The challenge to the world's first floating wind farm

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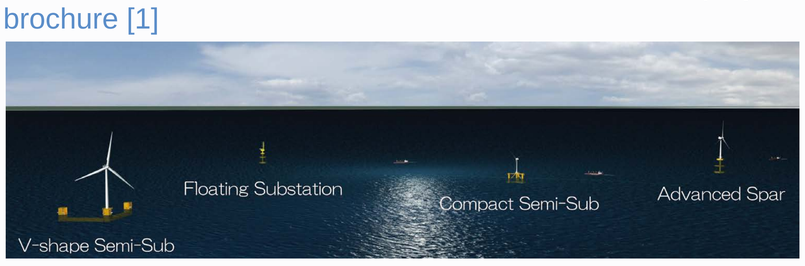
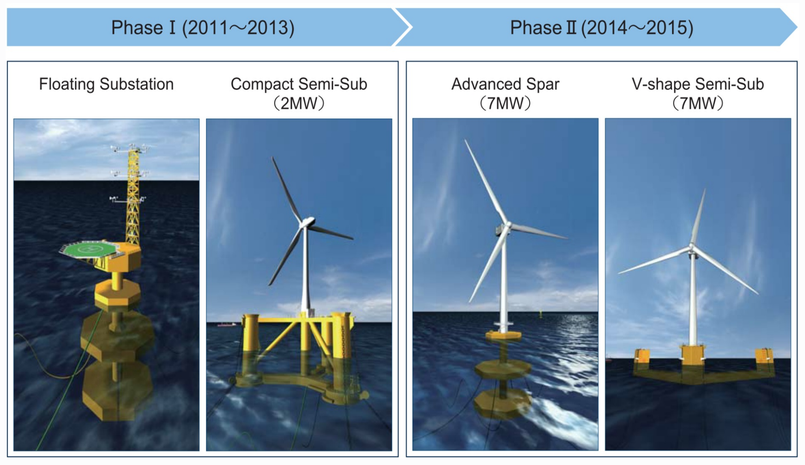
Project overview

Fukushima offshore wind consortium, which consists of Marubeni Corporation (Project integrator), the University of Tokyo(Technical advisor), Mitsubishi Corporation, Mitsubishi Heavy Industries, Japan Marine United Corporation, Mitsui Shipbuilding & Engineering, Nippon Steel & Sumitomo Metal Corporation, Ltd., Hitachi Ltd., Furukawa Electric Co., Ltd., Shimizu Corporation and Mizuho information & Research, is proceeding with Fukushima floating offshore wind farm demonstration project (Fukushima FORWARD) funded by the Ministry of Economy, Trade and Industry.

In this project, three floating wind turbines and one floating power sub-station will be installed off the coast of Fukushima. The first phase of the project consists of world first 2MW downwind floating wind turbine, the world first 25MVA floating substation and submarine cable, and were completed on 11th of November, 2013. In the second phase, two world largest 7MW wind turbines will be installed before 2015. The detailed information is available in the project brochure [1]





Research and development

Water tank test

By using a scaled model of 2MW compact semi-sub floater, water tank test was carried to clarify the response of the floater under design wind, wave and current conditions. The optimum control method during power production for floating wind turbine was also investigated.

Metocean Measurements

The floating substation is equipped with met-ocean measurement devices. Wind velocities are measured by using cup anemometers, wind vanes and sonic anemometers on the met mast, and the doppler ridar on the main deck. The wave and current are measured by using the wave meter and ADCP on the middle hull. The floater motion is also measured with accelerometers, GPS and gyros on the main deck, and a floater motion compensation algorithm is also developed.

