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Thunderstruck - Fidelis New Energy's GigaSystem Gears Up to Produce Sustainable Aviation Fuel, Renewable Diesel

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As concerns about energy security have come to the forefront, some in the mainstream have begun to pump the brakes on the idea of energy transition at any cost and reevaluate the practicality of some proposed solutions. But that hasn't changed the long-term outlook for energy transition nor the fact that numerous individual projects focused on alternative fuels, carbon capture, hydrogen and renewable energy are in the works, gaining in prominence and attracting a prodigious amount of investment. There is still an anticipation among investors that the market will increasingly demand greener production methods — they just need to be well-conceived, planned and executed. The good thing for Fidelis New Energy — a Houston-based firm focused on climate-impact infrastructure, including low-carbon, sustainable fuels — is that, among renewable producers, they're building a sustainable cost advantage through efficient, integrated design. In today's RBN blog we look at what Fidelis calls the Grön Fuels GigaSystem.

The GigaSystem promises to bring sustainable aviation fuel (SAF) and renewable diesel (RD) production together with carbon capture and sequestration (CCS), while utilizing carbon-negative power to reduce the carbon intensity (CI) of its fuels. Even more fundamentally, the system has the enviable capacity to handle multiple transportation options, with rail, pipeline and dock infrastructure, centrally located at the Port of Greater Baton Rouge. Fidelis and Optimized Process Designs (OPD), an affiliate of Koch Engineered Solutions, announced the execution of a lump-sum, turnkey definitive engineering, procurement and construction (EPC) agreement for the renewable fuels facility as well as design considerations enabling the optimized add-on of CCS and carbon-negative power to the site, all of which rely on the use of existing, proven technologies from leading global companies.

We've written a lot about RD, SAF and other alternative fuels over the last year, especially in our Come Clean series, which looked at how low-carbon fuel policies are incentivizing major shifts in the transportation sector. Along those same lines, as we said recently in Playin' By the Rules, a molecule's pedigree — how it is produced — has become at least as important as its energy content. It's the fundamental difference in the way value is established in renewable, decarbonized energy markets versus traditional commodities. In traditional energy markets, value is defined by physics, chemistry and geography. But in the world of renewables and decarbonization, value is primarily determined by rules that specify what a type of energy is worth, what is required to prove that worth, and how that value is ultimately captured by market participants. As we see it, the GigaSystem's backers seem to fully understand not only those rules and how to capture value based on them, but also the driving motivations behind the rules. So even if policies change (which they are prone to do) their fundamental value proposition will likely persist. What's more, their plan to marry proven, synchronous technologies with high-value terminaling assets ought to make them competitive under just about any regulatory regime. At the business end of the GigaSystem is alternative fuels production, so we'll start to dig in there.

Renewable Diesel, Sustainable Aviation Fuel

At its heart, the Fidelis project is centered on plans to produce 994 million gallons per year (MMgal/year) of distillate — that's about 65 Mb/d — with a flexible design that allows the site to optimize production to meet fast-growing demand based on market sentiment, capital inflows and regulatory and policy commitments. As shown in Figure 1, when optimized for RD (left bar and upper circle), the project would be able to produce about 48 Mb/d of RD and 17 Mb/d of SAF (approximately a 74/26 split), potentially becoming one of the world's largest RD producers and reaching about 6% of global production capacity by 2025.

