An Interview with Dr. Takeshi Ishihara, Professor of the University of Tokyo & Founder of the Consortium

Fukushima Offshore Wind Consortium

Symbol of Fukushima Restoration Could Spark a Global Energy Revolution

By *Japan SPOTLIGHT* Editorial Section

A new energy demonstration project in Fukushima is attempting to make a floating offshore wind farm a major energy source in Fukushima, which has been suffering from a nuclear power plant crisis these past three years in the wake of the earthquake and tsunami of 3.11. In November 2013, about 20 kilometers off the coast of Fukushima, a 2,000-kilowatt wind farm started working, with plans for two larger wind farms of 7,000 kW each to be floated later.

This major experimental project aims to make Fukushima a model region for the utilization of renewable energy sources, and could thus be considered a symbol of its restoration. *Japan SPOTLIGHT* interviewed Dr. Takeshi Ishihara, who is in charge of this project, at the University of Tokyo.

Q: A floating offshore wind farm is made up of a number of innovative technologies, such as floating wind turbine technology and advanced steel materials. Could you tell us what are the most notable technological innovations involved in this project?

Takeshi Ishihara, Professor, Department of Civil Engineering, School of Engineering, University of Tokyo

Ishihara: A wind farm floating like a ship at sea on such a large scale as this in Fukushima has never been put into operation anywhere in the world. Looking back at the history of wind farms, the first ground-based wind farm was created in Denmark in the 1970s, and in the 1990s Europe began a study on wind farms with their foundations set on the seabed. As a demonstration project, Norway's High Wind project established a large floating offshore wind farm for the first time in the world. In Europe certainly many wind farms are operational but most of them are in the North Sea and Baltic Sea where the depth of the water is at most 10-20 meters, even when quite far offshore. So in northern Europe, the spread of large offshore wind farms involves those built upon the seabed, not floating ones.

But in southern Europe, in the Mediterranean Sea, for example, or in the Atlantic Ocean, the depth of the sea a few dozen kilometers from shore easily exceeds 100 meters or 200 meters. In Japan as well, with the Pacific Ocean, we have very deep waters, and the same is true of the Atlantic off the east coast of the United States. It would be extremely difficult to create a wind farm built on the seabed and supported by stakes in the ground at such depths. It might be possible to build them near the shore, but it would be difficult to do so almost anywhere in the world because of possible legal conflicts over fishing rights or potential damage from wind farms to the local landscape.

Feasibility studies on the practical use of floating offshore wind farms have frequently been undertaken around the world in order to promote wind power as a new energy source, but our project is unprecedentedly large scale — bigger than any ground-based or sea-based wind farm in existence. A key to its feasibility is how to build it up as efficiently as possible in terms of construction costs, since its technological feasibility has already been proved.

On the issue of its economic efficiency, for example, the following questions need to be examined.

The chains used for mooring must be strong enough to last for 20 years without either replacement or maintenance. Research and development of advanced steel materials has been started to explore production of such durable chains. It would not be feasible to spend too much money on maintenance of a wind farm, unlike the case of a ship that can be inspected and maintained in dock at much less expense. Twenty years would be the minimum for the use of such materials for the chains — otherwise the cost calculations would

make it difficult to build such wind farms. Durability and corrosion resistance are the technical requirements that would make a floating wind farm feasible.

Our demonstration project is trying to clarify how these chains can endure the movement of deep water.

Q: I think the winds offshore are probably stronger than those closer to land, so I guess there is good potential for wind energy offshore. Could you clarify for us how much potential a floating offshore wind farm would have?

Ishihara: We estimate the potential of wind energy sources offshore, excluding the areas closer to land, to correspond to the annual electric power generation of Tokyo Electric Power Company (TEPCO). More precisely, our annual wind power potential in Japan is 1.86 billion kW and offshore wind power alone could total 1.57 billion kW in Japanese seas and Exclusive Economic Zone, the sixth-largest area in the world. This is by far greater than the potential of the other renewable energy sources such as solar energy (150 million kW) or geothermal energy (14 million kW). The total electric power capacity of all Japanese power companies today is around 0.2 billion kW, so the potential capacity of offshore wind power in Japan is eight times greater. The capacity of all the wind farms in the world is today about 0.3 billion kW and Japanese potential wind power capacity is five times as large.

