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2007 Energy Legislation

Lifecycle GHG Emissions: A New Hurdle for Biofuels

Turns out that getting enough Republicans and Democrats together last year to OK a greatly expanded Renewable Fuels Standard (RFS) may have been the easy part of the task. The real challenge is going to be figuring out how to implement the new law.

Over the coming year or so, the Environmental Protection Agency has to come up with the regulations to ensure that the RFS is met. What's more, Uncle Sam's environmental watchdogs must also deal, for the first time, with federal law requiring lifecycle analysis of greenhouse gas (GHG) emissions.

The RFS calls for use of biofuels that meet specified reductions in those emissions: 20% less than gasoline for new conventional (cornstarch-based) ethanol production; 50% less than the fossil fuel equivalent for biomass-derived biodiesel, biobutanol and other advanced biofuels; and 60% less than gasoline for cellulosic ethanol.

For a preview of just how rocky that road is going to be, take a look at what's happening in California as that state struggles to put in place Gov. Schwarzenegger's executive order requiring a 10% reduction in the carbon intensity of California's transportation fuels. It provides a revealing glimpse of the kinds of hurdles federal policymakers, the biofuels and transportation industries face in the coming year.

First, it'll be tough just to find an acceptable, accurate way to assess lifecycle emissions. The Greenhouse gases, Regulated Emissions and Energy use in Transportation (GREET) model, first developed at the Department of Energy's Argonne Lab in 1996, is commonly used today by the Department of Transportation and EPA. But it's widely acknowledged to fall short, underestimating emissions because it doesn't account for the carbon impact of changes in land use associated with increased biofuels production. Including them, however, won't go down easily with all policymakers and especially not with ethanol and biodiesel advocates.

Down the road, the development of cellulosic ethanol technology may allow production of energy crops such as switchgrass on marginal lands, potentially with a positive impact on carbon emissions. But for now, it's clear that more acreage will be drawn into production of other biofuels crops, chiefly corn, but also soybeans, as global demand for oilseeds for biodiesel climbs.

And that means converting forest or grasslands, in the U.S. or abroad, to cultivation causing one-time CO_2 emissions from clearing operations and the burning or decay of existing biomass. In addition, ongoing emissions from the cultivation of these acres may be greater than for those already under cultivation. Since they are less productive lands, use of fertilizer, water and pesticides is likely to be greater.

The carbon impact is enormous, Alex Farrell, a University of California-Berkeley professor and director of the university's Transportation Sustainability Research Center, recently told the California Air Resources Board (CARB) in a memo coauthored by Michael O'Hare, a professor at UC-Berkeley's Goldman School of Public Policy. The direct impact of land-use changes on emissions is greater than the emissions associated with the fuel production itself.

In fact, the magnitude of the increase shown in Farrell's analysis, preliminary to a study CARB con-

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Direct Emissions for Land-Use Changes for Biofuels Crop Production

in grams of CO_2 per MJ of energy produced	
Temperate grassland to corn (GREET model)	0.9
Temperate grassland to corn*	140
Tropical forest to corn*	539
Tropical forest to sugarcane*	289
Tropical forest to canola*	1031
Tropical forest to palm plantation^	197

**From R. Righelato and D.V. Spracklen (2007), ^L. Reijnders and M.A.J. Huijbregts (2008), both midline estimates, spread over 20 years*

In This Issue ...

What's happening on the Department of Energy's cellulosic ethanol plants? Nearly a year ago, DOE announced that six companies had been awarded grants to build cellulosic ethanol plants around the country using a variety of technologies and feedstocks. The goal: To prove the feasibility of commercial use of the technology , figuring out how to cut costs and improve efficiencies. Today, half of the grants are still under negotiation and one company recently began construction of its plant.

