Sustainability Insights | Research

Biofuel Regulations Stoke Demand, Volatility Hits Brakes

July 17, 2024

Increasing biofuel use, which we expect to accelerate over the next 5-10 years, should spur more demand over time, but recent volatility in demand may keep near-term investment outlays muted.

This research report explores an evolving topic relating to sustainability. It reflects research conducted by and contributions from S&P Global Ratings' sustainability research and sustainable finance teams as well as our credit rating analysts (where listed).

This report does not constitute a rating action

Authors

Chris Johnson
New York
chris.johnson@spglobal.com

Terry Ellis
London
terry.ellis@spglobal.com

Michael Grande
New York
michael.grande@spglobal.com

Pierre Georges
Paris
pierre.georges@spglobal.com

Contributors

Rachel Gerrish
London

Edouard Okasmaa
Stockholm

Bryan Popoola
Washington, D.C.

S&P Global Ratings

As biofuel policies and legislation continue to evolve across the globe to help nations meet their carbon reduction targets, the agribusiness and refining sectors are expanding production. According to data compiled by S&P Global Commodity Insights, biofuel production capacity will more than double over the next three years if announced projects are completed. Production capacity could further accelerate over the next decade to the extent that countries continue tightening carbon-reduction policies, with regulatory stipulations to include renewable fuels that help meet these goals.

This potential expansion wave faces some near-term uncertainties, but nonetheless will have varying credit impacts on several sectors, most notably agribusiness, refining, and transportation. We discuss the global regulatory landscape for biofuels, types of biofuels being produced and their respective carbon reduction benefits, and the credit impact on various sectors both in the near term (through 2030), medium (next decade) and long-term (beyond 2040).

Key Findings

- While biofuels have been used for decades, notably in transportation, regional and sectoral decarbonization targets and regulation can spur demand and production to another scale. Their use in existing engines and their lower carbon footprint when sustainably produced provide key competitive advantages to fossil fuels.
- Large-scale global adoption lags amid many hurdles, starting with uneven regulations, the need for further capacity investments, and broader environmental risks associated with some biofuel production.
- The regulatory landscape is rapidly evolving, and we believe this could benefit the agribusiness and refining sectors to some extent because of favorable remuneration schemes beyond top-line growth. But cost pressures on margins and profit volatility from competing feedstocks remain key risks, while increased fuel cost is an added risk for the transportation sector.
- Prospects over the next 10-15 years are positive, although the technology faces short-term hiccups, and electric vehicle (EV) adoption likely will eventually reduce road transportation demand for these fuels.

Our use of the term biofuels includes liquid fuels such as ethanol, biodiesel, advanced biofuels, and sustainable aviation fuel (SAF) sourced from agricultural or other biological renewable feedstocks. We exclude biogas and biomethane because they are used primarily for power generation and co-generation, not transportation. Additionally, they typically are not subject to the same regulatory developments as the fuels we discuss here.

Key factors in the emergence of biofuels

Today biofuels only make **6%** of global energy consumption.

But over **80** countries now have enacted biofuel policies in a bid to reduce their carbon footprint.

Some second-generation biofuels sourced primarily from waste can reduce emission by upwards of **50%** compared with fossil fuels.

Land use, **water** use, and energy-intensive **fertilizers** remain significant environmental costs for crop-based 1st generation biofuels

Over **90%** of biofuel consumption is concentrated in road transportation.

Aviation biofuel adoption reaching **40%** over 20 years is key if carbon reduction goals are to be met.

Biofuels Can Support Decarbonization, But Face Other Environmental Hurdles

Biofuels are derived from bio-based feedstocks such as crops and agricultural waste. Like fossil fuels, biofuels contain carbon and emit carbon dioxide at the point of use, albeit with a potentially lower carbon intensity. Biofuel production still involves some carbon dioxide emissions. Depending on the type of biofuel, this can include emissions associated with the collection of feedstocks, processing, and land use change. However, the decarbonization benefits occur because carbon is absorbed from the air during the growth of the feedstocks, so the whole life cycle must be considered. This growth, combustion, and regrowth pattern form a cycle of carbon between the atmosphere and biofuels, meaning the net increase in carbon dioxide is limited compared to fossil fuels.

