Fukushima Floating Offshore Wind Farm Demonstration Project
（Fukushima FORWARD）

- Construction of Phase II -

Fukushima Offshore Wind Consortium

Fukushima FORWARD

http://www.fukushima-forward.jp

7MW floating wind turbine Fukushima Shimpuu

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 had been completed in 2013. In the second phase the installation of the 7MW floating wind turbine Fukushima Shimpuu was

rotor diameter : 167m, hub height : 105m,the height of the top blade : 189m
depth : 32m, draft : 17m, length : 85m, width : 150m
no. of mooring chain : 8, chain diameter : 132mm

5MW floating wind turbine Fukushima Hamakaze

completed in June of 2015 and the 5MW floating wind turbine Fukushima Hamakaze will be installed in the summer of 2016.

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.

rotor diameter : 126m, hub height : 86m, the height of the top blade : 150m
depth : 48m,draft : 33m, length : 59m, width : 51m
no. of mooring chain : 6, chain diameter : 132mm

Installation of 7MW wind turbine on Fukushima Shimpuu

The nacelle of 7MW wind turbine by Mitsubishi Heavy Industries, Ltd was fabricated at Yokohama Dockyard & Machinery Works, the tower was manufactured at Kobe Shipyard & Machinery Works, and the blades over 80m were manufactured in Germany. All the above components were installed on the floater at Onahama port in Fukushima prefecture. The world's largest 7MW wind turbine installation was completed at the beginning of June, using one of the gigantic cranes which were only a few in the world. The height of the top blade is about 200m above the sea level.

Completion of installation of 7MW wind turbine on the floater

Blade

Installation of blade by special equipment

Nacelle

Construction of 5MW wind turbine and the floater for Fukushima Hamakaze

5MW down-wind turbine manufactured by Hitachi Ltd is now under construction and will be installed on Fukushima Hamakaze, which will be the second floating wind turbine facility in the second phase. Advanced spar floater for Fukushima Hamakaze is also under construction at Sakai Works of an affiliated company of JMU. The floater with 51m width and 33m draft is optimized for the construction and transport.

Upper hul under building

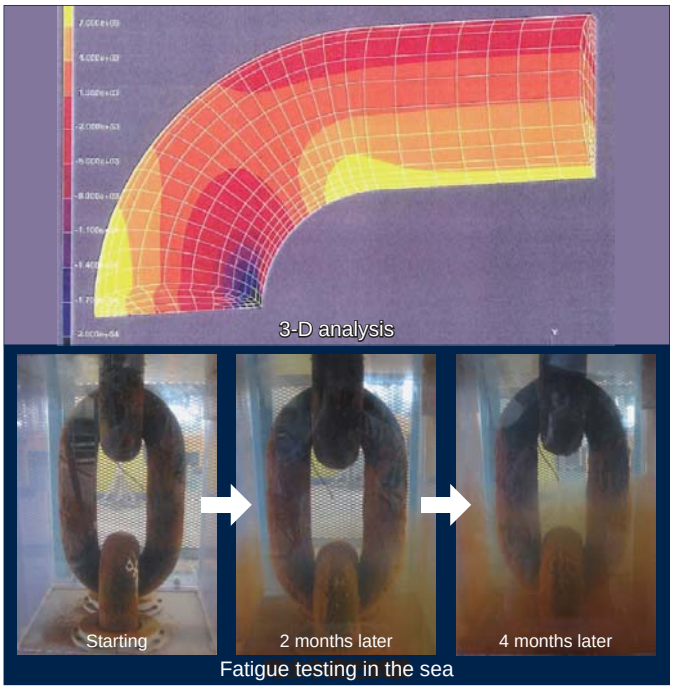
Floater under building

5MW down-wind turbine (the same type)

Mooring chain development

All mooring chain used for the four floaters, the material of which is made by Nippon Steel & Sumitomo Metal, are produced at Hamanaka factory. This material with lots of world track record is applicable to severe metocean condition in Japan and improves abrasion and fatigue resistances. By 3-D analysis and fatigue testing in the sea water, safety and reliability are validated. A dynamic analysis of the mooring lines by using measured floater motion, the lifetime of the mooring line was evaluated and the development of long life chain are also conducted.

