Empowering power systems: Researchers light up possibilities with solar panel based design

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A team of eight researchers at Kansas State University is using renewable energy to generate an agile power distribution system and transform the industry.

To support the work, the research team is using a four-year $1.1 million grant from the National Science Foundation's Cyber-Physical Systems program. The program funds innovative projects focused on cyber-physical systems, which coordinate between computational and physical elements. Of the 287 proposals submitted this year, the Kansas State University project was among the 18 proposals -- or 6 percent -- chosen for funding.

The Kansas State University project focuses on power distribution systems, which deliver electricity to homes. These systems will become very complex in the future because of increased usage of consumer-owned rooftop solar panels, which have seen more consumer interest with support from government incentives. To react and adapt to changes within seconds the systems will have to operate as cyber-physical systems.

"We are looking at ways in which we can provide fast control to be able to maintain balance between loads and generation to keep the system stable," said Anil Pahwa, professor of electrical and computer engineering and the project's principal investigator.

The researchers come from Kansas State University's electrical and computer engineering department and the computing and information sciences department. Researchers include: Scott DeLoach, professor of computing and information sciences; Sanjoy Das, associate professor of electrical and computer engineering; Balasubramaniam Natarajan, associate professor of electrical and computer engineering; Xinming "Simon" Ou, assistant professor of computing and information sciences; Noel Schulz, Paslay professor of electrical and computer engineering; Daniel Andresen, associate professor of computing and information sciences; and Gurdip Singh, department head and professor of computing and information sciences.

Electrical engineering faculty members will be working on intelligent algorithms for the project, while the computing and information sciences faculty will work on integrating everything together through a system architecture that supports adaptive behavior.

"We have to work together or we'll never get it done," DeLoach said. "We are very tightly connected."

The researchers want to make distribution systems more flexible by addressing events that can cause complications with solar panels. For instance, when clouds arrive, production of solar panels can drop suddenly and power then has to come from the grid, which can create problems. The researchers are also looking at ways to improve electrical flow if homes are disconnected from the grid by natural causes -- such as earthquakes, tornadoes or hurricanes -- or from a technical failure.

"The current standards are such that as soon as you lose power from the grid, all the solar panels have to be disconnected," Pahwa said. "But we feel that solar panels in the system should be able to maintain limited supply to the load without having connection with the grid."

To address complications with being disconnected from the grid, Kansas State University computing and information sciences researchers are developing a holonic multiagent system. This system can monitor what is going on in the power grid and then work with other agents to divide up roles and work as a team. Power sources at the top of the power grid distribute power to substations, which then distribute power to neighborhoods and homes.

"A neighborhood, for instance, would have its own organization of agents where each home might be represented by an agent," DeLoach said. "These agents talk to each other, so in a case where the neighborhood gets disconnected from the power grid, the agents can negotiate with each other and say 'I need this much power," or 'We need power at this location.'"

This powerful communication will help in emergency situations where power is disconnected, because these agents can determine and supply power to the most critical loads, such as hospitals. The system will also be beneficial in instances of cloud movement. The solution: Develop an agent that is responsible for monitoring the weather forecast and preparing the system for those situations.

While the researchers are focusing their efforts on solar panels, the infrastructure that they create has applications for a variety of renewable energy systems, including those powered by wind or even batteries.

"One of the goals of the smart grid is to be able to integrate more renewable energy sources into the system and empower customers," Pahwa said.

Provided by Kansas State University

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