



Children reading by the light of white LEDs installed at Golden Island Cottages, Inle Lake, Myanmar.

founder of the Light Up the World Foundation. LUTW is a nonprofit organization that distributes solid-state lighting systems to rural villages all over the world, including Nepal, Tibet, Pakistan, India, Ghana, and Sri Lanka. It relies on donations from individuals and corporate partners and on support from host countries and other international foundations.

The foundation's global lighting solution is a combination of two 1-W white light-emitting-diode lamps coupled with a 5-W solar panel and a lead-acid battery, although some systems use pedal generators or even small wind turbines. Unlike incandescent bulbs, LEDs don't need filaments, so they don't waste energy through heat losses; the illumination derives solely from electron-hole recombination in the semiconductor material. LEDs are longer-lasting and more efficient than kerosene lamps, and they produce less greenhouse gas emissions.

Irvine-Halliday credits physicist Shuji Nakamura of the University of California, Santa Barbara, with developing the necessary technology to bring solid-state lighting to the developing world. Nakamura invented the white LED while employed by Nichia Corp in Japan. The first white LEDs generated light inside a crystal of gallium nitride, powered by a 3-volt battery.

First, Nakamura developed a new technique for growing gallium nitride. Then he discovered he could make a brighter, more efficient blue LED by adding indium to the gallium nitride structure. That technique lowered the frequency of the emitted photons from UV to blue light. By sandwiching a layer of InGaN between two cladding layers of the wider-bandgap GaN, he created a quantum well effect, confining electrons to two dimensions instead of three and giving them a sharper density of states than is found in bulk materials.

the red and green photoreceptors of the eye and, when mixed with the blue light emitted by the LED chip, gives the appearance of white light. Finland's Millennium Prize Foundation, which honored Nakamura in 2006, equated his technological breakthroughs to Thomas Edison's invention of the incandescent lamp.

Energy efficiencies continue to improve. White LEDs now have energy efficiencies of 60% in the laboratory and 25–52% in actual use, which is a significant improvement over incandescent bulbs at 5% and fluorescent lighting at 15–25%. Nakamura believes white LEDs could reach 90% efficiency in the laboratory by 2011.

A major factor is cost. LED prices are currently about 10 times higher than incandescent bulbs, although they are cheaper in the long run because they last much longer and use less energy. LUTW's system costs about \$150, "far too much money to expect those at the base of the economic pyramid to have on hand," Irvine-Halliday admits. However, he realized that people in rural villages were paying that much per year for kerosene. So he devised a payment plan in which they can pay for

the system in installments, on a par with what they were spending on kerosene. After one year, they will own the system outright, with minimal maintenance costs of around \$2 per year.

Solid-state lighting is beginning to make inroads in the US as well. The Department of Energy estimates that 22% of all the electricity produced in this country is consumed by lighting, and widespread deployment of LED systems could cut that consumption in half and reduce costs substantially. For instance, Philadelphia replaced more than 14 000 of its red traffic light signals with LEDs, for a projected five-year savings of \$4.8 million. Raleigh, North Carolina, is in the process of making the switch to LEDs in its streetlights—as is Toronto, Canada—as part of the LED City program, an industry-government initiative dedicated to promoting LED lighting.

Another LED City partner, Ann Arbor, Michigan, switched 1000 of its streetlights entirely to white LEDs in November. City officials anticipate a 3.8-year payback on their initial capital investment and estimate they could save as much as \$100 000 per year in the long term. The action could also remove about 294 tons of carbon dioxide annually that would otherwise be emitted into the atmosphere. Eventually, the city plans to switch all of its streetlights to white LEDs.

Currently, LUTW has its LED systems installed in 20 000 homes in 42 countries, but Irvine-Halliday's vision is to light millions of homes. "We're just barely scratching the surface," he says of the foundation's achievements to date. "It's a matter of getting the word out. People need to know that there is a proven solution for lighting up the developing world."

Jennifer Ouellette

Science fellows craft policy on Capitol Hill

While in graduate school at the University of Washington, particle physicist Matt Bowen attended a symposium lecture on energy policy by Nobel laureate Steven Chu. The talk inspired Bowen to pursue energy-policy issues, and he became a senior program associate for the Board on Energy and Environmental Systems at the National Academy of Sciences. This year he was selected as an American Physical Society (APS) congressional fellow and is working with Senator Harry Reid

(D-NV) on energy issues.

