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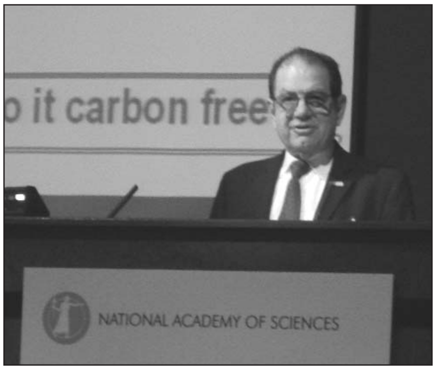
National Academies Energy Summit Addresses Broad Scope of Energy Challenges

If one thing can be said about the impression left at the end of the first day of the National Academies Energy Summit, it would be that the complexity of the energy situation facing the world's population deserves some appreciation. The two-day summit on March 13–14 featured distinguished voices in energy technology and policy. The speakers conveyed temporal, geographic, and technological scopes of the energy challenges.

The time scales woven through the talks ranged from the two-year-long Congressional term to the century-long horizon to consider climate change. Senator Jeff Bingaman (D-NM), chair of the U.S. Senate Committee on Energy and Natural Resources, opened the summit and cited the recent "unprecedented levels of public concern" about energy. Congress responded to those concerns by passing the Energy Independence and Security Act of 2007, he said. He compared current efforts to address the country's energy needs to previous intense national initiatives to reach technological goals. "The [engineering] tasks that faced the Apollo Project and the Manhattan Project were somewhat easier than today's problems," he said and indicated that current energy needs cannot be met by focusing on just a single technological goal.

James R. Schlesinger, former U.S. Secretary of Energy (1977–1979) and co-chair of the 2006 report "National Security Consequences of U.S. Oil Dependency" conducted by the Council on Foreign Relations, a nonpartisan resource for information and analysis, spoke candidly about the methods of national policymaking and



Raymond L. Orbach, undersecretary of science at the U.S. Department of Energy, listed materials needs to address broad energy challenges.

efforts to achieve national energy security. He said that an issue becomes popular with the public but then the urgency fades over time. He said, "You have to have the public with you" to design an energy approach that extends beyond the two, four, and six years of U.S. election cycles.

The farthest look in the future appeared in presentations about scientific and engineering outcomes. Ged Davis, co-chair of the Global Energy Assessment initiative from the International Institute for Applied Systems Analysis, mentioned the long time scales, 100 to 200 years in considering climate change, 50–80 years necessary to build new energy infrastructures and bring novel technologies into large-scale use, and the 25–35-year time frame considered with more conventional energy investments. Because of the long lead times, he said, there is a challenge in public communication, for there is no easy language to think and talk about the scale, size, implications, and institutions needed to address the task. He said that we must meet the challenge of "living with the complexity [of the energy situation] by doing our best to understand it, and to communicate [ideas] without doing violence to what the science is telling us."

In addition to introducing broad time scales, speakers at the Summit highlighted the global geographic scope and interdependence of the energy situation. "Each country talks about diversity of supply, but all those countries together cannot have diversity of supply," said Schlesinger. Kelly Gallagher, director of the Energy Technology Innovation Policy group at Harvard University, said that China installed 101 GW of new power in 2006 and 91 GW of new power in 2007. To put the large investment into a global context, "in two years, China has built the equivalent of India and Germany's electricity capacities combined," she said. She called for the United States and China to work together to address climate change.

The National Academies hosted the Energy Summit (Web cast at www.nas.edu/energysummit) in preparation for reports expected at the end of this year from the National Research Council's America's Energy Future Project (www.nas.edu/energy). The project is preparing four reports: "America's Energy Future: Technology Opportunities, Risks and Tradeoffs" and individual panel reports on energy efficiency, renewable electric power, and alternative liquid transportation fuels for the United States. The study is currently in Phase I, in which the panels analyze the potential of energy technologies for residential, commercial, industrial, and transportation systems and minimize uncertainties about the uses of these technologies. Phase II will be a series of studies to generate options and strategies for future energy policy.

On the second day, several presenters outlined the scope of technology challenges. Raymond L. Orbach, the undersecretary of science at the U.S. Department of Energy, said that existing energy technologies are nearly a century old, and that "basic science and transformational discovery are the only way to deal with [the energy] issue." His talk touched on a series of reports and grand challenges from the "Basic Research Needs for a Secure Energy Future" study at the Department of Energy. He listed five science-transforming energy technologies: solar, electrical energy storage, bioenergy, nuclear, and fusion. He cited that "...basic research in chemical and materials sciences is needed to surmount the significant challenges" for storage devices, including batteries and electro-

Recent Major Studies in Energy Policy

"National Security Consequences of U.S. Oil Dependency"
Council on Foreign Relations, October 2006
www.cfr.org/energy

"Energy Policy Recommendations to the President & the 110th Congress"
National Commission on Energy Policy, April 2007
www.energycommission.org

"Facing the Hard Truths about Energy"
National Petroleum Council, July 2007
www.npchardtruthsreport.org

"Lighting the Way: Toward a Sustainable Energy Future"
InterAcademy Council, October 2007
www.interacademycouncil.net/?id=12161

"Reducing Greenhouse Gas Emissions: How Much at What Cost"
McKinsey & Company, December 2007
www.mckinsey.com/clientservice/ccsi/greenhousegas.asp

https://doi.org/10.1557/mrs2008.121 Published online by Cambridge University Press

chemical capacitors, and that the "performance of materials and chemical processes under extreme conditions is a limiting factor" in nuclear energy systems.

