Where Will All the Feedstock Come From?

As a new wave of large-scale biomass-based diesel projects develops, experts suggest market forces are ready to deliver the necessary fats, oils and greases.

By Ron Kotrba | April 02, 2019

NEW KID ON THE BLOCK: CoverCress CEO Jerry Steiner says he can foresee farmers growing 5 million acres of his company's modified pennycress winter cover crop in 10 years, which could yield 400 MMgy of new high-quality oil.
PHOTO: COVERCRESS INC.

The vast number of large-scale biomass-based diesel projects announced in 2018 harkens back to the golden age of biodiesel in the mid- to late 2000s when a sort of irrational exuberance defined the market. Notable differences exist between then and now, however, such as the type and scale of these projects along with who is backing them, what is driving their development, and the maturity level of the market in which these projects are taking place.

Many of these new biomass-based diesel projects intend to produce renewable diesel at a much larger scale than even the largest biodiesel plant. Two of them alone—the 400 million-gallon expansion of Diamond Green Diesel in Norco, Louisiana, and the 600 MMgy greenfield project in Port Westward, Oregon, by Next Renewable Fuels Inc.—would add a billion gallons of capacity to the U.S. market that absorbed less than 3 billion gallons last year. World Energy is behind another massive project with its quarter-billion-gallon expansion that will quintuple production in Paramount, California. Ryze Renewable Fuels has two renewable diesel projects fully under construction in Nevada totaling 150 MMgy. Renewable Energy Group Inc. announced an amorphous renewable diesel project with Phillips 66 in Ferndale, Washington. ReadiFuels, a subsidiary of Applied Research Associates and partner to Chevron-Lummus Global, also has plans for a renewable diesel facility in Iowa.

And then there is coprocessing. The Marathon petroleum refinery in Dickinson, North Dakota, has been coprocessing renewable diesel with petroleum crude oil since last summer. Sinclair, BP and several other oil refiners are also either currently coprocessing large volumes, or plan to soon. "It's the quiet ones we have to keep track of, not the ones that have made the announcements," says John Cusick, a senior analyst with The Jacobsen. "I see coprocessing as being significant. It could open up a huge realm of demand. They're all gunning for it, but I don't see the actual feedstock demand coming as quickly as the market seems to think it will. We'll see renewable diesel conversions as refiners turn the lemons of their unprofitable oil refineries into the lemonade of renewable diesel. Once the line's crossed though, then we can decide what to think. We're starting to see a tipping point where low-carbon steps are viewed as good business, especially when they're tying executive compensations to low-carbon strategies. It is coming."

Greenfield biodiesel projects, which slowed to a crawl after the Great Recession, and the retooling of idled facilities, have also picked back up. Cargill's 60 MMgy soy biodiesel plant in Wichita, Kansas, is nearly complete. Benefuel plans to build two biodiesel refineries, a 20 MMgy facility in Ontario, Canada, and another in British

Columbia. Epitome Energy LLC is developing a soy crush and 30 MMgy biodiesel facility slated for Crookston, Minnesota. World Energy recently acquired an idled 40 MMgy biodiesel plant in Estill, South Carolina. Hero BX bought two shuttered facilities last year in Illinois and Iowa. The list goes on.

Cusick says there are at least 60 programs in place around the world driving demand for biofuels. "It's definitely heating up," he says of the looming pressure on feedstock supply. "It's an interesting moment that we ask this question, considering feedstock prices suffer despite what's just around the corner. The simple programs in place today and the slated growth create massive, ramping demand. I came into The Jacobsen out of the biodiesel trading bubble as an analytical person looking at the markets. Previously, I was pretty focused on the biodiesel world. It's been a fascinating thing to shift gears here. I've done a lot of work with refiners. With the feedstock situation, I think the tipping point is going to happen soon. With the programs and overall suck of fuel on virgin vegetable oils and low carbon-intensity feedstocks, we'll see dramatic shifts."

Unlike 15 years ago, Big Oil is now all in, whether it is through investment partnerships, coprocessing and refinery conversions, or signed offtake agreements for every gallon of renewable diesel to be produced. "We never had that in biodiesel," Cusick says.

At important business gatherings like the recent National Biodiesel Conference & Expo in San Diego, obligated parties are holding fewer discussions with ag behemoths such as Archer Daniels Midland and Cargill about buying biodiesel volumes and more talks with them about buying refined feedstock, Cusick says. "It's an interesting time," he muses. "We've had a lot of inquiries in the past year or two here at The Jacobsen from regulated parties about demand from the California market. That is driving the decision-making process."

