$125 million US-India Initiative drives expansion of university's solar energy program

Engineers at Washington University will work on low-cost solar cells and systems, while other partners will be deploying the technology in India

In "The Best Exotic Marigold Hotel" there is a moment where the only landline phone in the dilapidated hotel in Jaipur, India, starts ringing after a silence of many years.

Sunny, the hotel's owner, frantically digs through accumulated clutter in the hotel office trying to locate the phone before it stops ringing. Ironically he is hampered in his search by the cell phone conversation that is also demanding his attention.

The scene epitomizes a phenomenon called leapfrogging that holds great promise for sustainable development.

The idea is that developing countries can leapfrog developed ones by skipping older, more expensive technologies, such as telephone networks, and moving directly to newer less expensive technologies, such as cell phones.

According to Pratim Biswas, PhD, chair of the Department of Energy, Environmental & Chemical Engineering in the School of Engineering & Applied Science at Washington University in St. Louis, and the director of the McDonnell Academy Global Energy and Environmental Partnership (MAGEEP), the idea behind a recently announced U.S.-India consortium in solar energy is that India might be able to leapfrog energy production technology, moving directly to solar in areas of the country that have never been electrified.

WUSTL and its McDonnell Academy partner the Indian Institute of Technology, Bombay (IIT- Bombay), together with corporate partners, such as the St. Louis-based solar company MEMC Electronic Materials, Inc. (MEMC), will play key roles in the effort to define and invent solar technologies that might make this leap possible.

President Barack Obama and Prime Minister Singh of India walking towards the East Room Nov. 24, 2009.

The second of two giant bi-national partnerships in clean energy

In 2009, President Barack Obama and China's President Hu Jintao signed a memorandum of understanding to enhance cooperation on energy, climate change and the environment.

The presidents began by establishing a U.S.-China Clean Energy Research Center to facilitate joint research and development of renewable energy technologies by scientists from both countries. The center is supported by $150 million in public and private funds disbursed over the next five years and split evenly between the partners.

Initial research priorities are energy efficiency of buildings, clean vehicles and advanced coal technology.

Not too long afterward, Obama and India's Prime Minister Manmohan Singh announced a U.S.-India Partnership to Advance Clean Energy and established the U.S.-India Joint Clean Energy Research and Development Center, which also will be supported by $150 million in public and private funds.

Although India draws as heavily as China on coal for its energy needs, India chose to concentrate instead on three progressive energy strategies: solar energy, second-generation biofuels and the energy efficiency of buildings.

In April, the U.S. Department of Energy announced the winners of a competition to define research consortia that will tackle technological problems in each of these three areas.

The winning solar energy consortium, led on the American side by the National Renewable Energy Laboratory and on the Indian side by the Indian Institute of Science-Bangalore, will include WUSTL, which is paired with one of its McDonnell Academy partners IIT-Bombay.

The McDonnell International Scholars Academy is a WUSTL initiative that brings together top scholars from 28 premier universities in Asia-Pacific, the Middle East, Europe and Latin America to pursue education and research together.

One of the academy's major thrusts is collaborative energy research, pursued by WUSTL's MAGEEP.

Both the U.S. and India are contributing money toward the three consortia, which have also been asked to find matching corporate funds. MEMC, a St. Louis maker of solar cells, for example, will be a major contributor to the program.

Biswas estimates that altogether the consortium will receive about $50 million over the next five years, some for research but some also for the deployment of solar systems in India.

WUSTL's contribution

Washington University and IIT-Bombay have launched the Solar Energy Research Institute in India and the United States (SERIIUS) to help coordinate their efforts.

Biswas foresees a three-pronged research effort at WUSTL to advance the institute's goals, an effort he will lead together with Robert Blankenship, Cynthia Lo, P. Ramachandran and Venkat Subramanian.

One effort will build on the work done at WUSTL's Photosynthetic Antenna Research Center (PARC) since its establishment in 2009. PARC scientists study the elegantly arranged proteins plants use to harvest light and funnel the light to reaction centers. The fundamental knowledge gained in this intensive effort to understand how nature harvests light will guide the effort to improve next-generation solar technology.

The second goal is to develop processes for the production of solar cells that are lower cost and scalable, probably by switching to a material such as titanium dioxide (TiO_2) that is easier and cheaper to process than silicon.

In its pristine state, titanium dioxide absorbs only ultraviolet light, but combined with dyes, quantum dots, or nanowires, it can be used to make solar cells that absorb light at a wide range of wavelengths. These "dye-sensitized" metal-oxide solar cells are not yet as efficient as silicon solar cells, but they cost much less to make and process.

The third goal, says Biswas, is to find a way to store excess solar energy for use at night or when the sky is overcast. To be truly practical, the electricity generating

solar cells must be integrated with batteries to create a "solar system in a box."

Biswas remarks that the practical, deployable solar systems might include batteries that are traveling down the value chain. Batteries that can no longer hold enough of a charge to power an electric car in the U.S. could be integrated with photovoltaic systems used in buildings, or shipped to India for off-grid applications.

For example, reused batteries might provide energy for the cell towers India needs to power cell phone transmissions. Most cell towers are powered today by diesel generators, which are expensive to operate.

Why India?

Biswas is optimistic about the prospects for an energy leapfrog in India, perhaps because he witnessed the telephony leapfrog personally.

When he was growing up in India, it took a long time to get a landline connection. Today, the country has completely bypassed that system and most Indians own a cell phone instead. There are roughly 960 million cell phones in use in India, compared with about 330 million in the U.S.

According to Biswas the introduction of the cell phone has led to the social transformation of rural India over the past 15 years. Pre-cell phone India's poor farmers were often forced to take any price they were offered for their crops. With cellphones, they can now bid up the price and start to keep part of the profit for themselves rather than passing it to a middleman.

"There are exciting opportunities to explore alternative energy futures in places like India," Biswas says. "Distributed energy production makes more sense in a country not bound by existing grids, which run into stability problems if production is intermittent. In fact, some parts of India do not even have a grid!

"Although it is clear that the world's energy needs can only be met by relying on a mix of energy sources," he continues, "solar energy, coupled with energy storage options, will be one of them.

"The collaboration with India gives us the chance to explore solar's potential in a setting where its characteristics are better matched to needs and market demand. Some of the technology that develops in this encouraging environment might then transfer back to us," he says.

"Working with collaborators such as the IIT-Bombay, the Indian Institute of Science, Bangalore, and corporations such as MEMC, researchers at Washington University in St. Louis hope to make a difference in our energy future," says Biswas.

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