ELECTRICAL POWER AFFILIATES PROGRAM

2008-2011 Report

KANSAS STATE UNIVERSITY | College of Engineering

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LETTER FROM THE DIRECTOR

Dear Colleagues:

What an exciting time to be part of the electrical power industry! Smart grid, electric vehicles, alternative energy and other topics are at the top of today's engineering opportunities and challenges. Kansas State University's College of Engineering has had a long history of supporting the power and energy sector, and we continue to be a leader in the region and nation. The Kansas State University Electrical Power Affiliates Program (EPAP) was established in 2008 and in the last three years has provided programs and activities to benefit our affiliate partners, our students, our faculty and our region.

This report provides a summary of the key accomplishments and activities over the last three years. During that time we have had research projects with 13 faculty members, 13 graduate students and 7 undergraduate students. We also have taken over 70 students on road trips to see power plants, substations and control centers as well as participating in the IEEE Power & Energy Society Transmission and Distribution Conference and Exposition in New Orleans in 2009 (see picture and articles). These activities are combining to develop solutions to tomorrow's technical challenges and to create a well prepared workforce for the future.

We appreciate the support of our four founding EPAP members: Westar, Burns & McDonnell, Nebraska Public Power District and Omaha Public Power District. We are also excited about new partnerships with additional utilities, consultants and manufacturers. We also offer special thanks to ECE Department Head Don Gruenbacher, who directed the program for the first 18 months.

We hope you'll enjoy learning more about our activities at Kansas State University. If you have questions or would like additional information about the Electrical Power Affiliates Program, please feel free to email me at noels@k-state.edu .

Sincerely,

Noel N. Schulz

Dr. Noel Schulz
Director, Kansas State Electrical Power Affiliates Program
Paslay Professor of Electrical & Computer Engineering

KEEPING THE LIGHTS ON

Researchers look at preventing major power failures with Kansas wind energy

by Jennifer Tidball

One of Kansas' most abundant natural resources may hold the key to preventing major power outages. A team of Kansas State University engineers is using funding from the Electrical Power Affiliates Program to research how Kansas wind and other distributed energy sources can stop cascading failures.

Sakshi Pahwa, doctoral student in electrical and computer engineering from India, explored the topic for her recently completed master's project, "Distributed Sources and Islanding to Mitigate Cascading Failures in Power Grid Networks." The project was a winner earlier this year at the Capitol Graduate Research Summit in Topeka, Kan.

Pahwa's project co-advisers include Caterina Scoglio, associate professor of electrical and computer engineering, and Noel Schulz, Paslay professor of electrical and computer engineering and Kansas State University's first lady. Pahwa is continuing this work for her doctoral research under Scoglio and Ruth Douglas Miller, associate professor of electrical and computer engineering.

The research looks at using distributed energy sources 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 — like the one that happened in the Northeast Blackout of 2003, a power outage that affected 55 million people in the United States and Canada.

To prevent cascading failures, researchers are investigating a technique called islanding, which minimizes the impact of a power system fault to a small area. Islanding stops further disturbances in the network.

"We used a network partitioning algorithm, and then depending on where the fault is I can disconnect that portion of the network," Pahwa said. "That disconnected portion can then be powered using renewable or distributed energy sources, such as wind turbines or solar panels, with the remaining parts still being powered by conventional sources."

The Kansas wind can potentially provide abundant renewable energy to power the disconnected portion of the network. For data collecting and testing purposes, the researchers used the university's wind turbine north of campus as well as four other wind turbines installed at the Riley County Public Works Facility.

The university turbine was installed for Wind for Schools, a project led by Miller, director of the Kansas Wind Application Center. The Riley County wind turbines were installed for the Resourceful Kansas project, a cooperative effort between Miller, Scoglio, Riley County and the Lenexa, Kan.-based consulting firm GBA, and funded by the U.S. Department of Energy.

"We need to set up power systems that are reliable and stable so that when that wind is blowing, we can use that power, but when the wind isn't blowing, there are also stable systems," Schulz said. "That's what this project is about — modeling the network so we understand the different aspects for when there are changes, when the wind blows, when it doesn't and how that affects the power system."

Scoglio and Pahwa started the project when Pahwa was a master's student. As they began studying complex network systems, they turned to Schulz, a power grid expert who has done previous work with islanding. 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.

"With the proper design and the right intelligence, some of the problems related to power failures can be prevented," Scoglio said. "We need to make sure that the communication network will monitor the network, detect the problem and implement the reaction securely."

