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Brightening Afghanistan

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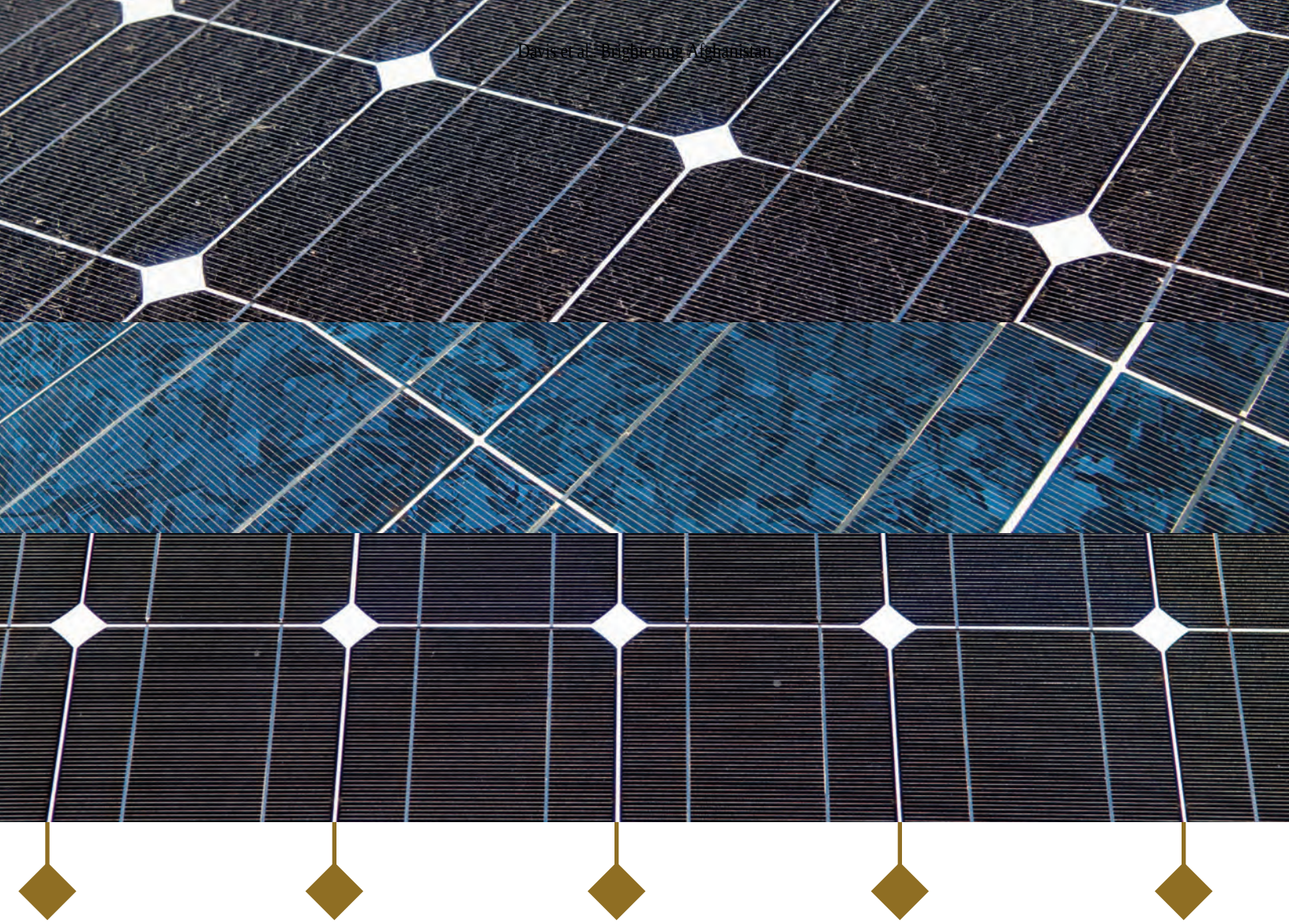

BRIGHTENING AFGHANISTAN

Researchers study renewable energy to power electricity-scarce country

Employees light a candle to see one another during a meeting.

A child reads a book by moonlight before bedtime.

Machines at a factory are at a standstill, sending workers home.

Without electricity in much of the country, these are common scenes in Afghanistan. A severe energy shortage threatens the nation's hopes of building its economy.

The country ranks as one of the lowest producers of electricity per capita in the world. More than 80 percent of the 29 million people in Afghanistan do not have access to electricity. Afghanistan depends on other countries for electric power, importing 73 percent of its electricity from neighboring countries.

Kansas State University researchers have proposed a solution: Harness the power of nature. The researchers include Anil Pahwa, professor of electrical and computer engineering; Ruth Douglas Miller, associate professor of electrical and computer engineering; and Mahdi Sadiqi, a native of Afghanistan who recently earned his master's degree in electrical engineering. They recently presented their findings to the IEEE — Institute of Electrical and Electronics Engineers — North American Power Symposium.

A rural disadvantage

The power supply in urban Afghanistan is sometimes sporadic, giving customers access to electricity just four to six hours a day. The situation is worse in rural Afghanistan. Electricity is scarce in rural areas, where about 70 percent of the country's population lives.

The lack of power makes everyday tasks more difficult. Rural community members are forced to use wood, diesel and kerosene as sources of energy for cooking, heating and lighting. They gather wood for fires to heat water. Schoolchildren have limited time to study in the daylight. Kerosene lanterns emit smoke and pollution inside some homes.

