ENERGY, STARTUPS, CELLULOSIC ETHANOL

# Inside the Mascoma Labs: Tracking Ethanol-Making Microbes from Lebanon to Rome

Ryan McBride 10/22/09


Microbiologist Larry Feinberg has dug into piles of waste from paper factories and explored hot springs in the West for microbes that he calls “tough bugs,” because of their ability to thrive in adverse conditions. The fierce bacteria are now shipped to the new labs and headquarters of Mascoma, a developer of cellulosic ethanol, in Lebanon, NH.

This week, Mascoma scientists gave me an inside look at the Lebanon labs where Feinberg and his colleagues are developing microorganisms to inexpensively turn materials such as wood chips, switch grass, and corn stalks into ethanol for fueling automobiles and machinery. Mascoma’s plans for streamlining the process of making cellulosic ethanol have been known since it launched with initial venture financing from Flagship Ventures and Khosla Ventures in 2006, but these are particularly exciting times at the company. In April, scientists at the firm were able to demonstrate their streamlined process in a lab experiment. The firm is now scaling up the process at a pilot production facility in Rome, NY, and plans call for completing one of the first commercial-scale cellulosic ethanol plants in Kinross, MI, by 2012.

Mascoma’s process is novel, for starters, because it would not require the use of food crops such as corn or soybeans, which are typically used to make ethanol. Ethanol production has driven up corn prices in recent years, and the total costs of producing such ethanol is high in part because lots of water and land resources are required to grow those feedstocks. Yet cellulosic ethanol production, which is Mascoma’s bread and butter, has plenty of challenges too. With traditional biochemical methods, enzymes are needed to digest the plant materials into sugars, and then yeast or bacteria are required to ferment the sugar to make ethanol. Mascoma’s key innovations include microbes that are genetically engineered to perform both those chores in a single step, making the process potentially more affordable than first thought.

Nathan Margolis, a lab manager at Mascoma, walked me through the labs that the company moved into about two months ago to explain how the firm is trying to harness a process which has been happening for hundreds of millions of years in nature, where bacteria are eating and digesting wood and grass and other plants to survive. “There’s a battle going on out there between the trees and the microbes trying to eat them alive,” Margolis said. “We’ve entered that battle on the side of the microbes” to produce ethanol from renewable sources.

We toured a lab where incubators were shaking up test tubes and glass bottles of yellow liquids that contained microorganisms. Here, the organisms are scrutinized and the genes that make them effective ethanol makers are identified. In nature, bacteria are particularly adept at digesting wood and other materials into sugar, but yeast are typically better at fermenting the sugar to make ethanol, or alcohol. Mascoma is reconfiguring the genes of yeast and bacteria so that each can perform both of those tasks in a single step. One of the firm’s leading microorganisms that can do this is a strain of yeast, which will soon graduate from the labs in Lebanon to the pilot facility in Rome. The exciting thing, according to Margolis, is that there are more efficient microbes than that stain of yeast in the firm’s pipeline.

Mascoma, which was founded by professors who work down the road from the company at Dartmouth College, recently moved into the new offices and labs from a nearby technology incubator that is also in Lebanon. Margolis told me that Adimab, the antibody discovery startup co-founded by Dartmouth professor and company CEO Tillman Gerngross, has expanded into Mascoma’s former space in the incubator.

On a floor below the microbiology labs are the proving grounds for the microbes, where experiments are performed to test how well they eat feedstocks such as corn stover, paper sludge, and wood chips. These labs had a sweet and yeasty smell not unlike some of the breweries I’ve visited over the years. (In fact, Margolis said, the firm’s informal name for the mixtures containing the feedstocks and microbes in the lab is “beer.”) This is the lab where the feedstocks are broken down, by means such as grinding and adding acid, before they are fermented with the microbes to make ethanol. Margolis showed me wood chips that had been broken down into what looked like brown sugar. In the next room, there were about two dozen 1-liter fermenters brewing up small batches of ethanol.

Still, there are some big challenges ahead for Mascoma. The company says it has already raised about $100 million in private equity and another $100 million in government grants and loans. Yet that money won’t cover the costs of the commercial-scale facility the firm has planned in Michigan. Over the summer,

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Mascoma chairman Bruce Jamerson transitioned from his role as CEO of the company to lead the operations of Frontier Renewable Resources, the commercialization subsidiary of Mascoma that is spearheading the effort to finance and build the plant in Kinross. Mascoma hasn't finished raising the money to finance the Kinross plant, which is expected initially to produce 20 million gallons of ethanol per year, said Michael Ladisch, chief technology officer of the company.

On the scientific side, Margolis said, the firm will likely have to develop a different microorganism for each feedstock used in its process. That means lots of work will need to be done at the firm's facilities in New Hampshire and New York in the years to come. Which should also keep Feinberg busy hunting down more tough bugs.

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