Searching for a U.K. Energy Policy with LEDs

Materials science can influence energy consumption in subtle ways. For example, semiconductors can generate dramatic savings in the energy needed for something as mundane as street lighting. In July, the Dutch electronics company Philips revealed that it had put up the first streetlamps that use light-emitting diodes (LEDs). The company now brags that "the lifespan of a streetlamp is no longer limited by the lamp, but by the pole."

The reasons for pursuing LEDs for lighting are obvious when considering that 20% of the electricity generated in the United Kingdom, for example, goes to lighting. In Thailand, the figure is more than 40%.

That is why Colin Humphreys of Cambridge University takes every available opportunity to bang the drum for lighting to move to new materials that consume much less energy. White LEDs could be 10 times as efficient as incandescent light bulbs and twice as efficient as fluorescent tubes.

Humphreys, a recent past president of the Institute of Materials and the Goldsmiths Professor of Materials Science at Cambridge, has his own research team studying the gallium nitride family of semiconductors. GaN is one of a number of new materials that could deliver light more efficiently than current technologies.

Humphreys reprised his message at a recent London meeting of the photonics community in England. He made an impassioned plea for the U.K. government to do something before it is too late. His message was that if the United States can put more than $50 million into its next-generation lighting program, while the Korean government plans to spend $100 million between 2005 and 2008 to develop an LED industry, why will the United Kingdom not provide support?

It is the U.K.'s energy policy that puzzles Humphreys. There are tax breaks for purveyors of alternative energy, especially wind turbines—a particularly attractive option on this windswept island. But there are no comparable schemes for technology that reduces energy consumption in the first place.

There are signs of interest within the government. The Department for Environment, Food, and Rural Affairs (DEFRA) referred to LED technology in its response to an inquiry into energy efficiency by the Select Committee on Science and Technology of the House of Commons. In its evidence, DEFRA said that "to deliver efficiency gains in the future, we will need to ensure that new technologies allow us to design buildings with low or zero carbon emissions, to retrofit difficult-to-tackle homes such as those with solid walls, and to introduce low-energy products such as light-emitting diode [LED] lighting."

Humphreys said that the United Kingdom is not quite "missing in action" on the LED front. One bright spot is in the quality of the materials research that goes on in its universities. And there is plenty of science to do before researchers really understand what goes on inside these devices. Unlike other semiconductors, GaN produces light from devices that are a crystallographer's nightmare. As Humphreys puts it, "One of the remarkable things about this material is that it has got a very high dislocation density, but it still emits light."

The attraction of GaN is that it is part of a versatile family. In principle, this "remarkable new semiconductor system of materials" can provide light of any color, according to Humphreys. Tweak the ingredients, and "you can dial up the color you want emitted," he said. Dial up "white light" and LEDs can be used instead of incandescent or fluorescent lights.

As yet, LEDs have infiltrated only a handful of niches, with transportation leading the way. An early application of LEDs has been in traffic lights. Here, it is not so much the energy savings that matter—although Humphreys does hold up as an example the city of Denver's cut in its annual electricity bill for traffic lights from $330,000 to $26,000—but rather the big savings in replacement costs obtained with LEDs. Lasting 10 years rather than six months, LEDs deliver substantial savings in operating costs.

LEDs have also hit the roads in the form of lighting in automobiles. The White House has given the green light to LEDs in this market. Well, it is really a red light: the newest presidential limousine has an advanced LED-based rear lighting system.

Before LEDs are taken up more widely, they have to enter the product lines of traditional lighting businesses, such as the makers of car lighting. One recent commercial move underlined the interest in LEDs. Philips recently showed its belief in the potential of LEDs when it bought out its partner in Lumileds Lighting LLC. Philips started this joint venture with Agilent in 1999.

When it announced the share purchase, Philips explained that the acquisition gives it expertise in the whole of the "business value chain" for LED lighting, from making the chips through including them in end products such as mobile phones or lighting fixtures. With mainstream lighting manufacturers showing interest in the technology, perhaps it will not be too long before the United Kingdom has an energy policy that appeals to Humphreys.

MICHAEL KENWARD

DOE Outlines Materials Research Needed to Improve Solar Energy Technologies

To help achieve the Bush administration's goal of increased use of solar and other renewable forms of energy, the Department of Energy's (DOE) Office of Science released a report in August describing the basic research needed to produce "revolutionary progress in bringing solar energy to its full potential in the energy marketplace." The report resulted from a workshop of 200 scientists held earlier this year.

"This report demonstrates the important contribution the entire scientific community can make to the development of new sustainable energy resources," said Raymond L. Orbach, director of DOE's Office of Science. "Science and basic research can and must play a key role in addressing the energy security needs of our nation."

Every hour, more energy from sunlight strikes the Earth than is consumed on the planet in a year, according to DOE; yet, solar electricity provides only approximately one-thousandth of the total electricity supply. The report notes that a "huge gap between our present use of solar energy and its enormous undeveloped potential defines a grand challenge in energy research" and that "sunlight is a compelling solution to our need for clean, abundant sources of energy in the future."

The report notes that progress in the proposed research could lead to artificial "molecular machines" that turn sunlight into chemical fuel; "smart materials" based on nature's ability to transfer captured solar energy with no energy loss; self-repairing solar conversion systems; devices that absorb all the colors in the solar spectrum for energy conversion, not just a fraction; far more efficient solar cells created using nanotechnologies; and new materials for high-capacity, slow-release thermal storage.