Sakshi Pahwa's research also fits in with the Renewable Energy Standards Act, which was signed in 2009 and states that major Kansas utilities should be able to generate about 10 percent of their power from renewable sources by 2011 and 20 percent by 2020.

"This project can reduce carbon emissions through renewable energy," Pahwa said. "It's a good opportunity to create jobs, and renewable energy incorporation is also a support to the conventional sources so we don't need to import fuels from other countries."

POWER DRIVEN

EPAP-funded research helps K-State student land job with sponsor

by Jennifer Tidball

For Sarah Kubler, a recent Kansas State University graduate, working on a power-related research project led to a job offer on the East Coast with Burns & McDonnell.

Kubler, a May 2011 master's graduate in electrical and computer engineering, began the job in mid-June at Burns & McDonnell's New England office in Wallingford, Conn., just off the Atlantic coast. Burns and McDonnell is a Kansas City, Mo.-based engineering design firm and is a member of Electrical Power Affiliates Program. For Kubler, it was an easy decision to work for the engineering firm.

"They are an employee-owned company and when I interviewed with them, I liked how they treated me," Kubler said. "I respect their work and it fits with my interests."

At Burns & McDonnell, Kubler is an assistant electrical engineer in the company's telecommunications group and works with communications equipment and substations. Her research experiences while studying at the university helped her land her current job, she said. As a student, she researched computer networking, wind turbines and computer security. She received EPAP funding for much of her research and was involved with other EPAP-related events and conferences.

"The Electrical Power Affiliates Program sponsored my first year and a half of research, which led me to research communications systems and networking equipment and the power grid," Kubler said. "During my interview with Burns & McDonnell, I told the company about my project and it matched their needs."

For her master's research, Kubler created a simulation model for communication networks. She ran basic power grid communication networks and researched securing and encrypting certain areas of the system. Kubler presented her master's project, "Reliable and Secure Networks for the Communication of the Power Grid," at the Capitol Graduate Research Summit earlier this year in Topeka, Kan.

"There is a growing need for energy," she said. "The smart grid initiative is adding new sensors and telecommunications network equipment to the grid. Plus, there is wind power and solar power being added. Wind power needs more control than previous power stations because the wind changes and adds more data. The communication network will need to handle all the data securely and reliably."

Kubler worked under Caterina Scoglio, associate professor of electrical and computer engineering, and was a member of the Sunflower Networking Group, a student team that researches networking and related areas. Scoglio co-directs the group with Don Gruenbacher, department head and associate professor of electrical and computer engineering.

Kubler's research with Scoglio focused on SCADA systems, or supervisory control and data acquisition systems. She looked at how to evaluate and improve SCADA systems to create reliable and quick communication. She has worked in the university's smart grid lab with Noel Schulz, Paslay professor of electrical and computer engineering and Kansas State University's first lady.

In addition to her research with power grid communication networks, Kubler worked on several wind-energy related projects while a student. She helped develop a database and website for the Kansas Wind for Schools Program, which helps rural schools put up small wind turbines. Kubler and several other Kansas State University researchers created a multi-network system that collected wind turbine data to use for a distributed-source renewable energy power system.

Kubler is from Chanute, Kan., and received her undergraduate degree in computer engineering from Kansas State University in 2009.

LOCATION, LOCATION, LOCATION

Funded by EPAP, graduate student's work identifies optimal locations for small-scale wind turbines

by Jennifer Tidball

Research with small-scale wind turbines has produced large-scale results within the academic and industrial communities.

Viet Nguyen, a May 2011 master's graduate in mechanical engineering from Phillipsburg, Kan., focused his master's project on the effects of turbulence caused by trees and buildings near small-scale wind turbines.

The Electrical Power Affiliate Program provided research funding and supported a trip to the Institute of Electrical and Electronic Engineers' Power and Energy Society's Transmission and Distribution Conference in New Orleans in April 2010. While at the conference, Nguyen took third place in the graduate student poster session and was awarded $500 and an internship opportunity in the industry's energy sector.

"It was a really good experience to go to this conference and see the reasoning for our work," Nguyen said. "Having the funding to do these sort of activities was really beneficial because I could learn more about the project and see how it could be applied in different industries."

Nguyen used real data and computer modeling to uncover a way to identify the optimal location for small-scale wind turbines, such as those found in backyards or around industrial sites.

"The wind around a small-scale turbine fluctuates and is not the nice continuous stream of wind that occurs around turbines high in the air," Nguyen said. "My research studied the effects when you are down lower on the ground to see if wind turbulence affects turbine performance."