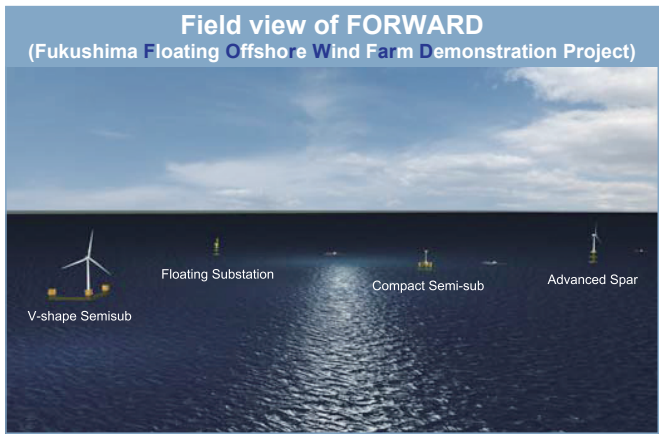
In the light of these impressive figures, we believe we have a sufficient amount of energy potential. If we can find a way to save costs, this could become one of the most important energy sources.

As a matter of fact, Spain has the highest percentage of wind power among its energy sources. Although wind power heavily fluctuates in accordance with natural circumstances, we can modify such fluctuations by increasing the number of wind farms. In Spain, they integrate their wind farms very well into small thermal power stations by taking advantage of the high voltage of batteries that wind farms produce.

Another merit of wind power is that a country can use it very quickly since wind farms can be constructed within two or three years, whereas it would take 10-20 years to construct a thermal power station with the same capacity as a wind farm. Thus even in developing countries without electric power sources, they could easily produce electricity from wind power, and that is why it is attracting the attention of experts there.

Q: As you say, it will be necessary to build many wind farms, especially floating offshore ones, to create a principal energy source. In that case, it would be very important how we tackle such issues as the safety of ships sailing between the offshore wind farms or protection of the fisheries industry. What do you think about these points?

Ishihara: Engineering experts at the University of Tokyo are currently studying the possible impact of such wind farms on ships in cooperation with the National Maritime Research Institute. Their assessments are based on how many ships would be affected by wind farm construction and how we could avoid collisions, as well as how a possibly detached wind farm mooring chain might affect other wind farms.



On the question of the fisheries industry, we do not know yet how we may be able to protect the industry from possible damage caused by wind farms. But this may not necessarily be a big question, since most of Japan's fishery is practiced in areas closer to the coast and not offshore. In addition, our mooring chains are long and a wind farm itself would not affect the quantity of fish caught by the industry. Research even shows the opposite of what may be expected — that the size of fish hauls is increasing.

Q: How about possible damage to landscapes and the question of noise?

Ishihara: On the question of landscapes, our wind farm in Fukushima is located 20 km from the coast, so there is no such problem. Unless we build it in an area far from the coast, we cannot fully utilize wind power. The problem of noise will not matter offshore. This is different from the case where a wind farm is built up close to people's homes.

Q: Are there any great advantages to wind power over solar power?

Ishihara: In the light of production costs, a wind farm on land would be much less expensive than a solar power system, and it could be built at about the same cost as existing energy production. As for offshore wind farms, of course, it depends on the region's existing wind power whether they work well or not. For example, there would be some places like the Setouchi Inland Sea in Japan where we do not have sufficient wind power, whereas, according to our joint study in cooperation with the New Energy Development Organization, we have a good amount of wind power in Choshi city in Chiba Prefecture only 3 km away from the coast.

Q: At this point, are there any good cost saving prospects for offshore wind farms?

Ishihara: As for wind farms on land, we have done simulations and already know what structures will lead to cost savings. But for offshore wind farms we have not been able yet to achieve good simulations because of the vibrations of the water. We do not yet know how such vibrations would impact floating wind farms. Today many countries' research institutes are competing to achieve good outcomes for such simulations.

Another technological issue related to these simulations is the possible impact of the vibrations of the water upon the electric power substations on floating wind farms. We need an electric power substation on a large floating wind farm in order to collect all the electrical power generated by smaller wind farms and raise the voltage of this accumulated power for transmission to land. Such a floating transformer system must be both durable and non-susceptible to motion. This is something that is unique about our project and distinguishes it from attempts in other countries.

