Cellulosic Ethanol Technology Holds Key To Inexpensive Fuel

Dartmouth College

Timing, alas, is nearly everything.

For years, Alla Kan, the director of the Technology Transfer Office at Dartmouth College in Hanover, N.H., shopped around the cellulosic ethanol technology developed by professor Lee Lynd at Dartmouth's Thayer School of Engineering.

No luck. Just lots of frustration. No one, it seemed, was interested in investing in research that would turn grasses, crop residue, paper pulp, wood scraps from mills and other forms of biomass into ethanol in one step called consolidated bioprocessing.

Not when gasoline was selling for $2 a gallon or less.

But gas prices topping $3 a gallon, oil selling for more than $90 a barrel, acceptance of global warming as a real threat, military conflicts in the Middle East, other geopolitical concerns — to say nothing of achievements in cellulosic ethanol technology — all combined to shift opinion.

"I have mailing lists and mailing lists over various periods of time," says Kan, whose scientific background in chemical research includes tertiary oil recovery to wring more petroleum out of underground reservoirs.

> *I knew the time would come, but it would depend on many factors, a lot of which were political, not scientific. Altogether, I probably presented the technology to 200 different companies and dozens of technology brokers over many years.*
>
> Alla Kan

Meanwhile, Lynd had found success in getting government grants for his research as Dartmouth assembled a considerable patent portfolio.

But the big break, in terms of commercializing the technology, came in 2005 when Lynd and businessman Bob Johnson were able to convince renowned venture capitalist Vinod Khosla to back a nascent company called Mascoma. The firm now has more than 70 employees, roughly half doing research in Lebanon, N.H., and the remainder in the company headquarters in Cambridge, Mass.

"Why was it so difficult for all those years?" muses Kan.

"The time was not ripe and the companies we approached did not have the foresight," she says. "But the geopolitical realities are such today that it is recognized that we need to look for alternative sources of energy so we don't have to depend on oilrich countries that are not particularly friendly to the United States.

"It's also because we are starving for new energy," she says. "That reality finally began to sink in and became a hot topic in the news. Yes, it was frustrating, but I was always confident that one day people would recognize the need for this technology. Time has proved us right."

Kan credits Khosla with giving Mascoma, which is now building cellulosic ethanol plants in several states, a kick-start. With Khosla's $4 million initial investment — and reputation for backing winners — others took notice. Now more than $39 million has been raised from private backers. In addition, state and federal grants currently total $75 million.

"He is a brilliant man with a good foresight for technology that can be commercialized," she says of Khosla, who co-founded Sun Microsystems. He then joined a venture capital firm that financed many successful Silicon Valley firms when they were small.

"We felt he would be able to help put together the right team to make this happen," she says. In the process, Dartmouth licensed Lynd's technology to Mascoma and took an equity share in the company. In addition, Mascoma is funding some of Lynd's continuing research at Dartmouth.

Khosla, whose interests in ethanol have been well publicized, says in a statement that he believes "Mascoma is poised to transform the current model for ethanol production.

"Mascoma's research and innovation in the field have solidified our leadership position in commercializing cellulosic ethanol technology and we expect a great and positive impact on the industry and consumers alike."

In an interview with CNNmoney. com, he says, "I think we have a replacement for oil today. It's cheaper, cleaner, it doesn't require a change of infrastructure, and it appeals to most of the lobbies. What is this platform? It's ethanol.

"In the past, ethanol was made from corn, which isn't that great environmentally and isn't very efficient — for every one unit of energy you get 1.5 units of fuel," he says. "Now, with bioengineering, we can make ethanol from agricultural waste, which is four to eight times as efficient."

Lynd Persevered

Lynd, who began his research on cellulosic ethanol in the late 1970s, says the lack of interest in his work gave him pause, causing him to think it might not be worthwhile.

“Frankly, in the time between then and 2005 or so, there was not much enthusiasm in this field,” he says. “And I did ask myself if perhaps there was something wrong that I just didn’t see.

