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Accounting for Carbon: Biofuel Projects Require a Different Economic Model

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Renewable fuel projects designed with traditional market dynamics in mind have a built-in economic disadvantage. To be cost competitive, renewable fuel plants and refinery conversion designs must look beyond the four walls of the plant. Designs that lower carbon intensity at every step from the field to the filling station can reap financial incentives that are critical to project success.

With interest in biofuels experiencing a resurgence in the U.S., now is a good time to take a fresh look at renewable diesel and sustainable aviation fuel (SAF) plant and refinery conversion projects. The rules that informed design of these facilities in the past may be changing.

As the U.S. works to reduce emissions, new plants and refinery conversions must consider the full life cycle of biofuel. The process begins and ends outside of the production facilities, but can impact design in sometimes unexpected ways.

Filling the Renewable Fuels Affordability Gap

At current feedstock and energy prices, renewable fuels are a poor competitor to other fuel options on the market. Until recently, new renewable fuel plants and refinery conversion projects have sought to lower the production cost by optimizing feedstock use and maximizing output of the finished product.

This approach is understandable, given that feedstock is the single largest cost input for renewable fuel plants, and production output is a hallmark of profitability. But the calculus is changing.

Construction of new renewable fuel plants and conversions of existing refinery assets are driven by financial incentives that can impact everything from feedstock selection to shipping method. In addition to the production-based tax credits available through the U.S. Environmental Protection Agency's (EPA) longstanding Renewable Fuel Standard (RFS) and the newly extended $1/gallon Biodiesel Production and Blending Tax Credit, California's Low Carbon Fuel Standard (LCFS) provides credits for fuel sold in California that meets the state's carbon intensity (CI) reduction requirements. The lower the CI score, the more credits the fuel receives.

While the LCFS credit market values are variable and currently provide less incentive dollars than the RFS RIN credits, the United States is trending toward more incentives that factor in fuel CI scores. With states like Washington and New York actively pursuing their own LCFS programs, it is conceivable that more states will follow. Perhaps this trend is more obviously seen in the recent Inflation Reduction Act (IRA). The IRA initiated a new SAF tax credit that provides $1.25/gal for SAF that reduces life cycle greenhouse gas emissions by at least 50%. This credit value increases by 1 cent per gallon for each additional percent point of reduction until it reaches $1.75. Additionally, existing fuel credits will transition to the new Clean Fuel Production Credit on Dec. 31, 2024. The Clean Fuel Production Credit will incentivize transportation fuels from $0.20 to $1 per gallon, based on their life cycle greenhouse gas emissions, and SAF from $0.35 to $1.75 per gallon.

To capture the considerable incentives these programs offer, designers of renewable fuel projects must assess the entire fuel production pathway — from the field to the refinery to the fuel tank — including the transportation of the raw materials and finished product along the way. They must then develop holistic design solutions that optimize a producer's ability to reduce CI and capture credits at every step.

This new design model requires designers to set aside old assumptions. Some design choices will likely change when their cost and value are recalculated through a CI lens. For example, natural gas is considered a low-cost fuel source in a current design scenario. Because it is not considered a green product, however, it may incur an LCFS penalty that makes it less affordable.

Renewable propane or renewable natural gas, on the other hand, may cost more, but will generate greater credits as a producer's CI score goes lower. In other words, decisions must be based on total cost, with the incentives factored into the equation.

Accounting for Carbon Emissions

In the Field

Everything from fertilizer choice to land use changes can impact a CI score. Even indirect changes — such as growing crops for fuel, rather than agricultural use — can affect the score, which factors in the carbon cost of transferring agricultural production to another field.

With a proactive approach, it is possible to reduce CI in the field, and producers can play a role in encouraging it. Consider that nearly half of the energy used in farming is related to the production and application of fertilizers. Organic alternatives to fertilizer, blue/green ammonia for low-carbon fertilizers, precision agriculture technologies, field management techniques that minimize fertilizer loss, and even tractor selection are among the many ways to reduce CI scores in the field.

Transportation and Logistics

Producers of renewable fuel can impact their fuel's CI scores by how they transport feedstock to their plants and ship renewable fuel products to their final destinations. The closer plants are to fields and end-markets, the lower the transportation costs and CI scores associated with them. But CI charges can be significantly impacted by transportation methods as well.