These fuels can be particularly useful in the decarbonization of hard-to-abate forms of transportation such as shipping, aviation, and trucking. Many biofuels are used as a drop-in alternative with internal combustion engines, at least to some extent, with few to no modifications. This is a key advantage. Biofuels such as ethanol can be blended with conventional fuels to support incremental decarbonization in most modern road vehicles, while in some markets powertrains are already capable of running solely on biofuels. This flexibility means they are established in many countries and, according to the International Energy Agency (IEA), bioenergy represented 6% of global energy supply in 2023.

Biofuels can be classified as either “first-generation” or “second-generation” based on their feedstocks:

- First-generation biofuels use crop feedstocks such as sugars (for ethanol) or edible oils (for biodiesel). Sugarcane, palm and soybean oils, maize, and corn are among the most common.
- Second-generation biofuels use nonedible “energy crops” and waste food or agricultural products, such as used cooking oil (UCO), forestry residues such as woodchips, agricultural residues such as rice husks, and even municipal waste. Specialized energy crops have also been developed that aim to accelerate growth cycles and maximize energy content.

Feedstocks are then refined into specific biofuels, mostly ethanol and biodiesel today, although renewable diesel and SAF are key growth areas for refiners. The emission reduction potential depends on the combination of feedstocks, production method, and blending rates (Table 1).

Table 1

Biofuels used in transportation

Biofuel	Typical feedstocks	Potential greenhouse gas benefit*	Proportion of biofuel production, 2023
Ethanol			
The most prevalent biofuel and can be blended directly into gasoline in different concentrations (10% blend E10, 10.5%-15% blend E15, etc.).	First-generation harvest-based feedstocks, especially corn, sugar beets, and sugarcane.	Average 40% reduction from corn-based ethanol compared to gasoline and diesel.	63%
Biodiesel			
Based on fatty acid methyl esters, can be blended with conventional petroleum diesel in a range of percentages, but	First-generation harvest-based feedstocks, but can only be blended with other diesel fuel.	About 70% reduction compared to petroleum diesel.	28%

engines must be slightly modified to run on blends above 5%-7%.			
Renewable diesel			
A direct substitute for fossil-fuel based diesel, can be used with existing diesel engine technology.	Crop-based feedstocks (refined oilseeds) and waste/biproducts including hydrogenated vegetable oils, used cooking oil, fats, and corn-based byproducts.	Average about 65% reduction compared with petroleum diesel, although higher with second-generation feedstocks.	8%
Sustainable aviation fuel			
A drop-in replacement for jet fuel, which can be blended depending on the feedstock and how the fuel is produced.	Can be sourced from both first- and second-generation feedstocks, including used cooking oil and soybeans.	Second-generation based feedstocks can deliver an 80%-90% reduction compared to jet fuel. First-generation based feedstocks are more likely to deliver a 50%-60% reduction, although inclusion of land use impacts potentially make this less than 50%.	<1%

*Greenhouse gas reduction amounts vary depending on the specific location, land use impact and production process.
Sources: U.S. Department of energy, EU, International Civil Aviation Organization.

Direct and indirect land use change associated with more feedstocks can lessen or even eliminate the environmental benefit. First-generation feedstocks require substantial land, water, fertilizer, and energy, which can lessen or negate the sustainability benefits provided by the carbon absorption during photosynthesis. Crucially, they may also compete with demand for food uses. Changes in land use can also lessen greenhouse gas benefits, especially if pristine forests are cleared to grow crops for biofuel production. Other environmental costs include water pollution from fertilizers and biodiversity loss from land conversion. With many second-generation biofuels being waste-based, the potential impact on land use is more limited, although these risks remain with specialist crops. In our view, second-generation feedstocks with low land use change risks and waste-based biofuel production can provide greenhouse gas benefits while limiting other environmental costs.