Name	Location	Conversion Technology	Feedstocks	Nameplate Capacity	Total Award	Status
Abengoa Bioenergy Corp.	Hugoton, Kan.	Thermochemical, biochemical hydrolysis	Corn stover, wheat straw, milo stubble, prairie grass	(from cellulosic feedstock): 15 Mgy	Up to $76 mil.	Negotiations with DOE completed for two-year phase 1 award of $15 mil.
Alico Inc.	LaBelle, Fla.	Thermochemical hydrolysis (with syngas fermentation)	Wood waste, citrus peels	7 Mgy from first unit, 13.9 Mgy from second unit	Up to $33 mil.	Phase 1 grant negotiations ongoing
BlueFire Ethanol Inc.	Corona, Calif.	Concentrated acid hydrolysis & fermentation	Sorted green and wood waste	16.6 Mgy	Up to $40 mil.	DOE negotiations for phase 1 one-year award of $3.7 mil. completed.
Iogen Corp.	Shelley, Idaho	Pretreated enzymatic hydrolysis & fermentation	Corn stover, switch-grass, barley straw, rice straw, wheat straw	18 Mgy	Up to $80 mil.	Negotiations ongoing. Iogen may seek its award under a Technology Investment Agreement (TIA)
Poet LLC	Emmetsburg, Iowa	Pretreated enzymatic hydrolysis & fermentation	Corn stover & by-products from co-located ethanol refinery	(from cellulosic feedstock): 25 Mgy	Up to $80 mil.	Negotiations completed for initial phase 1 two-year award of $3.8 mil.
Range Fuels Inc.	Soperton, Ga.	Thermochemical hydrolysis (with upgrading of syngas into ethanol & methanol)	Wood waste and energy crops	20 Mgy from first unit, 100 Mgy when finished	Up to $76 mil.	Broke ground for plant on Nov. 6, 2007. TIA cost-sharing awarded for phases 1 & 2 of five-phase project: $50 mil.

Sources: DOE, Bruce Dale of Michigan State University, Abengoa Bioenergy, BlueFire Ethanol, Poet, Range Fuels

GHG Emissions *(continued from page 1)*

tracted with UC-Berkeley to do, is causing jaws to drop in the biofuels community.

According to Farrell's memo, which he cautions includes only crude estimates that will likely change, emissions jump 140 grams per megajoule of energy produced when the land used for corn production is shifted out of temperate grassland. And that's the mid-line estimate, spreading the emissions out over a 20-year life span. That type of land use change is exactly what happens when landowners move acreage currently in the U.S. Department of Agriculture's Conservation Reserve Program to corn production.

Add these emissions to those attributed to corn ethanol production and use currently—75.9g/MJ—and the total is more than double the 92.1 g/MJ of emissions associated with gasoline.

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Worse, Farrell points to an even greater indirect impact of land-use changes: The consequences, for example, of losing an acre of tropical rain forest in Brazil when U.S. corn production displaces U.S. soybean acreage, prompting more soybeans to be planted in in Brazil on land previously used for cattle grazing, forcing the herders, in turn, to create new pasturelands from the rain forest.

Taking those indirect emissions into account raises the carbon total for corn-based ethanol substantially. Because there are so many unknowns, Farrell says, it isn't possible at this point to calculate how big that impact is. But his memo estimates a minimum increase of 84g/MJ and potentially as much as 10 times that much.

The final blow: Because "ethanol production today using U.S. corn contributes to the conversion of grasslands and rain forest to agriculture, causing very large GHG emissions," Farrell concludes, the indirect emissions "must be applied to *all* biofuel production that uses crops grown on arable land." There's no way around it, he says, "unless we unmake the global economy."

Of course, those conclusions aren't going unchallenged. When the UC-Berkeley researchers presented their draft study to California air quality regulators last week, representatives of the ethanol and biodiesel industries had plenty of questions about the team's assumptions and calculations.

As a parallel story unfolds on the national stage, the issue of land-use shifts will doubtless spark controversy in Washington as well. ■

Investing

DuPont Energizes Next Generation Biofuels Development

Chemicals giant **DuPont** [DD] is directing its powerful research efforts toward developing next generation alternatives to corn-based ethanol.

In partnership with **BP** [BP], DuPont is tapping its biotechnology know-how to develop biobutanol to blend with gasoline. Created by converting plant sugars into combustible alcohol, biobutanol has several commercial advantages over ethanol: better fuel efficiency and lower transportation costs, because it can be delivered through existing pipelines. It can also be blended at a higher rate (up to 16% versus 10% for ethanol) in current car engines, according to John Ranieri, the general manager of DuPont Bio-Based Materials Energy & Specialties.

Biobutanol, like cellulosic ethanol, can be produced from a variety of feedstocks, including grains and biomass. The first BP-DuPont biobutanol plant in the United Kingdom will use sugar beets. They are building a demonstration plant, expected to open in 2009, and aim to have a commercial facility in operation by 2013.

