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The U.S. Military's Great Green Gamble Spurs Biofuel Startups

By Todd Woody, Forbes Staff | Photos by Chris Leschinsky for Forbes

Eighty miles west of [El Paso](#), Tex., in a sunburned stretch of the New Mexico desert, Predator drones and blimps patrol the nearby border and immigration-agency SUVs speed through the desolate terrain, the occasional coyote loping across the scrub. Oddly, given that I'm more than 600 miles from the Pacific, there's a distinct salty ocean tang wafting on the breeze. But that's not the sea I'm smelling: The odor is emanating from algae growing in 30 acres of huge oblong ponds at Sapphire Energy's Green Crude Farm.

Funded with \$85 million from [Bill Gates](#) and other investors – plus \$104 million in government cash and loan guarantees – the world's only commercial outdoor algal biorefinery went online this summer and will eventually expand to 300 acres. The plan: extract 1.5 million gallons of green crude oil a year from patented pond scum fed a diet of carbon dioxide and sunlight.

Even before [San Diego](#)-based Sapphire broke ground on the demonstration plant last year, the U.S. Navy's green energy warrior, Vice Admiral Philip Cullom,

descended on the desert site to grill Sapphire execs on their technology and its potential to fuel battleships and jet fighters. “No question, the military has focused the company and given us a great challenge to meet,” says Sapphire executive Tim Zenk, standing on the catwalk of a tank where a mechanical arm is harvesting thick green goo pumped in from the algae ponds.

Scum ponds in the desert? The very idea conjures memories of the federal government’s decidedly mixed record at promoting alt-energy projects: Solyndra, FutureGen, A123’s electric-car batteries, synfuels in the 1980s, jojoba in the 1970s. Add to that all the many military boondoggles – Star Wars missile defense, for one – born of best intentions and bloated budgets.

Sapphire has yet to earn a dime from the Pentagon; the company’s government funding comes from the Departments of Energy and Agriculture. But since the days when the startup’s scientists were still tinkering in the lab, they’ve been sending their biofuel for evaluation to the Defense Department, the deepest-pocketed client of them all. “There’s no other entity that has the capacity, the planning, the commitment and the policy drivers to make technologies real and create a market,” says Zenk.

The U.S. military, the nation’s single largest oil consumer, wants to wean itself from petroleum, and is deploying its immense buying power and authority to commercialize nascent technologies deemed to be in the national interest.

The Navy, which aims to get half of its energy from renewable sources by 2020, has been buying biofuels in small but expensive quantities, as in four times the cost of conventional fuels. Earlier this year the Pentagon invoked the Defense Production Act to solicit proposals to build at least one integrated biorefinery

with \$210 million in government funding. The biofuel buy has outraged some congressional Republicans, who are attempting to bar the military from purchasing any fuel that costs more than petroleum.

It will be years before we know if the military's biofuels bet is a multibillion-dollar folly – or if the armed forces have planted the seeds of another global industry, as it did with nuclear power, semiconductors and the Internet. This much is certain: The Pentagon's largesse is already spurring the entrepreneurial zeal of startups like Sapphire that seek potential riches in shaping green technology to meet military needs.

For a first-hand look at that opportunity I find myself onboard a Navy C-2A Greyhound in July approaching the USS Nimitz some 45 miles off Oahu. I'm strapped into a backward-facing seat wearing a survival vest and a "cranial" – Navy-speak for a helmet equipped with sound-deadening headphones and goggles. The roar of the transport's twin props ratchets up and an airman in the last row of the dimly lit cabin starts pumping his arm wildly. "Go! Go! Go!" That's the signal to brace for landing. As the Greyhound drops toward the 1,100-foot deck of the aircraft carrier, the pilot throttles up to 150 miles an hour. We shoot across the tarmac until a hook embedded in the plane's fuselage catches a cable, whiplashing us to a dead stop. It was a short but historic flight from [Honolulu](#), the first biofueled Navy transport to land on an aircraft carrier. We flew on algae and used cooking oil mixed in a 50-50 blend with standard petroleum aviation juice. Some 450,000 gallons of that biofuel, produced by Silicon Valley's Solazyme and Dynamic Fuels, is also powering the 71 aircraft on deck – the F/A-18 fighter jets screaming across the blue skies above us, the E-2C Hawkeyes patrolling the surrounding airspace and the Seahawk helicopters ferrying

Secretary of the Navy Ray Mabus and top Navy brass between two biofueled destroyers and a guided missile cruiser steaming alongside the nuclear-powered Nimitz.

