MECHANICAL ENGINEERING DEPARTMENT

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Scientific Challenges in Sustainable Energy Technology

by

Dr. Nathan Lewis
George L. Argyros Professor and Professor of Chemistry
Division of Chemistry and Chemical Engineering
California Institute of Technology
Pasadena, CA 91125

Wednesday, January 17, 2007
3:30-4:30 p.m.
Room 402 Walter Digital Technology Center
Coffee and cookies will be available at 3:15 p.m. in Room 401 Walter DTC before the seminar

ABSTRACT — This presentation will describe and evaluate the challenges, both technical, political, and economic, involved with widespread adoption of renewable energy technologies. First, we estimate the available fossil fuel resources and reserves based on data from the World Energy Assessment and World Energy Council. In conjunction with the current and projected global primary power production rates, we then estimate the remaining years of supply of oil, gas, and coal for use in primary power production. We then compare the price per unit of energy of these sources to those of renewable energy technologies (wind, solar thermal, solar electric, biomass, hydroelectric, and geothermal) to evaluate the degree to which supply/demand forces stimulate a transition to renewable energy technologies in the next 20-50 years. Secondly, we evaluate the greenhouse gas buildup limitations on carbon-based power consumption as an unpriced externality to fossil-fuel consumption, considering global population growth, increased global gross domestic product, and increased energy efficiency per unit of globally averaged GDP, as produced by the Intergovernmental Panel on Climate Change (IPCC). A greenhouse gas constraint on total carbon emissions, in conjunction with global population growth, is projected to drive the demand for carbon-free power well beyond that produced by conventional supply/demand pricing tradeoffs, at potentially daunting levels relative to current renewable energy demand levels. Thirdly, we evaluate the level and timescale of R&D investment that is needed to produce the required quantity of carbon-free power by the 2050 timeframe, to support the expected global energy demand for carbon-free power. Fourth, we evaluate the energy potential of various renewable energy resources to ascertain which resources are adequately available globally to support the projected global carbon-free energy demand requirements. Fifth, we evaluate the challenges to the chemical sciences to enable the cost-effective production of carbon-free power on the needed scale by the 2050 timeframe. Finally, we discuss the effects of a change in primary power technology on the energy supply infrastructure and discuss the impact of such a change on the modes of energy consumption by the energy consumer and additional demands on the chemical sciences to support such a transition in energy supply.

BIO — Dr. Nathan Lewis, 2002 George L. Argyros Professor of Chemistry, has been on the faculty at the California Institute of Technology since 1988, and has served as Professor since 1991. He has also served as the Principal Investigator of the Beckman Institute Molecular Materials Resource Center at Caltech since 1992. From 1981 to 1986, he was on the faculty at Stanford, as an assistant professor from 1981 to 1985, and a tenured Associate Professor from 1986 to 1988. Dr. Lewis received his Ph.D in Chemistry from the Massachusetts Institute of Technology. Dr. Lewis has been an Alfred P. Sloan Fellow, a Camille and Henry Dreyfus Teacher-Scholar, and a Presidential Young Investigator. He received the Fresenius Award in 1990, the ACS Award in Pure Chemistry in 1991, the Orton Memorial Lecture award in 2003, and the Princeton Environmental Award in 2003. He has published over 200 papers and has supervised approximately 50 graduate students and postdoctoral associates. His research interests include: Light-induced electron transfer reactions, both at surfaces and in transition metal complexes. Surface chemistry: photochemistry of semiconductor/liquid interfaces. Novel uses of conducting organic polymers and polymer/conductor composites. Development of sensor arrays from these polymers that use pattern recognition algorithms to identify odorants, mimicking the mammalian olfaction process.
Website: http://www.cce.caltech.edu/faculty/lewis/index.html

Informal Faculty Luncheon: Wednesday, January 17, 2007, 12:00 noon. Meet in 1100 ME and walk to lunch with other faculty. Prof. Nathan Lewis will be able to attend.