APR06-2006-000949

Abstract for an Invited Paper
for the APR06 Meeting of
the American Physical Society

Scientific challenges in sustainable energy technology

NATHAN LEWIS, California Institute of Technology

We describe and evaluate the technical, political, and economic challenges involved with widespread adoption of renewable energy technologies. First, we estimate fossil fuel resources and reserves and, together with the current and projected global primary power production rates, estimate the remaining years of oil, gas, and coal. We then compare the conventional price of fossil energy with that from renewable energy technologies (wind, solar thermal, solar electric, biomass, hydroelectric, and geothermal) to evaluate the potential for a transition to renewable energy in the next 20-50 years. Secondly, we evaluate - per the Intergovernmental Panel on Climate Change - the greenhouse constraint on carbon-based power consumption as an unpriced externality to fossil-fuel use, considering global population growth, increased global gross domestic product, and increased energy efficiency per unit GDP. This constraint is projected to drive the demand for carbon-free power well beyond that produced by conventional supply/demand pricing tradeoffs, to levels far greater than current renewable energy demand. Thirdly, we evaluate the level and timescale of R&D investment needed to produce the required quantity of carbon-free power by the 2050 timeframe. Fourth, we evaluate the energy potential of various renewable energy resources to ascertain which resources are adequately available globally to support the projected demand. Fifth, we evaluate the challenges to the chemical sciences to enable the cost-effective production of carbon-free power required. 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.