In the biodiesel heyday of the 2000s, the main growth drivers were the $1 per gallon federal biodiesel tax credit and the Renewable Fuel Standard. "Now we're way beyond RFS2 and the federal programs," Cusick says. "It's hard to grasp, to be honest with you. It's kind of fascinating to understand the world in which decisions are now being made. RFS2 may swing back around in a year or two, but at the moment I don't see anyone spending money around RFS2. What I see today is people making chief decisions based on California's Low Carbon Fuel Standard."

California's LCFS is a big draw, but Oregon has a similar policy in effect, Washington is expected to pass and implement one soon, and British Columbia has one in place too. This is clearly a growing, expanding trend, but the Golden State's sheer market size, program maturity and greenhouse gas reduction hockey stick through 2030 makes it the golden child of low-carbon policies. And everyone wants a piece of the action. "One thing I see that is unique," Cusick says, "is if you look at the net back economics of renewable diesel production in California, it makes sense even without RIN credits."

California Gov. Gavin Newsom, elected in November, has a stated goal of eliminating petroleum diesel emissions in his state by 2030. California's annual diesel demand approaches 4 billion gallons. While electrification is seen as the savior to many climate change issues by injudicious environmentalists, most grounded, reasonable thinkers know electrification of heavy-duty markets will not come easily, soon or without a prohibitive cost. With 80 percent renewable diesel and 20 percent biodiesel, the California Advanced Biofuels Association believes the state can achieve Newsom's goal without eliminating the diesel engine.

Since 2010, California's use of biomass-based diesel has grown from 1 to 15 percent. During Q2 of last year, renewable diesel made up more than 10 percent of California's total diesel supply, according to the U.S. Energy Information Administration.

Stephen Kaffka, an agronomist at the University of California-Davis, says low-carbon fuel policies such as those on North America's West Coast have intrinsic value for oil companies, renewable fuel producers and engine makers, among others, as they keep diesel engines and fuels in the picture. "I can see a synergy in those projects under development with the oil industry and those who need diesel engines in various applications," he says. "It's a way to extend the useful life of diesel engines in terms of climate policy."

Feedstock Supply

With billions of gallons of biomass-based diesel productive capacity expected to come online in the next few years, the perennial question of where all the additional feedstock will come from to supply these facilities seems more important—and legitimate—than ever.

"The question is interesting," says Alan Weber, a partner with Marc-IV and advisor

to the National Biodiesel Board. Weber has been part of the NBB's RVO Working Group, which supplies important industry and feedstock data to U.S. EPA to inform the agency how much growth the sector can sustainably achieve for its annual RFS volume proposals, since its inception. "I started in biodiesel in the 1990s, and almost every year the question is raised on feedstock supplies, and almost every year I've been told there's not enough," Weber says. "I remember being told the industry can sustainably produce 250 MMgy and that's it."

In 2005, U.S. biodiesel production and use was less than 200 MMgy and soybean oil prices were about 26 cents a pound, Weber says. "Fast forward to now, the U.S. market is 2.6 billion gallons and soy oil prices are the same or less, in real terms." At press time soybean oil prices hovered around 29 cents a pound. With an average yearly inflation rate of 1.95 percent between 2005 and 2018, a dollar in 2005 has the spending power of about $1.29 today. Therefore, when adjusted for inflation, today's soybean oil price of 29 cents a pound is actually less than what prices were in 2005—despite massive U.S. and global growth in biodiesel production. Slightly less than half of all U.S. biodiesel production relies on soybean oil, about 46 percent, according to numbers shared by Don Scott, NBB's sustainability director, at the 2019 National Biodiesel Conference & Expo in San Diego.

"Think about the crops and stocks we've had over the past few years," Weber says. "When you compare the ending inventories this year to last year, we've got almost half a billion additional bushels sitting in storage. That equates to 700 million gallons of vegetable oil in those beans—it's huge. People lose sight of that." Of course, that oil is locked in the beans and those may still get exported, Weber acknowledges, and the excess inventories are partly due to the current trade war with China. "But the other part of it is advancements in technology," he says. "Look at yields. They've been above the trend line for the past four or five years. We've been aggressive in our comments to EPA that the use of trend lines is not sufficient due to advances in technology, which we expect to keep us above the trend line."