“But I was committed, though for much of that time, it seemed I was one of the few persistent ones who maintained faith in it.

“That meant that when venture capitalists got interested in the summer of 2005 — others began to take note somewhat earlier — I found myself in the position of being one of relatively few people who had long-standing activity in the field.”

As for the conversation he and Johnson had with Khosla on Oct. 7, 2005, Lynd remembers it as if it were yesterday.

“We had about a two-hour conversation about cellulosic ethanol,” he recalls. “At the end, Vinod said, and I quote, Let’s do this.’”

Lynd, a co-founder of Mascoma, which is named after a lake near Dartmouth, sits on the company’s seven-member board. He is also Mascoma’s chief scientific officer, dividing his time between his Dartmouth lab and Mascoma. The other co-founders are professor Charles Wyman, who is now at the University of California, Riverside, and Bob Johnson.

“I continue to lead research in my academic capacity at Dartmouth, which complements Mascoma’s activities,” Lynd says. “We see ourselves as scouts at Dartmouth. We are ahead of the main fi le, which at this point is Mascoma.”

Currently, that research is focused on developing a new generation of enzymes, microbes and processes for economical conversion of cellulosic feedstocks into ethanol. With this conversion will come a complete rethinking of the ways in which we fuel our economy, Lynd says.

“I got into this not to start a company, but as a service,” he says. “I believe that a transition to a world supported by sustainable resources is probably the defining challenge of our time.”

Plants in New York, Tennessee and Michigan

“One hundred years from now, people will look back on us and ask how well did humanity do on this issue. Frankly, I don’t think we’re doing too well with it now.

My gift to the world, as modest as it may be, is going to be advancing cellulosic biofuel technology.”

With backing from venture capitalists, Mascoma has built a multi-feedstock demonstration-scale biorefinery located in Rome, N.Y., that is being developed in partnership with several New York state agencies.

Construction was expected to start at the end of 2007 on a $40 million plant in Tennessee that will use switch grass to make 5 million gallons a year. This joint effort is backed by the University of Tennessee and will include $27 million for research and development activities.

Also in 2007, Mascoma and the state of Michigan announced plans to build one of the nation’s first commercial scale biorefineries using wood as a feedstock. This project is being developed with the Michigan Economic Development Corporation, Michigan State University and Michigan Technological University.

Lynd said the collaboration between Dartmouth and Mascoma has gone well.

“If I take a step back from the details, Dartmouth’s fundamental mission is to educate people and serve humanity,” he says. “Mascoma’s mission is to be a successful business in a direction that serves the world. A lot of our momentum is because of that service aspect.

“To some extent, this story is still very much in progress,” he adds. “Dartmouth has its mission rewards, with students being educated and the school getting credit for groundbreaking research. If all plays out well, Mascoma will be successful and help solve what is today one of our biggest problems.”

Five years down the road, Lynd says he can foresee Mascoma producing well over a billion gallons of ethanol a year for transportation fuel. While one billion is a big number, Lynd notes that the United States now uses 140 billion gallons of gasoline annually.

But growing the industry to 10 billion gallons of ethanol per year or more may come soon after, he says.

“To increase it to 1 billion, it has to be profitable, the technology has to work and you have to do a lot of things for the first time,” he says. “By the time you are at a billion gallons, however, you are replicating success and growth can be very rapid. It’s one of those things that starts very slowly and if things are properly aligned, can accelerate.

“Two thirds of the value of gasoline is the cost of oil,” he says. “Fuel production is dominated by raw material costs. (Think $80 plus for a barrel of oil.) So a very good question is what is the cost of cellulosic biomass. The answer is around $50 a metric ton, which is the equivalent of $17 a barrel.

“When you are starting with something that inexpensive and you have biotechnology on your side, which is arguably the transformative science of our time, it seems realistic to think that we can make fuel pretty cheaply.”

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