

Illustration of WindFloat, which is a semi-submersible floating foundation for multi-megawatt offshore wind turbines

# Floating foundation for offshore wind turbines

**WINDFLOAT** The ability to install offshore wind turbines in deep water increases the number of suitable offshore wind projects. A semi-submersible platform with a multi-megawatt offshore wind turbine, which can be deployed independently of water depths and geotechnical properties of the sea floor, will be launched this summer.

Craig Andrus

**W**indFloat is a patented semi-submersible floating foundation for multi-megawatt offshore wind turbines that has been developed by Seattle-based Principle Power. The ability to deploy wind turbines in deep water increases the number of suitable offshore wind project sites and permits access to higher quality wind resources. In addition, negative visual impact issues are mitigated as projects can be sited further from shore. Until now, there have been no commercially available solutions for deep-water deployment of offshore wind turbines. This summer, Principle Power will launch the

WindFloat fitted with a Vestas v80 2MW offshore turbine, the first semi-submersible platform with a multi-megawatt offshore wind turbine, and the first offshore wind turbine in the Atlantic.

This project is consistent with the European Industrial Initiative (EII) and the European SET Plan as well as with The United States Department of energy's strategy for offshore wind (OsWind). In addition, it falls squarely within the scope of the 2008 cooperative US-Portuguese MOU on ocean renewables.

The timing of this project is linked to two significant evolutions in the wind industry:

- ▶ Developers are looking for higher quality wind resources further offshore

- ▶ Offshore wind turbines are increasing in size anticipating economies of scale.

The confluence of these two evolutions are floating offshore wind turbines, which will allow developers to exploit the best offshore wind resources, unconstrained by water depth, with a foundation that can accommodate large turbines.

## Onshore assembly and dockside qualification

Traditional offshore deployment, using monopiles or other conventional foundations,

requires a large lay-down area for staging of equipment that is later assembled offshore. Specialised installation vessels, with a typical day rate of approximately USD 250,000, are employed to transport equipment to the installation site and perform the installation. All assembly, qualification and testing of the systems are conducted at the installation site in an uncontrollable marine environment. Operations can only be conducted when sea states permit. Additionally, each installation must occur in a serial fashion (one at a time) due to a limited number of installation vessels worldwide and the cost of charter.



impact. For conventional offshore wind turbine foundations, such as monopiles and jacket structures, piles have to be drilled or hammered into the sea floor. Gravity-based structures (GBS) require that a large area of the sea floor be prepared, levelled and then covered with the foundation. The WindFloat employs only drag embedment anchors, which remain stationary, causing minimal disturbance to the sea floor and the sea life environment.

### Decommissioning

Although none of the European installations have yet undergone decommissioning, the necessary procedures have been studied and documented. Removal of traditional monopile or jacket structures will likely consist of cutting the base of the pile(s) at the sea floor, leaving the embedded section in place. Removal of GBS foundations will most likely require large marine equipment spreads and prove to be highly impactful on the marine environment. It is widely agreed that the offshore operations, which are needed for the removal, will be both costly and unpredictable, as the availability of capable vessels, among other factors, will be in question.

In contrast, the use of drag embedment anchors as part of the WindFloat's conventional mooring configuration, allows for simple removal upon decommissioning. The seabed can be restored to its original state and the WindFloat towed back to shore. The hull may be refurbished and repowered with a new wind turbine generator, thus further extending the useful life of the system to 40 years and decreasing overall levelled energy costs.

### Operations and maintenance

Similar to tow-out operations, the entire system can be disconnected and towed back to shore for major maintenance procedures or in the event of a large system failure. The WindFloat's independence from large specialised offshore vessels results

in greatly reduced costs to the project for non-routine operations and maintenance activities. Routine maintenance can be most economically carried out using conventional vessels for personnel to access the structure.

### Depth insensitivity and permitting issues

Traditional installations have an inherent dependency on water depth (no economic solutions previously existed for deep water) and site sea floor geotechnical (sediment) conditions. The WindFloat, however, is inherently less sensitive to both the water depth and the sea floor sediment conditions in which it is installed. The incremental cost increase due to water depth is minimal as only more mooring line is required; all other equipment and design remains the same. With respect to geotechnical requirements, different anchor types and weights can be used dependent on variable soil conditions.

### Conclusion

The WindFloat offers a unique and transformational approach to deployment of offshore wind turbines worldwide. Significant opportunities for installation exist in deep-water locations such as the European Atlantic, the Mediterranean, off the West and East coasts of the United States and in the Great Lakes. Independent of water depths and geotechnical properties of the sea floor, WindFloat developments can occur in areas of stakeholder acceptance. Furthermore, cost and risk savings at each step of the supply, deployment and recovery value chain can be realised, resulting in economic and sustainable levelled energy costs for offshore wind projects.

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The WindFloat, however, provides for all fabrication, final assembly and qualification to occur onshore and dockside in a controlled environment. Furthermore, serial production methods and learning curve savings are applicable as major components can be fabricated at typical metal fabrication workshops. Final assembly of multiple units can take place simultaneously in a shipyard at a dry dock or slipway facility.

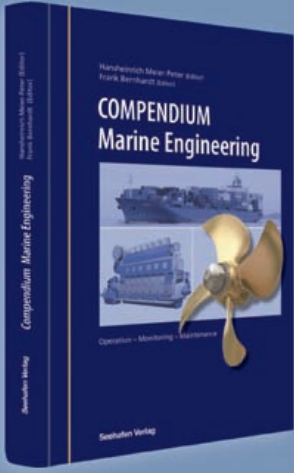
### Installation

The installation of a WindFloat only requires a connection to pre-installed moorings and export cable. One or several units at a time are wet-towed to the installation site. Standard anchor handling and conventional tug vessels are employed, carrying a typical day rate of approximately USD 25,000, a ten-fold reduction over traditional heavy lift vessels. Overall offshore operations are drastically reduced, minimising specialised labour and eliminating previously unavoidable offshore development costs.

This not only significantly reduces installation costs but also mitigates environmental

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