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Are We There Yet?

Not quite, but cellulosic ethanol may be coming sooner than you think

BY JENNIFER WEEKS

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Even as organizations ranging from Consumers Union to the Cato Institute cast doubt on the environmental value of corn-based ethanol, facilities designed to make it are popping up by the dozen throughout the Midwest. Meanwhile, cellulosic ethanol -- which can be derived from just about any plant matter -- draws near-unanimous environmental raves. Trouble is, the technology required for producing it economically still hasn't *quite* emerged. Thus, like the kid in the back seat on a long family car trip, investors and other interested observers have for years been demanding to know, "When are we gonna get there?" Over and over again, the response has been, "In a while."

Are we there yet? Are we there yet?
Photo: iStockphoto

Over the past year, however, things have started coming into sharper focus. In early July, U.S. Energy Secretary Sam Bodman announced a plan for making ethanol cost-competitive at $1.07 per gallon by 2012 and displacing 30 percent (60 billion gallons) of annual U.S. gasoline use by 2030. Currently, U.S. drivers use 140 billion gallons of transportation fuel a year, of which 3 percent (4.5 billion gallons) is corn-based ethanol.

Can the United States produce enough plant matter to make this much biofuel? A 2005 study [PDF] by the U.S. Departments of Energy and Agriculture, nicknamed the "Billion-Ton Study" -- referring to energy feedstocks, not the size of the report -- says that with the right policies we could generate more than 1.3 billion tons of biomass a year by mid-century, when large-scale bioenergy plants are likely to be in operation.

That's seven times more than today's output, with about one-fourth coming from sustainably produced forestry products like fuel wood, logging residues, and wood-pulping waste. The rest would come from agricultural products, but

corn plays a lightweight role in this scenario: Grain represents only about 6 percent of total inputs, dwarfed by crop residues and perennial crops like switchgrass and fast-growing trees.

Production costs are the main drag on cellulosic ethanol today. DOE estimates that it costs about $2.20 per gallon to produce cellulosic ethanol, twice the cost of ethanol from corn. Cellulosic plants yield less ethanol than corn per ton of feedstock, and enzymes that break down cellulosic plant tissue cost 30 to 50 cents per gallon of ethanol compared to 3 cents per gallon for corn. To commercialize the industry by 2012, production methods and materials need to become better, faster, and cheaper.

Learning from Termites

The biggest technical hurdle in making cellulosic ethanol is what researchers call "recalcitrance" -- the tough, woody fuel sources aren't broken down as easily as the simple sugars in corn. There are three basic steps to cellulosic ethanol production: pretreating the material to break cellular bonds, converting cellulose to sugars, and fermenting the sugars into ethanol. The challenge is to do this as efficiently as termites, which turn wood pulp into lunch with help from some 200 species of microbes living in their guts.

DOE is investing $250 million to set up two new Bioenergy Research Centers that will apply biotechnology to producing cellulosic ethanol and other biofuels. Biotech can torque up the process in two ways: by engineering microbes that excel at breaking down plant fiber, and by optimizing plants for use as energy crops. Just as agricultural scientists have engineered corn, wheat, and other commodities to maximize food production for 50 years, energy researchers aim to develop biofuel feedstocks that have high yields, don't require high amounts of inputs like water and fertilizer for growth, can be raised sustainably, and are relatively easy to process into fuel.

In a step toward this goal last September, an international research team that included DOE scientists published the complete DNA sequence of the black cottonwood tree, a member of the poplar family. The black cottonwood is only the third plant and first tree to have its DNA sequenced. By analyzing the genetic makeup of fast-growing plants like poplars, DOE aims to develop energy crops that can be adapted for different climate and soil conditions across the nation.

This approach could draw states outside of the Midwest into the biofuels game. For example, New York is working to commercialize willow trees for biomass energy, with support from DOE and USDA. According to DOE researchers, energy crops like poplar, willows, silver maples, and switchgrass could be grown for energy use over most of the nation.

Promoting diverse bioenergy crops across the nation would dilute the political clout of corn and soybean interests that dominate biofuel discussions today, and broaden support in Congress beyond the Midwest. And if USDA and DOE are correct and cellulosic ethanol can soon be produced for just a dollar per gallon, the price tag will give service-station owners incentive to install pumps and tanks for E85 -- a blend of 85 percent ethanol and 15 percent gasoline.

The ability to offer locally produced fuel would provide further cachet to station owners. Currently, there are fewer than 1,000 E85 stations in the nation, mostly in the upper Midwest, so few drivers have reason to buy flex-fuel cars and trucks -- or opportunity to fill them with ethanol. In short, growing new energy crops could turn ethanol from a regional into a national fuel.