Regulatory Developments Support Demand

Many countries have long-standing biofuel policies, but the largest agricultural economies have a material impact on production, trade flow, and consumption. Large players such as the U.S., Brazil, and Europe appear committed to further expanding biofuels in their economies, with recent extensions to policies that increase the role of biofuels in their decarbonization roadmaps. These regulations generally require biofuels to meet certain carbon-intensity reduction benchmarks compared with fossil fuels. More U.S. states are enacting similar regulations. Over 80 countries now have policies to support demand for biofuels, according to the IEA.

The EU has set a target of 29% renewable energy use in member states' transportation sectors by 2030, which is ambitious compared to other regions. U.S. federal mandates under the Environmental Protection Agency's (EPA) renewable fuels standard are a bit less aggressive. A large ethanol mandate has been in place for over 15 years, and targets are typically set only 1-2 years out. It calls for a 5% increase in non-ethanol renewables over the next two years. The real driver in the U.S. has been state regulation, led by California's Low-Carbon Fuel Standard (LCFS) implemented in 2016. Brazil, long the leading producer and consumer of ethanol, is expanding regulation to other biofuels under its RenovaBio program. Several Asian countries continue increasing blending mandates of renewable fuels into their fuel stocks (more details in the Appendix).

The emergence of SAF policies in recent years will underpin long-term demand growth as governments address hard-to-abate aviation emissions by leveraging the potential of biofuels. The EU and U.S. have notably set long-term SAF targets up to 2050, with the aim to change the fuel mix of aviation over the next three decades. The U.S. also has significant incentives, including tax credits, to stimulate the development of both feedstock and refining capacity for fuels that reduce emissions 50% compared to fossil fuel-based equivalents.

Regulations increasingly look to stimulate the development of second-generation biofuels as direct substitutes for fossil-based diesel. While ethanol will still play a key role in blending policies, countries are also using regulations to explicitly increase the share of biofuels based on waste. Beyond increasing blending volumes with first-generation fuels, these could deliver greater greenhouse gas reduction benefits than first-generation biofuels. Both EU and U.S. regulations look to progressively increase the share of advanced biofuels as part of overall targets. Policies also increasingly link biofuels with e-fuels (renewable fuels that use non-biological feedstocks) as part of a broader approach to tackling emissions, such as in the EU's Renewable Energy Directive (see "E-fuels: A Challenging Journey To A Low-Carbon Future", published March 25, 2024).

International alliances also increasingly look to promote biofuels as part of decarbonization strategies, potentially driving demand. In aviation, the market-based Carbon Offsetting and Reduction Scheme for International Aviation sets carbon targets for airlines and has attracted participation from the U.S., countries across Europe, Brazil, and many in Asia, voluntarily for now but mandatory beginning in 2027 (see "Europe's Airlines To Bear Highest Carbon Costs", published April 3, 2023). The scheme will require airlines to increase the minimum share of SAF they use or use approved carbon credits.

Meanwhile, the International Maritime Organization (which has 175 members) has published its Strategy on Reduction of GHG Emissions from Ships, which includes targets a 40% reduction in the carbon intensity of shipping by 2030, with biofuels being one potential solution.

