

## Here Comes Pond Scum Power

Algae biodiesel isn't practical yet, but startups and giants are enthusiastically exploring the possibilities

In a world spooked by global warming and thirsty for nonpolluting fuel, lowly algae hold a potent appeal. The plants sop up large quantities of carbon dioxide, a greenhouse gas, and produce tiny globules of fat that can be collected and turned into biodiesel fuel for trucks, cars, and trains. The oils might even be processed into aircraft fuel.

One of algae's great virtues is that the plant has so little in common with other sources of fuel. Unlike cornfields that are harvested to produce ethanol, algae farms don't require huge volumes of freshwater, nor do they tie up land that could be used for food crops. Algae flourish in saltwater or even wastewater and grow up to 40 times faster than other plants. Compared with current energy crops, algae have "the potential to deliver 10 or 100 times more energy per acre," says Ron C. Pate, a technical expert at Sandia National Labs. That's why industrial giants ranging from Chevron (CVX) to Honeywell (HON) to Boeing (BA) are starting up algae business units. "In the past two years, we have changed from algae skeptics to proponents," says Dave Daggett, Boeing's technology leader for energy and emissions.

Bringing down the cost of producing algae oil in commercial volumes—billions of gallons—is still a big challenge. "The scale required to grow algae to a meaningful dimension is staggering," says Bill Green, managing partner at VantagePoint Venture Partners. But biodiesel from other plants is already a robust market. In Europe, refiners are producing 1.4 billion gallons a year from rapeseed, soy, and other plants. In all, the world consumed \$1.7 billion worth of biodiesel last year. That should grow to \$26 billion by 2020, says market researcher Global Insight.

In the U.S., demand for such plant-based oils is quickly outstripping supplies. That and algae's mystique have attracted the attention of energy entrepreneurs such as Martin Tobias, CEO of Imperium Renewables in Seattle, which is armed with \$145 million in venture capital and private equity funding. Imperium buys practically every drop of oil U.S. algae startups are producing. So far it has sold just a few hundred gallons of finished fuel. But Tobias has dedicated a 5 million-gallon refinery to algae oil, and by 2011 he expects startups to be making 100 million gallons a year. At that point, Tobias reckons, the price per gallon will fall to \$1.70, from as much as \$20 today. "The only thing missing is the farms," he says. "I prefer not to operate a large-scale farm myself, but I may have to do it."

Extracting oil from algae is currently a cumbersome affair that involves drying and processing the plants. But some of the world's top genetic engineers want to create improved algae strains that will produce oil continually, eliminating the most difficult processing steps. "Farming and harvesting are both complex and expensive," says human genome pioneer J. Craig Venter, whose 2005 startup, Synthetic Genomics, is experimenting with algal genes. Rival Solazyme in South San Francisco has engineered more than a dozen specialized strains and ramped up pre-commercial production. "We can easily make thousands of gallons [of algal biodiesel] a month," says Chief Operating Officer Jonathan S. Wolfson.

Startups in the U.S. and Europe are turning to power companies and local governments to back larger trials, selling the idea that algae can offset some of the power plants' CO<sub>2</sub> emissions. On Nov. 2, German energy group E-On Hansa said it would build a \$3.2 million pilot algae farm at its Hamburg power plant with support from the city government. Portuguese biodiesel maker SGC Energia is investing in a \$3 million pilot algae farm next to a power plant. It will be up and running in 2008.

Many startups still have growing pains. GreenFuel Technologies in Cambridge, Mass., founded in 2004, quickly snared \$20 million to create a business around its patented algae bioreactor. But when its system was tested at a power plant outside Phoenix, the green goo grew too fast, overwhelming GreenFuel's ability to harvest the oil. Last June, after just two weeks, GreenFuel stopped the trial.

Despite the misadventure, though, the market proved forgiving. GreenFuel raised an additional \$5.5 million to pursue a lower-cost approach. It expects to announce new commercial trials in the next few weeks.