Bowen is part of a class of more than 160 science and technology (S&T) policy fellows who are working for a year in Congress or in executive-branch agencies (see story on page 27). Congressional fellows are sponsored by the American Association for the Advancement of Science (AAAS), the American Institute of Physics (AIP) and some of its member societies, and other organizations; after completion of a rigorous summer orientation session conducted

AIP fellow Rana goes to State Department

"I've spent my entire career so far in physics, but I've always been interested in politics and international relations and just didn't know how to combine the two passions," says particle physicist Lubna Rana, this year's American Institute of Physics State Department fellow.

Rana began work in September at the Bureau of International Security and Nonproliferation (ISN). She expects that as a PhD physicist, both her technical background and her analytical abilities will help her make a meaningful contribution.

Rana says that she is looking forward to spending her fellowship year learning about the American foreign policy making process and contributing to issues she had previously followed closely on the news. "I just want to have an extraordinarily interesting life," she says, "and have the best intellectual experiences I can find that can satisfy my interests."

After her fellowship, Rana plans to return to her position as a research scientist at the University of Maryland, College Park.



Rana

Jermey N. A. Matthews

by AAAS, each fellow was placed in an appropriate office.

Audrey Ellerbee, a recent graduate with a PhD in biomedical engineering from Duke University, heard about prospects for scientists in Congress from a lab-mate. "Everyone in the lab knew that I was interested in opportunities outside of academia," she says. Her colleague told her about the S&T policy fellowship program organized annually by AAAS. "I had not heard about it before but thought it might be a great opportunity for me, so I applied," she says. Ellerbee was selected for the Optical Society of America (OSA) and SPIE Arthur H. Guenther fellowship and is currently engaged in tax and banking policy issues for Sen. Carl Levin (D-MI). Although working in a field outside her training, she is drawing from her diverse background, which includes a summer stint as a financial analyst with JPMorgan Chase and Co.



Bowen

Natural Resources. Jackson, who has a PhD in materials science and engineering from MIT, is this year's recipient of the joint fellowship from OSA and the Materials Research Society (MRS). "I want to use my scientific knowledge to benefit society," she says, "but I didn't want to be in the lab for the rest of my life." Her personal goal while on the energy committee is to learn "where science comes to play in the policy process." She adds that more scientists need to

learn how to frame their issues in ways that policymakers can understand. As it happens, her OSA/MRS fellowship predecessor, Kevin Whittlesey, who worked for Representative Doris Matsui (D-CA) and is staying there through the end of this year, contributed guidelines for improving communication between scientists and nonscientists in the America Creating Opportunities to Meaningfully Promote Excellence in Technology, Education, and Science (COMPETES) Act (see PHYSICS TODAY, September 2007, page 34) that was passed into law this year.

Joining the mafia

Alicia Jackson is working on the staff of the Senate Committee on Energy and



Congressional fellows sponsored by physics-related societies this year include, from left, Alicia Jackson, Alex Apotsos, Audrey Ellerbee, and John Veysey.

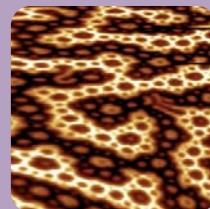
RT - SHPM Room Temperature Scanning Hall Probe Microscope



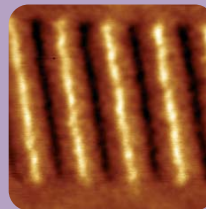
SHPM Image of
NIST
Calibration Sample



SHPM Image of
NdFeB
Demagnetised Magnet



MFM Image of
Hard Disk



RT-SHPM Head



Scanning Hall Probe Microscopy

- 50 nm spatial resolution
- Real time scanning with SHPM!
- Unprecedented sensitivity:
Up to 7 mG/Hz^{1/2}
- AFM or STM Tracking SHPM

Multi-Mode Operation:

- MFM, AFM, STM, EFM ...



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Bowen discovered that many former congressional fellows are still running around Washington, DC, and in government. "I'm very excited to be joining 'the mafia,'" he says, using the term that AAAS fellows apply to themselves. "Everyone looks out for each other, and former fellows form a great network and are willing to give advice, even when they are busy."

