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From *The 69th Meeting of The American Physical Society – Division of Fluid Dynamics*

Instrumented Drone Measurements Help Wind Farmers Site Turbines to Achieve Greater Efficiency

Researchers use drones to map the complex flow and terrain of wind farms

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Washington, D. C., November 21, 2016—Wind energy is a key part of the global energy future, expanding rapidly throughout the world in onshore and offshore settings. But to be sustainable, large scale, multi-megawatt (multi-MW) wind farming's economic efficiencies need to be maximized— and knowing where to place the turbines within the wind farm is a first step.

Without proper and strategic placement of wind turbines, the low-speed wind behind turbines, called a wake, decreases the efficiency of the wind farm. Wind tunnel tests have been used to guide placement, but their conditions are not representative of the complex flow behaviors in the field conditions of actual wind farms. So the question is, how to overcome this?

Bring on the drones. Moreover, *design* novel instrumented drones with a suite of sensors capable of gathering precise field data in the complex flow and terrain of an actual wind farm.

This was the approach of researchers from Switzerland. Team members with the Swiss Federal Institute of Technology in Zurich developed novel instrumented drones that made high-resolution measurements of wind speed, wind direction and turbulence encountered in actual wind farms. Results show detailed flow behaviors around the wind turbines, useful for developing simulation tools that can be used to optimize placement of wind turbines within the wind farms. This offers the turbines the most efficient use of the wind resource.

The researchers represent an interdisciplinary collaboration of hardware and software experts including aerodynamics, atmospheric flow physics, energy technology and materials science. They present their findings on November 20-22 at the American Physical Society's Division of Fluid Dynamics annual meeting in Portland, Oregon.

“In wind farms, the power output of wind turbines can decrease by up to 40 percent if the wind turbines are in the wake of upstream wind turbines, so there are intensive efforts to develop simulation tools that can be used to optimize the placement of wind turbines within wind farms,” said lead researcher Ndaona Chokani, lead researcher of the study.

In particular, the team is the first to develop and field test an instrumented drone used to measure, in detail, the airflow and mixing near and downwind of the wind farm. Chokani said, “These measurements shall accelerate the development of simulation tools that can be used to optimize the placement of wind turbines in onshore and offshore wind farms.”

The key to the current work is a seven-sensor, fast-response, aerodynamic probe used to make the time-resolved wind measurements. The probe is based on measuring technology used in conventional power plants, which was developed over the past two decades at the Swiss Federal Institute of Technology Zurich.

Developing tools that can guide decision-making on where to place wind turbines for maximum effect is a desirable goal because through improved efficiencies, clean energy prices will come down and environmental impacts will be reduced. “This will substantially reduce CO_2 emissions and the usage of water in the electricity generation sector, and further diversify the electrical energy mix,” Chokani said i.

The European Union’s 2020 energy targets require 15 to 17 percent electricity from wind, up from 8 percent at end of 2013. In the U.S., energy goals for wind power call for wind supplying 10 percent of the nation’s electrical demand in 2020.[1]

Next, Chokani and his colleagues intend to extend the proof-of-concept established by their drone’s measurements. They will use multiple instrumented drones flying in a swarm to make simultaneous measurements.

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Figure 1. View from the field testing in a wind farm of a novel instrumented drone fitted with a suite of sensors capable of gathering precise field data about complex air flow and terrains.

Abstract: E2.00003 : Drone Based Experimental Investigation of Wind Turbine Wake Evolution," by Balaji Subramanian, Ndaona Chokani and Reza Abhari is at 6:03-6:16pm PST, November 20, 2016 in Room A106

For more information about the APS DFD 2016 meeting, visit: http://apsdfd2016pdx.org/

MORE MEETING INFORMATION

USEFUL LINKS

Main meeting website: http://apsdfd2016pdx.org/
Technical program: http://meetings.aps.org/Meeting/DFD16/Content/3199
Meeting/Hotel site: http://apsdfd2016pdx.org/?page_id=30
Press Room: http://www.aps.org/newsroom/index.cfm
Look for live updates on Twitter throughout the meeting with *#APSDFD*

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[1] http://energy.gov/eere/wind/wind-vision

PRESS REGISTRATION
We will grant free registration to credentialed journalists and professional freelance journalists. If you are a reporter and would like to attend, contact Julia Majors (jmajors@aip.org, 301-209-3103) who can also help with setting up interviews and obtaining images, sound clips, or background information.

LIVE MEDIA WEBCAST
A press briefing featuring a selection of newsworthy research will be webcast live from the conference on Monday, November 21st. The first briefing at 2:00pm (EST) is about the forensic analysis of blood spatter and how changing the position of your fingers can help you swim faster. The second one at 4:00pm (EST) is about cat's Velcro-like tongues and bubbles. More information can be found at the following link: https://www.aps.org/units/dfd/pressroom/

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