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Proterro's low-cost nectar aims to fill biofuels' Holy Grail

by Jim Lane

At Advanced Biofuels Markets, the Cellulosic Biofuels Summit and most of the other conferences this year, the talk has been all about cheap sugar – the simple sugars that form the feedstock that is fermented into biofuels and renewable chemicals.

There are a proliferating number of technologies for accessing sugars, or fermenting them. There are traditional yeasts used in first-generation fermentation of starches and sugars into ethanol, or exotic enzymes that work on cellulosic biomass, or modified e.coli, cyanobacteria, yeast or even algal strains that produce drop-in fuels. Low cost sugars are cited by all as the technology that will transform the biofuels story from a struggle for viability into a race for epic scale.

If petroleum parity is the Holy Grail of biofuels, then cheap sugar is the nectar that fills the chalice.

A number of hot companies are working on the upstream problem – from advanced plant developers such as Ceres and SG Biofuels to pre-treatment specialists like KL Energy and Mascoma. A couple of companies, such as Comet Biorefining, have focused on the development of cheap industrial simple sugars.

"Feedstock is the key inhibitor," explained Proterro CEO Kef Kasdin, as she introduces her company's solution, Protose – a sucrose produced by her fast fermenting, modified cyanobacteria.

A new entrant in the search for cheap industrial sugars – Proterro

Proterro is one of the most intriguing entrants in quite a while in the race for cheap sugars. The company's technology uses sunlight, CO2 and water to create simple sugars that can be utilized as a feedstock for biofuels. If that formula sounds a little like what algae does, or Joule's technology – you're spot on. Proterro is using a form of genetically modified cyanobacteria. Here's what's different – its system derived from the operations of the humble tree leaf.

The Proterro approach is not to produce sugars in an aqueous phase – in water – but in a thin film bioreactor where the cells are at the surface of a fabric that transports water and nutrients to the organism.

The company is just now emerging from stealth mode. It's done so with with a roar, having embarked on an extensive PR blitz over the past few weeks to drum up visibility as it starts the process of broadening and deepening its investment pool. Having been formed with a an initial investment of $5 million from Battelle Ventures and Braemar Energy Ventures (an investor in Verenium, Solazyme and Enerkem) the company has proved that its science works, that it can create the simple sugars that it had targeted.

Next step, a search for partners to move further down the path towards commercialization of the technology. It's model? Licensing is one option and a joint venture is another. Proterro plans to be very flexible in how it will work with the marketplace.

Behind the Proterro technology

Certain cyanobacteria, as it happens, naturally produce molecules of interest as an osmotic response to salt stress; the trick is to genetically modify the organism to change the trigger from salt stress to something more easily under the control of the scientists, “to get control over the organism,” as Kasdin puts it.

The solution, as Joule constantly stresses, is in far more than the magic bugs, but in the engineering of the system. For, as every who has ever opened a can of Coke on a hot day can attest, CO2 doesn’t dissolve into water as well as we would like. You have to pump CO2 into water, and that takes energy, and removes the CO2 from the surface where the sunlight is.

So, here’s where Proterro borrows from the approach utilized by the leaf. Leaves can transport water and nutrients to a surface layer where CO2 and sunlight are being absorbed. The Proterro approach is not to produce sugars in an aqueous phase – in water – but in a thin film bioreactor where the cells are at the surface of a fabric that transports water and nutrients to the organism. The organism secretes, or “sweats” a sucrose solution, which is then collected using gravity.

This is the key difference between most algal-based technologies – which also aim to synthesize low cost sugars from sunlight, CO2 and water – and Proterro. The approach radically reduces the difficulties of getting the water out of the algae, or the algae out of the water. And by radically reducing the amount of water, it radically reduces the land footprint of the overall system.

The economic potential

“Better than the production price of Brazilian sugar cane,” says Kasdin of the price target set by the venture. And for sure, more flexible than sugar cane, in terms of geography. Proterro expects that the process will work in relatively northern climates well north of the sugar cane belt. That’s more significant than might be gleaned at first glance.

Think of all the CO2 at all those first-generation corn ethanol plants. All that can be utilized, along with water and sunlight, to generate simple sugars on site that can be fermented into ethanol. That’s without corn, without land use change, and reducing the potential impact of waste CO2. How much could an existing corn ethanol plant boost capacity by using its own CO2, and a Proterro like microorganism – somewhere in the range of 25-50 percent, according to the earliest, unconfirmed estimates by the company.

These are not insignificant opportunities — that could add 3-6 billion gallons to US corn ethanol production, without additional land or corn usage, and without expanding the current fleet of plants. It would also begin the process of sharply reducing the CO2 footprint of corn ethanol plants, possibly qualifying them as an advanced biofuel and opening up additional opportunities under the 36 billion gallons RFS mandate.

Different from Joule

How does it differ from Joule? In some ways, not much at all — the magic bug produces a simple sugar instead of a hydrocarbon, but otherwise would have some of the same elements of a modular production system that could be proved at extremely small scale, and uses a modified cyanobacteria.

To date, they’ve scaled up from the lab bench to a square meter system – and on their shopping list is a larger base module. From the business perspective, they are worlds apart – ultimately, Joule is a fuel and chemicals solution; while the Proterro approach works on the feedstock end, with a wide potential swath of partners, ranging from those seeking low-cost sugars for their own microbes, to companies that are looking to convert their waste CO2 from cost centers to revenue steams.

Moving out of R&D towards commercialization

Proterro is at an early stage. In their development process, they have yet to optimize the flow rates of water – for the amount of hydrogen required to make sugars is relatively small. They’ve been able to prove that the magic bugs will do their magic, but the design of the reactor and the optimization of rate and yield is among the hard work ahead.

For now, the company has been formed by Battelle Ventures, and Kasdin is doing double duty as a Battelle Ventures partner and Proterro's CEO. "We're now at the point of needing to do the next step, and raising capital and building a company are a full time job," said Kasdin, who plans to step aside as soon as the company is transformed from its "virtual company" status and begins to bring on management. "We wanted to be capital efficient and not bring on management until we had hit our first milestones."

A most interesting venture we'll enjoy keeping an eye on. For those who missed Proterro at Advanced Biofuels Markets, but are attending the BIO Pacific Rim Summit in Honolulu, CEO Kef Kasdin will be presenting the company and technology in more detail there.

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