"I want to learn how government works," says Alex Apotsos, a PhD civil engineer and oceanography expert also from MIT. Apotsos, the newest American Geophysical Union (AGU) fellow, previously spent two years as a Peace Corps water engineer in Mali and was discouraged by the way international policy can adversely affect underdeveloped regions. He is now motivated, he says, to learn how to get science incorporated into policy as he works on water

resource issues in the office of Sen. John Tester (D-MT).

John Veysey is this year's AIP congressional fellow and a physicist from the University of Illinois at Urbana-Champaign. Through his experience in the office of Sen. Robert Menendez (D-NJ), he hopes to learn about basic-science research funding. Veysey will assist the Menendez staff on the Senate energy and natural resources committee.

An inch deep and a mile wide

Eleanore Edson, last year's OSA/SPIE fellow, recalls her work on health policy for Sen. Hillary Clinton (D-NY) as incredibly rewarding. "I certainly learned more in that one-year period than I had in any other year." Her advice to the new crop of fellows is to "get accustomed to having a very broad portfolio. [Policy work] is inch deep and mile

wide, . . . and prioritizing multiple tasks will become a critical skill." Edson, currently a program officer at the Office of Naval Research through a AAAS S&T fellowship, hopes to pursue a career in international science policy.

Last year's APS fellow, Don Engel, worked for Rep. Rush Holt (D-NJ) on the America COMPETES Act. Engel says he learned that "policymaking is based on trust. Congress relies on experts to advise them, and they tend to trust scientists and professors." Engel now has a new fellowship and is working on policy analysis for APS. Alex Saltman extended his APS fellowship and continues to work for Rep. Adam Schiff (D-CA) on nuclear nonproliferation. Mark Wenzel, last year's AGU fellow, has extended his tenure on the staff of Sen. Christopher Dodd (D-CT), where he contributes technical expertise to many issues, including energy, the environment, and competitiveness.

Jonna Hamilton, last year's AIP congressional fellow, is now a AAAS fellow with the Foreign Agricultural Service at the US Department of Agriculture. "Policymakers are usually willing to meet with scientists who are willing to lend their knowledge to policy formulation," she says.

Jermev N. A. Matthews

Applications for congressional fellowships are due in early 2008. For details, visit <http://fellowships.aaas.org>, which has links to the various sponsoring professional societies.

International neutrino experiment breaks ground

A large project that will seek a small effect was inaugurated with a groundbreaking ceremony on 13 October. The Daya Bay Reactor Neutrino Experiment, located in China's Guangdong Province about 55 km northeast of Hong Kong, is designed to measure θ_{13} , the last unknown neutrino mixing angle.

The experiment will use eight movable underground detectors to monitor six local nuclear power reactors for the disappearance of electron antineutrinos (see PHYSICS TODAY, November 2006, page 31).

The ceremony marked the start of excavation for tunnels and experiment halls. It was attended by Chinese and American officials; Robin Staffin, associate director of the US Department of Energy's Office of High Energy Physics, is second from left in the photo. (Staffin has since become an adviser to Ray Orbach, DOE's under secretary for science.) The experiment is expected to be fully up and running in 2010. Chunli Bai, the Chinese Academy of Sciences' executive vice president (far left), said the experiment "bears great importance in strengthening international collaboration in the field of basic sciences."

More than 190 scientists from 35 institutions on 3 continents are involved in the



Daya Bay experiment, which in terms of both money and people is among the largest scientific collaborations between the US and China. The other participants are from Hong Kong, Taiwan, the Czech Republic, and Russia. DOE is expected to approve the final scope of US participation in the next few months, and to contribute about \$34 million, or roughly half the cost of detector construction.

Toni Feder

Industrial Physics Forum confronts energy challenges

Scientists from industry, government, and academia gathered this October in Seattle to discuss nuclear power, renewable sources, and related energy issues at the 49th Industrial Physics Forum organized by the Corporate Associates program of the American Institute of Physics (<http://www.aip.org/ipf>). The conference ran concurrently with the 54th annual AVS Symposium.

Although technological solutions dominated most sessions, the specter of climate change (see figure) loomed over the entire conference. For example, Rosina Bierbaum, an ecologist from the University of Michigan, illustrated a scenario in which annual US carbon emissions would nearly double by 2050 but could be halved in the same time if sustainable technology and policy are implemented.