Nguyen used Kansas State University's Kansas Wind for Schools wind turbine north of campus near the intersection of Denison and Kimball avenues in Manhattan, Kan. He obtained wind speed data from the turbine's anemometers and compared it with computer monitoring data he had developed through computational fluid dynamics. He found transfer functions and equation models that determined how much power a turbine could produce from a specific wind speed.

Nguyen saw positive results: Plugging anemometer data into computer models could accurately identify an ideal wind turbine location in a money-saving way and relatively short amount of time. A person can invest $400 for an anemometer to measure wind speed and identify the ideal location before spending nearly $6,000 for a wind turbine, Nguyen said.

"You can put an anemometer there, let it spin and see what you get from the wind," he said. "Then we can look at the wind terrain and see if that location is actually feasible before spending money on a wind turbine."

For his project, Nguyen worked under Zhongquan "Charlie" Zheng, former assistant professor of mechanical and nuclear engineering. He also worked with Ruth Douglas Miller and Bala Natarajan, both associate professors of electrical and computer engineering.

NEBRASKA PUBLIC POWER DISTRICT

Nebraska Public Power District is Nebraska's largest electric utility in terms of geographic coverage, with a chartered territory including all or parts of 91 of Nebraska's 93 counties. It was formed on Jan. 1, 1970, and is a public corporation and political subdivision of the state of Nebraska.

NPPD's revenue is derived primarily from wholesale power supply agreements with 52 towns and 25 rural public power districts and rural cooperatives that rely totally or partially on NPPD's electrical system. NPPD also serves about 80 communities at the retail level. More than 5,000 miles of transmission lines make up the NPPD electrical grid system, which delivers power to about one million Nebraskans.

NPPD uses a mix of generating facilities to meet the needs of its customers. This includes a nuclear plant, three steam plants, a combined-cycle facility, wind generation facilities, nine hydro facilities, nine diesel plants and three

peaking units. NPPD also purchases electricity from the federally operated Western Area Power Administration. NPPD is a member of the Southwest Power Pool, the Mid-Continent Area Power Pool and the Western System Power Pool.

The utility is governed by an 11-member Board of Directors popularly elected from NPPD's chartered territory. Learn more at www.nppd.com.

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UP CLOSE AND POWERFUL

Students get exclusive look at power facilities during sponsored tour of EPAP sites

by Jennifer Tidball

A sponsored tour of power facilities gave a group of Kansas State University engineering students a behind-the-scenes look at power generation and helped them learn about employment opportunities in the power industry.

The engineering students toured four different types of power facilities in Kansas, Missouri and Nebraska during a two-day trip in September 2009. The power facility tours were connected with members of the Electrical Power Affiliates Program — Burns & McDonnell, Nebraska Public Power District, Omaha Public Power District and Westar Energy — that also sponsored the trip.

Don Gruenbacher, associate professor and head of the department of electrical and computer engineering, led the trip and was accompanied by Warren White, associate professor of mechanical and nuclear engineering, and James Steichen, professor of biological and agricultural engineering.

The trip included 29 undergraduate and graduate students studying various types of engineering, including electrical and computer engineering, mechanical engineering, biological and agricultural engineering, and architectural engineering.

The first tour stop was the Westar Emporia Energy Center in Emporia, Kan. The facility was completed in June 2008 and complements Westar's wind energy program. The plant helps to offset renewable energy by meeting energy demand when the wind drops off and the turbines are no longer able to run.

"It was really good for the students because a lot of them are interested in renewable energy and want to learn more about it," Gruenbacher said. "They were able to meet with some of the plant engineers and they could go inside the plant and see how everything was running."

Next, the group traveled to Iatan Generating Station in Weston, Mo., where Burns & McDonnell was providing the engineering consulting and construction management for an addition to the existing coal plant. The station was under construction at the time of the tour but was later completed in 2010.

"Because the station was still in the construction phase, we were able to see some areas of the facility that we would not have been able to see if the facility was running," Gruenbacher said.

Afterward, the group went to Nebraska City, Neb., where they had a reception and dinner with the Nebraska Public Power District and met with power engineers.

The next day, the group toured the Omaha Public Power District's Nebraska City Station, a fairly new operating coal plant.

"After seeing the coal plant that was under construction, it was interesting for students to visit a coal plant already in operation and to see the different control aspects and watch them working," Gruenbacher said.