It is important to keep in mind that protein demand—not biofuels—drives soybean planting. As more of the world's economies grow and prosper, the more meat people will demand and, thus, the more protein meal will be required to feed livestock. In response to EPA, the RVO Working Group has looked at global demand for protein. "What we've found is that protein meal demand will increase from 300 million tons per year today to 400 million tons by 2030," Weber says. "Three quarters of that will come from soybeans vs. other oilseeds. That means an additional 5.5 billion pounds of soybean oil per year, or 750 MMgy, above and beyond today's demand for biofuels. That's just the forecast for additional oil created by protein meal demand and doesn't consider changes in technologies, innovations or yield increases."

The U.S. is growing more food and fuel on fewer acres. According to Farzad Taheripour, a professor of agricultural economics at Purdue University, U.S. farmland has shrunk by 23 million acres since the passage of RFS2 in 2007. It's also important to note that RFS2 policy requires that no new net U.S. farmland be brought into production beyond what was in use in 2007. While some land has been converted to farmland since then, this is former cattle grazing or pasture land—not pristine prairies—that has been converted to cropland to grow more protein meal for chickens, according to Scott. "We're growing more chickens and less cattle," he says. Since 1980, U.S. farmers increased soy production by 96 percent while decreasing soil erosion by 66 percent and using 8 percent less energy, according to the U.S. Soybean Sustainability Assurance Protocol, 2016.

Another critical aspect to remember about RFS2 is that the policy excludes palm oil from qualifying for biomass-based diesel production because it does not meet the 50 percent greenhouse gas emissions reductions threshold required when indirect land use change effects are calculated in. "It's quite clear the effects on habitat and especially tropical peat soils," Kaffka says. "From a carbon perspective it's quite nasty. It's the most productive oilseed by far per acre, and it's important for economies around the world. It mixes with other vegetable oils in ways that are hard to keep separate. But it's not clear to me though that using soybean oil produced in the U.S. more economically and efficiently in any way contributes to the palm oil problem."

Indirect land use change, introduced more than a decade ago by Princeton researcher Timothy Searchinger, is not "a bad idea," Kaffka says. "Markets have consequences, and land use is one of them. But Searchinger over-exaggerated and overestimated those consequences, and he underestimated the capacity of the agriculture industry to respond [to market demands]." Over the years, Kaffka has reiterated the importance of the virtuous cycle wherein innovation, invention and adoption lead to improved resource efficiencies and yields. "There's innovation occurring more or less constantly," he says. "In the U.S., we haven't seen an upper limit to use increases with the main commodities. And there are still opportunities for increased production from crops. Markets are a really great identifier of slack

resources, and carbon policies provide value."

Sustainable intensification is a growing, global phenomenon. It leads to more production on fewer acres and healthier land management through practices like nutrient, water and soil retention.

CoverCress

Whether through California orchards and nut farms intercropping canola in the winter months, or Midwest farmers planting carinata or pennycress, winter cover crops are one of many valuable ways to improve soil while making existing farmland more productive. "These winter annuals fit into existing rotations," Weber says. "They can utilize existing oilseed processing equipment and, on the production side, require no new equipment." Weber says one company to watch is CoverCress Inc., which has its own unique strains of pennycress targeting winter cover opportunities between corn and soybean rotations on up to 32 million acres in the Midwest. Even if just a small percentage of that land is used for CoverCress in 10 years, the crop has the potential to supply up to an additional 400 million gallons a year of high-quality virgin oil.

"The first thing we did was build a set of native genetics, which formed the basis for our breeding program," says Jerry Steiner, the CEO of CoverCress. "Then we created crosses and a test program. We got to the point of building a productive pennycress line, and since then we've added a molecular line through our partnerships with the University of Minnesota, Illinois State University, and Western Illinois University." Formerly named Arvegenix, CoverCress was incorporated in 2015 by retired Monsanto employees. With investment capital from Bayer, economic development money from the state of Missouri and St. Louis County, and traditional venture capital, Steiner says CoverCress, as an R&D company, is three years from commercial planting. "In our research phase, we are routinely getting 30 to 32 percent oil on a dry weight basis," Steiner says. "Our yields are around 1,500 pounds of production per acre. If we use solvent extraction, we capture a high percentage of the oil."

CoverCress crops are being grown at six research locations, with 1,000 to 2,000 5-acre plots per farmer. "Every line starts with a single seed, so we replicate and test —that's how we know what we've got," Steiner says. Agronomic work is being performed at another 20 locations. Much of CoverCress' inside research is conducted at the Donald Danforth Plant Science Center in St. Louis, Missouri.

