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Japan's Offshore Wind Power Rises within Sight of Fukushima Nuclear Plant

Unique turbines that float on the surface rather than rest on the seafloor can be placed in deeper waters

An experimental wind turbine floating about 20 kilometers off the coast of the stricken Fukushima Daiichi nuclear plant marks Japan's first step toward building the world's largest offshore wind farm. But the island country still faces huge challenges as it aims to boost renewable power sources in the wake of its greatest nuclear disaster.

The turbine is connected to the world's first floating wind farm substation in an ambitious bid to unlock offshore wind power in deep waters. Such technology could help Japan start tapping into offshore winds that are estimated to harbor about 1,570 gigawatts of power—more than five times the current capacity of Japan's power companies. (A gigawatt is one billion watts.) Wind is considered vital to the country's search for alternative energy sources in the wake of the Fukushima nuclear disaster. "I believe that the Fukushima project will help the Fukushima region and Japan as a whole move toward more use of renewable energy," says Takeshi Ishihara, a civil engineer at the University of Tokyo and leader of the Fukushima wind farm project.

A traditional wind turbine tower jutting upward from the seafloor becomes too expensive to install in waters deeper than 50 meters—a big problem for Japan because its coast is surrounded by a continental shelf ranging from 50 to 200 meters deep. But a floating wind turbine and substation with multiple huge steel chains anchoring them to the seafloor can operate in those deeper waters.

Furthermore, offshore wind farms can reap the benefit of higher average wind speeds compared with onshore wind farms—a two-year study showed speeds between 7.4 and nine meters per second offshore near Fukushima versus less than 4.3 meters per second on land. "Japan has lots of deep water off the coast, which is a good wind resource," says Walt Musial, principal engineer at the National Wind Technology Center near Boulder, Colo. "In order to develop that resource it needs to be at the forefront of development for floating turbine technology."

The first prototype Fukushima wind turbine has already weathered an earthquake, small tsunami and typhoons in October—all before the turbine and substation are scheduled to begin full operation in November. It was a deadly earthquake and tsunami that crippled the Fukushima nuclear plant on

March 11, 2011, which prompted the Japanese government to speed up the project's original plan for a 2016 demonstration.

Undersea cables connect the two-megawatt turbine to the same power grid that links to the Fukushima Daiichi nuclear plant. Japan's government has invested $226 million toward the installation of the first prototype turbine and two additional seven-megawatt wind turbines. If testing goes well, a private coalition that includes firms such as Marubeni, Mitsubishi, Hitachi and others has signed on to pay for full installation of 140 floating wind turbines.

The final one-gigawatt wind farm planned for completion in 2020 would generate the same power as a large nuclear reactor. That could contribute about 7 percent toward the Fukushima Prefecture's goal of using 100 percent renewable power by 2040, Ishihara says. He hopes Japan can eventually use offshore wind power to satisfy one third of the nation's power needs.

That dream remains a far cry from today's reality. Wind power contributes barely 0.9 percent (2.6 gigawatts) of Japan's total power capacity, says Paul Scalise, a research fellow at the University of Tokyo. Japan has not tapped much offshore wind power potential, in part because it lacks the shallow coastal waters exploited by European offshore wind farms.

The Fukushima project, backed by Japan's Ministry of Economy, Trade and Industry, is not the country's only venture into floating wind turbines. Japan's Ministry of the Environment is supporting a separate two-megawatt floating wind turbine near Kabashima Island that began operation on October 28. The projects use different technologies to stabilize the turbines against the ocean waves. Fukushima's turbine platform is a semisubmersible design with three buoyancy tanks arranged in a triangle around the turbine, Musial explains. By comparison, the Kabashima turbine platform represents a spar design that resembles a tall, thin buoy with much of its mass extending deep below the surface—offering greater inherent stability against the waves but requiring deeper waters for operation.

Norway first installed a spar design in its Hywind floating wind turbine in 2009, followed by Portugal's semisubmersible Windfloat turbine in 2011. But Japan's Fukushima project has made a mark with the world's first floating substation containing the electrical equipment needed to transfer power from turbines to shore.

Japan's offshore wind effort still faces big challenges, such as rough seas that make maintenance of wind farms difficult, Scalise says. He also warned of political obstacles raising the cost of such operations, including NIMBY (not-in-my-backyard) protests and rights to shipping lanes and fishing zones. (The Fukushima project still has to negotiate with local fishermen to build more than the first three prototype turbines.) "The farther that developers build wind farms off the coast of Japan to avoid political protests from various conflicting interest-groups and the NIMBYists, the more expensive it becomes to build, maintain and transmit electric power back to onshore customers," Scalise says.

Studies have shown that once turbines are farther than 16 or 20 kilometers at sea, they appear to be mere dots on the horizon on a clear day or perhaps even invisible otherwise, one reason why the prototype may be anchored where it is. The Fukushima project aims to deploy the full-scale wind farm beyond the horizon to avoid NIMBY concerns. But visible or not, the first prototype turbine and substation are a sign that Japan's future could be one that rises from the sea.