We will also need a special cable called a "riser cable" with a superior capacity to withstand fatigue, since we must connect large-scale electricity lines with cables under the sea. Hitachi Ltd. and Furukawa Electric Co. Ltd. in our consortium are in charge of developing such new technologies that no other country in the world has ever succeeded in creating.

Q: Could you please tell us how you share the work in your consortium? Is the University of Tokyo, for example, in charge of simulations of water vibration?

Ishihara: Marubeni Corporation is responsible for organizing the whole project. It is also handling administrative matters such as acquiring official permission from the local or central government in promoting this power station project and also collaboration with the fisheries industry, since it has long experience in managing power stations.

The University of Tokyo is responsible for the entire technological aspect of this project and I am a technical advisor to it. In addition to the simulation of vibrations, we are engaged in a study to measure wind velocity around the offshore wind farm. As I said, we are also working on resolving the question of how to ensure the safety of ships moving among the floating wind farms.

We are also in charge of PR activities for this project and promoting dialogue with the local residents in Fukushima on the whole structure, as well as the implications of the project at a center of communication with residents in Iwaki city. We are also creating brochures and websites to present our project to the public.

Q: Generally speaking, it seems to take a long time to develop renewable energy sources for practical use. Will it take a long time for this project to turn wind power into practical use as well?

Ishihara: It takes several years to construct a wind farm on land and about seven years on average offshore. However, in our project we plan to complete it in four years. Therefore our project is not only the largest and most technologically advanced to date, but will also be the quickest to be completed.

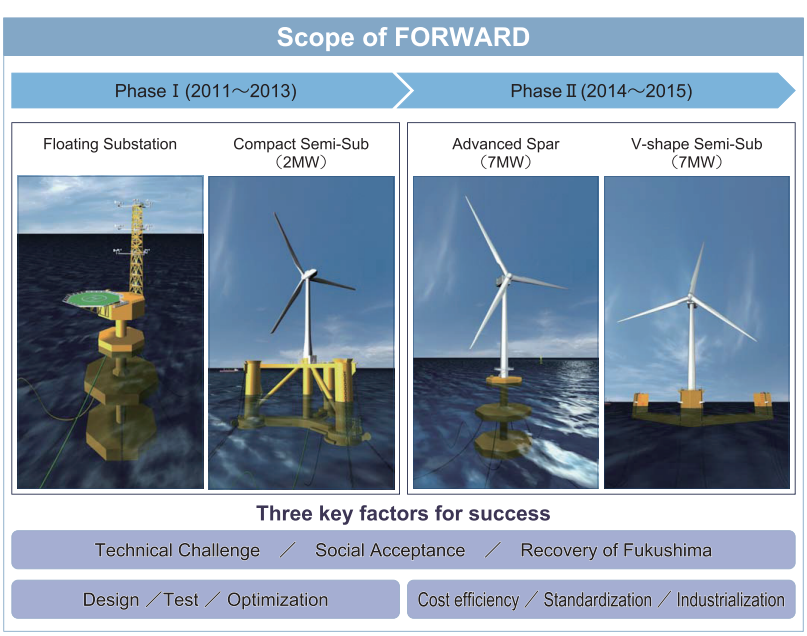
Q: How do you think your project will help the Fukushima economy emerge from the present crisis?

Ishihara: The electric power industry was the most important industry in Fukushima. It used to produce more than 10 million kW of electricity every year, including the power generated by the nuclear plants that will now be decommissioned, and provide Tokyo with 80-90% of this power, with the rest being consumed in Fukushima.

However, 4 million kW of that power has been lost due to the decommissioning of nuclear reactors. The Fukushima prefectural government has recently adopted an energy outlook, of which I am one of the authors, that says this lost 4 million kW of electricity can be restored by wind power. According to this plan, we will develop renewable energy sources that will meet the total demand for energy in Fukushima. Among these renewable sources, wind power is considered the main one. Fukushima will produce more than 3 million kW by 2030, according to this outlook. Today the total amount of electricity generated by wind power throughout Japan is at most 3 million kW.

In Fukushima we do not need to create any crucial new infrastructure for electricity, since we can use what is already in place for the nuclear plants to provide electricity to Tokyo. Fukushima already has such infrastructure and a good amount of wind power. This is certainly one of the best places for our project.

Q: Do you have an outlook for wind



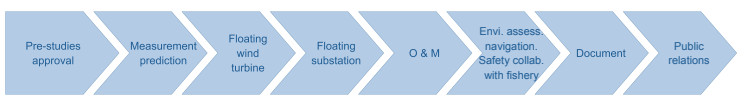
power in Japan overall?