"At DuPont, we are the first to be able to reengineer a cell to make something viable, something of value," says Ranieri in describing the vision for the company's biofuels initiatives.

In addition to biobutanol, those initiatives include finding a cost-efficient way to collect available cellulosic feedstocks and convert them to ethanol. DuPont's five-year partnership with the National Renewable Energy Laboratory and a joint venture with **Deere & Co.** [DE] have produced a complete set of processes, adaptable to any region, to take biomass from collection through pretreatment, saccharification and fermentation. In the U.S., DuPont is converting corn stover; in Brazil, sugarcane bagasse; in Europe, wheat straw; and in Asia, rice straw.

To test the commercial viability of its technology, DuPont plans a demonstration facility in the next one to two years. Meanwhile, **Poet LLC** will use the technology in its commercial-scale cellulosic project with the DOE in Emmetsburg, Iowa.

DuPont brings more than 100 years of chemical engineering experience to biofuels development and has already applied for 68 biofuel-related patents. DuPont CEO Charles Holliday, Jr., says the company has aligned its R&D investments with "exciting growth opportunities," including renewable energy.

Despite the enthusiasm, DuPont Bio-Based Materials is only a tiny part of a small business segment that itself accounts for less than 1% of total company sales, and the advanced cellulosic fuels won't start generating sales until 2012 in any case. In the meantime, its shares, recently traded at $43, will be driven primarily by how well its main agriculture, industrial coatings and performance materials segments do. Based on the company's positive outlook for 2008 and particular strength in agriculture, J.P. Morgan analyst Jeffrey Zekauskas rates DuPont a buy with a 12-month price target of $56. ■

Key Facts for Selected Publicly Traded Companies

Company	Symbol	Share price (as of 01/22/08)	Market value (as of 01/22/08)	Earnings per share (last 4 quarters)	Revenue (last 4 quarters)	P/E ratio*	Total Returns % Past 3 months	Past year	Three-year annualized
The Andersons Inc.	ANDE	$42.94	$788.0M	$3.25	2.1M	12.5	-11.7	10.1	55.3
Archer Daniels Midland Co.	ADM	40.19	26.3B	2.48	47.4B	15.1	17.3	30.9	25.2
Aventine Renewable Energy	AVR	9.53	388.0M	1.02	1.6B	43.3	-4.8	-52.4	NA
BP PLC	BP	62.46	232.9B	6.07	270.3B	8.8	-11.1	4.8	9.8
Deere & Co.	DE	83.15	33.5B	4.01	24.1B	13.4	5.8	84.2	40.4
DuPont	DD	42.54	38.4B	3.15	28.7B	12.3	-7.4	-11.5	2.2
Tyson Foods Inc.	TSN	13.45	3.3B	0.74	26.9B	28.5	-19.0	-13.3	-5.9
US BioEnergy Corp.	USBE	7.76	612.0M	0.70	500.8M	11.1	13.1	-40.7	NA
VeraSun Energy Corp.	VSE	9.80	924.0M	0.55	682.4M	16.9	-18.3	-43.9	NA
Verenium Corp.	VRNM	3.66	235.0M	-0.95	48.1M	NM	-33.5	-60.2	-17.9

Analysts' Recommendations (Total in January/3 months ago)

Company	Symbol	Strong buy	Buy	Hold	Under-perform	Sell
The Andersons Inc.	ANDE	3/2	1/2	1/2	0/0	0/0
Archer Daniels Midland Co.	ADM	3/4	4/5	4/2	0/1	0/0
Aventine Renewable Energy	AVR	0/2	3/3	11/6	2/2	3/3
BP PLC	BP	4/4	1/1	10/9	1/1	0/0
Deere & Co.	DE	4/3	6/7	7/8	0/0	0/0
DuPont	DD	2/3	4/3	9/9	0/0	0/0
Tyson Foods Inc.	TSN	1/1	2/1	7/7	2/1	0/1
US BioEnergy Corp.	USBE	0/0	2/2	5/4	0/0	0/1
VeraSun Energy Corp.	VSE	2/3	2/3	10/7	2/3	3/2
Verenium Corp.	VRNM	0/1	2/1	1/1	1/1	0/0