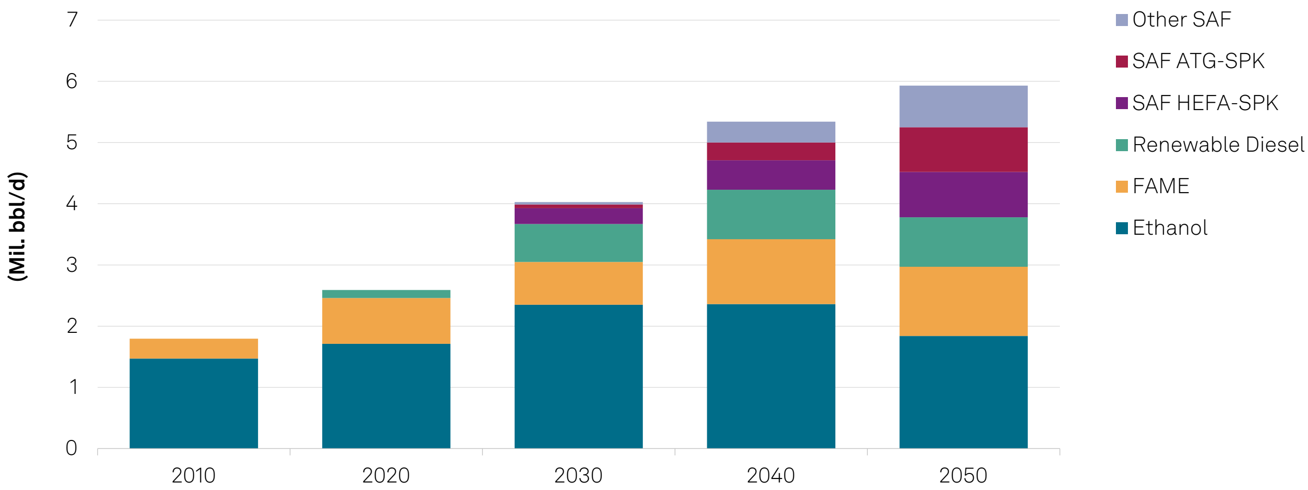
New Markets Likely Boost Second-Generation Biofuels Production This Decade

Key assumptions for our biofuel growth forecast are in part informed by S&P Global Commodity Insights' long-term projections for biofuel production and consumption. What follows is a summary of our assessment of the credit impacts that biofuel and SAF adoption may have on issuers that we rate, including midstream oil and gas producers, grain and oilseed processors, and other issuers in the transportation sector, primarily aviation.

We expect first-generation biofuel usage will continue to increase but lose share over time to renewable diesel and SAF. Ethanol and fatty acid methyl ester (FAME) are the predominant biofuels used in transportation today. They accounted for just over 90% of global biofuel consumption in 2023. Because they are primarily blended into gasoline and diesel, and therefore do not replace crude-based combustible fuels, we expect them to steadily lose share to renewable diesel (which is a direct substitute for crude-based diesel and more likely to be based on second-generation feedstocks) in the coming years. They should still increase absolute volumes through 2040 from additional regulatory blend mandates. S&P Global Commodity Insights projects ethanol's share of total biofuel production to fall to 56% (from 81% in 2020) and FAME to fall to 23% (from 19%) by 2030. Eventually ethanol's absolute production volumes could start declining by 2040 because of ongoing EV growth while FAME volumes taper off. By 2050, we expect their share of total biofuel production to fall to 50% (Chart 1).

Chart 1

Projected biofuel supplies by pathway type



bbl/d--Barrels per day. SPK--Synthetic paraffinic kerosene. Other SAF includes FT-SPK (Fischer-Tropsch SPK), HTL (Hydrothermal Liquification), MTJ (Methanol to Jet), PTL-SPK (Power-to-Liquids SPK). Source: S&P Global Commodity Insighs, "Fueling the Future -- Biofuels driving progress to net zero, February 2024".

We expect renewable diesel growth will accelerate over the next 5-10 years, but eventually stabilize thereafter

This fuel is getting the most expansion investment. S&P Global Commodity Insights projects a 15% increase for this share of biofuels by 2030 from near zero in 2020 as global production capacity more than doubles compared with 2023. Production volumes could increase another 30% in the following decade to 2040, then flatten as limited feedstock availability and to a lesser extent continued EV expansion curb expansion.