Mooring chain for Fukushima Shimpuu

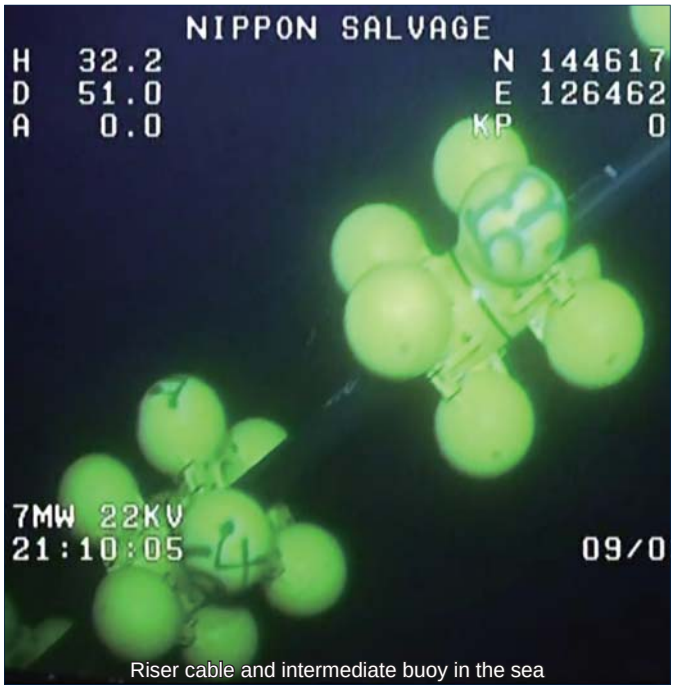


Fatigue testing in the sea

Riser cable development

The world largest riser cable is used to connect the sub-marine cable and floating substation as well as floating wind turbines. The riser cable needs to be designed against fatigue load and water shielding is required while optimizing it against floater movement and wave effect. To keep the riser cable in planned shape, the intermediate buoy, developed by Furukawa Electric Co., Ltd and local UJK was used from the 2nd phase. Since the commissioning in November, 2013, there has been no major problem on power transmission. The data measured by the censors attached on the riser cable is useful for the estimation of the life time of the cables and the development of O&M method.

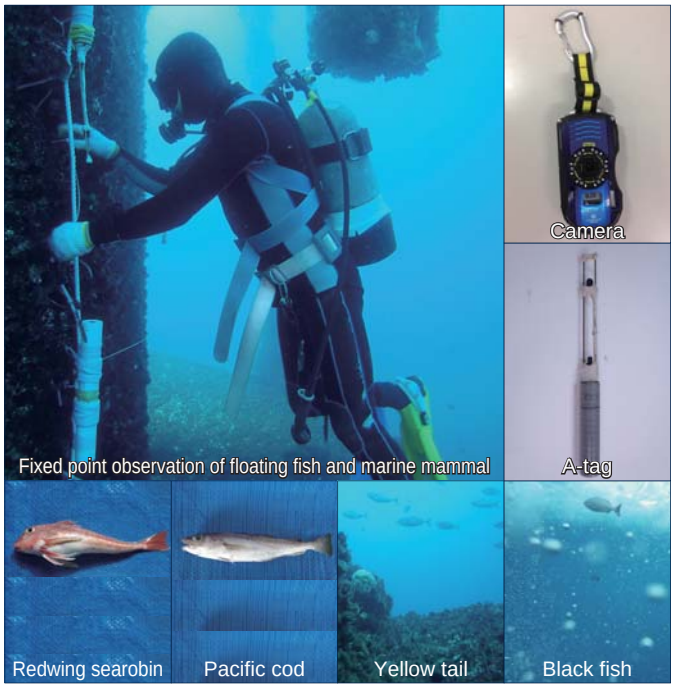
Installation of riser cable for Fukushima Shimpuu



Riser cable and intermediate buoy in the sea

Environmental impact assessment

After installation of 2MW wind turbine Fukushima Mirai and world-first floating substation Fukushima Kizuna, environmental impact around the site has been investigated. By visual inspection which is conducted four times a year from ship, albatross and pelagic cormorant are found as valued sea bird species and by sea bed fish inspection redwing searobin and pacific cod are found. By the fixed point observation through the year, pacific white-side dolphin is found as marine mammal and yellow tail and large scale blackfish is found to be more than around adjacent sea.



Marine navigation safety

To assess the risks of collision of ships and moored floating wind turbines, maritime traffic was investigated using AIS and navigation radar at Fukushima site. The collision, initiation of drifting and drifting behavior of ships and wind turbines were investigated in wave basins. Analysis code of Rotor-Floater-Mooring coupled analysis code was improved to investigate the response of mooring line in shallow water. The risk evaluation procedure of the chain drift was developed based on the risk scenario combined with a chain drifting simulation method.

