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## BALANCING THE POWER OF OFFSHORE WIND

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Fears that wind only provides power when it's blowing outside could be neutralized by drawing from a wide area — such as the U.S. Atlantic coast. Despite the buzz this week from Interior Secretary Ken Salazar approving the controversial Cape Wind project off Cape Cod, the United States has yet to construct any offshore wind farms despite a slew of ideas blowing around and 11 specific proposals on the table. Europe, meanwhile, has taken a lead in offshore wind, and is looking at more. While those U.S. projects inch forward, researchers see a wealth of wind being wasted.

Willett Kempton, a marine policy professor and offshore wind expert at the University of Delaware, calls the wind off the Mid-Atlantic coast “a huge resource. It's enough to run the whole East Coast.” He points to a 2007 study<sup>2</sup> which showed that two-thirds of the power available from wind off the East Coast could provide enough energy to completely satisfy the demand for electricity, light vehicle fuel, and heating fuel for the region from Massachusetts to North Carolina. But Kempton noted that study left an important question unanswered: What happens when the wind lets up?

In a recent paper, Kempton suggested that if you look at it the right way, the wind never lets up.<sup>3</sup> When it dies down in one spot off the Atlantic coast, it's invariably kicking up in another. The research demonstrates, he said, that a fleet of offshore wind farms strung together along a 1,500-mile high-voltage cable could, from their combined output, provide more than enough electricity for the East Coast without interruption. And, he told Miller-McCune.com, this could happen using everyday technology and a few institutional changes. “If you assume new technology, we could run the whole United States,” he added.

### It's All in The Balance

Even though the power supply and customer demand vary constantly, the power grid must maintain consistent voltage at all times. To avoid power failures when circumstances change, utilities generally “load balance” — firing up highly responsive gas-fired turbines to adjust to fluctuating demand for power. In effect, these generators are what keep the lights across town from flickering whenever the stadium powers up for a big game. Because variability is inherent in wind, Kempton says utilities use the same equipment to accommodate fluctuations in power levels introduced by the small volume of wind generation currently feeding into the grid. “If you have 20 percent wind, that's fine, no problem. We'll just ramp the generators up and down as the wind fluctuates.” So it works — up to a point. “It keeps the managers busy; it's not that they let the fluctuations go out and let your lights bulbs flicker, but it adds maybe 5 percent to the cost of wind power to do that management.”

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<sup>1</sup> Miller-McCune report©, April 29, 2010

<sup>2</sup> Kempton, W., C.L. Archer, A. Dhanju, R.W. Garvine and M.Z. Jacobson. 2007. Large CO<sub>2</sub> reductions via offshore wind power matched to inherent 3 storage in energy end-uses. *Geophysical Research Letters*, Vol. 34, LXXXXX, doi:10.1029/2006GLO28016, 2007.

<sup>3</sup> Klempton, W., F.M. Pimenta, D.E. Veron and N.A.Colle. 2010. Electric power from offshore wind via synoptic-scale interconnection. *Proc. National Academy of Sciences*, Vol. 107, June 2010.

However, “If you want to run 50 percent or 80 percent of your electricity from wind, then that fluctuation becomes more problematic.” This calls for either massive power [storage systems](#) to warehouse energy for a rainy (or not so rainy) day, or major investments for more gas-fired generators. Kempton believes that wind farms up and down the coast, under the power of local weather conditions, could perform the same load balancing function for one another that gas turbines provide onshore. The study tracked coastal winds over five years using hour-by-hour data from 11 offshore weather buoys and meteorological stations. Then they put together a computer simulation that substituted wind farms for weather stations and included the proposed interlinking cable. They generated data simulating five years’ worth of power feeds from the hypothetical wind farms. While the researchers found that output from individual wind farms varied widely over time, the power output of the network as a whole held steady. Fluctuations, when they did occur, were gradual, but at no time during the study period did power output on the simulated grid drop to zero.

Other wind energy researchers see potential in other U.S. coastal areas. For example, Stanford’s Mike Dvorak and Mark Jacobsen looked at the California coast and determined that despite deep water close to shore creating headaches for placing turbines, offshore wind conceivably could meet up to 83 percent of the state’s electricity demand. Kempton says the reliability of the North America’s coastal wind resource is a happy accident of geography. A similar exercise using data from Great Britain’s coastal areas suggested considerably less promising results.

