HOW DO OFFSHORE WIND FARMS CHANGE THE WIND?

Research aircraft flying at low altitude delivers high-resolution meteorological data. (Courtesy: Fraunhofer IWES/© Mark Bitter, TU Braunschweig)

The start of a new research project on wind-energy utilization could change the way wind farms are expanded on a large scale.

November saw the start of the X-Wakes "Interaction Between the Wakes of Large Offshore Wind Farms and Wind Farm Clusters With the Marine Atmospheric Boundary Layer" research project, which is being funded by the Federal Ministry for Economic Affairs and Energy (BMWi) to the tune of 3.4 million euros over a period of three years.

In the scope of X-Wakes, the researchers will be investigating how the wind conditions in the German Bight could change if offshore wind farms are expanded on a large scale. The project team will use data from extensive measurement campaigns and high-fidelity modeling approaches to improve industry models that are afterwards used to analyze the impact of the offshore wind farm cluster expansions.

IMPORTANCE OF OFFSHORE

The federal government's plans for the energy revolution in Germany foresee a share of at least 80 percent of the gross electricity consumption being covered by renewable energies by 2050. Offshore wind energy represents an important mainstay in this goal. The wind blows more continuously and powerfully at sea, but the area of the German Bight available for wind energy use is limited, so wind farms are usually constructed in groups, known as wind-farm clusters. These clusters can comprise up to several hundred wind turbines. Wakes with low wind speeds and heavy turbulence develop in the wind shadow behind the turbines, while upstream the wind speed is reduced due to blockage effects. Thus, turbines in these wakes produce less energy and are exposed to greater loads. Under certain atmospheric conditions, these wakes can extend for distances in excess of 50 kilometers.

"In our X-Wakes research project, we want to investigate these wakes and other accumulative effects such as the global blockage effect in more detail and discover how the wind farm clusters influence each other as well as what consequences a large-scale expansion of the offshore wind farm would have on wind conditions in the future," said project coordinator Dr. Martin Dörenkämper of the Fraunhofer Institute for Wind Energy Systems (IWES). "We hope to use the data gathered during the project to further develop our existing models in order to be able to predict the yields of the wind farms for future expansion scenarios under realistic conditions."

VARYING METHODS

The researchers are employing a combination of complementary methods in the project. Stationary measurements at different locations in the German Bight, e.g. on wind turbines, converter stations, and the FINO long-term measurements deliver meteorological data continuously, and the extent of the wakes is analyzed on a large scale with the aid of satellite-based remote sensing data.

"In addition, measuring campaigns with a research aircraft at low altitude also deliver high-resolution meteorological data," said Dr. Astrid Lampert from the TU Braunschweig, the research spokesperson for the collaborative project.

In addition to the Fraunhofer IWES and the TU Braunschweig, five more research partners are involved in the cooperative project: the Karlsruhe Institute of Technology (KIT), the University of Oldenburg with the ForWind — Center for Wind Energy Research, the University of Tübingen, the Helmholtz-Zentrum Geesthacht Center for Materials and Coastal Research, and UL International GmbH.

The project consortium is supported by the associated partners Innogy SE, Vattenfall, RWE Renewables, Nordsee One GmbH, and Tennet TSO, who are providing wind-farm data and access to their offshore infrastructure for measurements. In addition, the German Meteorological Service (DWD) and the Federal Maritime and Hydrographic Agency (BSH) are also available to the project partners in an advisory capacity.

Stationary LIDAR measuring buoys deliver meteorological data continuously. (Courtesy: Fraunhofer IWES/© Jörge Schneemann, ForWind – Uni Oldenburg)

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Case study: Turbine 'multi-tasking'

Wind-farm project boasts company's special ability to provide multiple operations for turbine installation.

Argentina is serious about increasing its renewable energy resources, aiming for 20 percent of its power to come from renewables by 2025. The country has also shown it is willing to invest in new technologies to help meet its energy targets.

As part of this drive, ALE completed the transportation, craneage, and electro-mechanical installation (TCI) of 16 wind-turbine generators for the Loma Blanca wind-farm project. ALE was able to provide the whole wind services TCI package for the operation, providing one point of contact from the receipt of components to power generation.

A total of 176 items needed to be transported the 80 kilometers from Almirante Stomi Port in Puerto Madryn to the Loma Blanca wind-farm site. ALE transported the components via abnormal load transport, including specialist wind-blade trailers.

Once delivered to each wind-turbine platform, the components were offloaded. ALE overcame the site's challenging narrow roads by adapting a crawler crane.

The dirt roads between the wind turbines were only 6 meters wide in parts, so ALE adapted a crane with the latest SPMT technologies, enabling the crane to be easily moved on the wind farm site. After installation, ALE was able to move the crane in one piece, instead of disassembling its sections for reassembly in the next lift position each time, and therefore significantly reduced the project's schedule.

ALE completed the transportation, craneage, and electro-mechanical installation of 16 wind-turbine generators for the Loma Blanca wind-farm project. (Courtesy: ALE)

ALE used several cranes to lift each item, with the largest being a 69-meter-long blade, and the heaviest was a 111-metric-ton rotor. ALE then performed the full electro-mechanical installation of each wind turbine, with a hub height of 100 meters.

For the transportation, ALE used three-blade trailers, two lowbed trailers, and 20 axle lines of SPMT. For the craneage and installation work at the Loma Blanca site, ALE deployed a crawler crane, Manitowoc 18000, as the main installation crane, as well as numerous mobile cranes for pre-installation work, tailing and offloading.

The project benefited from the combination of experts from ALE's Wind Services division working alongside ALE's experienced and knowledgeable Argentina branch.

This was the first time this model of wind turbine had been installed in South America. Once complete, the Loma Blanca wind farm project will have a total of 64 wind turbines providing 200 MW of electricity for Argentina's national grid.

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