Going LOW IN LOUISIANA

A few hours north of New Orleans, where two massive renewable diesel plants already operate, a smaller project with huge implications for both biofuels and CCS is moving forward.

BY TOM BRYAN

PROVING GROUND: An aerial view of the stratigraphic test well that Strategic Biofuels drilled in Caldwell Parish, Louisiana, to demonstrate that CO_2 can be safely and securely stored deep underground there, and that the reservoir has decades of storage capacity.
PHOTO: STRATEGIC BIOFUELS

In the hours before Hurricane Ida's landfall in late August, two of the nation's largest renewable diesel producers, each under expansion, briefly shut down operations in southern Louisiana. While both Diamond Green Diesel, in Norco, and Renewable Energy Group, in Geismar, weathered the storm without incident, Ida was an inconvenient reminder of their coastal proximity.

Meanwhile, 230 miles to the north, Strategic Biofuels LLC, just days after completing its landmark carbon capture and sequestration (CCS) test well research—and virtually unaffected by Ida—pressed on with its own renewable diesel effort at the Port of Columbia in Caldwell Parish.

"This far north, the storm wasn't an issue," says Strategic Biofuels CEO Paul Schubert, explaining how the site of the proposed plant, largely insulated from the Gulf's extreme weather, is a fortuitous but tangential attribute of its inland location. "We're sitting above an ideal reservoir for carbon sequestration, and it just happens to be in the heart of a massively underutilized fiber basket."

Schubert says the proposed 33.7 MMgy renewable diesel plant, along with its planned CO_2 injection wells, will be located on a 300-plus-acre site near the quiet Ouachita River port where components of the facility will eventually be delivered via barge. Other products could also come and go by river, but the ultra-low-carbon biofuel produced there will be delivered to the West Coast via rail, as a Union Pacific main line runs past the site.

When built, the plant will utilize forestry waste as a feedstock, primarily Southern yellow pine thinnings from plantation forests in the area that have been privately managed for over a century. Strategic Biofuels has secured a 20-year agreement for forestry

waste that would be delivered to the facility in the form of wood chips. Schubert says forest timber is the top agricultural product in Louisiana, and just as weeds must be controlled in Midwest farm fields, commercial plantation forests in the South are crops that require thinning.

When a plantation forest is grown, Schubert explains, as many as 700 seedlings are planted per acre to ensure forest density. The developing trees compete for sunlight, nutrients and water. Ultimately, most of those trees are removed via thinning to allow the largest, healthiest pines to grow to harvestable size. "By the time trees are big enough for lumber production, that same plantation will hold just 100 to 120 trees per acre," he says, explaining that at least two rounds of thinning occur over the course of the 30- to 35-year tree-growing cycle, one at about 12 to 15 years and a second one about seven years later. Without thinning, Schubert says, harvesting commercial timber for construction, furniture, and telephone poles would be virtually impossible.

The branches and treetops from the thinnings are left on the forest floor to rot, producing greenhouse gases. The larger tree trunks, or rounds, have traditionally been used for pulp and paper production. But pulp mills in the region, which once consumed more than 4 million tons of forest waste annually, have shut down. "It was a depressed market even before the pulp mills closed, and now it's even worse for the loggers and timber owners," Schubert says. "Our plant will be able to use about 1 million tons of forest waste per year. The demand we'd create for these materials will be greatly appreciated by the timber owners and the loggers."

The proposed plant, dubbed Louisiana Green Fuels, would gasify the forest waste into carbon monoxide and hydrogen and

use the Fischer-Tropsch process to create paraffins, which would then be upgraded, via cracking, to synthetic renewable diesel. Schubert, a Ph.D. chemist with 35 years of experience in the petrochemical and renewable fuels industry, is spearheading the project along with the company's Chief Operating Officer Bob Meredith, who has nearly 50 years of experience in the oil and gas industry. Along with their own forestry, technology and renewables experts, they're leveraging support from Koch Project Solutions and Hatch, a global engineering and project management firm.

The cost of the project could ultimately be about $1.5 billion, with the CCS component representing roughly 10% of the overall price. "Carbon capture requires equipment that selectively removes carbon dioxide produced in the process," Schubert says, breaking down some of the near- and long-term costs of CCS. "We end up with a high-purity CO_2 stream that is then compressed and injected about a mile underground where it is held by the same forces that have held oil and gas underground for millions of years. The wells require specialized metallurgy because of the corrosiveness of the greenhouse gases that are being stored. Long-term, there are well monitoring costs, both from the surface and via peripheral monitoring wells."

