Gale-force winds are whipping waves to dizzying heights as a thin silhouette of an 80-meter-high mast dimly appears through the mist. Driven by the howling wind, the mast's rotor blades spin furiously in the night air. Although it has neither pillars nor stilts for support, the mast stays upright, leaning only slightly. It's hard to believe, but there it is: a wind turbine floating on the water.

Such wind turbines haven't been built yet — but planning for them is well under way. In fact, beginning in 2009, a first prototype off the southwest coast of Norway will demonstrate whether this technology can stand up to heavy winds and waves. The floating wind turbine is a cooperative project between Siemens' Renewable Energy division — the world market leader for offshore wind farms — and the Norwegian energy company StatoilHydro. As Norway's potential wind energy sites are often in nature conservation areas, the country's energy sector is looking to the sea. Denmark set up its first offshore wind farms more than 15 years ago, but to date, these have all been located near the coast in depths of less than ten meters, where anchoring is relatively easy. Expansion, however, is difficult, due to factors such as fishing grounds and bird migration zones.

But now Siemens and StatoilHydro are taking their Hywind project out to the high seas, where winds are stronger and more consistent than near the coast. According to the National Renewable Energy Laboratory in the U.S., for instance, wind potential at 5 to 50 nautical miles off U.S. coastlines is greater than the installed generating capacity of all U.S. power plants, which is more than 900 gigawatts.

200 Meters Deep. Norway is ideal for prototype testing because the seabed drops steeply offshore. At 12 kilometers from land, where the wind turbine will be placed, the seabed is about 200 meters below the surface. StatoilHydro is responsible for the underwater part of the facility, while Siemens will supply the tower and the complete turbine. For its Hywind prototype, StatoilHydro is using a "spar buoy" concept that features a steel and concrete buoy equipped with ballast tanks — a concept that has been used with floating drilling platforms for many years. The buoy's 120-meter-long float is designed to ensure that the structure's center of gravity is far below the water surface, thus preventing the wind turbine from bobbing to and fro in the waves like a bathtub thermometer. The ballast tanks will make it possible to precisely set the center of gravity. And to ensure that the structure doesn't drift away, it will be held by three steel cables moored to anchors on the seabed. The power generated will be sent ashore via a marine cable. The simple anchor/steel cable design is the key that makes it possible to install the turbine in very deep waters, unlike a massive pillar design, which would become uneconomical at depths in excess of 100 meters.

"We hope to be able to use this concept at depths of up to 700 meters," says Siemens Renewable Energy Division CTO Henrik Stiesdal, who is based in Brande, Denmark. At greater depths, the costs for steel and anchors would make such facilities too costly. An offshore farm with up to 200 turbines could supply almost a million households with electricity.

The first step in that direction will be to build and test a prototype. The prototype now being planned will be outfitted with an electronic control system to ensure that the turbine doesn't tip too far and become unstable. The system will make it possible to alter the angle of the rotor blades and thus the structure's response to incoming wind, thereby enabling the facility to balance out any swinging motions. It's also been suggested that the generator and hub could be tipped, which would shift the facility's weight and compensate for swaying movements. "We still need to test all of these things," says Sjur Bratland, project manager for StatoilHydro. "What we're doing here is developing technology for a future market. With its turbine expertise, Siemens is a reliable partner with a lot of forward-looking ideas." Bratland believes the Hywind solution will be perfect for regions that have few energy resources and little available free land, but good wind conditions at sea." Candidates include Japan and the U.S. ■ *Tim Schröder*

Tapping an Ocean of Wind

StatoilHydro of Norway and Siemens are developing the world's first floating wind turbine — opening the door to harvesting the power of the wind on the high seas.

Future offshore wind turbines will be fixed to a steel tube extending 120 meters under the surface. Along with three steel cables, the tube makes the design robust enough to work on the high seas.