(Don't) Subsidize This

Both corn and cellulosic ethanol got major boosts from the 2005 Energy Policy Act, which required fuel suppliers to use 7.5 billion gallons of renewable fuels by 2012, with each gallon of cellulosic ethanol counting as 2.5 gallons toward the standard. In 2013, the 2.5-to-1 ratio ends, but by then, refiners will be

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required to use 250 million gallons of cellulosic ethanol annually.

The Energy Act also authorized more than $4.2 billion in grants, loan guarantees, and production incentives for cellulosic ethanol over the next decade. "The numbers are reasonable, but our spending on biofuel programs so far falls short of the rhetorical passion and imagination that we've seen," says Jason Grumet, executive director of the National Commission on Energy Policy. "What's been appropriated is probably adequate to support one or two facilities, but banks will probably want to see more than one or two cellulosic ethanol plants before they start funding them, so we're not on the large-scale-growth path yet."

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Many observers argue that cellulosic ethanol would be more competitive in the long term if producers avoided relying on state and federal subsidies to expand the industry. In this view, with fossil-fuel prices on the rise and the ecological cost of relying on them becoming ever more obvious, an efficient fuel source like cellulosic ethanol can survive -- even thrive -- without a nudge from the government. Relying on subsidies only opens the industry to charges of political cronyism -- and makes investors nervous that the governmental goodies won't survive the next big vote.

For now, however, subsidies aren't going away. In fact, they're increasing. A recent report [PDF] from the International Institute for Sustainable Development estimated that biofuels receive $5.5 billion to $7.3 billion in subsidies every year, and that this support will rise as high as $11 billion per year by 2012. Most of these subsidies are linked to output, not to market demand. But even Energy Secretary Bodman acknowledges that ethanol may not need its current 51 cents per gallon tax credit extended after it expires in 2010, although he says it will probably need some federal support to attract long-term investment.

In the Meantime

Even though cellulosic ethanol still leans on government support, private investors are showing increasing confidence in it. Venture capitalists like Richard Branson, Vinod Khosla, and Bill Gates are touting it as the next killer app, and Fortune 500 companies are getting into the game. For example, DuPont is working with DOE to make ethanol out of corn stover (leaves and stalks), and Chevron recently announced joint cellulosic ethanol fuel ventures with DOE and the University of California at Davis.

"We don't view biofuels as competitors to oil and gas. We view them as part of what the world has to do to diversify the fuel supply," Chevron vice president Don Paul said at a DOE/USDA renewable-energy conference in October. "Somewhere out there in 2025 or 2030, we're going to need every molecule we can get."

Paul projected that, within five years, large-scale cellulosic ethanol demonstration plants will be operating and farmers will be planting new energy crops. Just this month Broin Companies, the biggest dry-mill ethanol producer in the U.S., announced plans to convert a 50-million-gallon-per-year corn ethanol factory in Emmetsburg, Iowa, to a 125-million-gallon-per-year bio-refinery that will make cellulosic ethanol from corn fiber and stover. Broin has applied for matching funds from DOE and aims to complete the project by 2009.

Cellulosic ethanol's environmental benefits may give it a boost in the marketplace. At that same conference, Chicago Climate Exchange (CCX) Vice President Mike Walsh estimated that farmers who grow corn for ethanol could soon earn carbon reduction credits of 3 to 20 cents per gallon at CCX. Several state farm bureaus already earn and trade credits at the exchange for soil carbon management activities. The exchange hasn't determined how to quantify greenhouse-gas benefits from ethanol, but it's safe to predict that if corn ethanol is worth anything in carbon markets, cellulosic ethanol will be worth more, since corn is more carbon-intensive to grow than other potential energy crops.

It will be hard for cellulosic ethanol advocates to resist lining up for subsidies when work on a new farm bill starts next year. With a Democratic Congress in place, the 2007 farm bill will be a prime vehicle for renewable-energy initiatives. Congress will be looking at how to manage farmlands currently set aside for conservation, especially with ethanol investments driving up demand for corn. And farmers may not have reason to shift from corn or soybeans to energy crops like poplars or switchgrass unless Congress realigns existing subsidies.

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Khosla and others have suggested indexing ethanol subsidies to the price of oil, so that biofuels would get less government support when oil prices are high and more when gasoline prices drop. Moving in this direction would signal that biofuels are ready to compete on their own strengths. And, says Grumet, Congress should stop directing biofuel funding to pet projects: "Half the federal support that's been appropriated has been earmarked, and it's hard to develop a coherent program without some central coordination. We need some deference to the scientific process."

In other words, if we shut up and let the researchers drive, we may get there in five years.

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Jennifer Weeks is a freelance writer based in Massachusetts. Her recent articles have appeared in Plenty, Harvard Magazine, *and Nature Network Boston.*

< **Previous**