Strategic Biofuels could be the first renewable diesel producer in the world to capture and sequester CO_2, but the ethanol industry is also aggressively pursuing sequestration to lower the carbon footprint of ethanol blended into gasoline. Already, more than 50 U.S. ethanol plants are engaged in the early stages of CCS exploration or investment, 31 of them signing on to aggregate their carbon dioxide via pipeline across multiple states for sequestration in North Dakota. Half a dozen ethanol plants owned by Valero (parent company to Diamond Green Diesel) have signed onto a separate CCS pipeline project; and Marquis Energy has commissioned a 5,000-foot sequestration test well at the site of its bio-industrial complex in Hennepin, Illinois. Last year, Gron Renewables, which has proposed a massive four-phase renewable diesel project at the Port of Greater Baton Rouge, also began studying CCS.

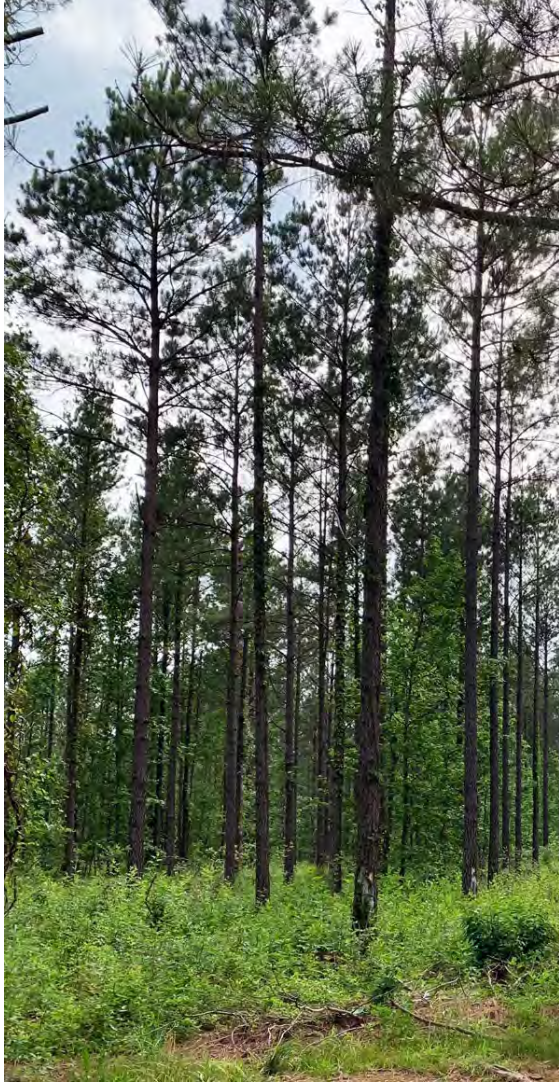
Low CI, High Returns

A plan to produce less than 34 MMgy of renewable diesel at a time when larger companies like DGD, REG and Gron are proposing, commissioning or already operating plants 10 times that size, may seem dubious. But Schubert says the estimated profitability of Louisiana Green Fuels makes up for its comparatively small scale.

