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Where the wind blows, power is restored

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Where the wind blows, power is restored

Researchers look at preventing major power failures with Kansas wind energy

All it takes is a simple walk across the Kansas State University campus to notice the obvious: Kansas wind is an abundant — and powerful — natural resource.

A collaborative group of Kansas State University researchers is looking at ways to channel this valuable natural resource and prevent major power outages.

The project involves four Kansas State University women — three professors and one doctoral student — and several other researchers. The three professors are Noel Schulz, Paslay professor of electrical and computer engineering and the university's first lady, and Caterina Scoglio and Ruth Douglas Miller, who are both associate professors of electrical and computer engineering. Sakshi Pahwa, doctoral student in electrical and computer engineering, India, has worked with all three professors on her master's project and current doctoral project.

"It's been a great combination of talent in multiple areas," Schulz said. "That's really where the exciting research and solutions are — in the interdisciplinary areas."

The researchers are looking at how to use distributed energy sources, such as wind turbines, to avoid cascading failures in power grids. A cascading failure occurs when an interconnected part of a power system fails and then triggers successive parts to fail, often leading to a widespread power failure. One of the most famous cascading failures was the Northeast Blackout of 2003, a power outage that affected 55 million people in the United States and Canada.

"Many of these cases involve very complex systems that have a communication network on top that can be very vulnerable," Scoglio said. "That means if something goes wrong, these failures can spread and become very dangerous."

To prevent these cascading failures, the researchers are investigating a technique called islanding, which restricts or "islands" a power system fault to a small area. Islanding prevents a power failure from spreading.

"That disconnected portion can then be powered using renewable or distributed energy sources, such as wind turbines or solar panels, while the remaining parts are still being powered by conventional sources," Pahwa said.

That's where the Kansas wind fits in: It can provide the renewable energy that could power the disconnected portion of the network.

"We use electrical power everywhere," Schulz said. "We need to set up power systems that are reliable so that when that wind is blowing, we can use that power, but when the wind isn't blowing, they're still stable systems."

Support from industry

The power grid research has been funded by the Kansas State University Electrical Power Affiliates Program, a partnership with four companies that supports student research programs. The companies are Westar Energy, Burns and McDonnell, Nebraska Public Power District and Omaha Public Power District.

"Because of the support from these companies we're able to really look at problems, perform in-depth work with industry and get real data," said Schulz, who is the director of the Electrical Power Affiliates Program.

Through the program, students such as Pahwa can work with these industry partners to address real problems and create solutions.

"I think that innovation, coming from research and support from companies, such as those that are part of our Electrical Power Affiliates Program, can really bring the country back to a better economic situation," Scoglio said. "Innovation creates jobs and can really improve the whole nation."

Scoglio, along with Don Gruenbacher, associate professor and head of the department of electrical and computer engineering, direct the Sunflower Networking Group, a student research team that works in networking and related areas. The team currently has 10 members, including Pahwa.

Scoglio and Pahwa started the cascading failure project when Pahwa was a master's student. As they began studying complex network systems, they turned to Schulz, a power grid expert. They also collaborated with power systems expert Anil Pahwa, professor of electrical and computer engineering, and Shelli Starrett, associate professor of electrical and computer engineering.

Pahwa's completed master's project, "Distributed Sources and Islanding to Mitigate Cascading Failures in Power Grid Networks," was a winner at the Capitol Graduate Research Summit in Topeka, Kan., earlier this year.

Pahwa is continuing her doctoral research under Scoglio and Miller. The researchers want to improve their islanding techniques and they are incorporating real data from wind turbines.

Wind for schools

For data collecting and testing purposes, the researchers have used two sets of wind turbines: the four wind turbines at the newly opened Riley County Public Works Facility and Kansas State University's wind turbine north of campus.

The Riley County wind turbines were installed for the Resourceful Kansas project, a cooperative effort between Miller, Scoglio, Riley County and the Kansas City-based consulting firm GBA. The project has been funded by the U.S. Department of Energy. Two Kansas State University students are also involved: Handuwala Dulan Weerasinghe, doctoral student in electrical and computer engineering, Sri Lanka, and Kellen Manning, senior in electrical engineering, Olathe.

The university turbine near the intersection of Denison and Kimball Avenues was installed through Wind for Schools, a project led by Miller as director of the Kansas Wind Application Center. Wind for Schools is a Department of Energy-funded effort that helps rural schools put up small wind turbines.

"Wind Powering America, the DOE initiative that began Wind for Schools, started by picking states with good wind resources but poor wind development," Miller said. "The project is meant to encourage wind industry growth as well as its acceptance and work force development. It can encourage students' interest in wind at an early age so they may study it in school and eventually work in the wind industry."

Kansas is one of 11 states to participate in the program, which has placed 13 wind turbines in Kansas communities, including Solomon, Colby, Greenbush and Concordia.

Miller sees the program as beneficial in two ways. It educates children, teachers and the surrounding community because the schools commit to including the turbines in their curricula. Secondly, Miller's Kansas State University students benefit because they help provide the initial groundwork, such as cost and input energy, for the turbines.

"The program helps give younger students the option of working close to home when they finish school," Miller said. "You can bring rural development into the state through wind energy."

Kansas State University a leader

While the wind energy research is important in the power industry, its influence reaches further. It makes Kansas State University a leader for the Renewable Energy Standards Act, which was signed in 2009 and requires major Kansas utilities to generate about 10 percent of their power from renewable sources by 2011 and 20 percent by 2020.

"This project benefits the state because it reduces carbon emissions through renewable energy," Pahwa said. "It's a good opportunity to create jobs, and renewable energy incorporation also supports conventional sources so we don't need to import fuels from other countries."

But equally important is that the project shows how the university's research can make the power grid even smarter, Schulz said. While other schools have moved away from projects in the power area, Kansas State University has maintained its strong power emphasis, putting the university in a good position to continue research opportunities.

"This is a great example of how our land grant mission and how working with engineering is helping to make not only the state of Kansas better, but also to make our power grid more secure and help our national infrastructure," Schulz said.

By Jennifer Tidball, Communications and Marketing