Quick Facts

NREL and its industry partners used thermochemical and biochemical process modeling and techno-economic and life-cycle analysis to demonstrate scenarios to meet the $2.15/gallon cost goal for cellulosic ethanol.

Significant improvements in pretreatment, enzymatic hydrolysis, and fermentation helped meet the cost goals for biochemical conversion, while advances in methane and tar reforming and fuel synthesis helped meet the cost goals for thermochemical conversion.

From 2002 to 2012, the modeled cost of cellulosic ethanol production decreased from $9.00/gallon to $2.15/gallon.

Scientists led pilot-scale projects at NREL's Integrated Biorefinery Research Facility and Thermochemical Users Facility to validate the modeled production costs.

The work done to meet the cellulosic ethanol cost goal is also being used to advance drop-in biofuels. For example, biomass-to-sugar and syngas conversion technologies are applicable to the production of drop-in biofuels. In addition, the compositional analysis techniques are similar between cellulosic ethanol and drop-in biofuels, and pilot- and bench-scale equipment for cellulosic ethanol is easily repurposed for drop-in biofuel production.

NREL Proves Cellulosic Ethanol Can Be Cost Competitive

Ethanol from non-food sources—known as "cellulosic ethanol"—is a near-perfect transportation fuel: it is clean, domestic, abundant, and renewable, and it can potentially replace 30% of the petroleum consumed in the United States, but its relatively high cost has limited its market. That changed in 2012, when the National Renewable Energy Laboratory (NREL) demonstrated the technical advances needed to produce cellulosic ethanol at a minimum ethanol selling price of $2.15/gallon (in 2007 dollars). Through a multi-year research project involving private industry, NREL has proven that cellulosic ethanol can be cost competitive with other transportation fuels.

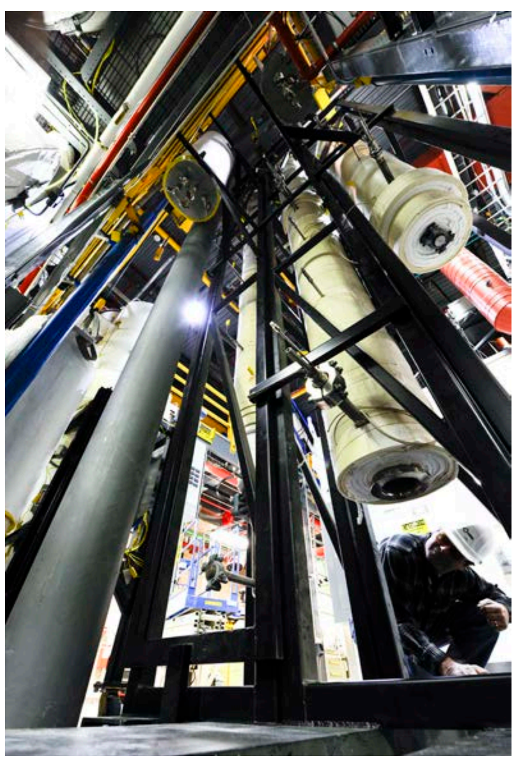
After several years of modeling, performing biomass-to-fuels conversion test runs, and compiling and analyzing market data, NREL was able to demonstrate actual scenarios to meet the cost goal, which was established by the U.S. Department of Energy (DOE) in 2006. NREL met the cost goals using both biochemical and thermochemical processes.

The biochemical process used a dilute-acid pretreatment of corn stover (stalks, leaves, and cobs) and then employed enzymes to release the sugars from the pretreated stover. The mix of sugars were then fermented together to produce ethanol at a minimum ethanol selling price of $2.15/gallon.

The thermochemical platform focused on indirect gasification—using high temperatures to convert woody biomass into a methane-rich gas called syngas, then employing a catalyst to convert the syngas into mixed alcohols, including ethanol. NREL demonstrated an indirect gasification scenario with a minimum ethanol selling price of $2.05/gallon.

The models developed by NREL have enabled private industry to ramp up efforts to commercialize cellulosic ethanol production. Facilities to produce cellulosic ethanol are under construction across the country, including DOE-supported projects led by Abengoa in Hugoton, Kansas; POET in Emmetsburg, Iowa; and INEOS in Vero Beach, Florida.

Industry and DOE are also leveraging the research to commercialize other technologies for biomass conversion, including converting cellulosic feedstocks into drop-in biofuels that are compatible with existing infrastructure and nearly indistinguishable from gasoline, diesel, and jet fuel.



NREL's Thermochemical Pilot Plant was used to develop and demonstrate the technologies to meet DOE's cost goals. Among the equipment in the pilot plant is the recirculating regenerating reformer, which provides continuous reforming of syngas and continuous regeneration of the catalyst.
Photo by Dennis Schroeder, NREL 25486

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