Researchers on the British study observed “large power swings in a 12-hour period” during the height of winter, when the region faces its highest demand for power. From that experience, lead researcher James Oswald of Coventry University suggested that “distributed generation would not help much” in the case of the British Isles, “since most of the region experienced the same wind conditions.” By contrast, according to Kempton, from the Bermuda High to the Nor’easter, “there is almost always a pressure gradient somewhere and cyclonic events move along the [Atlantic] coast. There are a few times of low power throughout, but they are not due to any one particular weather pattern.”

### **An Energy Superhighway**

Kempton calls his proposed cable interconnect the Atlantic Transmission Grid, although he imagines it as an “energy superhighway.” It would shuttle power between wind farms spanning 1,500 miles (2,500 kilometers) of coastline, eventually sending that power to shore wherever it is needed. “We have a uniform grid, in a sense, already. Everything in the Eastern Interconnection is all connected together. But this would make one line that would enable us to move a lot of power north and south.” Kempton estimates the transmission system would add less than 15 percent to the capital cost of offshore wind generation and says the figure is “in line with the market cost of leveling wind via existing generation.”

There are also other start-up issues that will raise the price, including a provision in the federal Merchant Marine Act of 1920 that requires the ships used to build the offshore portions to be U.S.-built and U.S.-citizen owned, ruling out use of vessels and experienced crews from Europe. Building the entire offshore wind generation and transmission system remains a significant undertaking, something the Stanford researchers also noted in the California study. “We haven’t calculated the amount of steel that would be required,” Kempton said, “but we have calculated in terms of production capability, and it’s on the order of 10 or 15 full-size automobile production facilities.”

That industrial capacity doesn't require an equivalent intellectual ramp-up, since the transmission technology is readily accessible. "There are undersea cables exactly like the one's we're describing that connect New Jersey to New York," Kempton said, in addition, "[t]here is a long run in Europe connecting Norway to Belgium" with a 580 km cable. "It's not that we're requiring some kind of new technology."

### **Boss Wanted**

However, Kempton concedes an offshore interconnection would be costly and that "there is no agreed upon mechanism for the company that builds it to recover their costs." An interstate offshore interconnect might prove a bit of a conceptual stretch for electric utilities and their regulators, who have been traditionally confined to arranging their affairs state by state. But Kempton believes existing power distribution by "independent system operators" that operate on a regional basis (take California's ISO, for example) could implement the "early phases of this without any new organizations or new structures." That, he believes, would achieve some of the desired "smoothing." Even so, caveats remain.

"If you want to go the long distances that we show in our article, then you would need some authority that would have the ability to regulate and recover costs and determine who's got the right to use and how much they should charge." He has even proposed a name for this entity: the Atlantic Independent System Operator. "It's creating a whole new institution, although it would be similar to those that operate regional power distribution systems on land."

### **An Ever-Growing Circle**

While two offshore wind projects in the United States, Cape Wind and one off the Delaware coast, appear to be nearing the construction stage, both currently plan to cable their electricity directly ashore to utilities in their abutting localities. Kempton says when completed, the two projects would tap no more than 0.01 percent of the region's wind energy potential, and he is hopeful that in the long run his ideas will be of some help. (Cape Wind says its 130 turbines could produce up to 468 megawatts, but acknowledged the more likely figure would be 170 megawatts, which it said is 70 percent of demand for the Cape Cod/Martha's Vineyard/Nantucket area.)

"People always think of wind as a highly fluctuating resource and therefore not very useful. Not true. Because at low levels of wind, which is all we're going to see for years anyway, it's very easily managed within the power system," Kempton suggested. "This study shows that you can cheaply bring in large amounts of wind without getting the kinds of fluctuations that individual wind farms are known for." Kempton's science and policy proposals make sense to David H. Matthiesen, associate professor at Case Western Reserve, who leads a group of researchers studying the potential of offshore wind power on the Great Lakes.

"As you draw a circle, as the circle gets bigger, the odds become better that the wind is blowing somewhere in that circle," he said from the offices of the Great Lakes Energy Institute in Cleveland, Ohio, "I can see this playing out very nicely in the Great Lakes. The weather that Chicago's getting, we'll get in two days; if you could have a regional network like that, it would make balancing that base load from wind energy a lot better."