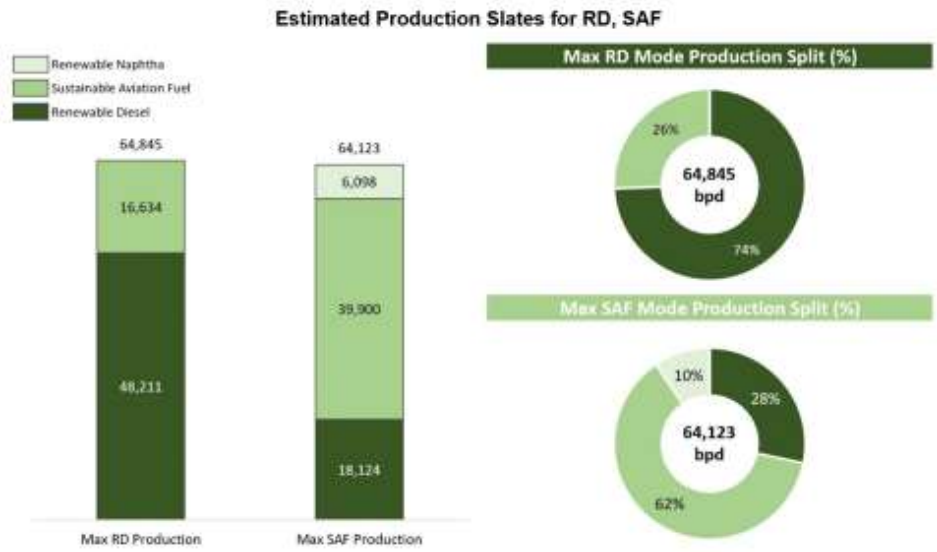

Figure 1. Estimated Production Slates for RD, SAF. Source: Fidelis New Energy

But if market conditions warrant and it is more economic to produce SAF, the plant would also be able to transition "on-the-fly" to a setup (right bar and lower circle) that could produce about 40 Mb/d of SAF and 18 Mb/d of RD, plus about 6 Mb/d of renewable naphtha, a bioplastics feedstock (approximately a 62/28/10 split). *That* setup would make Fidelis one of the world's largest producers of SAF, with the potential to represent 30% of global production by 2025. There's even a pathway for the facility to eventually produce 100% SAF if necessary, allowing it to supply rapidly evolving markets.

The RD and SAF produced by the Fidelis plant would be eligible for credits under California's Low Carbon Fuel Standard (LCFS) — the most significant policy supporting the rapid buildout of RD and SAF production facilities across the U.S. The LCFS was adopted in 2009 and implemented in 2011 with the goal of lowering the CI of the state's transportation fuels. (For a detailed explanation of the LCFS and why it matters, see Come Clean, Part 6.)

The key to the LCFS is the CI score, a measure of the lifecycle greenhouse gas (GHG) emissions associated with producing, distributing and consuming a fuel. Fuels with high CI scores pay a penalty, but fuels with lower CI scores generate a credit. For example, diesel has a target CI score of about 90 in 2022, according to the California Air Resources Board (CARB). For producers using renewables for fuels production, different feedstocks can have higher or lower CI scores. With that in mind, Fidelis says its fuels would have a stand-alone CI of 24.6 (RD and SAF combined), based on a feedstock slate of vegetable oils, animal fats and, eventually, emerging future blendstocks, but the other elements of the GigaSystem would give it significant additional advantages under the LCFS. Add in the CCS part of the project and the CI falls by more than 9 points to 14.9. Add in carbon-negative power and the CI drops by an additional 32 points, all the way to minus 17.2. (More on CCS and carbon-negative power in a bit.) Low-CI fuels generate credits equal to the difference in CI from the fuels they replace. Under this scenario, that would be 107.2 credits, based on a CI score of 90 for diesel (90 less minus 17.2 = 107.2).

Regardless of feedstock, Fidelis anticipates it will have a decisive advantage in CI based on that combination of technologies. Figure 2 shows the project's estimated dispatch curves for soybean oil (SBO), tallow (animal fat), distillers corn oil (DCO) and yellow grease (like used cooking oil or waste vegetable oil) for renewable fuel producers. [For our non-power folks who may be unfamiliar with dispatch curves, it just means the order in which producers are utilized based on their variable costs, so being in the lower left of the chart is most advantaged (see Talkin' 'Bout My Generation).]