The two-day tour concluded at Fort Calhoun Nuclear Station in Blair, Neb., a nuclear power plant owned by the Omaha Public Power District. After going through security, the group received an exclusive tour of the facility before returning to Manhattan, Kan.

Organizers said the successful trip helped fulfill the EPAP mission of generating student interest in power. They plan to organize a facility tour every other year, alternating years between touring EPAP power facilities and traveling to the national Transmission and Distribution Conference and Exposition, organized by the IEEE's Power and Energy Society.

"We want to get students out to where the jobs might be, because it is a better way to let them see what employment opportunities might involve," Gruenbacher said. "We want to foster those relationships between students and companies."

A WORLDWIDE PERSPECTIVE

Transmission and Distribution Conference sparks student interest in power and energy

by Jennifer Tidball

Thanks to supporters in the electrical power industry, more than 30 Kansas State University undergraduate and graduate students received an international look at the power industry while attending the most recent Transmission and Distribution Conference and Exposition.

The students networked with companies, listened to speakers and participated in poster sessions from April 19-22, 2010, at the Ernest N. Morial Convention Center in New Orleans. The conference trip was funded by the Electrical Power Affiliates Program.

The international conference occurs every two years and is sponsored by the Institute of Electrical and Electronics Engineers — or IEEE — Power and Energy Society, a nonprofit association of more than 27,000 individuals engaged in the electric power energy industry. Noel Schulz, the EPAP director and Paslay professor of electrical and computer engineering, accompanied the students to New Orleans.

"The conference was really a wonderful learning opportunity for our students," said Schulz, who is the president-elect of the IEEE Power and Energy Society and will spend 2012 to 2013 as its president. "Through presentations, panels and exhibitor displays they were able to obtain a comprehensive look at the power industry. Without support from EPAP, this opportunity would not have been possible."

The 2010 conference, "Smart Solutions for a Changing World," had a special emphasis on the smart grid and its impact on industry and the world's economy.

At a poster session, several Kansas State University students presented papers on their research involving power delivery and operations. Viet Nguyen, a May 2011 master's graduate in mechanical engineering from Phillipsburg, Kan., took third place in the graduate student poster session.

The conference also featured booths from more than 600 domestic and international power companies, manufactures, and organizations, as well as federal agencies and research facilities. Other events let the students interact with participants from other universities and colleges.

"I especially liked a lecture about the emergency response after Hurricane Katrina and about an electrical engineer who was in New York during the Sept. 11 attacks," said Clayton Stubbs, senior in electrical engineering, Abilene, Kan. "It was interesting to see what engineers had to do in response to those emergencies and how they had to overcome obstacles."

Both Stubbs and Nicholas Stueve, senior in electrical engineering, Topeka, Kan., decided to attend the conference as sophomores because they wanted to learn more about the industry and determine what area of study they wanted to pursue.

"Since the conference, we've both decided that power systems is the area we want to study," Stueve said. "The conference really helped me make that decision because I was able to see what kind of opportunities were out there."

Both Stubbs and Stueve had summer internships with Westar Energy in Topeka. Stubbs worked with distribution engineering and Stueve worked with reliability engineering. They plan to attend the 2012 Transmission and Distribution Conference and Exposition, May 7-10, 2012, in Orlando, Fla.

OMAHA PUBLIC POWER DISTRICT

The Omaha Public Power District is one of the largest publicly owned electric utilities in the United States, serving more than 340,000 customers in 13 southeast Nebraska counties. It was organized as a political subdivision of the State of Nebraska in 1946. Policies and rates are set by an eight-member Board of Directors elected by the people in the areas served. The organization's mission is to deliver high-value electricity and other essential services to customers. Learn more at www.oppd.com.

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ELECTRICAL POWER AFFILIATES DAY

EPAP Day helps industry connect with students

by Jennifer Tidball

Members of the Electrical Power Affiliates Program teamed up with the Kansas State University department of electrical and computer engineering for Electrical Power Affiliates Day twice this year.

The most recent event was Sept. 7, 2011 in the Rathbone Hall Atrium, the center of K-State's College of Engineering. A similar event also occurred March 9.

"EPAP Day provides an opportunity for industrial representatives to come to campus and interact with students through class presentations and display tables," said Noel Schulz, director of EPAP. "This helps students at all levels learn about careers in engineering, particularly power industry careers."

