AIChE's Critical Issues Series on Energy

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Addressing Today's Energy Challenge

Recent data released by the U.S. Dept. of Energy (DOE; Washington, DC; www.doe.gov) indicates that global energy consumption will increase by 57% from 412 quadrillion Btu in 2002 to 645 quadrillion Btu in 2025. Much of this growth is expected in the countries with emerging economies, such as China and India. There is no question that current hydrocarbon supplies will not support these rapidly growing energy demands. As a result, this energy crunch is fueling a groundswell of initiatives to develop economically viable and environmentally friendly alternative energy solutions.

The latest installment of the Critical Issues Series (CIS) on energy, held at the AIChE 2006 Spring Meeting (Apr. 23–27; Orlando, FL), set the tone for a very open and candid dialogue about the future of energy and AIChE's role in it. "Energy is undoubtedly one of the most important issues facing our society, and one that will continue to impact the chemical enterprise, the chemical engineering profession, and the careers of current and future chemical engineers," said Dale Keairns, senior advisory engineer, Science Applications International Corp. (SAIC) and CIS moderator.

Patrick Davis, DOE technology development manager and fuel cell technology team leader, kicked off the forum with highlights of the President's Advanced Energy Initiative (AEI), particularly the hydrogen, fuel cells and infrastructure technologies program and the DOE's 2007 budget for improving efficiency and developing alternative fuels (Table). The AEI includes the development of a "cellulosic ethanol" within six years that is competitive and practical, better batteries for use in hybrid-electric vehicles, hydrogen fuel cells and affordable H_2-powered cars, zero-emission coal-fired power plants, and clean, safe nuclear energy. "The application of these technologies has already reduced the high-volume cost of automotive fuel cells from $275/kW (2002) to $110/kW (2005) by increasing the power density and reducing the platinum loading," said Davis. "Natural-gas-based hydrogen production has also dropped from $5/gal gasoline equivalent (gge) in 2003 to $3.10/gge in 2005," he continues. Research progress in reforming and purification technologies is being independently verified this year and the results are expected to be validated in full-scale hardware in 2009.

"Despite such progress, it will take a long-term commitment from the international community and decades, perhaps generations, to find the most viable energy solutions," said John Chen, AIChE President and professor of chemical engineering at Lehigh Univ. (Bethlehem, PA). At the CIS, Chen gave an update on the activities of AIChE's recently established Commission on Energy Challenges (CEC; www.aiche.org/energy/index.aspx) — whose mission is to explore the Institute's role in addressing the complex technical, sociological, economic and sustainability issues of energy production, usage and conservation.

Conservation and utilization of alternative energy sources must be part of these solutions. To this end, biomass and the use of household waste, which currently supplies 8–10% of world's total energy consumption, will most certainly be tapped more broadly. Speaking on this subject at the CIS was Jeffrey Siirola, AIChE past president (2005) and technology fellow at Eastman Chemical Co. (Kingsport, TN), who noted that this energy alternative will have key significance for rural areas throughout the developing world, where the main sources of energy for household use and food production are diminishing supplies of fuel wood, along with biomass residues and human and animal power. "By using the potential offered by renewable energy sources, agro-ecotechnologies, and innovative institutional and financial arrangements, rural areas could 'leapfrog' to more sustainable energy systems and food security," said Siirola. "These new energy programs [for sustainable rural development] must be based on a convergence between national development policies and goals, and locally perceived and identified priorities," he continued. "In addition, they must be environmentally sound, socially acceptable and economically viable."

AIChE® Energy Critical Issues Series

Table. DOE 2007 funding for Advanced Energy Initiative.

Energy Sources	FY2007, $ Million
Batteries	30
Fuel cells	82
H_2-powered cars	166
Biomass	150
Coal†	330
FutureGen	54
Hydrogen	114
Nuclear	392‡
Solar	148
Wind	44

Source: U.S. Dept. of Energy.
†Coal: $500 million rolls over from 2005.
‡Includes $250 million for the Global Nuclear Energy Partnership, supports Generation IV, Nuclear Power 2010, and the Nuclear Hydrogen Initiative.

Balancing act

States across the U.S. have their pick of promising solutions, but each solution comes with a challenge. For nuclear power, the challenge lies in the risk of an accident and the disposal of waste materials; for coal, it's the environmental impact of burning it in traditional power plants; for photovoltaics, it's the need for vast amounts of land and lots of sunshine. Natural gas is a promising option because it has less of an impact on the greenhouse effect. The evaluation of renewable resources is anything but straightforward. "For every advantage, there seems to be an equally plausible caveat that must be resolved," said Siirola. For instance, "Would the use of cellulose as a feedstock require more nonrenewable fossil energy for its production than the petroleum it replaces?" he asked.

"Assessing capital and operating costs, and the uncertainty of these options, requires a collaborative source of technical innovation in the areas of energy and energy-related chemical and biological challenges, as well as a consortium of industry partners to develop consensus process evaluation parameters and standards for industry, academia, and government agencies," noted Siirola. "AIChE can take a leadership role to provide access to validated energy information and data; to develop standardized and transparent methods of energy process analysis; and to facilitate comparative energy analyses and accelerated energy technology innovation."

To this end, Calvin Cobb, AIChE past president (2001) and president of Cobb and Associates, explored ways that the technological community would arrive at a consensus on useful metrics for evaluating energy systems. He recommends first defining the goal and scope of the alternative, then identifying potential risks of the alternatives (*e.g.,* how a given decision or course of action might impact the timing, likelihood, or relevance of certain worst-case scenarios of the option selected). Finally, at financial inventory and impact assessments, evaluation should be performed (*e.g.,* calculate the direct and indirect costs, future and contingent liability costs, and internal costs and external costs of the alternative) and compared with other courses of action.

Gaining perspective

One overarching theme that emerged from the CIS was that AIChE, with its technical expertise, should provide a neutral ground for methodically exploring energy options, and for sifting through the conflicting analyses that sometimes characterize the energy debate. There was also a great deal of sentiment that AIChE should do more to educate the public about energy issues. Communicating to the public needs to start with the environment. This is the one concept that many people identify with. "After this connection is made, a logical transition to energy needs and energy technologies that are environmentally compatible will get people to listen," noted one audience member.

Speakers and attendees alike pointed to nuclear and waste-to-energy options as ones that face public perception obstacles, instead of technical ones. The panel of speakers pledged to look at energy supply and demand equally, use a systems approach in evaluating energy options, address global issues, and consider unconventional energy sources and renewables. CEP

To view the Critical Issues Series presentations online, visit www.conferencearchives.com/aiche2006/index.html. The presentations will be available online until November 2006.