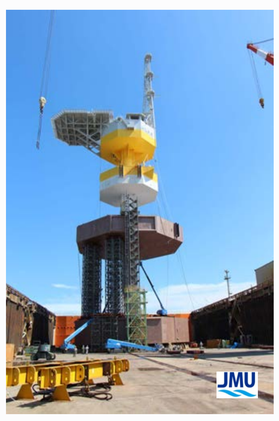
Compact semi-sub floater for 2MW turbine

The construction of compact semi-sub floater for 2MW downwind turbine was completed in May 2013. This floater consists of one center column, three side columns and three braces, and the main deck beams and the pontoon beams support the wind turbine. The compact semi-sub floater has advantages for construction and installation due to its shallow draft. The draft of the floater can be controlled by using the ballast tank located at the bottom of the side columns.

World first 2MW downwind offshore wind turbine was installed on the compact semi-sub floater in June, 2013. The 55m tower was divided into three sections and after the installation of the nacelle, 40m blades were installed .

Advanced spar floater for substation

Construction of the floating substations on the advanced spar floater was completed in June, 2013. On the main deck of the upper hull, a met mast and a helicopter deck are installed. Inside the upper hull, the world first floating substation is located. The bottom hull is filled with concrete to lower the center of gravity, which enabled the construction and towing in vertical position. The floater motion is controlled by using the cob under the upper hull, and the middle hull.



Floating grid integration system

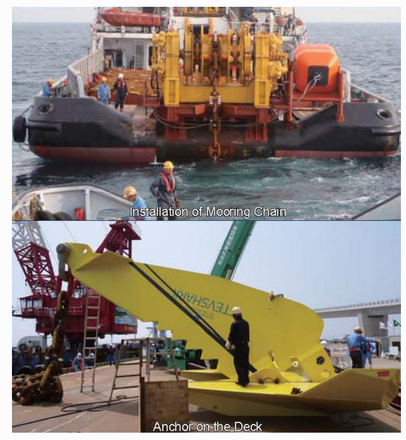
An offshore floating transformer system which is both durable and unsusceptible to floater motion is developed and the performance against vibration and inclination was evaluated through shaking table tests. Furthermore, a large capacity water proof riser cable superior to fatigue is developed and optimized by motion analysis. Based on these technology, the world first floating offshore transformer system was established against severe metocean conditions.

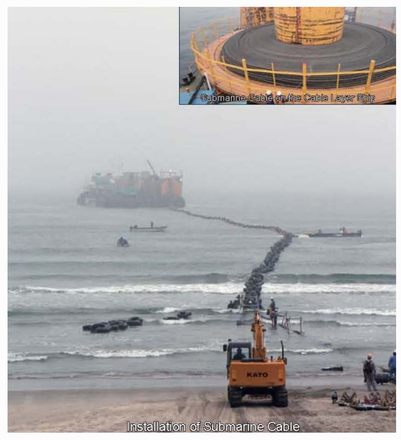
Installation and grid connection

The compact semi-sub floater with 2MW downwind turbine left Chiba dock of Mitsui Shipbuidling & Engineering on 27th of June, 2013. After testing at Onahama Port, it was towed to the site.

The advanced spar floater for floating substation left Isogo dock of JMU and towed to the installation site directly. From the 16th of June, 2013, the anchoring began.

In May, 2013, the anchor and mooring chain for both floaters were installed. In June, at the coast of Hirono, where onshore substation is located, the construction of the submarine cable began. The grid connection of the floating offshore wind turbine and substation was completed on 31st of October.





Conclusions

The first phase of the Fukushima FORWARD project has started power generation on November 2013. The first phase of the project can be summarized as follows.

1. Although several typhoons were observed around the project site during construction, all the technical problems were solved and the installation has finished on schedule successfully.
2. Eight months have passed since the installation and the world first floating substation and 2MW down wind turbine have been operating without any problems. The capacity factor of 43.5% were achieved in December 2014, which is higher than the estimated 35%.
3. Metocean and floater motion measurement on the substation and compact semi-sub with 2 MW turbine started. All the collected data are under analysis.

Acknowledgement

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Reference

[1] Fukushima FORWARD English brochure, http://www.fukushima-forward.jp/pdf/pamphlet3.pdf

Fukushima Offshore Wind Consortium
Fukushima FORWARD

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