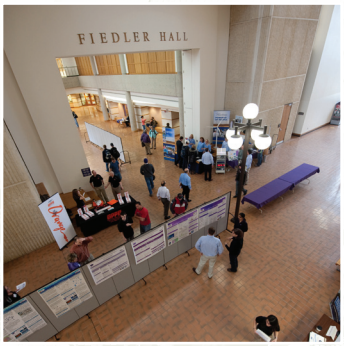
During the day, each EPAP member — Burns & McDonnell, Nebraska Public Power District, Omaha Public Power District and Westar Energy — had displays where students could stop by and talk with representatives to learn more about the power industry.

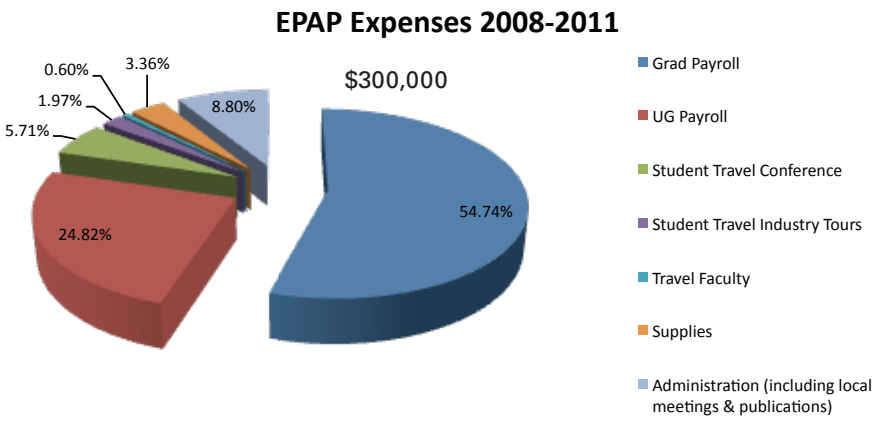
At the September event, guest speakers from the four companies spoke to 18 undergraduate and graduate classes, reaching out to more than 500 students in the architectural engineering, civil engineering, computer and information sciences, construction science, electrical and computer engineering, and mechanical and nuclear engineering departments. Additionally, 15 faculty members participated in class discussions, and more than 20 faculty, staff and administrators attended an industry reception in the afternoon.

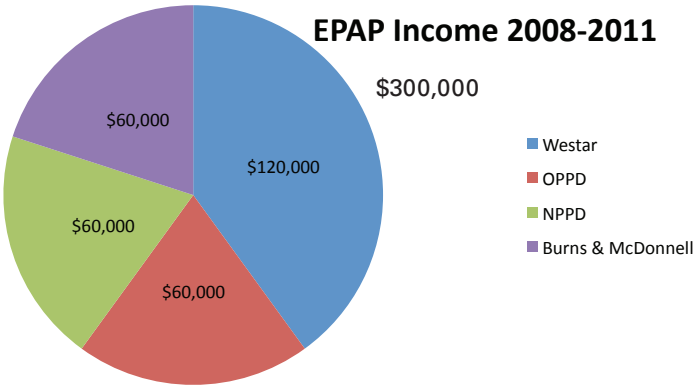
Other activities focused on industry-related topics. Representatives from the four EPAP companies conducted mock interviews with 25 students to help them with their future career activities. Event organizers also sponsored a free lunch for more than 400 engineering students.

Because the event was such a success, organizers plan to have the event every year during the fall semester before the All-University Career Fair.

"Industrial support of Kansas State University will increase in importance as we move toward K-State 2025," Schulz said, referring to the goal to become a top 50 public research university during the next 14 years. "The Electrical Power Affiliates Program is an example where four companies can make a difference for our students and faculty. They can contribute to the advancement of the College of Engineering by enabling undergraduate and graduate research projects, student travel to conferences, plant trips to industrial sites and more."







Student Research Publications and Presentations

Anthony Hawkins

- "Wind Turbine Power Capture Control with Robust Estimation," by Tony Hawkins, Warren N. White, Guoqiang Hu, and Faryad Darabi Sahneh, presented at the 2010 ASME Dynamic Systems and Control Conference, Boston, MA.
- "Region II Wind Power Capture Maximization Using Robust Control and Estimation with Alternating Gradient Search," by Tony Hawkins, Warren N. White, Guoqiang Hu, and Faryad Darabi Sahneh, presented at the 2011 American Control Conference in San Francisco, CA.

Shengyang He

- Shengyang He, Shelli K. Starrett, "Modeling Power System Load Using Adaptive Neural Fuzzy Logic and Artificial Neutral Networks," 2009 North American Power Symposium Proceedings, Mississippi State University, Oct. 2009.

