

## Vindu's View: Algae Startups Chase Dreams of Fuel from Pond Scum

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There's a certain poetry in the notion of jet planes shooting across the sky, powered by pond scum.

Throw in the prospect that fuels made from algae could slow global warming, replace petroleum and make a fortune for their creators, and the vision becomes irresistible. Dozens of start-ups, in Silicon Valley and around the world, are chasing green-slime dreams.



It's a daunting but important quest. With oil prices topping \$100 a barrel and rising concern about manmade climate change, we need to find renewable fuels that reduce our dependence on petroleum and cut our carbon emissions.

"Algae has a chance to save the planet," said Michael Fertik, who is quietly working on a startup, Mighty Algae Biofuels, in addition to his main job as chief executive of ReputationDefender in Menlo Park. "It's not a category killer. It's category Armageddon."

Well, hopefully not *Armageddon*. But you get the picture.

Microscopic, single-celled algae have been around for billions of years. The simplest of plants, they are quite efficient at converting light, water and carbon into oily compounds called lipids that can be extracted and processed into diesel fuel, gasoline, crude oil, even salad dressings and skin creams.



"Algae are the original oil producers," said Jonathan Wolfson, chief executive of Solazyme, a South San Francisco company that is trying to grow algae in giant fermentation tanks more typically used for beer. "The last time you filled up your car, the gas came from oil that very likely originated with an algal bloom 100 million years ago."

The challenge for entrepreneurs like Wolfson: How do you convert algae into usable oil on a massive scale at a price comparable to pumping petroleum out of the ground?

It is, as the techies like to say, a non-trivial problem.

First, you have to find the right species of algae. Then you have to figure out the best way to make it grow. Then you have to devise a method for getting the oil out. Then you have to refine it into something that can run your car or an airplane. To top it all off, volume needs to be high enough to drive the cost down to \$2 or \$3 a gallon from about \$20 now.



"People think all we have to do is grow this stuff, extract the oil and here we go," said Al Darzins, a group manager at the National Bioenergy Center, part of the National Renewable Energy Laboratory. NREL spent two decades researching algal oils before federal policy makers decided ethanol had more commercial promise. Just recently, the lab resumed its algae work.

NREL studied algae in open ponds, an industrial farming approach used by some companies, including LiveFuels of Menlo Park. While ponds have the advantage of being relatively cheap, it's hard to control temperature and water loss. Unwanted algae species can also take over the pools.

Another strategy, advocated by companies like Mighty Algae and GreenFuel Technologies of Cambridge, Mass., is to grow algae in special containers, or bioreactors, which can be manipulated to optimize the plants' exposure to sunlight and nutrients.



High capital costs are the biggest problem with bioreactors, said Rich Hilt, a LiveFuels co-founder who left the company but still follows the industry. GreenFuel ran into financing trouble last year, forcing the company to slash its staff and bring on Bob Metcalfe, co-inventor of Ethernet technology, as CEO. (Fertik claims his small team has licked the cost problem through a "galactically cheaper" design.)

Solazyme is pursuing a third path, one I find especially fascinating: growing algae in the dark in large tanks and feeding them sugar to supercharge their growth. "It's a thousand times more productive than the natural process," said Harrison Dillon, a geneticist and patent lawyer who serves as the company's president and chief technology officer.

Solazyme says it has already made thousands of gallons of high-grade biodiesel and even light sweet "biocrude" with its processes, which can use anything from chemical waste to wood chips as a source of carbon.

The company, which raised \$10 million in equity financing and \$5 million in debt last year, is still experimenting with different feedstocks, algae species and oil extraction methods. Scores of containers with telltale green scrawls dot the lab and computers are constantly measuring conditions in the fermentation tanks.



Dillon said he hopes to reach commercial-scale biodiesel production in two or three years. Refiner Imperium Renewables of Seattle and petroleum giant Chevron of San Ramon have already signed partnership agreements with the company.

To help pay the bills, Solazyme is using its technology to make specialty oils for the cosmetics industry, including one ingredient that could fetch more than \$20,000 a liter.

Darzens and other experts caution that economical algal oil production is at least five years away and could take up to a decade. Rival biofuel technologies, such as the bacterial oil generation being explored by Bay Area startups LS9 and Amyris Biotechnologies, could prove to be more successful.

Still, the algae efforts are well worth pursuing. Recent research suggests that existing biofuels like ethanol and diesels made from soybeans and oil palms cause more environmental harm than they're worth.

Scientists estimate that a commercial algae farm could probably produce 5,000 gallons of oil per acre of land, compared to around 50 gallons an acre from soybeans and 600 gallons an acre from palm oil. Depending on the species and the manufacturing process, the algae could also be grown in the desert or other inhospitable places so they wouldn't tie up valuable land that could be used for food crops.

The potential of algae has certainly seduced investors, from the prominent Silicon Valley venture capitalists to the poor suckers conned into giving money to De Beers Fuels, a South African company that collapsed last year in a web of deception.

"There's a lot of overpromising, and there's going to be a heck of a lot of people underdelivering," said Wolfson.

He doesn't plan to be one of them.