Wind power explored off California's coast

In many ways, wind energy seems an ideal energy source. Fields of mighty turbines spinning in rhythm could harness carbonless power and shuttle it off to homes and industries. But questions remain about the feasibility of wind parks: How much will they cost? Can this unpredictable energy source be relied upon to contribute appreciably to the country's power needs?

A team of Stanford researchers set out to find answers in a recent study of the California coast and will present their research during a Dec. 13 poster session at this year's meeting of the American Geophysical Union in San Francisco. The poster is titled "California Offshore Wind Energy Potential."

Michael Dvorak, a Stanford doctoral student in civil and environmental engineering, joined Mark Jacobson, professor of civil and environmental engineering, and Cristina Archer, consulting assistant professor of civil and environmental engineering, in evaluating the potential for harvesting wind energy offshore in California.

"This is basically the first study that's a detailed look at places where we could develop offshore wind energy in California," Dvorak said. "Some of the studies have looked at the wind speeds offshore, but they hadn't looked at the [water] depth and wind speeds at this high of resolution."

Deeper water means higher costs for building wind turbines. Not only would it require more materials to reach the bottom and anchor the structures, but, as the water depth increases, so does the power of the waves constantly slamming into the turbine supports, Dvorak said.

Furthermore, most engineering research worldwide has been focused on building turbines in shallow water, like that of the North Sea in Europe, where all of the existing offshore wind parks are. Consequently, most available technology is geared toward building turbines in water less than 20 meters deep. Though wind speeds are usually higher further offshore, the study concluded it would likely be more economical to build in shallower water.

To assess wind speeds, the team employed computer models like those used by meteorologists to predict weather patterns. The researchers looked at wind speeds in 2005 and 2006 at locations along California's coast to estimate how much power could be generated annually.

Findings indicated that two of the three study areas are less than ideal for harvesting wind energy. Water depths of greater than 50 meters in the San Francisco Bay Area would require floating platforms, similar to those used for oil and gas exploration, but not yet developed for use in wind technology. In most of Southern California, the winds die down during the summer and thus would not generate a steady amount of power throughout the year.

The third study area the researchers looked at was a specific area in Northern California off Cape Mendocino. They found that a wind park at this site would supplant about 5 percent of California's electricity coming from carbon-emitting sources, Dvorak said. When combined with offshore wind energy at several other sites, it may be possible to produce between at least a quarter—and potentially all—of California's electricity.

Unfortunately, most transmission lines available to deliver power are in the southern part of the state, where winds are not as strong. But Pacific Gas and Electric Co. is looking into ocean wave-energy projects in Northern California, which also would require new transmission lines.

"There's a chance the wind and wave-energy projects could dovetail together and lower the transmission costs for both projects," Dvorak said.

A recent study authored by Archer and Jacobson and published in the November Journal of Applied Meteorology and Climatology examined ways to link wind farms to further exploit economies of scale and thereby reduce the cost of wind energy. Interconnecting multiple parks can offset the intermittent nature of wind and make it a more dependable source of energy, the authors said. And, like the wave-energy project, it would be cheaper to have an integrated set of transmission lines instead of separate connectors to each wind park.

Offshore wind farms have made headlines lately, as some residents of Cape Cod have argued that a potential Cape Wind project there would spoil their pristine view. A survey conducted earlier this year by Opinion Research Corp. found that, despite a vocal minority, 84 percent of all Massachusetts residents and 58 percent who live on or near Cape Cod support the Cape Wind project, Dvorak said.

"The proposed Cape Cod wind project, if it was built, would be the largest offshore wind park in the world," Dvorak said, noting smaller projects in Europe have been met with more support. Projects in Denmark, for example, began with one or two offshore turbines, he added. The proposed Cape Cod wind park calls for the construction of 130 turbines in Nantucket Sound.

In informal conversations with people who live near Cape Mendocino, Dvorak said most people seemed willing to sacrifice their view to have an environmentally friendly source of power.

Still, he added, "You would want to do a pretty extensive survey of the local population and the environment to see how they would be affected."

Another limiting factor is the development of new technology. Under provisions of the Merchant Marine Act of 1920, the construction of ships and offshore equipment—both of which are needed to build the wind turbines—must be done in the United States, even though there are experienced crews and ships outfitted for this sort of work in Europe.

"You can't actually farm it out to a foreign vessel," Dvorak said. "So the first offshore wind project of this type is going to incur a lot of extra cost."

It would take seven to eight years before a wind park like the one in Northern California could start producing electricity, Dvorak said, given the required environmental considerations.

Source: Stanford University, by John Cannon