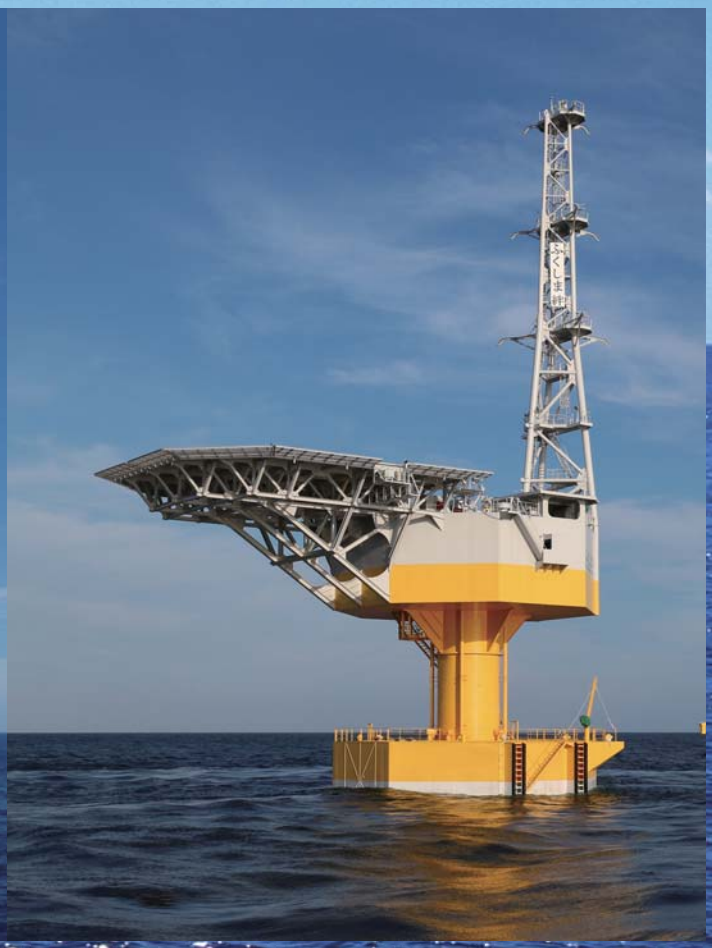
Fukushima Floating Offshore Wind Farm Demonstration Project
（Fukushima FORWARD）

- Construction of Phase I -



Fukushima Offshore Wind Consortium

Fukushima FORWARD

2MW Downwind-type Floating Wind Turbine “Fukushima Mirai”

Fukushima offshore wind consortium 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 have been installed off the coast of Fukushima. The first phase of the project consists of the 2MW floating wind turbine, the world first 25MVA floating substation and submarine cable, and have been completed in 2013. In the second phase the world largest 7MW floating wind turbine and the 5MW

66kV Floating Substation “Fukushima Kizuna”

floating wind turbine will be installed before 2015.

This project will establish the business-model of the floating wind farm and contribute to future commercial projects. The consortium members are also expected to learn know-how of floating offshore wind farm, which will be one of the major export industries in Japan.

The Fukushima FORWARD project believes to help Fukushima to become the center of new industry which will create new employment in this region to recover from the damage of the Great East Japan Earthquake in 2011.

Water tank test

By using a scaled model of 2MW compact semi-submersible floater, water tank test was carried to clarify the response of the floater under design wind, wave and current conditions on April, 2013. The optimum control method during power production for floating wind turbine was also investigated. A dynamic analysis model of FOWT is validated by comparing with the water tank test and onsite mesurement data.

Water Tank Test at National Marine Reserch Institute

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 lidar 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.

Met-mast on the Substation

Wind Vane and Cup Anemometer

Meteorogical Observation Instrument

Thermo-hygrograph

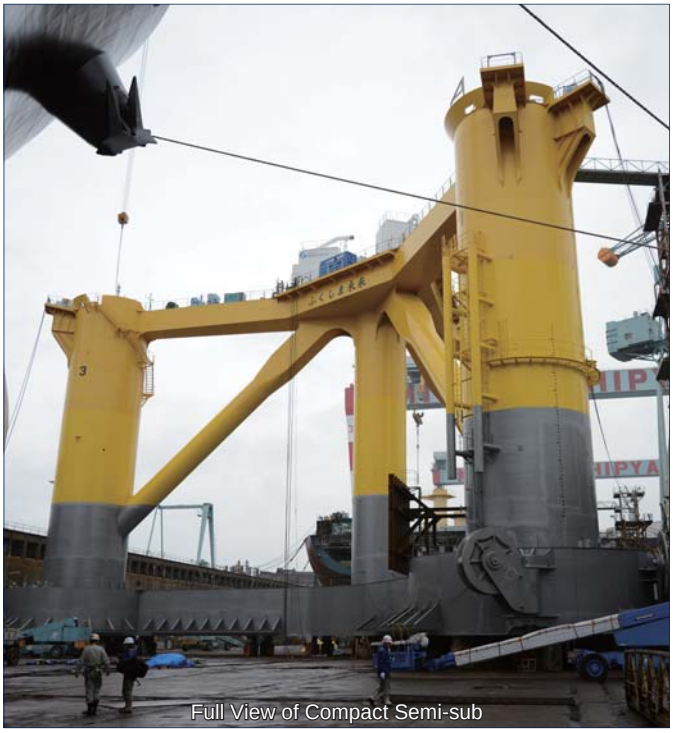
Doppler Lidar

Current meter

Wave Meter

Compact semi-sub floater for 2MW downwind 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, three braces, the main deck beams and the pontoon beams which support the wind turbine. The compact semi-sub floater has advantages for construction and installation due to its shallow drought. The drought of the floater can be controlled by using the ballast tank located at the bottom of the side columns.