Algae being harvested at Sapphire Energy's Green Crude Farm in New Mexico.

This is the Great Green Fleet, the first Navy strike force powered by biofuels and a two-day demonstration of Mabus' determination to permanently float an energy-independent flotilla by 2016. "We're moving forward and we're not going to let up," says Vice Admiral Cullom, the deputy chief of naval operations for fleet readiness and logistics.

It's not just about biofuels. The Marines are tapping solar and other technologies to make battlefield bases in Afghanistan energy independent and more impervious to enemy disruptions of supply lines that have extracted a high price in blood and treasure. And the Army in August opened bids to buy \$7 billion in renewable energy to make its domestic bases less vulnerable to power grid disruptions.

Algae is one of the great green hopes for creating a biofuels industry that can reach the scale necessary to bring down costs and compete against fossil fuels. Whether grown in bioreactors or in desert ponds, algal oil mostly sidesteps the food and land conflicts that potentially can limit other biofuels. It's largely about bioengineering, hence Solyazme's headquarters in the biotechnology corridor of South [San Francisco](#).

Founded in 2003 by Jonathan Wolfson, a financial entrepreneur, and genetic

microbiologist Harrison Dillon, Solazyme began talking to the Department of Defense in 2007. “At the point when you’re still in test tubes and shake flasks, you’re thinking to yourself, ‘Ok, we need catalysts to continue to advance this technology,’” says Wolfson, sitting in a conference room that features a large framed photo of a Navy ship that steamed down the West Coast burning Solazyme’s algal oil. “As a technology-driven company we needed discipline to become a production company. And there’s no organization that I can think of that can drive more discipline into an organization than the DOD.”

Solazyme grows heterotrophic algae in bioreactors. The algae consume sugar and excrete crude oil. After Solazyme began supplying the military with small quantities of algae biofuels for evaluation, the DOD awarded the company its first significant contract in 2010. The next year a United Airlines 737 flew the first commercial biofueled flight on Solazyme’s Solajet fuel. A contract with Volkswagen followed. “The fact that we could even make that United flight was a direct result of the work we had been doing with the Navy,” says Wolfson.

The military work also prompted discoveries of new strains of algae, which explains why next to its research labs Solazyme built a kitchen to bake up batches of chocolate chip cookies, honey mustard dipping sauce and crackers. While testing strains, Solazyme scientists found one that produces what tastes remarkably like olive oil but is healthier and could replace eggs and butter in a smorgasbord of foods. “Your mouth recognizes it as fat, but it has a remarkable reduction in calories and eliminates saturated fats,” says Genet Garamendi, Solazyme’s vice president of corporate communications, biting into an algae-infused cookie that beat Mrs. Fields’ hands down in an impromptu taste test.

Solazyme struck a deal to commercialize its Betty Crocker crude with Roquette,

the French food conglomerate. Other Solazyme strains are being produced for cosmetics and the company signed an agreement with Unilver to use its algae oil in consumer products. In May, Dow Chemical said it would tap a strain of Solazyme algal oil for use in electrical transformer insulating fluids.

The commercial aviation industry is eager to become a major buyer of biofuels as a hedge against oil price spikes that can wipe out years of profit. But cash-strapped airlines are counting on the military to get production rolling. “There’s not a single commercial-scale facility up and running today and we’re all keen to see what happens to price and supply when you have commercial quantities in production,” says Jimmy Samartzis, United Airlines managing director of global environmental affairs and sustainability, referring to the Defense Department’s move to bankroll biorefineries.

