Unlocking wood's energy

March 1 2009, By Tom Avril

Deftly using a pair of tweezers, Scott Geib pulls apart the insides of a yellowish, wormlike critter - the larva of a tree-devouring pest called the Asian long-horned beetle. Something in the insect's gut allows it to make short work of wood, but what?

In a greenhouse several hundred yards away, some of Geib's Pennsylvania State University colleagues are growing rows and rows of designer poplar trees. The slender plants have been genetically tweaked so that their woody fabric has a weak link, allowing better access to the energy-rich sugars inside.

One way or another - whether by tinkering with trees or by borrowing the secrets of beetle larvae that eat them - these researchers are determined to turn wood into liquid fuel for your car.

Called cellulosic ethanol, this fuel also can be made from grasses and other woody material, and some form of it could be in your car as soon as next year.

That's when refiners are required to start adding small amounts of the wood-based fuel to gasoline, both for energy security reasons and for the perceived environmental benefit. But for now the technology is costly, especially given the low price of oil. And the fledgling cellulosic industry will be hard-pressed to make as much as the law requires, analysts and federal officials say.

So efforts to improve the process, such as the ones at Penn State, are

being closely watched.

"My sense is, this is like any other technology introduction," said Tom Tuffey, a renewable-energy expert at the nonprofit group Citizens for Pennsylvania's Future. "It will take some time to develop. When it develops, it's going to be pretty good stuff."

It is generally acknowledged that there will be no one-size-fits-all solution for powering the car of the future. Cars in Arizona might run on solar-powered electric batteries, say, while elsewhere, wind power could be used to make hydrogen to run a fuel cell. Gasoline will be part of the equation for decades.

In Pennsylvania, one answer could well be grasses and trees - generally thought to be easier on the environment than corn, the current source of almost all U.S. ethanol.

A company called Coskata Inc., partly owned by General Motors, is building a 40,000-gallon-per-year cellulosic ethanol facility in Madison, 30 miles from Pittsburgh. Another firm is considering a plant in Clearfield County, west of State College. Two dozen cellulosic facilities are in the works elsewhere, anticipating the 2010 federal mandate for refiners to blend 100 million gallons of the stuff with gasoline.

But a recent report from ThinkEquity L.L.C., a San Francisco-based investment research firm, estimated next year's U.S. cellulosic production at less than one-third that amount - just 28.5 million gallons. (In the event of such a shortfall, the Environmental Protection Agency can issue a waiver.)

A key part of the problem is that while wood is easier to grow than corn, it's tougher to break down. That's partly because its cell walls are reinforced with a hardy material called lignin.

"It's nature's plastic," said Ming Tien, a Penn State biochemistry professor.

The sturdy bonds between lignin molecules must be broken apart to get at the cellulose, which in turn must be broken down to sugar to make ethanol. It's an expensive process, typically requiring heat and acid.

Several years ago, Tien had an idea for a better approach: Why not create plants in which some of the lignin molecules were already separated, with easy-to-digest proteins inserted between them?

It would be almost like having a protein zipper, which could be unzipped with a substance called protease, an enzyme widely used in clothing stain removers.

Tien enlisted the help of colleague John Carlson, a professor of molecular genetics in the university's school of forest resources.

Carlson determined that the right sort of protein was contained in the parsley plant, so he simply took the relevant gene from that plant and inserted it into poplar trees.

In August, Carlson, Tien and others reported that their designer trees, which must be kept in a special greenhouse, yielded anywhere from 5 percent to 50 percent more sugars than regular poplars. The variation apparently depended on just where the parsley gene was inserted into the poplar genome.

For some trees, the results were just as good even when the scientists did not use the protease enzyme. The sugars may have become more accessible simply by grinding, Carlson said.

Any commercialization of the technology is at least five years away,

Carlson said.

The study of the Asian long-horned beetle, meanwhile, is likely even further from yielding a marketable process. But the research recently got a boost from an unfortunate event: an infestation in New England.

First found in the United States in 1996, the pest is believed to have hitchhiked here inside packing crates from China. It has turned up in New York, New Jersey, Illinois and now Massachusetts, burrowing into and sickening thousands of trees.

Most of the infested trees are fed into a wood chipper at the direction of the U.S. Department of Agriculture, to limit the insect's spread.

But Geib, a Penn State postdoctoral fellow in biochemistry, was allowed to collect 300 logs in Massachusetts in January, using a chainsaw.

Before driving back to Pennsylvania, he and a colleague were required to double-bag the logs and then place the bags in plastic tubs sealed with tape.

Back at school, Geib and others chop up the logs in a secure greenhouse, looking for beetle larvae. In the lab, they pull the guts from the larvae and then extract the woody food that is inside.

The larvae are thought to digest wood with the help of a lively community of microbes. Bacteria, yeast and fungus all may play a role, by secreting various enzymes.

The Penn State team now seeks to determine which ones are most important - by identifying the enzymes and, by reading the genetic recipes, figuring out which microbes produce them.

"It's like taking 50 puzzles, mixing up all the pieces, trying to sequence all that, and putting it all back together," Geib said.

A big part of the appeal is uncovering the basic scientific knowledge.

But some day, if they are lucky, one of those puzzle pieces may end up in the tank of your car.

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