Importing more electricity would not help the country's predicament in rural areas, where the infrastructure does not exist. Expanding the power grid to mountainous rural areas is nearly impossible.

"The central power authority is already having trouble taking care of everybody's needs in Afghanistan, and there are often electricity shortages," said Pahwa, who experienced many power outages while teaching at a university in Kabul, Afghanistan's largest city. "Adding new customers would be an extremely difficult proposition, and the infrastructure does not exist. Alternatives must be found."

Renewable solution

Kansas State University researchers found that Afghanistan can use more renewable energy to power the country.

They created model power systems in the province of Bamiyan in the northern part of Afghanistan using the computer software Hybrid Optimization Model of Electric Renewable, or HOMER, developed by the U.S. Department of Energy's National Renewable Energy Laboratory.

Researchers discovered that the most ideal solution is a hybrid system powered by renewable resources, including water and the sun, and a battery backup. Renewable energy could power an entire system for a rural community. With significant amounts of snow during the winter and sun during the summer, this system could be used throughout the year. Wind energy was not suitable for the selected site because of low wind speeds.

The ideal model would implement energy curtailment a few hours per day for each customer to reduce the cost of generated electricity, encouraging community members to find ways to limit their power usage.

Plugging into benefits

More renewable electricity in Afghanistan could reduce poverty and deforestation, and improve health care, living standards and education. With more electricity, students could access technology using a computer and the Internet. Community members could access electronic news to stay informed. Factories could stay powered and employ more workers.

Researchers said they hoped to encourage private investors and local community members to take advantage of Afghanistan's renewable energy potential.

"We want to show private investors, the government, community members and nonprofits that Afghanistan has enough renewable energy sources that can be integrated affordably in our communities," Sadiqi said.

By Trevor Davis, Communications and Marketing

Professors Anil Pahwa and Ruth Douglas Miller worked with a former graduate student — an Afghanistan native — to improve the country's electricity supply with renewable energy.

BY THE NUMBERS

80 percent of Afghanistan's population without access to electricity

29 million people in Afghanistan

73 percent of Afghanistan's electricity is imported

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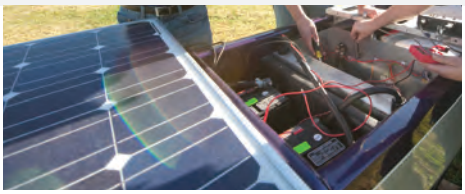

Solar-powered charging stations for plug-in vehicles

Switching from gas-powered to electric and hybrid vehicles can reduce air emissions and improve air quality. Larry Erickson, professor of chemical engineering, directs a project to help develop solar-powered charging stations for electric and hybrid vehicles.

Engineering and construction firm Black & Veatch awarded Kansas State University a $200,000 grant for the research. The solar panels will power charging stations for plug-in vehicles, and will provide shade from the sun and protection from rain, snow and ice. The Kansas State University stations will be used for research, development, education and charging vehicles.

The project will allow researchers to better understand the technical, social, environmental and economic issues surrounding plug-in vehicles. Possible research topics include the environmental impact, consumer attitudes and the distribution of electricity.

The grant comes as auto manufacturers have released plug-in models like the all-electric Ford Focus, Chevrolet Volt and Nissan Leaf. The federal government is requiring that auto manufacturers nearly double the average fuel economy of their fleets by 2025.

By Trevor Davis, Communications and Marketing

New material for improved lithium-ion batteries

Steven Klankowski, doctoral candidate in chemistry working with Professor Jun Li, is making new materials that could be used in future lithium-ion batteries. The materials look to improve the energy storage capacity of batteries for mobile devices so they will last longer between charges.

Lithium-ion batteries that can store energy and deliver power more rapidly will be a more viable alternative power source for vehicles and machines powered by alternative energy. Solar- and wind-powered technologies could switch to the battery when there is a lack of wind or sunlight to produce energy.

Klankowski is developing and testing a high-performance nanostructure of silicon coated onto carbon nanofibers for use as an electrode in lithium-ion batteries. The electrodes give the battery greater charge capabilities and storage capacity. The material helps the electrode store roughly 10 times the amount of energy as current electrodes — giving the batteries a 10-15 percent improvement in current battery technology.

The material is also studied for its ability to store energy.

According to U.S. Department of Energy's requirements, a battery must remain at 80 percent capacity after 300 charge-discharge cycles.

By Greg Tammen, Communications and Marketing

Using biomaterials to improve the quality of roads

Dunja Peric, associate professor of civil engineering, and her research team are working with lignin, a plant-based sustainable material that can be added to improve the quality of unpaved roads throughout Kansas. More than 70 percent of the 98,000 miles of roads in Kansas are unpaved and made from loose granular soils with particles that are not bound to each other on the road surface.

This limits the speed of vehicles and often generates dust, denigrating the quality of the road. Travel is impaired because of raveling and washboarding, which are forms of soil collapse on the top surface of the road. These are all things that can be mitigated by lignin because it holds the soil particles together and in place.

In an agricultural state like Kansas, lignin is an abundant resource and has the potential to improve unpaved roads, leading to lower maintenance costs throughout the state.

Lignin can be extracted from many types of crop residue, and it can also be an extra source of income to farmers and the agricultural community if there is a demand for this crop residue. Lignin is a sustainable and non-toxic product, unlike traditional soil stabilizers such as fly ash or cement, which contain some heavy metals that could contaminate soil.

By Jennifer Tidball, Communications and Marketing