United buys more 4 billion gallons fuel a year and Samartzis and other airline executives, who have worked with the Navy on biofuel standards, are on aboard the Nimitz. “When we talk to funders and investors, we consistently hear that getting that first plant will be absolutely critical and subsequent plants will be easier to fund and get off the ground,” he says.

Also on deck is Michael McAdams, president of the Advanced Biofuels Association, a Washington trade group. He says at least a dozen of his 45 member companies are expected to put in bids with the military to build the biorefineries. “That’s an incredible statement to the marketplace,” McAdams says as a biofueled fighter jet screams by.

Whether the biofuels industry can scale up to provide the 8 million barrels the Navy needs annually at a price Uncle Sam can afford is the big unknown. A [report](#)

prepared by the Rand Corp. for the Secretary of Defense last year bluntly concluded that the military would not be able to secure sufficient supplies of biofuels at a competitive price. “Because of limited production potential, fuels derived from animal fats, waste oils, and seed oils will never have a significant role in the larger domestic commercial marketplace,” the report stated. “Algae-derived fuels might, but technology development challenges suggest that algae-derived fuels will not constitute an important fraction of the commercial fuel market until well beyond the next decade.”

Navy Secretary Ray Mabus inspects the Great Green Fleet. Photo courtesy of the U.S. Navy.

Such skepticism hasn’t deterred an emerging green military-industrial complex. At forums organized by the [American Council on Renewable Energy](#) in Washington, the group’s chief executive, retired Navy Vice Admiral Dennis McGinn, connects his military comrades with green tech entrepreneurs, financiers and old-line defense contractors. “We want to promote a much better understanding about the government requirements,” says McGinn, “and a much greater understanding by the government of what the options are out there, not just technology but financial options to try to mobilize private capital to accelerate and expand the pace of renewable energy adoption by the military.”

That’s where Sierra Energy chief executive Michael Hart met Col. Bob Charette, Jr., director of the Marines expeditionary energy office and the force behind efforts to install green technologies on battlefield bases. The startup, based in Davis, Calif., is developing technology to transform a blast furnace into a machine that can vaporize garbage and produce either diesel fuel or electricity. It’s a decidedly low-tech-looking metal cylinder connected to a conveyer belt that feeds

the contraption a diet of discarded bottles, plastic, metal and other detritus. Oxygen and steam injected into the cylinder's base gasifies the trash, leaving a gas that can be refined into diesel. The possibility of using such technology on remote battlefield bases caught the Marines' attention and changed Sierra's business plan.

"The Marine Corps said, 'Make it modular so it can be delivered in the field,' and they wanted us to produce liquid fuels, so that's what we did," says Hart, pointing to a prototype being tested at the decommissioned McClellan Air Force base outside Sacramento. Hart is betting that if he meets the Marines' needs he can capture a potentially lucrative military market – and sell to cities seeking to generate renewable energy while slashing landfill bills.

"The DOD is serious as a heart attack," he says.

In a wood-paneled office aboard the Nimitz, Vice Admiral Cullom points out that when the Navy decided to build nuclear-powered ships like this one, the technology was too expensive to be commercially viable. Yet the nuclear fleet projected American power to the far corners of the globe and laid the groundwork for a domestic nuclear power industry.

The Navy can do the same with biofuels, he argues. "We owe it to the American taxpayer to have a decent payback period, to have a good ROI," says Cullom, a veteran commander who holds a Harvard MBA. "But our ROI is different in many ways. We also look at the long-range vision of where are we going to be. We can't keep going on a path like this. We have got to have that path be a very different trajectory for 2020 or 2030."

Sapphire hasn't priced its algal oil yet, but the company expects it to be competitive with petroleum by 2018 if it can produce a minimum of 5,000 barrels a day, according to Zenk. To get there, the startup needs to develop higher-yield algae strains, cut production costs and attract capital. A lot of capital.

"I don't want to oversell to you – there are a lot of challenges ahead of us," says Zenk. "But every energy transition has been led by our government and primarily it's been military-driven, and the same is true this time."

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