Full View of Compact Semi-sub

Deck Beams


Footing Ballast and Pontoon Beams

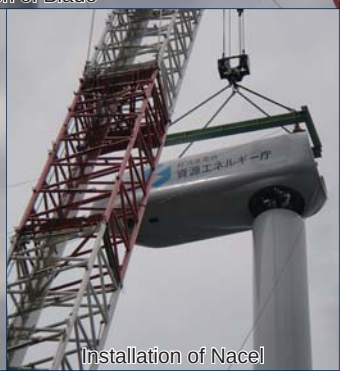
Installation of 2MW downwind turbine

The 2MW downwind offshore wind turbine was installed on the compact semi-sub floater in June, 2013. At first the three sectioned 48.5m tower and the nacelle were assembled and then 39m blades were installed. After receipt of commissioning test at Onahama, the 2MW downwind offshore wind turbine on the semi-sub floater was towed to the site and began to generate power in November.

Lifting of Blade

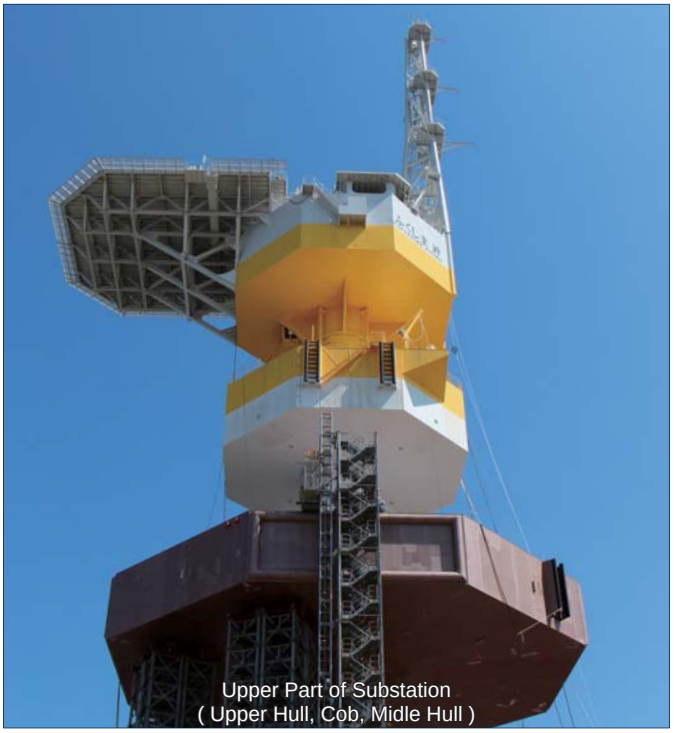

Installation of Blade

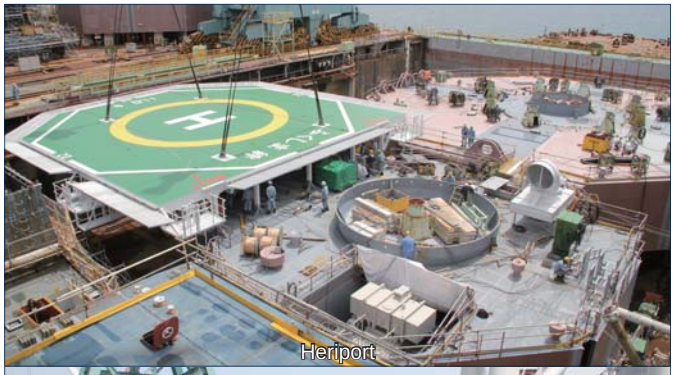

Installation of Tower


Installation of Nacel

Advanced spar floater for substation

The 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 heliport are installed. Inside the upper hull, the world first floating substation is equipped. 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 by waves is reduced by the unique hull shape with cob, middle hull and lower hull.


Upper Part of Substation
(Upper Hull, Cob, Midle Hull)


Heriport


Roof of Transformer Station and Foundation of Tower

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.


Transformer on Floater


Inclination Test


Vibration Test

Section of Submarine Cable


Tension Test for Rizer Cable

Installation of the compact semi-sub and advanced spar

The compact semi-sub floater with 2MW downwind turbine left Chiba dock of Mitsui Engineering & Shipbuidling on 27th of June, 2013. After testing at Onahama Port, it was towed to the site and installed. On 11th of June, 2013, 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 for the substation began and finished in October.

Towing of Compact Semi-sub

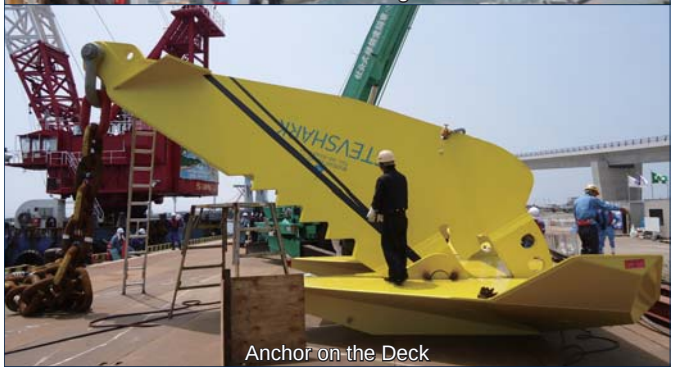
Leaving Dock of Compact Semi-sub

Towing of Substation

Installation of anchor, chain and submarine cable

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

Installation of Mooring Chain



Anchor on the Deck

Submarine Cable on the Cable Layer Ship

Installation of Submarine Cable

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