World-leading Offshore Wind Power. Here!

Huge offshore floating wind turbines located off the coast of Hirono Town and Naraha Town in Fukushima Prefecture started operation in November 2013. Various innovative technologies combined with people’s passion are working together to create a “symbol of reconstruction.”

The Japanese archipelago is surrounded by ocean. In order to exert the potential of such abundant resources, there are active movements towards the establishment of offshore wind power generation throughout the country. Among them, a project is ongoing offshore of Hirono Town and Naraha Town, Fukushima Prefecture, namely, the Fukushima Floating Offshore Wind Farm Demonstration Project. In waters about 20km offshore of the coastal area, Fukushima Mirai (Future), which is a floating wind power generating facility with a height of over 100m, and Fukushima Kuzuna (Bonds), which is a floating offshore substation equipped with transformer facilities, are now in operation. The most outstanding characteristic of the facility is that they float like ships, as the term “floating” shows, unlike wind farms fixed on the seabed with a substructure. “The world’s first demonstration and research project will start in Fukushima: upon hearing this I was moved to take on the challenge.”

This is a quotation from Mr. Tomotumi Fukuda of Marubeni Corporation, who presides over the Fukushima Offshore Wind Farm Consortium. The consortium consists of ten of Japan’s leading companies in the areas of wind turbines, floating structures and power transmission lines, together with the University of Tokyo. Innovative technology and knowledge are gathered toward the goal to “Make Fukushima the frontier of renewable energy.” Not only the development of the floating offshore substation, but connecting the floating wind turbine and substation with a power cable is also a method that cannot be seen in any other project.

Aiming for “coexistence” and exploring the development path

People in Fukushima are also intently watching the development of the new possibilities of wind power generation. “I expect that it will become a major source of energy in the future,” says Mr. Takashi Yoshida, the Promotional Supervisor of the Renewable Energy Industry, Commerce, Industry and Labor Department at Fukushima Prefectural Government.

“Promotion of the introduction of renewable energy is an important measure of the prefecture. We would also like to exert our utmost efforts to make it truly conducive to the reconstruction of the region, such as promoting industrial clusters and job creation related to wind power generation.”

And there is another important theme we must not forget. That is “coexistence with the fisheries industry.” Mr. Tetsu Nozaki, the Chairman of the Fukushima Prefectural Federation of Fisheries Cooperative Associations says, “People in the fisheries industry also fully recognize the importance of this project. Local industry also has high hopes for the project, and I would like to see the establishment of world-leading efficient and stable renewable energy.”

On the other hand, there are also problems. What kind of impact the wind power generation facility will have on fishing areas is still unknown. “A system to ensure smooth communication between us and the consortium is being established, such as the foundation of a co-operative committee of fishermen. We would like to seek a way to make mutual development through collaboration, by gathering our ideas.”

Takashi Yoshida
Promotional Supervisor of Renewable Energy Industry, Commerce, Industry and Labor Department, Fukushima Prefecture

Tetsu Nozaki
Chairman, Fukushima Prefectural Federation of Fisheries Cooperative Associations

Municipality

Fisheries industry

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Photos provided by Fukushima Offshore Wind Farm Consortium

66kV submarine cable

66kV submarine cable

Offshore substation (150/22kV substation/observation tower) and associated near floating structure

22kV riser cable

22kV riser cable

Intermediate buoy

Intermediate buoy

Submarine part

Mooring anchor

66kV submarine cable

Fukushima Mirai, the 2MW wind turbine and floating structure, and Fukushima Kuzuna, the offshore substation, in waters 20km offshore and where the depth is about 120m.
The Making of the Floating Wind Turbine.

Almost everything was an unprecedented experiment. In addition, nature provides sudden and frequent changes. What kind of problems did the project members face, and how did they get to the point of starting the operation of the two floating structures? We would like to go over the record of their efforts up to now.

The moment the long-standing tension among project members slightly relaxed came in October 2013, 19 months after the consortium kicked into gear in March 2012.

"At any rate, everything was so difficult," Mr. Tetsuji Shiroeda of Shimizu Corporation talks openly about what was on his mind, looking back at the project so far.

Toward the Forefront of the Wind Power Industry with a Project that Leads the World

Then, let us review the way the Fukushima Floating Offshore Wind Farm Demonstration Project has been working up to now. First, following the Great East Japan Earthquake in 2011, on December 1, 2011, Fukushima Prefecture submitted the Prioritized Request on the Reconstruction of Fukushima Prefecture to the Local Office of the Headquarters for the Reconstruction from the Great East Japan Earthquake. The request included an initiative for reconstruction using the Fukushima Floating Offshore Wind Farm Demonstration Project as a stepping stone to further develop the strong points of Fukushima Prefecture, which had previously been making efforts towards the spread of renewable energy.

Responding to the request, on December 22, the national government publicly solicited the company to whom the project is entrusted. Marubeni Corporation, with strong record in offshore wind power generation, business abroad, assumed the role as project integrator, with the participation of members such as Shimizu Corporation, Mitsubishi Corporation, Mitsubishi Heavy Industries, Ltd., Japan Marine United Corporation, Mitsui Engineering & Shipbuilding Co., Ltd., Nippon Steel & Sumitomo Metal Corporation, Hitachi, Ltd., Furukawa Electric Co., Ltd., Mizuho Information & Research Institute, Inc., and with the University of Tokyo serving as the technical advisor. Compared to Europe and other countries, Japan is still largely behind in the area of wind power generation. In addition, because the availability of adequate land sites on the plains of Japan is diminishing, expectations toward offshore wind power generation are increasing. Particularly, floating structures are at the stage where demonstration and research has started recently in countries such as Norway and Portugal. In all cases, only one offshore wind power generation facility is floating on the water. The Fukushima Floating Offshore Wind Farm Demonstration Project is the first project in the world where two facilities (including a substation) are being floated. Thus, it also offers an occasion for Japan to make a big leap forward and become the world’s leader in this area.