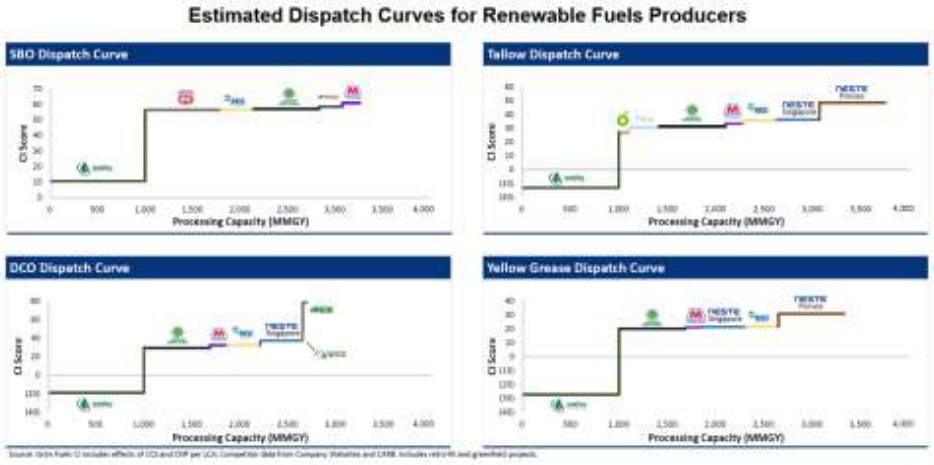

Figure 2. Estimated Dispatch Curves for Renewable Fuels Producers. Source: Fidelis New Energy

Note: Publicly Available Data May Not Include Non-Public Carbon Intensity Reduction Initiatives.

In each of the four scenarios, Fidelis (indicated by the green Grön Fuels logo to the far-left of each graph) achieves a substantially lower CI score –– all but SBO below zero –– than other producers that can utilize that feedstock. The key takeaway here is that, even if the buildout of renewable transportation fuels causes demand for feedstocks, and thus costs, to rise (which is an anticipated outcome), the GigaSystem's other carbon-cutting strategies give it an industry-leading CI potential — and it's not close. So, if the relative value of one feedstock rises or falls versus the others, Fidelis can react accordingly and maintain its CI advantage. Further, the system is also designed for maximum flexibility when it comes to feedstocks through its proven pretreatment technology and could potentially utilize a tossed salad of other emerging sources such as camelina, carinata, pennycress, pyrolysis oil and algae oil as they become increasingly available.

Carbon Capture and Mitigation

Renewable fuels like RD and SAF are considered to be critical parts of long-term decarbonization, but their production (and low CI scores) is enabled not only by the production plant's flexibility, but also by its integrated approach, of which carbon capture plays a significant role. It's important to note that unlike facilities that have tried to add carbon-capture capabilities over time, the Fidelis facility is a newbuild site designed with carbon capture as a goal from the get-go.

The site's location on the Port of Greater Baton Rouge is near the GigaSystem's carbon sink, a sequestration site currently under development. It has a prospective storage resource estimate of 380 million tons of carbon dioxide (MMt/CO_2) based on third-party engineering, which Fidelis says is large enough to sequester decades of emissions from the GigaSystem, with additional room available for third-party CO_2

emissions. It is estimated that the site could eventually have between 720 MMt/CO_2 and 2.8 billion Mt/CO_2 of storage capacity, based on Department of Energy guidelines for storage volume estimates. And that captured carbon is yet another potentially lucrative opportunity based on the 45Q tax credits that could be earned. (See Way Down in the Hole, Part 7 for how that math works.)

Further, the Fidelis plant's proximity to a contracted and geologically attractive carbon sink in an established CCS jurisdiction provides it an advantage over carbon-capture projects that rely on retrofits to existing facilities in jurisdictions that lack clear CCS laws and regulations. For example, the three projects that aim to capture CO_2 emissions from ethanol production in the Midwest all rely on moving that CO_2 to a sequestration site hundreds of miles away, adding significant expenses to either retrofit existing natural gas pipelines or build new ones optimized for CO_2 transportation. The Fidelis plant would be connected to the sequestration site by a 32-mile pipeline that would move CO_2 in its supercritical "dense phase," which not only makes it easier to move through a pipeline but also allows it to be injected into the sequestration site without requiring additional compression. (For more on shipping CO_2 and its dense phase, see The Air that I Breathe, Part 4.)