* The P/E ratio is based on the current year's earning estimate.
NA = Not Applicable
NM = Not Meaningful

Sources: MorningStar, Thomson One Analytics, Thomson First Call via Yahoo

Biofuels Industry

E3 BioFuels' Bankruptcy is No Harbinger

With high corn prices and low ethanol prices painfully squeezing ethanol profit margins, it's ironic that the first casualty in the ethanol industry's fight to survive apparently had little to do with the state of the ethanol market. The culprit in the recent bankruptcy filing by the owners of **E3 BioFuels-Mead LLC,** a first-of-its-kind closed-loop ethanol production facility, was more prosaic: boiler trouble. Shortly after the $80-million operation known as Genesis opened last June, the company suffered an explosion in one boiler. As a result, the Mead, Neb., plant never operated at more than half capacity and shut down this past fall.

Does the setback cast a pall over the development of other closed-loop operations being developed by firms such as **Panda Ethanol Inc.** [PDAE] and **Bion Environmental Technologies** [BNET]? No. Those companies don't use the same process as E3 BioFuels, and claim that investors educated about their technologies aren't shying away.

"Our technology platform approaches integration from a completely different direction," says Craig Scott, Bion Environmental Technologies spokesman and vice president of capital markets. Bion plans an 84,000-head beef cattle feedlot with a 42 million gallon per year (Mgy) ethanol facility in upstate New York, using a patented system to extract "combustible solids" from the manure. Those solids, which Scott likens to artificial fireplace logs, are burned to run the ethanol plant's boilers.

Bion plans to capitalize on its expertise with waste treatment technology to secure permits to site livestock facilities near existing ethanol plants or to develop new integrated facilities "in strategic nontraditional locations, such as upstate New York." The company aims to locate facilities within 250 miles of potential customers for the beef raised on site.

"I don't believe Genesis' problems will affect us," Scott says. "Bion can make a strong case [with investors] for its technology and business model." Its St. Lawrence County, N.Y., project is at least a year from construction and two from beginning operations, according to Scott.

Panda Ethanol's forays into closed-loop ethanol production should be similarly unaffected, according to Bill Pentak, Panda's director of corporate communications and investor relations. The company plans to open this spring in Hereford, Texas, the first of five planned ethanol plants, producing up to 115 Mgy each. A mix of sand and manure from nearby feedlots will be heated to accelerate decomposition and create a synthetic gas, which will then be used to power an ethanol plant with four times the capacity of E3 BioFuels' Genesis operation.

Moreover, E3's problem is not the method technology, says David Hallberg of **Prime BioSolutions**, which holds a minority interest in the E3 BioFuels plant. Experts hired by his company attribute the explosion to "operator error, largely due to excessive haste during start-up," he adds.

E3 BioFuels spokesman R.J. Wilson says construction failures at the plant are likely to be the subject of litigation. "But for the construction failures, we would have reached substantial completion months, if not a year, ago and never would have been in Chapter 11." Wilson adds, "had we achieved substantial completion," the unique nature of the E3 BioFuels-Mead process would have allowed the company to weather higher commodity prices and lower ethanol prices.

Hallberg, who had the original idea to link a feedlot with anaerobic digestion and ethanol production and remains co-holder of the patent behind the plant's process, had a falling out in 2006 with E3 BioFuels' majority owner, Dennis Langley. The two reached a settlement, and Hallberg stepped away from plant construction and planning. Now, Hallberg says, his company's goal is "to acquire the facility from E3 through the bankruptcy court and get things put back into shape," though it is not clear when the plant will operate again or how much it will cost.

Both E3 BioFuels and Prime BioSolutions had planned, separately, to open a number of similar plants around the country, and Hallberg knows that if he hopes to interest investors in any new facility based on the same technology, the Genesis plant needs to work. At least one of Prime BioSolutions' other projects has been put on hold so that the company can focus on righting the Genesis plant.

The irony of Genesis' situation, according to a veteran ethanol producer and cattleman in the region, is that the new, presumably riskier, technology "worked like a charm." Lee Reeve, whose Reeve Agri Energy ethanol plant and Reeve Cattle Co. operates separately in Garden City, Kan., says the anaerobic digesters were fine; it was the boiler, usually trouble-free equipment, that caused the problem.