Ishihara: We do not have such a national outlook. However, according to our colleagues working on wind power, the most conservative outlook is 10 million kW by 2020 and 20 million kW by 2030, to be mainly provided by wind farms on land.

But it will be difficult to provide 20 million kW only by land-based wind farms due to the limit on inland locations. I think half of this amount should be provided by floating offshore wind farms. For example, in Tokyo, we do not have any location with good wind but in Fukushima, Ibaragi and Chiba the potential of wind power generated by offshore wind farms would correspond to the electricity provided by TEPCO. Kansai Electric Power Co. and Chubu Electric Power Co. seem to have a similar situation. I guess these three power companies in collaboration with each other could promote significant development of renewable energy sources.

FORWARD members and main role

FORWARD member	Main role
Marubeni Corporation [Project integrator]	Feasibility study, approval and licensing, O & M, collaboration with fishery industry
The University of Tokyo [Technical adviser]	Metocean measurement and prediction technology, marine navigation safety, public relations
Mitsubishi Corporation	Coordination for grid integration, environmental impact assessment
Mitsubishi Heavy industries, Ltd.	V-shape semi-sub (7MW)
Japan Marine United Corporation	Advanced spar, Floating substation
Mitsui Engineering & Shipbuilding Co., Ltd.	Compact semi-sub (2MW)
Nippon Steel & Sumitomo Metal	Advanced steel material
Hitachi Ltd.	Floating substation
Furukawa Electric Co., Ltd.	Large capacity undersea cable
Shimizu Corporation	Pre-survey of ocean area, construction technology
Mizuho Information & Research institute, Inc	Documentation, committee operation



Q: Could you give any time frame for the implementation of your project?

Ishihara: Our demonstration project will be finished in 2015 and we are planning to put it into practice by 2018 in building up 20 wind farms for commercial use.

Q: Would this have a big positive impact on the economy?

Ishihara: Yes. A wind farm would need 20,000 parts and components. There would be an enormous impact upon the industries providing them. In our consortium, Marubeni and Mitsubishi Corp. are already engaged in large-scale investment in US and European wind farm operations. We can take advantage of their business experience. Some 5,000 tons of steel would be necessary to build one wind farm. That is the same quantity for constructing a 200-meter-high building in Shinjuku. If we build 10-20 wind farms each year, that would mean we will create a city like Shinjuku every year. Three shipbuilding companies have joined us, since it is today very difficult for them to find opportunities to build ships using 5,000 tons of steel under the current serious depression of their industry.

As we also need economic research in our project assessment of the impact upon the local economy, we invited Mizuho Information & Research Institute to join us.

Q: Will your project be one of cooperation among companies from different countries?

Ishihara: Our project is a demonstration project and we have already chosen our partners, all Japanese ones. But at the stage of its commercialization it will be open to global competition. We would welcome any company that could provide its products at the cheapest price. They can collaborate with Japanese companies in production and R&D or they can invest in our operations. We need a large sum of money, after all, to build floating offshore wind farms. A wind farm with 1 million kW capacity would cost 30-50 billion yen — equal to the construction cost of a nuclear power plant.

International collaboration would certainly be welcome in the sense that the whole project could take full advantage of the strengths of each member of the team. Investment is certainly a good way for any overseas company to make the best contribution to our project.

Our energy market, which has so far been ruled by monopolies, will be liberalized soon. I would welcome any international company joining this remarkable energy revolution.

Q: What specific positive impact will this project have on the economy of Fukushima, given that it is being considered as a symbol of Fukushima's restoration?

Ishihara: This project will create a large number of job opportunities in Fukushima. Around 10,000 people were employed by nuclear power stations in Fukushima before the crisis. Our wind farm project will create more than 10,000 jobs. We can see a precedent for this in Germany. Creating a new industry definitely leads to job creation.

On the other hand, we will need to get approval from the fishing people who are concerned about the possible negative impact on their business. We need an objective assessment of such an impact and of how to compensate them for possible losses brought about by our project.

In order to make it truly a symbol of restoration in Fukushima, we will need to continue to communicate with local residents to achieve a consensus on its implementation. We would really like to pursue our model project fully supported by local residents. This would make our project a symbol of the potential wealth and happiness of the people in Fukushima. JS