The summit also included technology initiatives in the private sector. The director of Climate Change and Energy Initiatives at Google.org Dan Reicher presented Google's multimillion dollar RE<C program, which aims to decrease the cost of electricity from renewable energy sources to less than the cost of electricity from coal. The energy sources of most interest are solar thermal, wind, and enhanced geothermal, "hot dry rock" systems. Amory Lovins, cofounder of the Rocky Mountain Institute, talked about energy efficiency measures, including the potential for light metals and polymer composites to decrease automobile weight and thus fuel use.

Further talks on climate change technologies, greenhouse gas policies, biofuels, the hydrogen economy, nuclear and coal resources, auto fuel economy standards, and electricity and fossil fuel use, as well as an address by Samuel Bodman, the current U.S. Secretary of Energy, completed the landscape of energy technology and policy.

ASHLEY PREDITH

European Light Research Opens Door for Optical Storage and Computing

The goal of replacing electronics with optics for processing data in computers is coming closer through cutting-edge European research into the mysterious properties of "fast and slow" light. The long-term aim is to boost processing speeds and data storage densities by several orders of magnitude and take the information technology industry into a new era, combining greatly improved performance with dramatically lower energy consumption.

The phenomenon of "fast and slow" light arises from the dispersion of electromagnetic waves when they interact with, and travel through, a physical medium such as a crystal. This can have the effect of slowing down the light pulses, or on occasions appearing to cause local acceleration. These speed variations have the potential for developing purely optical devices using just electromagnetic radiation, rather than electrical signals, to store and process information. In the more immediate future, these properties will be used to enhance existing hybrid communication systems combining electronic and photonic (light-based) devices. But first more fundamental research is needed, and the current state of play along with a roadmap for future projects was discussed at a recent workshop organized by the European Science Foundation (ESF).

The project achieved its main objectives of reviewing the state of the art, highlighting possible applications, and gathering a dispersed European community of scientists, according to the workshop's convenor Marco Santagiustina of the University of Padova, Italy. "There were two remarkable highlights: slow and fast light research has immense potential in applications like microwave and millimeter wave photonics, and secondly such applications can be targeted by making progress in a selected set of technologies," said Santagiustina.

Light signals are already used for communication over fiber optic cables, but cannot yet be stored directly, or used for computation. This would require slowing down the light signals so that they can be buffered within a small area, and can be achieved by exploiting "fast and slow" light effects. According to the workshop report, before the arrival of true photonic computing, there is the more immediate prospect of building optical interconnects, for example in communication networks, which would reduce latency, the time taken for signals to travel from source to destination. Latency imposed by the communications network has become a significant problem in an age of globalization where computers in different continents are cooperating in tasks that need to be executed very quickly in fractions of a second.

Another more immediate application of "fast and slow" light is likely to come from the ability in processing ultrawide band microwave signals, for radio communications, both for mobile telephone and wireless LANs, according to the report. "Fast and slow" light can be harnessed to transmit radio frequencies directly over fiber, making it easier, cheaper, and more efficient to connect base stations or wireless access points. "Radio over fiber is an existing application field destined to grow in the near future," said Santagiustina. "This field will also represent a significant step forward for the photonic/electronic convergence. In that area the time-delay/phase-shift provided by slow and fast light devices can yield unprecedented functions."

Some of these functions have not yet been conceived, but the fundamental point is that converging photonics with electronics reduces delays and increases the bandwidth available, cutting costs and boosting communications capacity, according to the report.

The workshop "Slow and Fast Light: Fundamental Issues and Applications" was held in Venice, Italy, in October 2007. Each year, ESF supports approximately 50 Exploratory Workshops across all scientific domains. These small, interactive group sessions are aimed at opening new directions in research to explore new fields with a potential impact on developments in science.

The report is available online: www.esf.org/fileadmin/be_user/ew_docs/06-081_Programme.pdf.

Experts Call on Increasing Support to Superconducting Technology Studies in China

The Chinese government should launch a major research project on superconducting technology, as it is of significant importance for ensuring national energy security and raising energy efficiency and reducing emissions, urged experts at a workshop held at the Chinese Academy of Sciences (CAS) Institute of Electronic Engineering on March 6–7 in Beijing.

With the support of CAS and the State Administration of Foreign Experts Affairs, the meeting was organized by the International Innovation Partnership Program on Supercomputing Technology, an initiative to back up the teamwork of Chinese scholars in the field at home and abroad. Also present at the meeting were some senior experts in China.

According to the experts, speeding up the materials research and its application demonstration is the key to promoting the practical use of the technology. They also said that the development of such technology at room-temperature is critical to upgrade the country's key competitiveness.

To implement the project, said the experts, long-term objectives and a development blueprint should be mapped out. It should be conducted step by step and by taking advantage of the collective wisdom of Chinese experts at home and abroad.

The meeting suggested that applied and demonstrative research be conducted hand in hand with various basic research projects in the field. Importance should be placed on such topics as the application of a superconducting magnetic system, superconducting power technology, superconducting communication technology, addressing bottleneck issues and building up complete capacity for simulation, design, and manufacturing. At the same time, efforts should be made to address relevant technical subjects, such as cryogenic technology, refrigeration technology, electric power and electronic technology, low-temperature high-voltage and insulation technology, and superconducting power systems, so as to promote its application in energy, transportation, and environment industries. □

https://doi.org/10.1557/mrs2008.121 Published online by Cambridge University Press