That's also the sentiment of Vern Eidman, an economist at the University of Minnesota who studies the economics of the biofuels industry. Genesis' woes remind everyone that this is brand-new, complex technology. It won't necessarily slow down the adoption of this technology, says Eidman, but "it would keep people who aren't very knowledgeable from throwing money at it. And that's probably a good thing." ■

On the Horizon

GM's E85 Plug-In Cars

General Motors [GM] is betting on cellulosic ethanol. And not just by investing in **Coskata Inc.,** the small company that says it has perfected technology that will enable it to make large quantities of cellulosic ethanol for about $1 a gallon by 2011 or so.

GM also hopes to nab a giant share of the future market for fuel-efficient vehicles by merging two alternative-fuels technologies: Plug-in battery-operated cars and flexfuel vehicles, which can run on E85. In 2010, the automaker is expected to start production of cars representing phase one in that plan—the hybrid gasoline-electric Chevy Volt and Saturn Vue Green Lines—eventually ramping up to 100,000 a year. Those vehicles will be able to travel about 40 miles a day on the rechargeable battery alone and are expected to get 80 to 100 miles per gallon of gasoline used.

Down the road, however, GM intends to substitute E85 for conventional gasoline as the liquid fuel component. Industry analysts expect hybrid E85/plug-ins to get about 400 miles per gallon of gasoline used. Average mpg of total liquid fuel used (15% gasoline, 85% ethanol) should fall in roughly the same range as for the gasoline/plug-in hybrid.

GM's interest in ethanol can't help but be good news for the biofuels industry—putting not only the giant automaker's funds but its marketing might—behind ethanol-powered vehicles. Other car manufacturers, notably Japanese makers Honda and Toyota, so far have expressed little interest in ethanol-powered cars.

But they and others will quickly ramp up development the minute it becomes clear the cellulosic ethanol can be made in abundance. David Cole, chairman of the Center for Automotive Research, says: "Making ethanol for $1 per gallon isn't just a game changer. It's a whole new ballgame." ■

How much per mile is that? The use of new fuels and combined energy sources for vehicles spells the need for new ways to measure the fuel efficiency and fuel costs of operating cars and trucks. Mpg of gasoline will no longer do the job. Ratings on plug-in hybrids, for example, will need to take into account how much electricity is needed to recharge batteries.

That's likely to prompt auto manufacturers, government regulators and others to develop new standardized measurement tools to help consumers understand comparisons. Energy used per mile traveled represents one variable. But the use of different energy sources means cost per mile traveled will become a lot more complicated to figure out. ■

WORLD BRIEFS

Britain's version of a renewable fuels standard is under fire. The U.K.'s national academy of science, the Royal Society, says that the Renewable Transport Fuel Obligation, which goes into force in April, doesn't encourage biofuels with the best greenhouse gas (GHG) savings. Setting a GHG reduction target and assessing biofuels for their GHG savings are among the recommendations the group put forth.

Pure Biofuels Corp. [PBOF] is ratcheting up its feedstock production with the purchase of 14,000 hectares of land near Pucallpa, Peru. This is in addition to the 60,000 hectares already acquired by the company for the cultivation of African Palm to provide oil to Pure Biofuels' two Peruvian biodiesel plants currently under construction. When on line, the company will have a total capacity of 62.5 million gallons per year (Mgy).

Europe is mulling a ban on certain biofuels imports. The draft law under consideration would ban biofuels derived from crops grown on certain lands, including forests, wetlands or grasslands. Also under discussion: requiring biofuels to deliver a minimum level of GHG savings.

Recent tax hikes are hurting Germany's biodiesel industry. The country started taxing the fuel in late 2006 and added a second increase in January. Only 10% of German biodiesel capacity is now being utilized. To soften the blow in the beginning of 2007, Germany mandated use of a biodiesel blend. But over 90% of that requirement is met with imports.

BUSINESS BRIEFS

A trio of companies is partnering up to explore Jatropha oil as a potential biofuels feedstock. **Archer Daniels Midland Co.** [ADM], **Bayer CropScience AG** and **Daimler AG** [DAI] plan to make use of ADM's biodiesel refinery experience and Daimler's completed research project demonstrating Jatropha as a viable feedstock. Bayer CropScience will develop herbicides, soil insecticides and fungicides for use in cultivating Jatropha.