Carbon-capture economics have been difficult to manage at other RD refineries, which typically produce volumes at about 6 Mb/d, but the Fidelis site offers significant economies of scale that are advantageous for both RD/SAF production and carbon capture. Fidelis estimates that its facility will be able to abate 9 MMt/CO_2e in emissions each year through its production of RD and SAF alone — that's equivalent to offsetting the emissions to 1 million homes or taking 1.7 million cars off the road — and the emissions reductions increase once the project's carbon capture and carbon-negative power elements are included. Once CCS is added to the mix, emissions reductions reach 10 MMt/CO_2e per year, climbing to 14.4 MMt/CO_2e once carbon-negative power is included. (Note: Those estimates assume the site produces 74% RD, 26% SAF.)

In addition to fuels production and CCS, a third critical piece of the GigaSystem is a carbon-negative power plant. (For more on carbon-negative power and how it could work, see Into The Woods and Space Oddity.) The biomass-based power plant would be capable of producing 280 megawatts (MW) of power using mostly vegetative debris such as forestry waste, agricultural residue and hurricane debris as feedstocks, but with the flexibility to use a variety of materials. (Using CCS to capture the CO_2 that would have otherwise been emitted makes the power plant carbon-negative.) The use of carbon-negative power not only helps reduce the CI of the fuels produced at the plant, but also powers the carbon-capture equipment and the on-site renewable steam methane reforming (SMR) hydrogen plant (utilizing renewable naphtha and renewable offgas as feedstocks). Fidelis says the plant will supply enough electricity to cover nearly 90% of the facility's total power-consumption needs.

Location, Location, Location

The low CI scores and feedstock flexibility are key advantages in the RD and SAF markets, but the site's Louisiana location is also a big plus –– Fidelis describes it as the crossroads of agricultural trade and traditional fuels production, as shown in Figure 3.

Figure 3. Transportation Options From Grön Fuels GigaSystem. Sources: RBN, Fidelis New Energy

The site's location at the Port of Greater Baton Rouge provides ready access to U.S. and export markets, as it boasts connections to a number of transportation options:

- Direct manifest and unit-train access, which provides efficient inbound and outbound rail movements for heated feedstock and finished SAF/RD fuels.
- Barge access on the Mississippi River and the Gulf Intracoastal Waterway, which provides extensive domestic barge connectivity.
- Tanker access via the deepwater portion of the Mississippi River, allowing for imports and exports to global markets.
- Access to long-haul pipeline systems for refined products, which provides connectivity to the East Coast, including New York Harbor and additional export optionality.
- Bi-directional access to hydrogen pipelines that serve the Gulf Coast. (More on hydrogen in a bit; see Gulf Coast Highway for more on a potential Texas-Louisiana hydrogen hub.)

Design Follows Philosophy

With the GigaSystem, Fidelis aims to set a new standard for clean renewable fuels production. To that end, Fidelis has embraced what it refers to as its RACER framework — rational, all-inclusive, continuous, environmental impact, and reduction — for project development and investment. Fidelis uses that methodology in its selection of industries and projects to pursue, then in iterative design optimizations. It considers environmental, social and governance (ESG) priorities and related economic values, as

well as traditional economic considerations. To that end, Fidelis has worked with OPD to add synergistic components to the Baton Rouge site. For example, the project's design allows it to reform renewable offgas, naphtha and supplemental natural gas to produce green hydrogen, in a process also powered by the facility's carbon-negative power plant. In another example, Fidelis, its technology providers and OPD came up with a way to produce biogas from the plant's wastewater treatment plant through anaerobic digestion. The project is expected to produce about 1.4 MMcf/d of biogas, which would be consumed internally to displace natural gas consumption. The plant rendering in Figure 4 shows how all the pieces we've discussed so far come together.