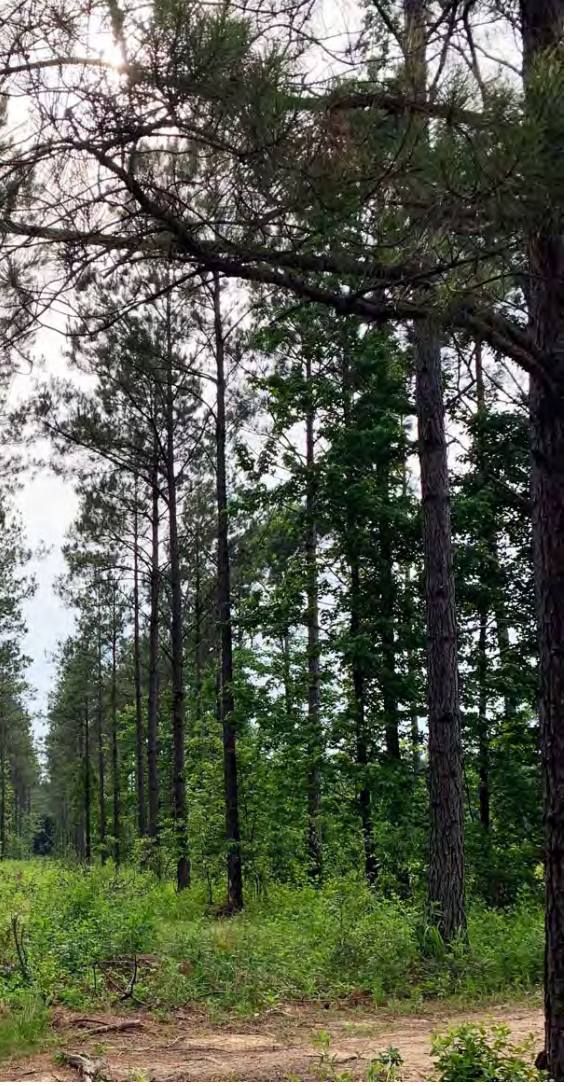
Schubert says the economics of the project are driven by CO_2 sequestration. "That's fundamentally how we're different. If we were just proposing to build this plant without sequestration, we'd end up with a CI for forestry waste in the low-to-mid 20s," he says. "But when we generate our own green power and then add CCS, we get down to a remarkable minus 238. It's a game changer," Schubert says. "So, when you start looking at the combination of federal credits (RINs) and California Low Carbon Fuel Standard (LCFS) credits—which would make up nearly 80% of the total market value of the fuel—the margins are over $10 per gallon. That's almost a million dollars a day at full capacity."

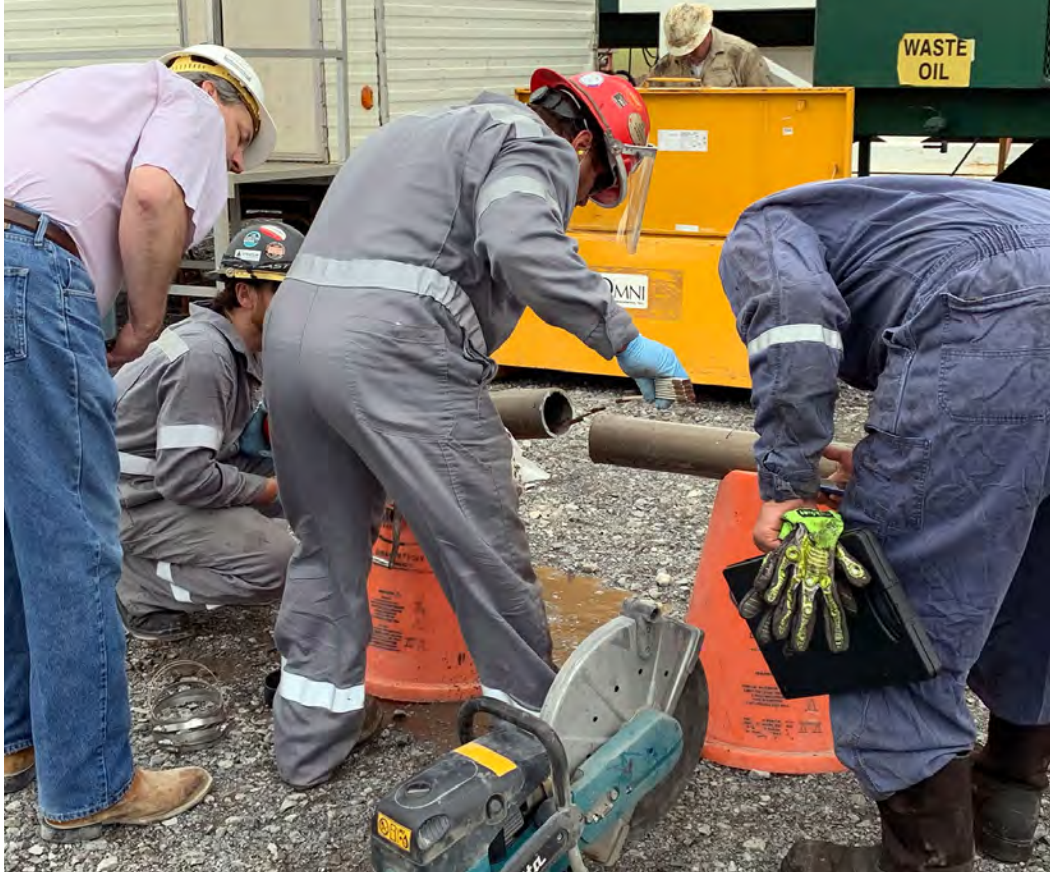
The CI of a biofuel, as defined by California's LCFS, ultimately determines the biofuel's value in the California marketplace. For the sake of comparison, Schubert says, renewable diesel made from soybean oil and canola oil generally achieves a CI score in the mid-50s; corn oil and animal fats in the mid-30s; and used cooking oil—"considered the best of the lot, if you can find it"—about 20. "Forestry waste alone is almost on par with used cooking oil (UCO)," Schubert says. "It gets you into the low 20s, but sequestration takes it down to an entirely new level."

