

# Mass. company making diesel with sun, water, CO2

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CAMBRIDGE, Mass. – A Massachusetts biotechnology company says it can produce the fuel that runs Jaguars and jet engines using the same ingredients that make grass grow.

Joule Unlimited has invented a genetically-engineered organism that it says simply secretes diesel fuel or ethanol wherever it finds sunlight, water and carbon dioxide.

The Cambridge, Mass.-based company says it can manipulate the organism to produce the renewable fuels on demand at unprecedented rates, and can do it in facilities large and small at costs comparable to the cheapest fossil fuels.

What can it mean? No less than "energy independence," Joule's web site tells the world, even if the world's not quite convinced.

"We make some lofty claims, all of which we believe, all which we've validated, all of which we've shown to investors," said Joule chief executive Bill Sims.

"If we're half right, this revolutionizes the world's largest industry, which is the oil and gas industry," he said. "And if we're right, there's no reason why this technology can't change the world."

The doing, though, isn't quite done, and there's skepticism Joule can live up to its promises.

National Renewable Energy Laboratory scientist Philip Pienkos said Joule's technology is exciting but unproven, and their claims of efficiency are undercut by difficulties they could have just collecting the fuel their organism is producing.

Timothy Donohue, director of the Great Lakes Bioenergy Research Center at the University of Wisconsin-Madison, says Joule must demonstrate its technology on a broad scale.

Perhaps it can work, but "the four letter word that's the biggest stumbling block is whether it 'will' work," Donohue said. "There are really good ideas that fail during scale up."

Sims said he knows "there's always skeptics for breakthrough technologies."

"And they can ride home on their horse and use their abacus to calculate their checkbook balance," he said.

Joule was founded in 2007. In the last year, it's roughly doubled its employees to 70, closed a \$30 million second round of private funding in April and added John Podesta, former White House chief of staff under President Bill Clinton, to its board of directors.

The company worked in "stealth mode" for a couple years before it recently began revealing more about what it was doing, including with a patent for its cyanobacterium last year. This month, it released a peer-reviewed paper it says backs its claims.

Work to create fuel from solar energy has been done for decades, such as by making ethanol from corn or extracting fuel from algae. But Joule says they've eliminated the middleman that's makes producing biofuels on a large scale so costly.

That middleman is the "biomass," such as the untold tons of corn or algae that must be grown, harvested and destroyed to extract a fuel that still must be treated and refined to be used. Joule says its organisms secrete a completed product, already identical to diesel fuel or ethanol, then live on to keep producing it at remarkable rates.

Joule claims, for instance, that its cyanobacterium can produce 15,000 gallons of diesel full per acre annually, over four times more than the most efficient algal process for making fuel. And they say they can do it at \$30 a barrel.

A key for Joule is the cyanobacterium it chose, which is found everywhere and is less complex than algae, so it's easier to genetically manipulate, said biologist Dan Robertson, Joule's top scientist.

The organisms are engineered to take in sunlight and carbon dioxide, then produce and secrete ethanol or hydrocarbons — the basis of various fuels, such as diesel — as a byproduct of photosynthesis.

The company envisions building facilities near power plants and consuming their waste carbon dioxide, so their cyanobacteria can reduce carbon emissions while they're at it.

The flat, solar-panel style "bioreactors" that house the cyanobacterium are modules, meaning they can build arrays at facilities as large or small as land allows, the company says. The thin, grooved panels are designed for maximum light absorption, and also so Joule can efficiently collect the fuel the bacteria secrete.

Recovering the fuel is where Joule could find significant problems, said Pienkos, the NREL

scientist, who is also principal investigator on a Department of Energy-funded project with Algenol, a Joule competitor that makes ethanol and is one of the handful of companies that also bypass biomass.

Pienkos said his calculations, based on information in Joule's recent paper, indicate that though they eliminate biomass problems, their technology leaves relatively small amounts of fuel in relatively large amounts of water, producing a sort of "sheen." They may not be dealing with biomass, but the company is facing complicated "engineering issues" in order to recover large amounts of its fuel efficiently, he said.

"I think they're trading one set of problems for another," Pienkos said.

Success or failure for Joule comes soon enough. The company plans to break ground on a 10-acre demonstration facility this year, and Sims says they could be operating commercially in less than two years.

Robertson talks wistfully about the day he'll hop into the Ferrari he doesn't have, fill it with Joule fuel and gun the engine in an undeniable demonstration of the power and reality of Joule's ideas. Later, after leading a visitor on a tour of the labs, Robertson comes upon a poster of a sports car on an office wall, and it reminds him of the success he's convinced is coming. He motions to the picture.

"I wasn't kidding about the Ferrari," he says.