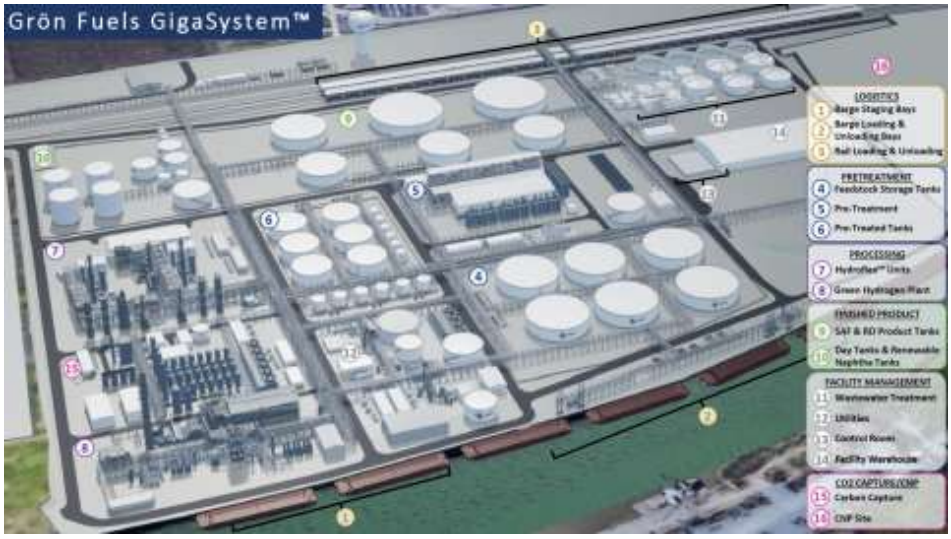

Figure 4. Rendering of the Grön Fuels GigaSystem. Source: Fidelis New Energy

With national and state policies in place to incentivize the production of alternative fuels, CCS and other energy transition goals, Fidelis believes its comprehensive approach and reliance on proven technology — in addition to a design that incorporates optimizations for CCS and carbon-negative power from the start — will help establish the GigaSystem as a world-class renewable fuels facility. We will be tracking it and other efforts to develop energy transition projects.

"Thunderstruck" was written by Angus and Malcom Young and appears as the first cut on side one of AC/DC's 12th studio album, *The Razors Edge*. Released as a single in September 1990, the song went to #5 on the Billboard Mainstream Rock Singles chart and has been certified Platinum by the Recording Industry Association of America (RIAA). Angus Young has stated that the song started with his riff and was developed with his brother Malcom for the rhythm part of the song. The tune –– whose key lines include "I looked 'round and knew there was no turning back" –– has been featured in several films and is used prominently at Dallas Cowboys football and Oklahoma City Thunder basketball games. Personnel on the record were: Brian Johnson (lead vocals), Angus Young (lead guitar), Malcom Young (rhythm guitar, backing vocals), Cliff Williams (bass, backing vocals), and Chris Slade (drums, percussion).

The Razors Edge was recorded during 1990 at Windmill Lane in Dublin and Little Mountain Sound in Vancouver, with Bruce Fairbairn producing. Released in September 1990, it went to #2 on the Billboard 200 Albums chart and has been certified 5x Platinum by the RIAA. Four singles were released from the LP.

AC/DC is an Australian rock band formed in Sydney in 1973 by brothers Angus and Malcom Young. They have released 18 studio albums, three live albums, two soundtrack albums, one EP and 48 singles and have sold more than 200 million records worldwide. Twenty members have passed through the band's ranks since its beginning, AC/DC was inducted into the Rock and Roll Hall of Fame in 2003. Singer Bon Scott died in 1980 and guitarist Malcom Young died in 2017. There has been no official statement on the future of AC/DC since the November 2020 release of the *Power Up* album, which was dedicated to Malcom Young.