Re-thinking renewable energy predictions

March 3 2016

Wind turbines in Ireland

Unlike conventional energy sources, like coal or oil, the supply and demand of renewable energy are, to a large extent, unpredictable because they are affected by the natural fluctuations in the power source itself. This poses a number of difficulties in calculating how much renewable energy will be available for consumer needs at any given time.

A team of researchers, led by Prof. Mahesh M. Bandi of the Okinawa Institute of Science and Technology Graduate University (OIST) wanted to explore some of these scientific problems involved in the fluctuations of renewable energy and how to better predict energy outputs. The team recently published their results in the *New Journal of Physics*.

"A fluctuating power source threatens the even distribution of power in the electrical grid," Bandi said. "That makes it difficult to balance the fluctuating power output with the fluctuating consumer demand."

Bandi and two of his co-authors, Golan Bel and Colm Connaughton, were post-docs at the Los Alamos National Laboratory at the same time and learned that they liked to "cook up scientific problems while hiking," said Bandi. So they decided to take their questions about renewable energy fluctuations with them on a hike in Okinawa, Japan.

The team, including Märt Toots, a graduate student working with Bandi at OIST during his first year rotation, analysed data from the Irish grid wind farms and saw that power outputs from the farms on the grid fluctuate in similar ways. This is different than previously thought.

"It's generally assumed that geographically distributed wind farms are independent. In other words, the fluctuations in power output from one wind farm are different from that of another wind farm, say 50 km away," Bandi said.

Instead, the data that Bandi and his team analysed showed that the wind farms on a grid no longer function independently of one another in response to local wind speed conditions, but instead become part of a larger geographic weather system that forces all the wind farms to have similar or correlated outputs for a time span of up to one day.

"If there is a medium that connects them, then one will observe that the two wind farms will fluctuate in a similar fashion. This does not mean their outputs are exactly synchronized at every instant, but on average their outputs fluctuate very similar to each other. The average is important. That is what we mean by correlated," said Bandi.

The unpredictability of wind power supply, as well as working with a

larger geographic weather system can then create errors in forecasting power output. Therefore, Bandi and his team quantified two types of errors found in forecasting through statistical analysis to identify trends and analyse fluctuations around those trends in the wind power grid data. The two types of errors are: time-scale and scaling.

Time-scale error is the interval of time which the statistical models are not making any predictions, which creates uncertainty for select periods of time. Scaling error is the degree to which current forecast models fail to predict correlations in the fluctuations between different wind farms for generated power, which Bandi says is not often taken into consideration because "when people estimate error, they don't think about correlations."

The statistical analysis performed by the researchers could be important in more accurately predicting the supply and demand necessary in wind power and this method could be applied in other renewable energy research.

"This technique or tool is not limited to wind power," Bandi said. This means it can also be used across other renewable energy sources to predict error, so long as they possess time-related corresponding changes that have a statistical structure.

More information: Grid-scale fluctuations and forecast error in wind power. iopscience.iop.org/article/10. … 630/18/2/023015/meta

Provided by Okinawa Institute of Science and Technology