Consider, for example, a Midwestern plant that produces renewable diesel using waste from a nearby meatpacking plant, which it then transports to California via rail. Like over-the-road trucking, rail transportation raises CI scores. Producers fare better when seeking opportunities to transport feedstock and fuels using water transportation. For example, they can save money and achieve better CI scores compared to rail transport by shipping Midwest-produced soybean oil by barge to the South and then by a large liquid carrier to California.

The storage and transportation of internationally sourced feedstocks present special challenges to landlocked producers, especially when they are competing with processors located closer to ports. To make a strong economic case for using international feedstocks, processors typically need facilities on the East, West and Gulf coasts. Because market dynamics change, logistics flexibility benefits all producers.

Processing

Renewable fuel producers can make a significant impact on CI with their choice of steam, electricity and other plant energy source, as well as the chemicals used in processing. For example, ethanol plants that consume both natural gas and electricity can reduce CI by switching from natural gas-fueled boilers to more energy-efficient combined heat and power (CHP) units. CHP units, which produce heat and electricity simultaneously, are not typically considered in traditional renewable fuel plant or refinery conversion designs. In LCSF markets, ethanol plants can also reduce CI by sequestering high purity CO2 rather than releasing it to the atmosphere.

Production choices can also impact CI scores. Ethanol plants that produce dry and wet distiller grain, in addition to the corn oil used for renewable fuel, must account for the CI of both products.

Feedstock Choice

Feedstock represents the single largest cost input for renewable fuel plants. The best way to lower this cost and improve renewable fuel economics is to use feedstocks not intended for human consumption.

Food feedstocks, including renewable grain and triglycerides, cost more than waste material stocks, such as used cooking oil, beef tallow, white grease, poultry fat and distiller's corn oil. Food feedstocks also hurt CI scores due to the deferred land use and fertilizer charges associated with their production. For nonfood stocks, processors typically pay only recovery costs.

When choosing waste material feedstocks, it's good to remember that waste product streams are not all equal. For example, used cooking oil may be less expensive than beef tallow. Producers must consider their options carefully to minimize complications for renewable fuel incentives.

Fuel Choice

Producers can further improve CI scores by remembering a simple principle: Never allow fungible products to leave a facility without improving their CI value. Producers typically do this by minimizing high-carbon inputs, such as natural gas, and wringing value from low-carbon outputs through product coprocessing.

This does not mean eliminating natural gas and other high-carbon inputs from all operations. Rather, it means choosing low-carbon inputs for places that allow them to be monetized. Consider, for example, lower-carbon propane, which costs more per gallon than higher-carbon natural gas but has no greater intrinsic value — except in California, where propane use helps lower CI scores. Currently, using lower-carbon propane outside of California only increases energy bills with no CI benefit. In California, however, lower-carbon propane is a cost-effective fuel choice because of the incentives available for using it.

Higher-carbon inputs can be further minimized by finding alternatives to hydrogen — which after feedstock selection, is the second-greatest cost input in renewable diesel and SAF production. In a traditional refinery, hydrogen is typically produced as a byproduct in the reforming or by using steam methane reforming (SMR). There are new opportunities to produce less carbon intensive hydrogen by adding a carbon capture utilization and storage (CCUS) facility to an existing SMR unit (blue hydrogen) or by introducing electrolysis (green hydrogen) production methods. In renewable diesel and SAF plants, both hydrogen's purchase price and carbon value must be accounted for. If produced from natural gas and steam, hydrogen is "taxed" with the carbon costs used to create it. It enters a plant at one price, and leaves at a higher one.

Designers of new plants and refinery conversions, therefore, should look for ways to recycle the excess heat created in hydrogen production so less energy leaves the plant. Solutions include the use of hydrogen alternatives (e.g., blue hydrogen, biomassed green hydrogen) that reduce the high-carbon inputs used in hydrogen production.

Design Matters

Current and future market dynamics call on processors to take advantage of the incentives from all four legs of the renewable fuel stool:

- Renewable Fuel Standard
- Biodiesel Blender's Credit
- Sustainable Aviation Fuels Credit
- Low Carbon Fuel Standard (or other future state standards)

To achieve the greatest value, developers need to think differently about how to design new plants and convert old ones. Whether or not they qualify for all available incentives could make or break a project's success.

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