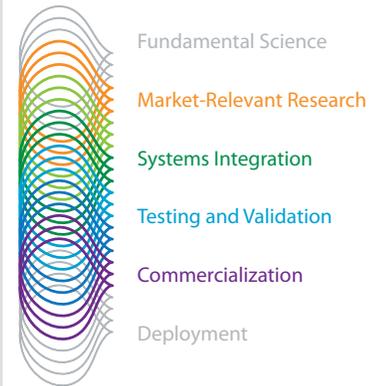


innovation



The Spectrum of
Clean Energy Innovation



Novel Biomass Conversion Process Results in Commercial Joint Venture

A novel biomass-to-ethanol process developed, integrated, and demonstrated at pilot scale at the National Renewable Energy Laboratory (NREL) is the basis for one of the world's first cellulosic ethanol demonstration plants. The 74,000-ft² plant in Vonore, Tennessee, began production in January 2010.

Through a Cooperative Research and Development Agreement (CRADA) with DuPont, NREL and DuPont scientists and engineers developed a unique low-cost pretreatment process that converts raw biomass to ethanol in high yields. The process was developed to facilitate the commercial readiness of lignocellulosic ethanol, which is ethanol produced from nonfood biomass feedstocks such as corn stover, agricultural waste, and energy crops.

The pretreatment enables the conversion of hemicellulose to sugars and makes the cellulose portion of the biomass more amenable to enzymatic digestion. This ensures that all biomass sugars are available for fermentation to ethanol, thereby increasing ethanol yields and reducing production costs.

A Four-Year Partnership

Starting with bench-scale tests and finishing with a series of pilot-scale runs, NREL and DuPont worked on both the science and engineering to improve pretreatment, fermentation, and process integration.

For the first two years of the partnership, NREL and DuPont developed unique processes for pretreatment, enzymatic hydrolysis, and fermentation at the bench scale. These processes

Through deep technical expertise and an unmatched breadth of capabilities, NREL leads an integrated approach across the spectrum of renewable energy innovation. From scientific discovery to accelerating market deployment, NREL works in partnership with private industry to drive the transformation of our nation's energy systems.

This case study illustrates NREL's innovations and contributions in Market-Relevant Research through Commercialization.



DuPont Danisco Cellulosic Ethanol uses technologies developed with the National Renewable Energy Laboratory to run one of the world's first pilot-scale cellulosic ethanol production facilities. PIX 17196



NREL is a national laboratory of the U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, operated by the Alliance for Sustainable Energy, LLC.

were integrated to demonstrate economic feasibility. Next, the team developed a pilot-scale process design and implemented significant equipment modifications in NREL's biochemical pilot plant

After 4½ years of work, the team successfully completed four 3-week runs in NREL's one-ton-per-day biochemical pilot plant, generating quality data that demonstrated economic feasibility. Bringing the project to this size and scale required continuous collaboration, with both teams working side-by-side.

The Birth of a Joint Venture

DuPont has taken what was learned during the NREL CRADA and is commercializing the technology. Through a recently formed joint venture, DuPont Danisco Cellulosic Ethanol, LLC, along with Genera Energy and the University of Tennessee, have built the dedicated pilot-scale biorefinery in Tennessee that will use the technology and processes initially developed within the NREL-DuPont CRADA.

Additionally, they will use a proprietary organism developed through a CRADA between NREL and Genencor, a division of Danisco, as part of the technology package that will be used to produce cellulosic ethanol. The organism, based on NREL's patented bacterium *Zymomonas mobilis*, can ferment biomass derived sugars into high yields of ethanol with fewer by-products.

The company held a grand opening for its pilot plant in January 2010 in Vonore, Tennessee. It will invest \$140 million initially to integrate the pretreatment process and fermenting organism developed with NREL to convert corn stover and switch-grass to ethanol and is expected to produce 250,000 gallons of ethanol annually. A commercial-scale facility, operational in the next three years, is expected to follow. The biorefinery is a major component of the University of Tennessee Biofuels Initiative, a farm-to-fuel business plan that will use biomass feedstocks grown by local farmers to support a state biofuels industry.



Credit: MA Mortenson Company

Expanding NREL's Pilot Plant

NREL and DuPont did much of their pilot-scale testing in NREL's Process Development Unit in the Alternative Fuels User Facility (AFUF) in Golden, Colorado. Now NREL's capabilities in pilot-scale testing and process integration are expanding.

The new Integrated Biorefinery Research Facility (IBRF), shown here in an architectural rendering, will allow NREL to accommodate a greater number and variety of collaboration requests from industry partners, like DuPont, that want to test integrated pilot-scale biochemical conversion processes.

The new space will feature a 27,000-ft² high-bay, new and upgraded laboratories, and additional office space. It will process up to one dry ton of feedstock per day and will offer a broad range of equipment options and configurations. The IBRF is scheduled for completion in 2010.

National Renewable Energy Laboratory

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