Amelia Hodges

- S. Pahwa, A. Hodges, C. Scoglio, S. Wood, "Topological Analysis of the Power Grid and Mitigation Strategies against Cascading Failures." 4th Annual IEEE International Systems Conference, April 5-8, 2010, San Diego, CA, USA.

Mark Hopkins

- M. Hopkins, A. Pahwa, "Economic Feasibility of Owning a Small Wind Generator," Kansas State University Sustainability Conference, January 2009.
- M. Hopkins and A. Pahwa, " Monte-Carlo Simulation of Energy Production by a Small Wind Generator," Proceeding of the 40th Annual North American Power Symposium, Calgary, Alberta, Canada, Sep. 2008.
- M. Hopkins (Advisor: A. Pahwa), "Renewable Energy Intelligent Dispatch," Student Paper Contest, IEEE Power Engineering Society General Meeting, Pittsburgh, PA, June 2008.
- M.D. Hopkins, A. Pahwa, T. Easton, "Intelligent Dispatch for Distributed Renew-able Resources with Energy Storage," IEEE Transaction on Smart Grid (under review).
- Miller, R.D., Nagengast, D., Hopkins, M., "Wind for Schools in Kansas: A Second Year Progress Report," Windpower 2009: American Wind Energy Association Annual Conference, Chicago, IL, May 2009.

Anita Jose

- Anita A. Jose (Advisor: A. Pahwa), " Economic Evaluation of Small Wind Generation Ownership under Different Electricity Pricing Scenarios," Student Paper Contest, IEEE Power and Energy Society General Meeting, Minneapolis, MN, July 2010.
- A.A. Jose (Advisor: A. Pahwa), Economic Evaluation of Small Wind Generation Ownership under Different Electricity Pricing Scenarios," Student Paper Contest, IEEE Power and Energy Society T&D Conference and Exposition, New Orleans, LA, April 2010.
- Anita A. Jose (Advisor: A. Pahwa), "Residential Load-Curtailment Schemes in the Presence of Wind Generation and Storage," K-State Research Forum, March 2010.
- Anita A. Jose and A. Pahwa, "Economic Evaluation of Small Wind Generation Ownership under Different Electricity Pricing Scenarios," North American Power Symposium, Arlington, TX, Sept. 2010.
- A.A. Jose, A. Pahwa, R.D. Miller, "Intelligent Dispatch of Small Wind and Solar Generators," IEEE Power Engineering Society Transmission and Distribution Annual Meeting, New Orleans, LA, April 2010.

Viet Nguyen

- Nguyen, V., Zheng, Z. C., Miller, R. D., and Natarajan, B., "Computational Simulation of Local Atmospheric Turbulence for Flow past Buildings and Trees," Journal of Wind Engineering and Industrial Aerodynamics, 2011.
- Nguyen, V., Zheng, Z. C., Miller, R. D., and Natarajan, B., "Simulation of Wind Speeds for the Environment of a Small-Scale Wind Turbine," Wind Energy, 2011.
- Nguyen, V., Zheng, Z. C., Miller, R. D., and Natarajan, B., "Computational Simulation of Local Atmospheric Turbulence and Its Effect on Small-Scale Wind Turbines," AIAA Conference, Wichita, KS, Mar. 31, 2010.
- Nguyen, V., Zheng, Z. C., Miller, R. D., and Natarajan, B., "CFD Simulations of Local Atmospheric Turbulence for Small-Scale Wind Turbines," Institute of Electrical and Electronics Engineers Power & Energy Society Transmission & Distribution (IEEE PES T&D) 2010 Conference and Exposition, New Orleans, LA, Apr. 19, 2010.
- Nguyen, V., Zheng, Z. C., Miller, R. D., and Natarajan, B., "CFD Simulations and Tools for Improving the Siting of Small-Scale Wind Turbines," Kansas State University Sustainability Conference, Manhattan, KS, Mar. 30-31, 2011.

Sarah Kubler

- S. Kubler, S. Pahwa, N. Schulz, C. Scoglio, "A simulative analysis of the robustness of smart grid communication networks", Proceedings of the 43rd North American Power Symposium, Boston, MA, Aug 4-6 2011.
- Poster Presentation at the 2010 IEEE PES T&D Conference and Expo, New Orleans, LA, May 2010.
- S. Kubler, M. Youssef, R.D. Miller, C. Scoglio. "Wind data transfer program for Skystream wind turbines," Windpower 2010: American Wind Energy Association Annual Conference, Dallas, TX, May 2010.

