

Catalysis in an Energy Thirsty World

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Energy is one of the world's biggest businesses. After years of effort around the world, there is no one, clear solution available today to meet the looming global energy resource problem. Many approaches have been proposed, often with sizable technical or practical challenges remaining. What I shall try to do is review some of the many energy options and discuss the major challenges remaining while focusing on catalytic solutions where applicable. We have seen old and new solutions to meet global energy needs, including new drilling techniques for petroleum, commercialization of coal to selected chemicals, especially in China, the use of hydraulic fracking and horizontal drilling to bring shale oil and NG to the surface, the use of a variety of biomass feedstocks, an increasing application of solar-based devices, new approaches to H₂ production, and the development of wind and tidal sources of energy.

Recent discoveries of shale gas (trapped natural gas (NG)) brought to the surface by relatively new drilling techniques, horizontal drilling and hydraulic fracking, have created the possibility of vast new sources of NG in specific regions around the world [1]. Thus, where this new trapped gas has been recovered, we have seen a paradigm shift in the price of natural gas versus petroleum. NG is the only major feedstock that has gone down in price from 2004-2012. Increasingly, power companies in the USA are converting to NG as an energy source. The big opportunity remains in converting this NG to more value-added chemicals. Today NG is used to produce ammonia, ethylene/propylene, syngas, Fischer-Tropsch hydrocarbons, and methanol. Catalysis will lead the way if companies are to expand the diversity of approaches for a mega platform of NG to chemicals.

An overview of many of the options and opportunities offered above will be provided with a focus on a few requiring ambitious catalytic solutions, in particular the use of trapped NG, and solar energy. The new reserves of trapped NG offer a near term (to ~2060) source of a cleaner and greener feedstock, while other technology advances target the big hurdles around solar energy as a major global resource to eventually displace the world's dependency on fossil fuels in the latter half of the 21st century. Huge opportunities exist which require the activation of methane directly to low carbon chemicals. Until an acceptable CO₂ solution to the use of coal is achieved, this will limit the growth of coal as a global, major resource for future energy.

1. J. Armor, *J. Energy Chem.* 22(2013)21–26.