Powering wind energy with superconductivity

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Argonne National Laboratory, working with Advanced Magnet Lab in Florida, has received an award to develop superconducting drive generators for windmills.

Energy prices and environmental concerns are driving the United States to rethink its energy mix and to develop domestic sources of clean, renewable energy.

Our nation possesses abundant resources to create electricity from the wind, and the U.S. Department of Energy (DOE) is working toward generating 20 percent of the nation's electricity supply from wind power by 2030. To help make this vision a reality, DOE recently awarded six projects to help develop next generation wind turbines and accelerate the deployment of advanced turbines for offshore wind energy in the United States.

Advanced Magnet Lab, located in Palm Bay, Florida, is leading one of these projects to develop the first fully superconducting direct-drive generator for large wind turbines with the goal of significantly reducing

the cost of wind energy. DOE's Argonne National Laboratory is one of Advanced Magnet Lab's partners in this project.

"Direct-drive generators eliminate the need for a gearbox, which reduces weight, eliminates moving parts and reduces maintenance costs," said Jerry Nolen, an Argonne Distinguished Fellow and collaborator on the project. "Turbines based on superconducting technology will have a huge impact on how future electricity is generated by reducing costs and increasing reliability and efficiency."

Wind turbines work like a fan, but in reverse. Instead of using electricity to spin blades to create wind, they use wind to spin the blades to create electricity. Drive trains convert the blades' energy into electricity.

This early research and development project will focus on using superconducting wires, which have essentially zero electrical resistance, allowing for greater electricity flow and making generators smaller and lighter for their given output. Since superconductors operate at cryogenic temperatures, cooling is important to the system's architecture.

The project will also feature a direct-drive generator to eliminate the massive gearbox, typically the component with the highest maintenance costs in conventional wind turbines. Since gearbox size increases rapidly with turbine power rating, it also limits the size of windmills.

"Argonne is an excellent partner and has extensive expertise and experience in superconductivity, the design of cryogenic systems and modeling tools for large-scale simulations, which will be key in helping us optimize our design," said Vernon Prince at Advanced Magnet Lab. "The economic viability of large turbines requires a significant reduction of the size and weight of the drive train, which can be achieved through the use of superconductors and a very robust turbine structure."

Advances in drive-train technologies and configurations will help the United States remain a global leader in wind energy and reduce its future cost. Success could also lead to new planning, construction and manufacturing jobs in the renewable energy market.

Provided by Argonne National Laboratory