Sakshi Pahwa

- S. Pahwa, A. Hodges, C. Scoglio, S. Wood, "Topological Analysis of the Power Grid and Mitigation Strategies against Cascading Failures." 4th Annual IEEE International Systems Conference, April 5-8, 2010, San Diego, CA, USA.
- Poster Presentation at the NetSci International School and Conference, Boston, MS, May 2010
- Poster Presentation at the 2010 IEEE PES T&D Conference and Expo, New Orleans, LA, Apr 2010
- S. Kubler, S. Pahwa, N. Schulz, C. Scoglio, "A simulative analysis of the robustness of smart grid communication networks", Proceedings of the 43rd North American Power Symposium, Boston, MA, Aug 4-6 2011

Laxman Subedi

- Subedi (Advisors: A. Pahwa and S. Daws), "Trouble Call Analysis Supported byIntelligent Techniques," Student Paper Contest, IEEE Power and Energy Society General Meeting, Minneapolis, MN, July 2010
- L. Subedi (Advisors: A. Pahwa and S. Das), "Trouble Call Analysis Using Artificial Immune System Techniques," Student Paper Contest, IEEE Power and Energy Society General Meeting, Detroit, MI, July 2011.

Sean Wood

- S. Pahwa, A. Hodges, C. Scoglio, S. Wood, "Topological analysis and mitigation strategies for cascading failures in power grid networks", Proceedings of the 4th Annual International IEEE Systems Conference, San Diego, CA, Apr 2010.

FUELING FACULTY RESEARCH

A look at collaborative and individual EPAP-funded projects

by Jennifer Tidball

Stewart Stanton and Shelli Starrett

Their research: Stanton and Starrett have led a research group of seven graduate and undergraduate students in looking at voltage stability and how to keep the interconnected transmission grid working. Because voltage collapses happen spontaneously and can lead to wide-area blackouts, the researchers looked at ways to monitor the power system and make sure it stays stable. The students were able to use different computer tools to simulate and measure the power system. By doing so, they could better understand where weaknesses occurred and they could characterize the system to help build better models.

"The boiling of research activity draws a crowd and it draws interest beyond those directly involved in the project. There's a lot of recruiting value in drawing a crowd of students, especially if they are studying different types of engineering."

Stewart Stanton, associate professor of electrical and computer engineering

"A big benefit of the power affiliates is having a foundation of funding available for student projects. These projects then generate student interest in both jobs in the power industry and in graduate school."

Shelli Starrett, associate professor of electrical and computer engineering

Bala Natarajan and Ruth Douglas Miller

Their research: Research by Natarajan and Miller involves modeling turbulence to determine its impact on siting wind turbines, and energy production from small wind turbines in cluttered environments. The researchers use computational fluid dynamics — or CFD — simulations to understand the impact of operating small turbines in turbulent environments close to a home/office, where trees or buildings affect wind flow. They also research how turbulence affects the physical structure of the turbine. Early findings indicate that it is possible to offset some of the effects of turbulence with appropriate design of power electronics within a turbine. Natarajan and Miller plan further research in the area.

"My background is in statistical signal processing as applied to sensing networks and wireless communication systems. Following the example of radio propagation modeling in cluttered environments for cellphone tower siting, I had the idea to develop models for siting small wind turbines in cluttered environments. This will help people decide if it was worth it to invest in a wind turbine for their homes/offices. For me, it was a new area of research, and EPAP really helped foster our work in this area. The program helped me not only make connections with faculty outside my area, but it also gave us an opportunity to bring this interesting problem to the forefront."

Bala Natarajan, associate professor of electrical and computer engineering

"As the director of the Wind Applications Center, I am keenly aware of the importance of small and community wind to the growth of the wind industry in Kansas, and also of the difficulties in small-wind siting. I hope our work will produce something that helps individuals install small wind turbines that work and help Kansas citizens understand the value of wind. The utility members of EPAP know the importance of public acceptance in helping get their wind farms up and running, and increasing the amount of renewable generation in their portfolios. I am as always delighted to work with them."

Ruth Douglas Miller, associate professor of electrical and computer engineering

Anil Pahwa and Sanjoy Das

Their research: Research by Pahwa and Das is helping utility companies better identify where problems and power outages occur in electrical distribution systems connected to homes. By combining Pahwa's knowledge of power systems and Das' expertise with modeling and optimization, the researchers are creating an identification method based on idiotypic networks, which is a form of biological mapping in electrical systems. The researchers have made the method work in smaller systems and are getting ready to test it on a larger system based on real data.