With conventional breeding, natural mutation and gene editing, CoverCress has been able to favorably modify both the oil and meal of pennycress. The seeds are naturally small, about the size of camelina seeds, but less round and more disc-shaped. "The most important change was in the meal," Steiner says. "Native pennycress meal was not useful—it had way too much fiber in it." Native pennycress has a dark, blackish-colored seed whereas CoverCress seed is golden-colored. This is because the modifications have removed the fibrous coating, thereby reducing the fiber. In addition to reducing fiber, CoverCress also has been able to lower the content of a key antinutrient called glucosinolate. "Glucosinolate is similar to what gives horse radish its peppery pop, which reduces animals' desire for intake because it's less palatable," Steiner says. "As a natural biocide, it has a pungent smell that tells animals, 'don't eat me.'"

Native pennycress oil possesses extremely low saturated fat content, about 4 percent, according to Steiner. "Native pennycress is also about a third erucic acid," he says. "In ours, we've eliminated that and turned it into oleic acid," which helps provide a dual-use for the oil as both feedstock for biomass-based diesel as well as food-grade oil.

CoverCress has worked with two different planting methods. One is distribution of seed over standing corn fairly close to harvest time. The other is spreading seed post-harvest and tillage. Once distributed on the field in the fall, rain is all that's needed.

Come May, the crop is ready for harvest followed by immediate soybean planting. Not only does CoverCress provide three crops in two years, but it also helps soil and ecosystem health. "Cover crops play an important role," Steiner says. "I understand it's difficult for farmers to invest in things that have slow returns. That's a problem we aim to solve. Our cover crop will not only provide soil benefits but also the side benefit of making money along the way. In the Midwest, there's a lot of drain tile and water just flows right through. Farmers need something to hold on to those nutrients and protect the soil."

The company is targeting 30 to 32 million acres of farmland south of Interstate 80 in corn and soybean rotation. "A significant number of our test fields are in Illinois," Steiner says. "Illinois is our marker for the corn-soybean belt." Steiner emphasizes that CoverCress is not developing a new commodity. "A crop only has value if you

can take it somewhere to process," he says. "We're in talks with a number of people willing to modify facilities to take our crop in May when we harvest. We need more collection and crop locations. When farmers sign up, we offer them a fixed price and a known delivery location. It's contract production. We've done all the work to develop this. We've made significant investments in our unique composition of CoverCress. We've filed for intellectual property protection. We envision plenty of processing locations, so from a farmer's location it's enticing and convenient, but we're not aiming to make a whole new commodity crop with 10 people selling CoverCress seed. We want to entice the first company to place their bets with us, and we'll offer exclusivity for a return on investment."

Where will CoverCress be in 10 years? "Of that 32 million acres," Steiner says, "there is no reason we couldn't be on 5 million of those in 10 years. Our yield goal in 10 years is 2,000 pounds an acre with 30 percent oil, or about 600 pounds of oil an acre." At its goal yields and oil content, 5 million acres would mean an additional 400 million gallons of bio feedstock into the supply chain. And what if all of those identified 32 million acres were planted with CoverCress as a winter cover crop? This alone could lead to an astounding 2.4 billion gallons of newly available feedstock.

Waste Oils

While 46 percent of U.S. biodiesel comes from soybean oil, another 46 percent is derived from waste oils and fats, according to Scott: 14 percent from animal fats; 17 percent from used cooking oil (UCO); and 15 percent from distillers corn oil (DCO). "That diversity is a real strength," Weber says. "It allows producers to alter their use based on regional and global dynamics."

Exactly how markets identify slack resources, as Kaffka said, is exemplified in the cases of waste oils. Several years ago, UCO became in hot demand for biodiesel production. "Market demand put upward pressure on prices, and all of a sudden we started seeing collection in Brazil, India, Mexico," Weber says. "The higher price incentivized more collection, innovation and efficiencies." Kaffka says it's quite possible there is still a fair amount of unrecovered waste oils in the economy not served by the rendering industry. "As the value of that material increases, through carbon and fuel policies, society becomes more efficient," he says. "There is also discussion about recovery of lipids from wastewater treatment facilities, and progress is being made in that area. None of these things are bad—they're all good. High-value uses will prevail, and other uses will fade."