Unlike other advanced biofuel feedstocks, forest waste—at least in northern Louisiana—is widely available and reasonably priced. "Used cooking oil nationwide is largely spoken for, and the reality of the current renewable diesel boom is that most production will be reliant on soybean oil out of the Midwest," Schubert says. "That comes with transportation costs and energy use, which adds to your carbon footprint, and soy oil has competing uses, too. The margins from soy oil-based renewable diesel are around $1 per gallon, and with only a twenty percent increase in soybean oil cost, they could go negative. Our feedstock is actually in oversupply because other uses for it have dried up regionally."



Schubert says it is ironic that California, which is the destination for Louisiana Green Fuels' renewable diesel—a product of forest waste—is a state that could benefit from thinning its federal forests to make them more fire resilient. "It's true, but the way the federal Renewable Fuel Standard works now, you're not allowed to use any material from a federal forest—not so much as a pinecone," he explains, adding that





PIECE BY PIECE: Multiple 30-foot core sections were collected using the stratigraphic test well. To verify the presence of adequate upper and lower containment and injection intervals, each 30-foot section was cut into three equal sections for analysis.

PHOTO: STRATEGIC BIOFUELS

PINE PLANTATION: Rows of pine trees in sustainably managed forests like this one can take up to 35 years to produce. The forests are typically thinned 12 to 15 years after they are planted, and then again about seven years later.

PHOTO: STRATEGIC BIOFUELS

discussions are taking place at the highest levels of forest management to evaluate the role biofuels could play in forest health and fire mitigation. "For now, we're focused on private land here in Louisiana, which makes up 81% of the forested land," he says.

Schubert says there is enough land available to Strategic Biofuels in northern Louisiana to carry out a second and even third phase of the planned project, essentially doubling or tripling its total capacity of renewable diesel and sequestered CO_2. And he believes the company could easily extend its range of control on the surface to command an extended plume rights area for future growth. "We could use the same wells and simply transport the carbon dioxide via pipeline a few miles from additional plants," he says. "There is more than enough feedstock in the region to support growth."

The Well and Geology

Early on, Strategic Biofuels made a bold decision to put the stratigraphic test well ahead of everything else on its project development timeline, betting that collecting data on the geologic viability of the site would provide a glidepath for future investment.

"We could have carried out years of work before putting steel in the ground, but we didn't," Schubert says. "We saw that the carbon intensity reduction that CCS brings to the fuel is where the money is. And we were confident that the test well would essentially de-risk the project."

He describes the test well investment as a calculated bet that paid off. "For us, the well drives everything. We raised the funds for the test well program—85 percent being raised in northern Louisiana with people who really understand drilling for oil and gas. And we did this with the understanding that we could drill the well and it could fail, even with the right geologic work to back it up. But if we succeeded, as we did, the returns would look good for everyone involved."

The goals of the test well program were to demonstrate that CO_2, the main greenhouse gas generated during the fuel production process, can be safely and securely stored deep underground, and that the storage reservoir has sufficient capacity to store all the gas produced over the plant's lifetime. Schubert says completing the test well program was an essential prerequisite for securing a permit for the EPA Class VI sequestration well.

