



THE ENERGY CHALLENGE

Cooking Up More Uses for the Leftovers of Biofuel Production



Kevin Moloney for The New York Times

Ed Lehrburger, PureVision's chief executive, says he thinks the new form of lignin his company makes could sell for \$300 a ton.

By HILLARY ROSNER
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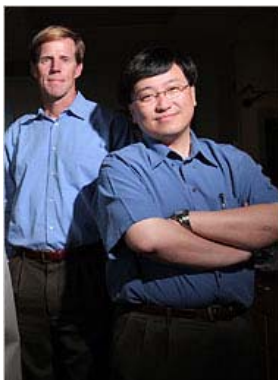
The baking tins and muffin cups lining the countertops in a corner of Ronald Holser's cluttered laboratory were filled with curious substances resembling angel food cakes and loaves of bread.

The Energy Challenge New Fuels With New Products

Articles in this series will periodically examine the ways in which the world is, and is not, moving toward a more energy efficient, environmentally benign future.

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Mark Kegans for The New York Times
Victor Lin, right, the founder of Catilin,

But Mr. Holser did not advise eating them. The concoctions were prototypes for biodegradable weed barriers and sticky films intended to hold grass seeds on the ground long enough to germinate.

If Mr. Holser, a research chemist, and his colleague Steven F. Vaughn, a plant physiologist, are successful, they will have found more than ecologically friendly ways to fight weeds and grow grass.

They will have found innovative uses for a byproduct of the production of biodiesel fuel, glycerol. This, in turn, could help transform the biodiesel industry into something that more closely resembles the petroleum industry, where fuel is just one of many profitable products.

"Just like petroleum refineries make more than one product that are the feedstock for other industries, the same will have to be true for biofuels," said Kenneth F. Reardon, a professor of chemical and biological engineering at [Colorado State University](#) in Fort Collins. "Biorefining is what the vision has to look like in the end."

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(Page 2 of 2)

"For every gallon of biodiesel you make, you make a pound of glycerol," said George Kraus, a professor of chemistry at Iowa State, where he is director of the Center for Catalysis and a collaborator of Mr. Lin. "A lot of people have been contacting us about burning it, and we say there have to be better uses."

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Kevin Moloney for The New York Times Chim Chin, a researcher at PureVision Technology, works with equipment that distills ethanol and leaves lignin as a byproduct.

The price of glycerol, now 20 to 50 cents a pound, could drop as low as 5 cents a pound as biodiesel production increases.

Mr. Kraus said the higher quality glycerol made with the new process could command a much higher price. "What we see," he said, "is an opportunity to make something that might cost 80 cents a pound."

In another lab at Iowa State, Robert C. Brown is using distillers' dry grain—a main byproduct of corn ethanol that is largely sold as animal feed—to produce hydrogen and a compound called PHA. Mr. Brown hopes his version of PHA, which is biodegradable, could be used for surgical gowns and gloves that must now be disposed of as medical waste.

"Critics of corn ethanol like to say the process isn't very efficient," Mr. Brown said. "Part of that is because your products aren't just fuel." Finding other high-value applications, he added, lets producers "justly say, this is not a waste stream; it adds to the profitability of the plant."

Back in Peoria, Mr. Vaughn is also looking at making products from distillers' dry grain, including another biofuel. The grain is more than 10 percent oil, and one ton of it can yield 30 gallons of biodiesel.

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Interest in the biorefinery model is not limited to research scientists and start-up companies. Archer Daniels Midland is expanding some of its wet mill plants, which already churn out ethanol and a variety of other corn-based materials like high-fructose corn syrup, amino acids and sorbitol, to make industrial products. It has begun making propylene glycol, a widely used compound, from glycerol.

"As petroleum prices increase and we try to become more independent with regard to energy and petroleum in general," said Mark Matlock, senior vice president for research at the company, which is based in Decatur, Ill., "there are other opportunities that come up for industrial chemicals as well as fuels."