Weber says what happened with DCO is a "perfect example" of the impact a growing biodiesel market has on feedstock innovation. DCO is a byproduct of ethanol production. Prior to significant biodiesel growth, DCO went out in distillers grains—the resultant feed product after all the corn starch is converted to alcohol. "Now, because of biodiesel demand, almost all dry mills have the capability to extract DCO from thin stillage," Weber says. "But yet we're still not pulling all the potential oil out, as we're extracting less than a pound per bushel." While local livestock market needs also determine how much DCO an ethanol producer may desire to extract, Weber says we can see additional DCO volumes in at least two ways. "One, ethanol production has not plateaued," he says. "Exports to other regions and increased E15 demand may continue to grow ethanol production, which would increase DCO supplies. Two, ethanol producers can look at increased extraction rates. If extraction were increased by four-tenths of a pound, this would lead to 350 MMgy of additional DCO volumes. And currently not all DCO generated is going to biodiesel. A significant volume of feedstock can be pulled back into the biodiesel space."

As renewable diesel production demands more refined feedstock, Weber says biodiesel producers will continue to look at interceptor, or trap, grease. While it's not easy to work with, demand will necessitate innovation.

"I think there's still opportunity from both the agriculture and the recycling and waste recovery industries for additional biodiesel feedstock supply," Kaffka says. "If the climate problem is real, and most think it is—and we can argue about the severity and rate—these seem to be no-regret steps to me."

Biodiesel Opportunities

Although the rise of renewable diesel may, on the surface, seem threatening to biodiesel in terms of competition for feedstock and end-use markets, most experts agree that the two fuels are—or certainly can be—complimentary to each other. For instance, biodiesel-blended renewable diesel can provide a 100 percent renewable product that provides the lubricity diesel engines need in an ultra-low sulfur world. Used together, they can reduce emissions significantly and, as Kaffka says, keep diesel in the picture.

Certainly markets are changing—progress necessitates change—but these changes can open up opportunities for biodiesel to carve out new, or expand on existing, niches. "Biodiesel assets in California are in a great position," Cusick says. "And I

think we'll begin to see them gel around New York Harbor to supply heating oil markets in the vacuum of Argentine imports." In addition, low-sulfur demands from marine fuels can be a huge draw for biodiesel. Come Jan. 1, 2020, the International Maritime Organization is requiring bunker fuels to lower sulfur content by volume from 3.5 to 0.5 percent. "It's time to be creative," Cusick says.

The biggest challenge for coprocessing is feedstock, Cusick says. "They need a highly refined biomass feedstock that doesn't aggravate the beast of the refinery. What they'll want is a highly refined feedstock with no metals. Perhaps the smartest thing to do is position methyl esters as a refined feedstock for coprocessing. For biodiesel, that is the kind of thinking that should be had. Is it overkill? Maybe. But on paper, it makes sense. At the moment, we don't have the vegetable oil refining infrastructure for future demand. At this juncture, we have no intermediary refining and processing structure to create fungible product for coprocessing. This is something the ag and biofuels sectors should think about."

Conclusions

Kaffka says this argument of feedstock shortages has been around for a long time. "But we haven't actually seen it," he says. Historically, the industry has demonstrated there is ample feedstock to meet demand in a sustainable way, Weber says. "We have a diverse supply of feedstock, but there is still room for innovation," he says. "Having additional capacity and additional demand through the LCFS and RFS will drive that innovation, as it has in the past. We will see other feedstock sources come to fruition. Innovation does happen. If we have demand and the right market signals, that's when see new sources come online. I think we have sufficient feedstock supply to grow this market."

Weber points out that there is a difference between capacity and demand. While much new capacity is under development to meet demand from the LCFS, he notes that LCFS volumes can be nested within RFS obligations. In other words, fuel sent to California to meet the LCFS can also be used to satisfy RFS obligations. "Last year the U.S. market consumed 2.6 or 2.7 billion gallons in domestic and imported biomass-based diesel," he says. "So then all of a sudden if a line is drawn in the sand in 2030 at 3.4 billion gallons, that's not a huge jump in volumes needed to supply the marketplace."

Cusick also suggests that, as additional domestic capacity comes online, it is possible U.S. renewable diesel producers could take market share away from Neste imports to the tune of hundreds of millions of gallons, potentially.

The big message is that markets became too dependent on RFS2, Cusick says. "The biodiesel industry needs to focus on initiatives the way it did with Bioheat," he explains. "Apply that same mentality to marine fuel development. Really understand where biodiesel fits in the next 10 to 15 years. This is coming. Not because biodiesel did a bad job. Biodiesel paved the way for this. The reality that refiners are doing this with their own infrastructure, it's just smart business and logical. It's a question now of beginning to adapt. We need to understand creatively once again where this industry can participate. The idea of the biodiesel industry providing the correct refined product for coprocessing sounds crazy, but making diesel out of UCO sounded crazy too."

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