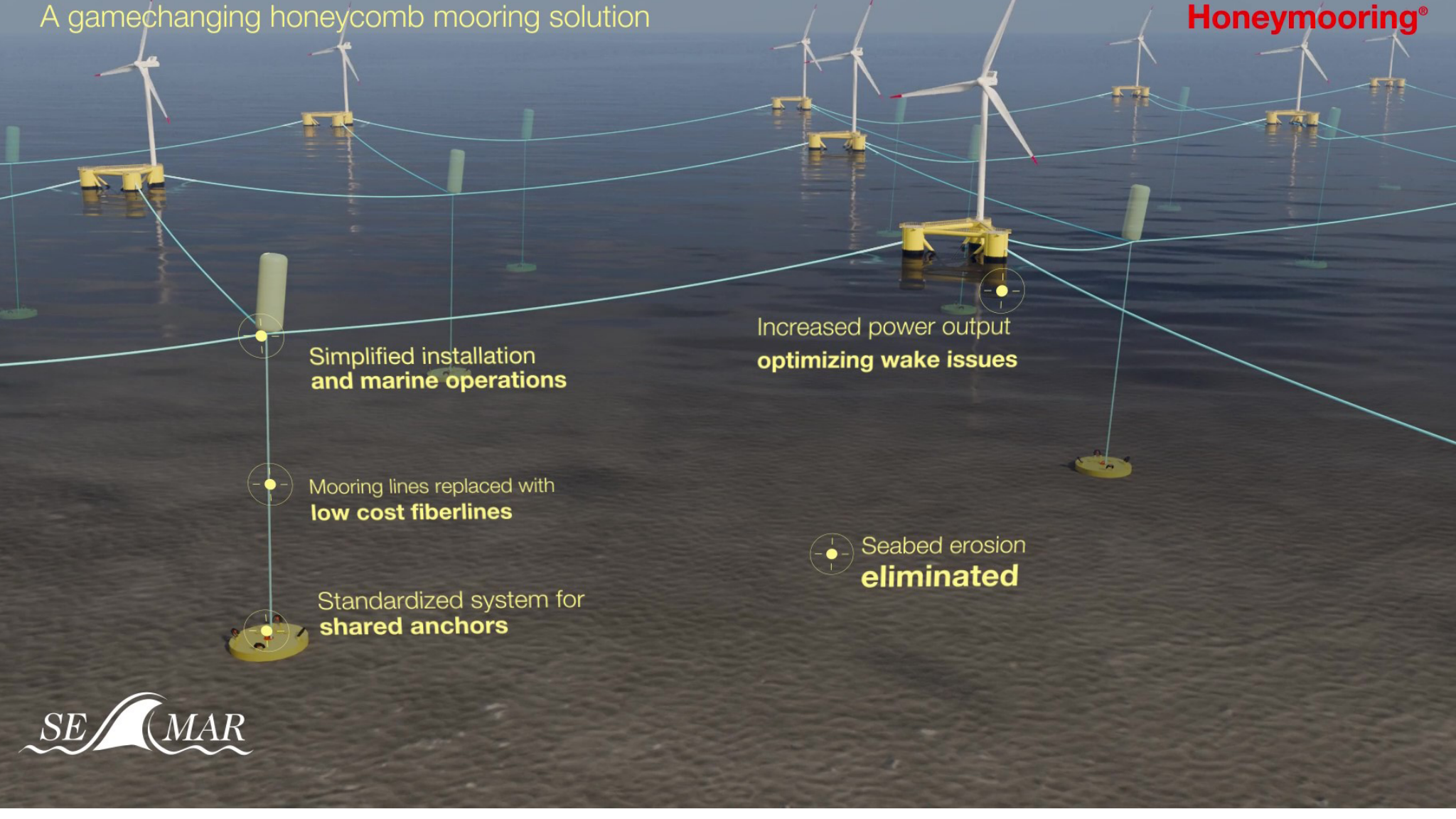
Honeymoring is far more standardized and you can quickly scale the system to fit an extensive range of water depths, while sharing the anchored buoys, where the only design modification needed is to increase or decrease the length of vertical mooring lines. Within the same wind-farm, Honeymooring will in many cases have totally standardization of the components, meaning all anchors, all vertical taut lines, all buoys and all horizontal lines are equal.

The forecasts indicate that increased standardization will be a crucial enabler for the floating wind industry. We believe the higher level of standardization and the simplified installation offered by Honeymooring, are likely to be the key enabler to install a complete wind-farm in one installation-season only. One year expedited start of power-production, can have great impact for the overall project economy.



6. Honeymooring utilizes proven standardized components

The main components in the Honeymooring system are synthetic fiber ropes, buoys, and anchors. These are proven technologies with long track records used in different applications across different industries. We are, of course, putting effort into designing cost-efficient buoys with solid attachment points. But it is not the components of Honeymooring that are innovative. It is the way we are combining them that is unique! We believe that using standardized components will be beneficial in qualifying Honeymooring as a technology.



7. The Honeymooring solution is applicable for most types of floaters

Honeymooring can moor any of the other innovative floater designs on the market, whether your wind turbine uses a SPAR floating substructure, a semisubmersible, or other solutions. Therefore, Honeymooring is floater agnostic, disregarding tension-leg platforms; it only cares about your floater's fair lead! While being developed with the floating wind industry in mind, the system is usable for any floating structure which will benefit from being moored in arrays. This includes aquaculture structures as well as floating solar parks. We predict that we will be able to develop cost-optimized versions of Honeymooring by reducing the horizontal distance between the floaters since aerodynamic wakes are not a concern in these industries.

About Semar and the commercial use of Honeymooring

Semar AS is a consultancy company for the oil and gas and offshore floating wind industries. Our services include feasibility studies, concept development, design, installation, and removal of offshore and marine structures. The company is partly owned by DOF Subsea (43%). The DOF Group is a worldwide supplier of maritime operations and one of our clients.
Semar has a long track record of serving the oil and gas industry with structural and marine operation services since 1980. A pre-study has already confirmed the cost-saving potential and technical feasibility of Honeymooring.

We are currently building an even stronger foundation for the Honeymooring-technology in a large R&D project. We are maturing the concept further and doing the required numerical analysis methodology with our industry partners during the project. The results are the foundation for making Honeymooring ready for commercial use at scale shortly.

By 2025, we intend to be industry-leading in designing and analyzing mooring systems for offshore floating wind farms. The global demand for floating wind power increases exponentially, and we strive to become a significant contributor to realizing this potential.

Semar is currently searching for partners to establish a commercial demonstration project to finalize the technology qualification of Honeymooring for commercial use.

Are you interested in joining our adventure?

Read more and fill out our contact form!