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But despite the many uses for byproducts, the biorefinery model is more difficult than it may seem. "The dream is the multiproduct biorefinery," said Jim McMillan, manager of biorefining process research and development at the National Renewable Energy Laboratory in Golden, Colo. "The challenge is that the market for the fuels is like two orders of magnitude bigger than for even a fairly big chemical" that could be produced alongside the fuel.

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invented a way to make biodiesel fuel that also yields a higher-quality glycerol. With him are Larry Lenhart, chief executive, and Yang Cai, a researcher.

Glycerol is used in a variety of products, including foods, soap and dynamite. But as biodiesel fuel production in the United States has risen, the market for glycerol has become saturated.

If scientists like Mr. Holser, who works at the [United States Department of Agriculture's](#) research center in Athens, Ga., and Mr. Vaughn, who works at the department's National Center for Agricultural Utilization Research in Peoria, Ill., can expand the number of valuable uses for the syrupy liquid, biodiesel makers could sell their glycerol instead of paying someone to haul it away.

"Every week I get at least one or two calls from biodiesel producers who have all this glycerol and don't know what to do with it," Mr. Holser said.

Glycerol, also called glycerin, is not the only byproduct of biofuel production that is the subject of experiments. Scientists are also looking at profiting from the leftovers from the production of corn ethanol and cellulosic ethanol, made from materials like switch grass, corn husks and prairie grass. Around the country, scientists, entrepreneurs and venture capitalists are becoming increasingly interested in making more than fuel out of the raw materials for biodiesel fuel and ethanol.

"The opportunity, as we think about increasing our consumption of biologically derived fuels, is to consider what besides fuels can we make," said Erik Straser, general partner of MDV Mohr Davidow Ventures, a venture capital firm in Menlo Park, Calif.

Some researchers, like Mr. Holser, are simply trying to find new uses for the regular byproducts of biofuels: distillers' dry grain from corn ethanol and lignin from cellulosic ethanol.

Other researchers are trying to develop technologies and processes that could yield different, more valuable byproducts. And still others are placing their bets on "biorefineries."

In the foothills of the Rocky Mountains, not far from the Coors brewery in Golden, Colo., PureVision Technology is making lignin. A natural compound that helps provide strength and rigidity in plants, lignin makes up 15 to 25 percent of most plants.

Most plans for cellulosic ethanol processing call for burning the lignin to generate steam and heat to run the process. As a fuel, lignin is worth around \$40 a ton.

PureVision has devised a way to make a different form of lignin — one with a molecular composition that could make it an attractive material for a variety of industrial products like glues, sealants and detergents.

Ed Lehrburger, PureVision's founder and chief executive, said he thought his lignin could sell for \$300 a ton or more. Mr. Lehrburger said his company was collaborating with a wood and paper products manufacturer that is interested in using the lignin for a biobased glue for its laminates, plywoods and other products.

"Lignin is going to be one of the big drivers of the switch from oil-based to biobased products," Mr. Lehrburger predicted.

In Ames, Iowa, Victor Lin has created a technology that changes the production process for biodiesel. Among other attributes, Mr. Lin's invention yields a higher quality form of glycerol, which could be more easily converted into useful industrial materials. A chemistry professor and the associate director of the Center for Catalysis at [Iowa State University](#), Mr. Lin is also the founder of a company, Catilin, which is backed by an initial \$3 million in venture financing from MDV.

The production of biodiesel fuel requires a catalyst. Mr. Lin created a catalyst that is safer and easier to use than the one commonly used now, reducing the cost of producing biodiesel and its impact on the environment (requiring less water, for instance).

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Dr. Lin and his colleagues are trying to turn the resulting glycerol into a substance called 1,3 propanediol, or PDO, the base material for a substance used in upholstery, carpets, clothing and other applications. [DuPont](#) uses PDO to make its Sorona line of fabrics.

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