Safeway Inc.'s [SWY] fleet will now run on biodiesel. The grocery chain is converting its 1,000-plus truck fleet to B20 nationwide, reducing carbon dioxide by 75 million pounds annually, the equivalent of taking almost 7,500 cars off the road each year.

Australian-based Agri Energy Ltd. is selling its U.S. biofuels business to a consortium of investors for $42.5 million. The deal includes a Beatrice, Neb., 60 Mgy biodiesel facility, which is set to begin production by the end of this month, as well as an adjacent 55 Mgy ethanol project still under development. Agri Energy put a hold on its Australian project developments three months ago but still intends to proceed with two planned projects in Austria and Hungary.

A 30 Mgy biodiesel plant that will use algal oil is in the works for Coolidge, Ariz. **PetroSun BioFuels Refining** plans the facility as a joint venture with an as-yet-unnamed partner. The biodiesel will meet ASTM standards and be made with nonpotable water at a carbon-neutral facility. PetroSun Biofuels will supply algal oil from algae farms the company plans in Arizona. Residual algal biomass will be used by the firm to make ethanol.

Diversified Energy Corp. successfully produced biogasoline during a recent demonstration of their Centia process. Initially developed by North Carolina State University, the process renders a product that closely resembles unleaded gasoline and can be used in engines, stored and distributed as if it were a fossil fuel. Diversified Energy plans to demonstrate that any renewable oil can be used as the feedstock to make biogasoline, jet fuel and renewable diesel.

Venture capitalists poured $3.4 billion into renewable energy last year, according to Greentech Media Inc. Although the largest portion went to solar power, biofuels was the recipient of the second-highest amount, almost $800 million. Overall, venture capital investment in the sector was up 50% over 2006 levels.

Virgin Atlantic plans a jet biofuel test flight in February, flying a Boeing 747 from London to Amsterdam using a 20% biofuel blend with an unmodified CF6 engine. The demo flight is the product of joint research by **Virgin**, **Boeing Co.** [BA] and **GE Aviation.**

RESEARCH AND TECHNOLOGY

Hoorah for combined heat and power (CHP) dry mill ethanol plants. The EPA's CHP Partnership program says that plants using CHP systems—producing energy from a single fuel source on site—are 55% more energy efficient than state-of-the-art dry mill plants purchasing energy from a central power station. CHP facilities may also achieve negative net CO_2 emissions, depending on the energy source.

A new one-step process to make biodiesel is in the works at the University of Arkansas. Researchers are studying the use of a process, known as supercritical methane treatment, that turns chicken fat and tall oil fatty acid into biodiesel, with yields of 89% and 94%, respectively. The one-step process dissolves the inexpensive feedstocks without the need for a catalyst.

***E. coli* can efficiently synthesize next generation biofuels,** thanks to a method developed by UCLA researchers. By genetically modifying the bacteria, scientists produced high yields of isobutanol in particular. The school licensed the technology to **Gevo Inc.,** a company dedicated to developing next generation biofuels.

Is the Caribbean the new biofuels frontier? The answer may come with studies of the biofuels production potential of Haiti, El Salvador and the Dominican Republic. A $750,000 donation is being furnished by the Inter-American Development Bank's Sustainable Energy and Climate Change Initiative, which will partner with Brazil's Export and Investment Promotion Agency to take a closer look at the limitations and advantages of each country.

Ethanol from switchgrass is more efficient than expected, according to a joint USDA and University of Nebraska study. It yielded 540% more energy than used to produce it, much more than the previously assumed 343%. Another plus: estimated average GHG emissions from ethanol derived from switchgrass were 94% lower than from gasoline.

An algae-to-biofuels project is getting a lift—$150,000 grant from **Xcel Energy Inc.** [XEL] to the Univ. of Minnesota. It will be used to support research being done in conjunction with the Metropolitan Council, serving the Twin Cities area. One main focus: using wastewater and heat from treatment plants to cultivate algae as a means of growing the microrganisms in cold climates.

A greener, lower energy production method for biodiesel is on tap from **Thar Technologies Inc.,** a firm specializing in high pressure processing. The company obtained a $2-million grant from the National Institute of Standards and Technology's Advanced Technology Program to develop a cost-efficient process to produce biodiesel without using hexane, a hazardous air pollutant.