"We had developed ideas about how to solve power-related problems and this funding helps us begin to test them and see if they are something worth pursuing further. Utility companies are looking for solutions, often to problems where they don't have the time or resources to investigate them, but it may be something that a professor and research team could investigate. That's an advantage of this program — it helps us to recruit more graduate students to work on these research projects."

Anil Pahwa, professor of electrical and computer engineering

"The Electrical Power Affiliates Program provides us with problems that are challenging enough to be solved using various research methods. This makes it more enticing to us because power engineering is becoming more and more interdisciplinary. You have researchers from other areas joining to make power systems more efficient and more reliable. With the emergence of the smart grid and the interest in renewable energy, there is renewed interest in power systems. There is a lot of excitement surrounding it."

Sanjoy Das, associate professor of electrical and computer engineer

Caterina Scoglio

Her research: Scoglio has led two student EPAP-funded projects related to the topic of robustness of power grids and incorporation of renewable energy. One project involves the evaluation of the robustness of the transmission grid with respect to cascading failures. The research looks at using different mitigation strategies, including islanding with the use of renewable distributed sources, to minimize the impact of cascading failures. Another project evaluated the robustness of the communication networks associated with power grids to find results on how failures in one network can affect the other network, and how the robustness of the power grid may be improved by proper interconnection with the communication network.

"Along with providing financial aid to three students, the EPAP projects have been the source of inspiration for our contribution to two other projects, both sponsored by the U.S. Department of Energy. The Power Affiliates program at K-State has also been instrumental in spreading greater awareness among the people involved, their responsibility to society and also encouraging the use of the vast amount of renewable energy present in Kansas."

Caterina Scoglio, associate professor of electrical and computer engineering

Warren N. White

His research: As a mechanical engineer, White is researching how to build better wind turbines. He has looked at power capture and how to get the most power possible from the wind. White has also researched wind turbulence and how it causes vibrations in turbines. Vibrations on the turbine blades can tear up a turbine's transmission and lessen the life of the turbine. White is working on ways to better measure and sense vibrations so that he can determine how to minimize their influence.

"EPAP funding helped me open up a new area of application for my research, which is nonlinear control theory. We were able to see wind turbines as having applications of system identification and adaptive control in addition to model uncertainty, and we saw interesting problems that we wanted to solve. Overall, vibrations are the most pressing concern for wind turbine performance."

Warren N. White, associate professor of mechanical and nuclear engineering

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GENERATING UNDERGRADUATE INTEREST

A look at EPAP-funded projects from undergraduate students
by Jennifer Tidball

Andrew Bowman

"Doing research really opened my eyes to how complex power issues can be. To make a system run the way you want has a lot of variables involved. I never really realized how complex it was and the amount of mathematics that go behind keeping all the lights on. It's really kind of amazing."

Andrew Bowman, senior in electrical engineering from Wichita, Kan.

His research: Bowman spent a year analyzing voltage stability with a research team under the direction of Stewart Stanton and Shelli Starrett, both associate professors of electrical and computer engineering. Bowman helped develop a program that modeled power flow and he ran simulations to understand when voltage collapses occurred and what caused them. Ultimately, his project could help prevent voltage collapses. Bowman had a summer internship with Burns & McDonnell's energy market. He also spent the summer of 2010 at Burns & McDonnell and had a summer 2009 internship with Westar Energy. Bowman plans to work in industry after graduating in December.

Kellen Manning

"The Electrical Power Affiliates Program really helped me get out from behind the desk and talk with people who are dealing with real power problems, especially with respect to wind energy. It's been great actually meeting the people who are installing wind turbines, discussing their problems with them and trying to come up with potential solutions."

Kellen Manning, senior in electrical engineering from Olathe, Kan.

His research: Manning has helped with two EPAP-funded projects. Under the direction of Stewart Stanton and Shelli Starrett, both associate professors of electrical and computer engineering, Manning modeled a large power system and created graphical analysis of power voltage curves. He worked with Ruth Douglas Miller, associate professor of electrical and computer engineering, on a second project involving wind energy. He collected data from anemometers at the university's wind turbine north of campus and at the newly opened Riley County Public Works Facility. His real-world measurements supported the master's project of Viet Nguyen, who looked at wind turbulence on small-scale turbines. Manning graduates in December and plans to pursue research through graduate school.