Struggling with the Huge Structure both Under and On the Sea!

However, what awaited the members was a series of works to open up a new horizon on an unexplored frontier. In addition to the fact that “everything was so difficult,” as mentioned in the beginning, “in fact, seas near Japan tend to have steep waves and swift currents, on top of the frequent arrival of typhoons. The conditions are severe considering the situation around the world. Since we decided to venture into a floating type project facing such conditions, professionals in the wind power generation sector abroad were surprised, saying ‘are you serious?’” explains Mr. Shiroeda.

Against such a background, Japan does not have much experience in offshore construction, even though it is a maritime nation.

This project started with ocean-based research by Shimizu Corporation to consider the planning layout of the floating structures. “Where should we lay out the transmission cable? We studied the geological distribution of the seabed and other factors, and by making adjustments with local people with the help of Marubeni Corporation, selected an appropriate site.”

In November 2011, a test to pull the anchor and chain set at the actual site was conducted. After all project members felt the positive response that “it should work at this site,” the project took a major step forward from the design of the wind power generation facility to its construction. A joint venture formed with Nippon Steel & Sumikin Engineering Co., Ltd. was in charge of the towing and mooring the floating wind turbine from Tokyo Bay, and the laying and burying of the submarine cable. Although it is necessary to set an anchor and chain for mooring the floating structure, the wind turbine rises 100m from the sea surface. It is not easy to affix a structure of such size to the seabed. “The chain designed is a huge one, with a diameter of 132mm. We repeatedly had discussions with Mitsui Engineering & Shipbuilding, the company that designed the chain, to consider a secure construction technique. The construction work to moor the floating structure in waters 120m deep with this chain, the largest in Japan, is unprecedented.”

In Order to Make the Facility Truly Acceptable to the People

What Mr. Fukuda from Marubeni was prioritizing in this project was “speediness.” “I thought that it was important to complete the actual facility at the earliest possible moment and to let people see it turning.” However, nature is unpredictable. There were many unexpected incidents, such as the successive occurrence of heavy typhoons this summer.

“Once the work starts, you basically spend the whole period at sea. One worker spent nearly a whole month without returning onshore. It is a cardinal rule that one must do what can be done at that time, by closely watching the weather at the site,” says Mr. Shiroeda.

Conquering such difficulties, the first period of the construction work, which was until the end of FY2013, was completed. Mr. Shiroeda says, “We reached this point with various kinds of cooperation, such as people in the fisheries industry joining in and providing patrol ships. We believe that it is necessary to securely implement demonstration research, and utilizing the results in subsequent cases will make this facility something that is truly acceptable to the people.”
The World’s Trend is Offshore Wind Power: Japan is Striding Forward!

Large growth of the wind power generation market is continuously expected worldwide in the future. Japanese companies also have a favorable opportunity for exploring new businesses.

2MW wind turbine and semi-submersible floating structure

How Do the Facilities Resist Severe Conditions?

During the first period of the demonstration research, the world’s first 6MW floating offshore substation was constructed by Hitachi, Ltd. The substation differs largely from conventional onshore substations. The facility must maintain its insulating capacity and operability even when the floating structure sways. Routine operation and monitoring for unplanned operation will also be necessary. Further, because the substation serves an important role of supplying power to critical facilities for ensuring safety, including lights to avoid maritime collision accidents, high reliability and an emergency backup system in case the facility has a breakdown are necessary. These qualities will be ensured from various points of view, by also checking the state of aging degradation through regular demonstration checkups.

How do the facilities resist severe conditions?

The Wind Turbine Itself is Designed for Offshore Use as Well

The 2MW wind turbine by Hitachi, Ltd., which is a supplier of downwind type wind turbines, was improved for the project. In addition to the design to increase the strength of the tower, devices such as a gear box and hydraulic unit were also designed to work on the oscillating floating structure. Further, because the supporting structure is floating, and not fixed like onshore or seabed-affixed facilities, movement caused by the turning of the turbine itself must also be restrained.

The wind turbine itself is designed for offshore use as well.

Protecting the Wind Turbine from Motion and the Elements!

A compact semi-submersible floating structure requires design and analysis capabilities to estimate the behavior of the facility in marine environments, and to minimize the vibration and oscillation caused by waves, winds and currents. Deep consideration was made based on the technology developed by Mitsui Engineering & Shipbuilding Co., Ltd., through the designing and construction of offshore oil and gas floating structures. In order to verify the validity of the design methodology, various sensors were installed on the floating structure and the wind turbine, and monitoring will continue for two and half years. This is expected to provide valuable data and knowledge.

The facility must maintain its insulating capacity and operability even when the floating structure sways.

Harnessing Expertise!

Technology Leading the Way to a New Era of Power Generation

The project will enter the main stage from FY2014, which will be an important step towards the realization of a large-sized offshore floating wind farm in the future, such as the addition of a 7MW wind turbine, which is one of the largest in the world. Know-how and knowledge are pouring in from experts in various fields in order to overcome technical challenges one by one.