The report further notes that revolutionary breakthroughs come from basic research: "We must understand the fundamental principles of solar energy conversion and develop new materials that exploit them."

Solar energy conversion systems fall into three categories: solar electricity, solar fuels, and solar thermal systems. Workshop participants considered the potential of all three approaches. They

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identified 13 priority research directions with the "potential to produce revolutionary, not evolutionary, breakthroughs in materials and processes for solar energy utilization."

Cross-cutting research directions include coaxing cheap materials to perform as well as expensive materials; developing new solar cell designs that surpass traditional efficiency limits; finding catalysts that enable inexpensive, efficient conversion of solar energy into chemical fuels; and developing materials for solar energy conversion infrastructure, such as transparent conductors and robust, inexpensive thermal management materials.

The Office of Basic Energy Sciences in DOE's Office of Science organized the 2005 workshop on solar energy research needs. Two hundred scientists from the United States, Europe, and Asia examined the challenges to developing solar energy as a competitive energy source and identified the basic research directions that show promise to overcome these challenges. The workshop was the second in a series following the 2002 Basic Energy Sciences Advisory Committee study on "Basic Research Needs to Assure a Secure Energy Future." The first workshop examined basic research needs for the hydrogen economy.

The DOE's report, "Basic Research Needs for Solar Energy Utilization," can be viewed and downloaded at Web site www.sc.doe.gov/bes/reports/files/SEU_rpt.pdf. Hard copies of the report are available upon request from the Office of Basic Energy Sciences at Web site www.sc.doe.gov/bes.

Scientific Council of the European Research Council Announced

The European Commission in Brussels announced in mid-July the 22 founding members of the Scientific Council of the European Research Council (ERC), a funding organization for frontier research proposed by the European Commission under the Seventh Research Framework Programme (2007–2013). The Scientific Council will be an independent body whose role is to determine the ERC's scientific strategy and ensure that its operations are conducted according to the requirements of scientific excellence. The 22 founding members were chosen by an independent panel of high-level scientists chaired by Chris Patten, Chancellor of Oxford and the University of Newcastle upon Tyne.

Among the appointed members are **Daniel Esteve**, research director at the French Commission for Atomic Energy (CEA); Esteve's main fields of research are statistical physics, nuclear magnetic resonance, superconductivity, mesoscopic physics and nanosciences, and quantum computing; **Hans-Joachim Freund**, director of the Department of Chemical Physics at Fritz-Haber-Institut der Max-Planck-Gesellschaft; Freund has published more than 400 scientific papers in the field of physical chemistry at surfaces and model catalysts; **Michal Kleiber**, head of the Computational Science Department at the Institute of Fundamental Technological Research at the Polish Academy of Sciences, who has just completed his term as Minister of Science and Information Society Technologies in the Polish government; Kleiber has done research on modeling and large-scale computer simulations in solid and fluid thermomechanics, materials science, bioengineering, and system reliability as well as on numerical methods and software engineering; **Norbert Kroo**, vice president of the Hungarian Academy of Sciences, whose interests center on condensed-matter research and optics (e.g., neutron scattering in solids and liquids; the interaction of laser light with matter; the development of new types of lasers and their application in research, technology, metrology, and medicine; near-field microscopy; and plasmonics); and **Jens Rostrup-Nielsen**, director of the R&D Division of Haldor Topsoe, whose research focuses on catalysis, fuel cells, and hydrogen.

FinnSight 2015 Project Relies on Perspectives from Science, Technology, and Society

The scope of the FinnSight 2015 foresight project of the Academy of Finland and the National Technology Agency, Tekes, is unique in Finland. It will examine changes in the global operating environment, emerging needs of business and society, and development perspectives in science and technology. Work of this type is needed in order to meet the challenges of innovation and research activity promptly and successfully, according to the organizers of the program.

The main goal of FinnSight 2015 is to use expert panels to help identify important joint future areas of expertise for science, technology, business, and society. This will lay the foundation for new internationally competitive centers of excellence and expertise clusters. Simultaneously, the foresight project will reinforce strategy work at the Academy of Finland and Tekes.

Academy of Finland President Raimo Väyrynen and Director General of Tekes Veli-Pekka Saarnivaara head the executive group of the FinnSight 2015 project. Ahti Salo from Helsinki University of Technology will act as project manager.

The core of the foresight project comprises 10 expert panels. The panel themes are learning and learning society, services and service innovations, well-being and health, environment and energy, infrastructures and security, bio-expertise and bio-society, information and communications, understanding and human interaction, materials, and the global economy. The chairs and members of the panels are experts from the fields of science, business, and social policy, and will examine the issues under consideration from different perspectives. The panels include about 120 external experts whose work is supported by specialists from the Academy of Finland and Tekes.

The chairs of the panel on materials are Hilkka Knuuttila of Borealis Polymers Oy and the University of Joensuu and Päivi Törmä of the University of Jyväskylä. The chairs of the panel on environment and energy are Allan Johansson of the Technical Research Center of Finland (VTT) and Director Harri Turpeinen of Neste Oil.

The panels are scheduled to begin their work in October 2005 and continue through early 2006. The Academy of Finland and Tekes will publish the results of the foresight project in August/September 2006.

A comprehensive science- and technology-related foresight program of this scope is unprecedented in Finland. Previously, the Academy of Finland has conducted reviews of the state and quality of scientific research, and Tekes has performed analyses related to dynamics, clusters and applications, technologies, and expertise within the content definitions of its strategy. □

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