Collaboration with fishery industry

Not only the regular meeting with fisherman, but also the research on fishing environment, fish catch testing, fish research by ROV and provision of marine information data are proceeded. Through these activities, by developing a new fishing method and clarifying the effect of fishing bank and fish gathering, future direction of the collaboration between floating wind turbine and fishery industry was investigated.

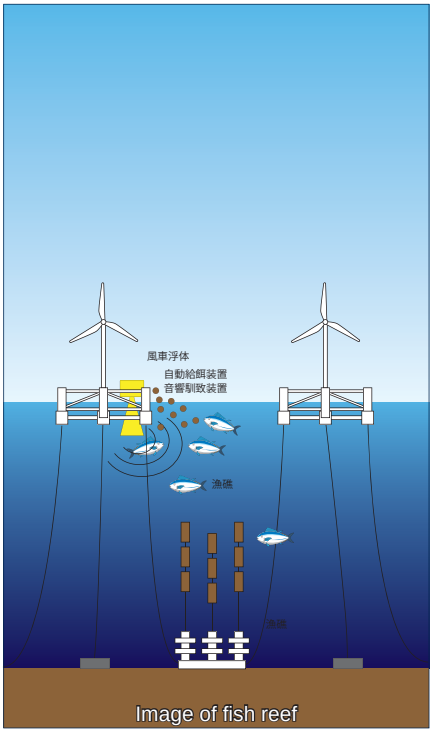
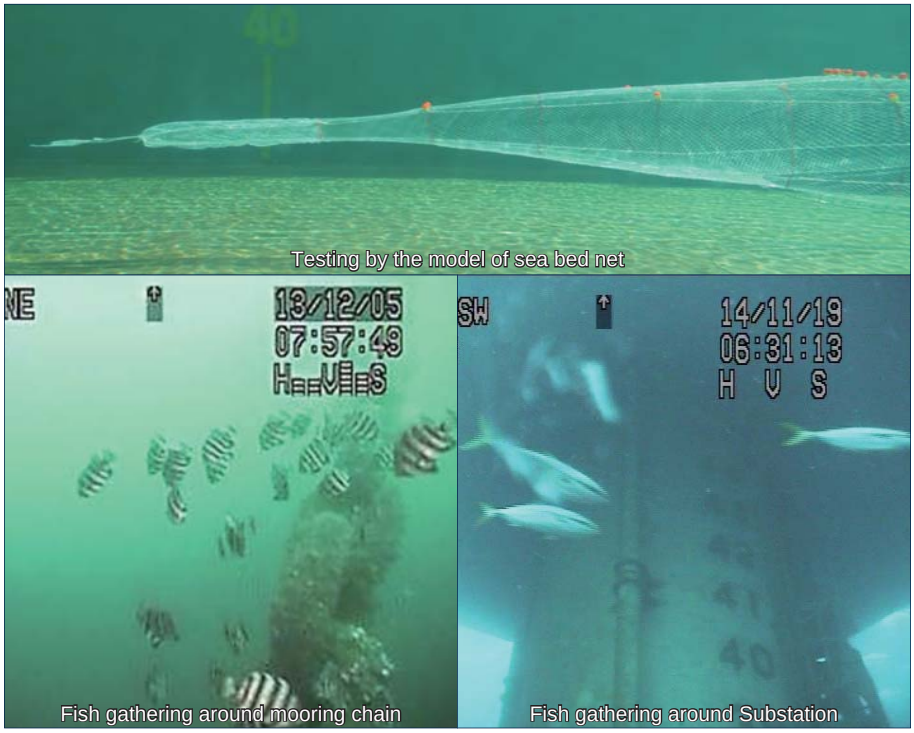


Image of fish reef



Testing by the model of sea bed net

Fish gathering around mooring chain

Fish gathering around Substation

Operating and maintenance

2MW wind turbine and world first substation are working well since the commissioning at the end of 2013. At the landing point of sub-marine cable, the onshore switching station is constructed and the four people are always managing the offshore wind turbine facility by remote monitoring. While the normal maintenance work for the power facility is done by boat, emergency response training by helicopter is also implemented to execute necessary behavior in the case of emergency and more effective access method and O&M method are developed.


Monitering at the on shore Switching station

Monitoring camera

Marine navigation safety monitoring

Marine navigation safety monitoring

Emergency response testing by helicopter

Access by boat

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