The Tide Is Turning: Turbine Rides Underwater Currents Like a Kite

Thursday, 25 September 2008

here is no market yet for turbines that turn the tides into a source of energy from deep beneath the sea. But that has not stopped mechanical engineers at the University of Strathclyde's Energy Systems Research Unit (ESRU) in Scotland from developing one that will ride the tide while latched to the seabed by a cable—like a kite flying on a windy day.

The ESRU team's goal: create a device that literally goes with the flow rather than resting on the sea bottom like an underwater windmill—a model already being developed by a handful of companies. The kite and cable model is designed to facilitate placing tidal turbines in deep water, where the stronger current has the potential for providing greater power but also makes it extremely difficult to plant a turbine in the seabed.

"The problem with regular turbines is the bigger they get, the harder they work, and the more likely the force of the water is to damage the turbine," says Andrew Grant, an ESRU mechanical engineer. "Our turbine can fly like a kite in the water." Instead of planting the base of a turbine in the seabed, researchers need only plant an anchor for the tether.

Another key difference in ESRU's design is that the turbine has two rotors attached—one in front of the other that turn in opposite directions on a single axis. The rotors' blades are made of either solid aluminum alloy or glass-reinforced plastic, depending on their sizes. By having the rotors turn in opposite directions, Grant and his team are trying to cut down on reactive torque (which pushes the turbine in the opposite direction) so that the unit can be attached to a relatively simple mooring system even in very deep water. This "contra-rotating" design has been tested on wind farms since the 1980s but did not provide an advantage (in terms of generating more energy with less wind) in the open air, Grant says.

New York City-based Verdant Power, Inc., has experienced firsthand the trials and tribulations of developing working tidal turbines. In fact, Verdant has taken the technology further than anyone else, having operated in New York's East River since 2006. That project began with six windmill-like turbines anchored to the river bottom, 30 feet (nine meters) below the surface, churning at a peak rate of 32 revolutions per minute. After the powerful current of the East River—which is actually a tidal channel—damaged the rotors and broke off some of the original fiberglass and steel blades, the company earlier this month whittled its test bed down to two turbines with new aluminum–magnesium blades 16 feet (five meters) in diameter.

"We only need two to complete our operational tests," says Trey Taylor, Verdant's president and head of market development. The East River turbines are already providing power to a nearby grocery store and parking garage on Roosevelt Island, situated in the river between Manhattan and Queens. The U.S. Department of Energy recently awarded Verdant $1.2 million for the company to further develop its technology over the next two years. Another $3.3 million has come in from the Canadian government—Verdant is testing a new type of turbine in the Saint Lawrence River near Cornwall, Ontario, that sits on the riverbed rather than being moored to the bottom.

Taylor says he is familiar with the ESRU's work and that Verdant itself even tested a tethered, kitelike turbine back in 2002. "I know what they're doing, and they've got a long way to go," he says. "We found that the tidal forces moving against it caused it to move up and down too much." Taylor says that the twin-rotor design is intriguing but questions whether the blades rotating in different directions might mitigate the turbine's efficiency in capturing the full strength of the tide. "It takes a combination of science, engineering and physics to get it right," he says, adding that he likes it whenever anyone experiments with tidal turbines because everyone working on the technology benefits from the results.

As ESRU preps its turbine technology for sea trials, which begin next week, Grant acknowledges that a number of questions remain. The researchers have not determined whether they need to float a buoy above to further stabilize or secure the turbine (addressing Taylor's concern about the turbine moving up and down too much). It is also unclear how the turbine will behave when there is no strong tide, and how the turbine's motion may affect an electric power cable attached to it. (For example, will the cable become twisted if the turbine moves around too much?)

ESRU scientists do not believe their technology will harm marine life, but admit they do not know whether the tethered turbines will attract or scare off fish. "The turbines turn slowly, so we're not talking about chopping up fish," Grant says, noting the installation of the mooring may initially disrupt the seabed but likely will not have to be touched once it is set in place. Verdant has spent about $9 million thus far on its East River project; one third of the funds were spent on studies to gauge the potential impact of the turbines on vessel navigation, aquatic life and fish migration.

Grant acknowledges that tidal-derived power has a long way to go before it can be used as a mainstream source of energy. "There are big barriers to making money out of this," he says. "There's a lot of technical risk, so there's a lot of financial risk, too." He expects it will be a decade or more before ESRU's turbines are ready to be used in earnest in the sea—much more testing must be done, in addition to the environmental impact studies and garnering of support from utility companies.

Renewable energy has always suffered from the fact that the best places to capture sunlight, wind, waves and tides are also the most remote locations, which means an infrastructure is required to send the power where it is needed. "In the

U.K., it's quite difficult to get the power utilities interested in this," Grant says. "To get to this energy, you would have to run power lines across the country, which creates environmental concerns."

This has not stopped Verdant and other companies from trying. Lunar Energy, a U.K. tidal power company, in March began working with Korean Midland Power Company to create a giant 300-turbine field in the Wando Hoenggan Waterway off the South Korean coast. The plant is expected to provide 300 megawatts of renewable energy to Korean Midland Power by December 2015.

Utilities interested in tapping into tidal power will have to spend money to create the energy-delivery infrastructure, or at least convince government to pay for it. One thing working in favor of new energy sources: the cost of oil is not getting any cheaper.

Source: Scientific American (http://www.sciam.com/article.cfm?id=turbine-that-rides-the-tide)