Board Action Area 4: Conversion Science and Technology

Although R&D on cellulosic ethanol has made progress in reducing estimated conversion costs (see Figure 4), production costs remain too high for biomass-based fuels to compete in the marketplace. Transformational breakthroughs in basic and applied science will be necessary to make plant fiber-based biofuels economically viable. For example, one key barrier is the natural "recalcitrance" or resistance of plant fiber to break down into sugar intermediates. The scientific and technological challenges here are formidable. Significant work is needed to better understand plant cell walls, where the plant fiber or lignocellulose is embedded, to enable cost-effective breakdown and deconstruction of plant material. The biotechnology revolution -- with its powerful new tools of genomics and systems biology -- holds promise for developing the biological knowledge at the system, cellular, and molecular level that could enable us to re-engineer plants, enzymes, and microbes to overcome recalcitrance.

Another key barrier is to understand how plant material breaks down thermally. In addition, there is potential for new progress in chemical and thermochemical conversion processes through improved catalysis. In short, significant transformational basic research and applied R&D will be necessary to meet the challenge of developing cost-effective, commercially viable conversion technologies that will be needed to support a major move to cellulosic biofuels.

To date, researchers have focused predominantly on cellulosic ethanol, and ethanol is likely to be the first cellulosic biofuel to become commercially available. But the potential also exists to produce other fuels including higher alcohols, "green" gasoline and diesel, and aviation fuels produced via enzymatic and microbial and/or chemical catalytic processing of biomass. Significant issues of feasibility, cost, and scalability remain. Yet such advanced biofuels would have numerous advantages, for example, having energy content comparable to current petroleum based fuels, and easier integration into the existing fuel infrastructure.

Next Steps

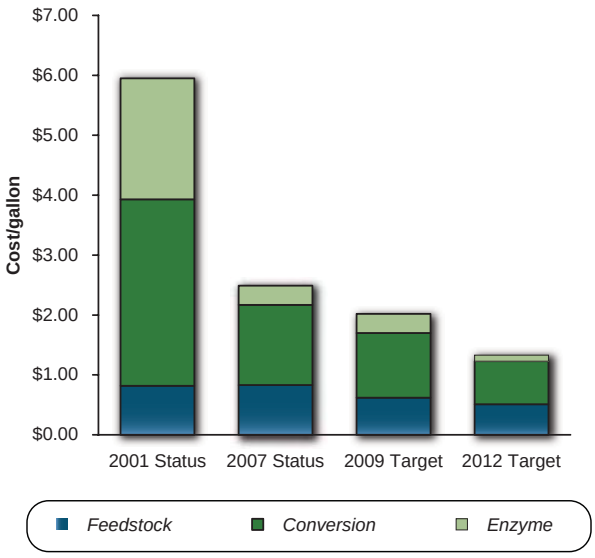
- Developing the knowledge of plants, microbes, and enzymes at the system, cellular, and molecular levels so as to enable re-engineering of these biological systems to substantially reduce conversion costs and increase product yields.
- Developing technologies to enable co-production of marketable fuels and value-added co-products that can improve overall production economics.
- Discovering and developing better technologies for the production of hydrocarbon fuels from lignocellulosic biomass, utilizing microbial, thermochemical, or catalytic processes.
- Addressing fundamental issues of catalysis in the gas and liquid phases, including characterization and durability.
- Addressing the feedstock-conversion interface with the ultimate goal of robust utilization of regionally diverse, multiple, variable, and potentially complex feedstocks.
- Optimizing processes to make technologies economically viable on a small scale.
- Identifying processes and innovations achieved in related industries, such as petroleum refining that can be leveraged to improve the performance of biofuel conversion pathways.

Biomass R&D Board Actions

The Board has established an interagency working group to guide the exploration of concepts capable of leading to cost-effective and commercially viable processes for converting cellulosic and other forms of biomass to biofuels, including: ethanol; higher alcohols; and green gasoline, diesel, and aviation fuels. The interagency working group is comprised of NSF, DOE, USDA, EPA, DOD, and other agencies. Immediate actions are as follows:

- The Biomass Conversion Interagency Working Group (BCIWG) developed and implemented mechanisms to improve interagency coordination, promote interagency knowledge sharing, and track on-going biomass conversion Research, Development, and Deployment (RD&D) across the Federal sector in May 2008.
- The BCIWG will also develop a comprehensive, integrated 10-year federal RD&D biomass conversion plan that includes agency roles, goals and key milestones and identifies gaps by December 2008.

Figure 4: *2012 cost competitive target and status (biochemical)*



Source: DOE EERE Office of the Biomass Program, Multi-year Program Plan, Appendix C.