The test well sits on top of a series of interconnected saltwater aquifers that possess geologic features making them capable of accepting CO_2 for decades. The depth of the brine aquifers ranges from 5,000 to 6,000 feet—far below any drinking water reservoirs in the area. Under federal regulations for Class VI wells used for carbon dioxide injection, storage reservoirs must have an adequate upper confining zone. "The Midway Shale is above these forma-

CCS FRONTIER: While Strategic Biofuels may become the first renewable diesel producer to capture and sequester CO_2, the U.S. ethanol industry is aggressively pursuing CCS through pipeline aggregation and independent projects. Marquis Energy, the sixth ethanol producer in North America, has commissioned a 5,000-foot sequestration test well (shown here) at the site of its bio-industrial complex in Hennepin, Illinois.
PHOTO: MARQUIS ENERGY

tions, and it is very thick and impervious," Schubert says, adding that the California LCFS requires an additional safeguard—a lower confining zone. "Fortunately, we have that as well. It's exactly the right geology."

What makes the geologic formation under Louisiana Green Fuels even more attractive is the historic absence of oil and gas production in the area. Schubert says the main "leak path" for sequestered carbon dioxide from deep geologic reservoirs is old, poorly capped wells that penetrate confining zones. "We don't have that problem," he says. "The nearest former oil well is nearly four miles away, and our CO_2 plume won't expand that far."

Eventually, the current test well will become a monitoring well, and Strategic Biofuels plans to drill two or more Class VI sequestration wells on site for redundancy. "If one goes down, we'll be able to switch over to the other," Schubert says.

The test well data, being managed by consulting partner Geostock Sandia LLC, has proven excellent. "Their analysis indicates that each well would have at least double the CO_2 storage capacity needed for the life of the plant," Schubert says. "You're looking at a 30-year timeline, and our reservoirs have vastly more capacity than that."

With the expectation of filing for a Class VI well permit this winter, Strategic Biofuels is in the process of pulling together months of test well data—including extensive 3D modeling of the reservoir. Meanwhile, Schubert says, the Louisiana Department of Natural Resources is taking steps to establish primacy over Class VI well permits in the state. "The expectation is that the EPA will grant them that primacy soon," he says, adding that state oversight should expedite the process.

Mineral Rights

Louisiana is one of a few states that have established clear laws around "pore rights," or the rights to sequester CO_2 underground. "There are only a handful of states that have even tried to define this," Schubert says. "It's an open question in most states. Is it the surface owner? Is it the mineral rights owner? Is it shared? Defining this is a big deal, and Louisiana has done so—establishing that the rights belong to

the surface owner. The logic is that mineral rights are the right to extract valuable minerals from underground. Sequestration is storing, not extracting."

Securing the pore rights is critical for the success of the project. However, Schubert says that the state legislature was visionary in terms of establishing the framework needed to support CCS projects. "The legislature established that CCS is in the public interest, and therefore established an eminent domain right to acquire the pore rights," he says. "That's ultimately very important because it protects the project from being blocked," he explains, adding that the carbon dioxide plume within the deep geologic space is expected to extend out a 1.5- to 2-mile radius from the injection point over 30 years of operation. "Without eminent domain, someone with even a tiny piece of land above this plume might be able to prevent the project from being built," he says.

Because there has never been any significant oil or gas production in the Caldwell Parish, the targeted sequestration zone has no current value. Schubert says Strategic Biofuels intends to negotiate a fair market value with surface owners nonetheless. "And if there are people who hold out or make unreasonable demands, we would be able to use eminent domain to acquire the rights to inject CO_2 in that deep zone."

Throughout the first and second quarters of 2022, Strategic Biofuels will advance the plant's engineering design, giving greater clarity to the cost of the project, while applying for the required regulatory permits and putting third-party contracts in place. Schubert believes the plant could be mechanically complete by mid-2025 and in full commercial operation later that year.

Although Strategic Biofuels' project is not subject to the weather risks that projects closer to Louisiana's Gulf Coast face, the critical risks all project developers face is de-risking economic, schedule and execution risks. "Thomas Edison said there's a way to do it better … find it! That's what our team has done," Schubert says. "We've de-risked the project's economics by drilling the test well first. On top of that, we've built a team with deep expertise in wells, forestry, fuels and business, and then brought in industry leading partners to de-risk execution and schedule. Truly a better way to high-margin, carbon-negative fuels."

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