The state of solar

March 15 2011, By Allie Nicodemo

Arizona has more sunny days per year than any other state in the U.S. Phoenix residents enjoy more than 300 sun-filled days per year, according to the city's official website. Given this seemingly endless supply of sunlight, why isn't the state completely powered by solar electricity? ASU researchers explain why Arizona has yet to see a complete solar overhaul, and what projects are underway to make solar electricity more accessible to everyone.

Compared to the East Coast, Arizonans enjoy relatively low electricity costs. This is partly because the largest nuclear power plant in the country, Palo Verde, is located here, says Stephen Goodnick, a professor of electrical engineering in the Ira A. Fulton Schools of Engineering. Goodnick also serves as Deputy Director of ASU LightWorks, an initiative that brings together all light-inspired research at ASU.

Since solar is more expensive than conventional electricity, Arizona residents have been slow to convert.

"People started adopting it because of the incentives and rebates," Goodnick says. "But without that economic incentive it just depends on helping the environment, and that motivates a much smaller group."

Solar panels are expensive to install and cost more per watt of electricity, says Venkatachalam Krishnan, a research assistant in the School of Electrical, Computer and Energy Engineering and graduate student in engineering. While a kilowatt-hour of electricity that originated from a nuclear power plant may cost 10 to 12 cents, the same amount of solar

electricity could cost 25 to 30 cents per kilowatt-hour, Krishnan says.

Large-scale solar projects have been stalled because of project financing difficulties as well. For example, the Solana Generating Station is an APS solar plant that has been in the works for several years but has not been completed due to a lack of financial support.

“They finally received loan guarantees from the government, but it took that federal intervention,” Goodnick says. Once completed in 2013, the Solana Generating Station will be one of the largest solar power plants in the world, serving 70,000 APS customers.

Aside from cost, the other reason solar is not our main source of electricity is because it is difficult to store. Sunshine is plentiful during the day, but people need access to electricity at night as well. If the prevalence of solar continues to increase within the existing energy infrastructure, this problem will need to be solved.

“There’s not a good storage technology, which you would need to mitigate the fact that it’s not working at night or if it’s a cloudy day,” Goodnick says. Engineers at ASU are working to improve existing storage methods, such as batteries, which currently don’t provide adequate storage for their weight. Another possibility is using solar thermal technology to heat up a carrier liquid, like molten salt. The liquid can store heat for 8 to 10 hours, producing steam to power turbines and generate electricity, even at night. APS will use this method at the Solana Generating Station, Goodnick says.

Once the problem of storage has been addressed, solar electricity will make more economic sense for both businesses and residents of Arizona.

“The cost of solar electric has been coming down rapidly,” Goodnick says. “Based on current trends, some say by 2015 it will be at least equal

to the cost of utility electricity."

Henry Braun is another ASU research assistant and graduate student in engineering. He says residents will probably switch to solar electricity before businesses, recognizing solar as a smart long-term investment.

"If you're paying retail price for your electricity, it becomes worth it to do solar sooner," Braun says.

Residents who do switch to solar will need to connect to the existing electrical grid – the network that links power suppliers and consumers. Researchers at ASU's Power Systems Engineering Research Center are working to build a smart grid that adapts to advancing technology as hundreds of thousands of people begin producing solar power locally.

ASU researchers are also working to make solar panels more powerful and effective once they are more widely used. Solar panels are made up of solar cells, or photovoltaic cells, which are made of amorphous silicon. "It's similar stuff to what the processor in your computer is made of," Braun says.

Photovoltaic cells convert photons – the basic unit of light energy – directly into electricity.

"The basic idea is that when a photon hits an electron, it adds energy to it and you harvest that energy," explains Braun.

Rooftop solar panels typically have a large, rectangular surface area made up of solar cells. Unfortunately, current systems operate at about 18 percent efficiency, which means only 18 percent of the sunlight hitting the solar panel is converted into electricity. With this low efficiency rate, panels must be large enough to collect as many photons from the sun as possible, and building these large panels is expensive.

However, another approach is to concentrate sunlight onto smaller, more efficient solar cells. ASU is taking its expertise in materials and combining it with the University of Arizona's expertise in optics to develop a new technique that will make such concentrating solar systems more efficient.

"If the cost of the solar cell is the limiting factor, we could make a very small solar cell and then make a giant mirror that concentrates all the light on it," Goodnick says. "It's the same amount of sunlight but focused on a very small piece of solar cell."

A solar cell built for one of these concentrated systems would operate at a 35 to 40 percent efficiency rate. The cell structure would be more complicated, with different types of cells layered on top of one another.

"Each part of that stack is optimized for a particular part of the solar spectrum, and that's why it's more efficient," Goodnick says. These new solar panels will also be equipped with a special tracking system that allows them to follow the sun as it moves across the sky, ensuring maximum sunlight absorption all day long.

ASU's campus is already partially powered by solar electricity. The university is considered a leader in college sustainability by the Sustainable Endowments Institute, earning a grade of A- on the College Sustainability 2010 Report Card.

"We're about to celebrate reaching 10 megawatts of solar power generated at peak power, which is the largest of any university in the country," Goodnick says. As the ASU campus continues its solar transformation, it also serves as a testing facility for new advances in solar technology.

Provided by Arizona State University