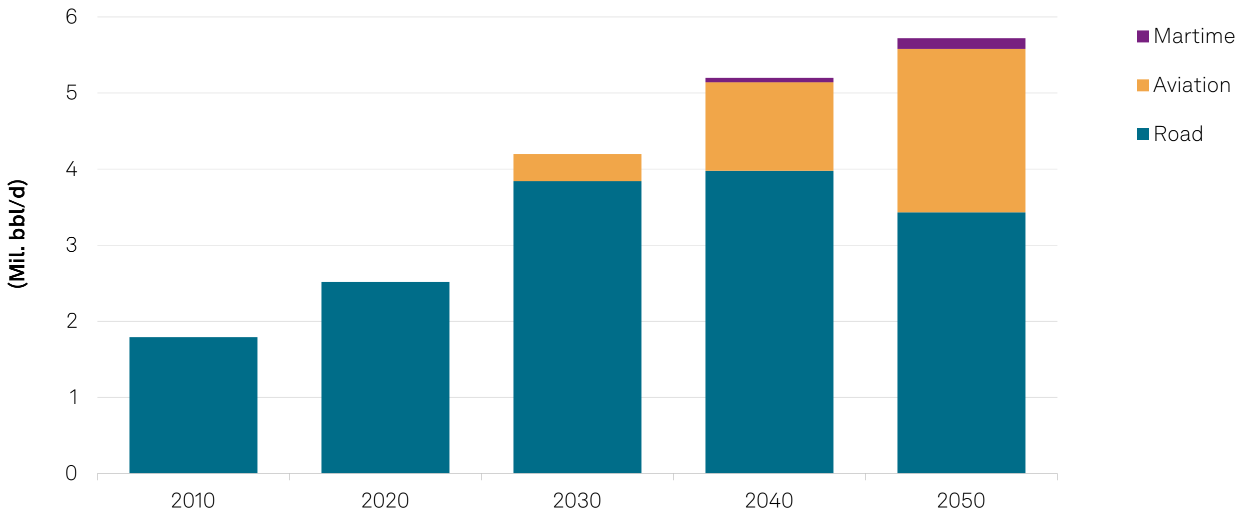
We expect most incremental production to come from biomass-based diesel in the U.S., but Asia-Pacific and Brazil will also steadily expand their shares. Ethanol has the largest share of plant-based biofuel production and consumption, but that will change. S&P Global Commodity Insights estimates that ethanol growth will peak after 2040 and gradually drop thereafter. After catching up with Europe's production capacity in recent years, we project U.S. production to more than double to 405 barrels per day by 2030 (from a 2022 base year). We expect Brazil and Asia-Pacific to be the next two largest contributors to volumetric production expansion, with respective increases of 59% and 52% over the same period. These growth rates would make the U.S. the largest producer of total biomass-based biofuels by 2030, followed by the EU and Asia-Pacific (excluding mainland China).

Consumption will remain concentrated in road transportation over the next 5-10 years. In 2023, road transportation consumed over 90% of all biofuels, which S&P Global Commodity Insights estimates equated to roughly 3 million barrels per day of mostly ethanol and FAME. We project this production will increase almost another 30% by 2030, keeping road transportation as the primary end market for biofuels (Chart 2).

Aviation demand won't become material for another 10 years, and maritime demand will remain muted. We assume widespread SAF adoption only well beyond 2030, and it will require significant investments in new production pathways to meet regulatory targets. SAF production at scale has yet to take off. Global SAF production is negligible at present, accounting for less than 1% of global jet fuel consumption. However, production is set to expand over the next decade to meet regulatory mandates. consumption. By 2040, aviation could make up roughly 14% of total biofuel consumption and rise closer to 40% by 2050, according to S&P Global Commodity Insights. These long-term moves will likely require a combination of continued expansion of HEFA pathways and still-to-be launched alcohol-to-jet and other alternatives (Chart 1). This suggests significant technological advancement is still required to give SAF a substantial share of total jet fuel consumption, reducing certainty that these fuels will materially affect aggregate supply and demand over time. We think maritime adoption will remain well below 5%.

Chart 2

Biofuel consumption across transportation medium



bbl/d--Barrels per day. Source: S&P Global Commodity Insights, "Fueling The Future--Biofuels Driving Progress To Net Zero, February 2024".

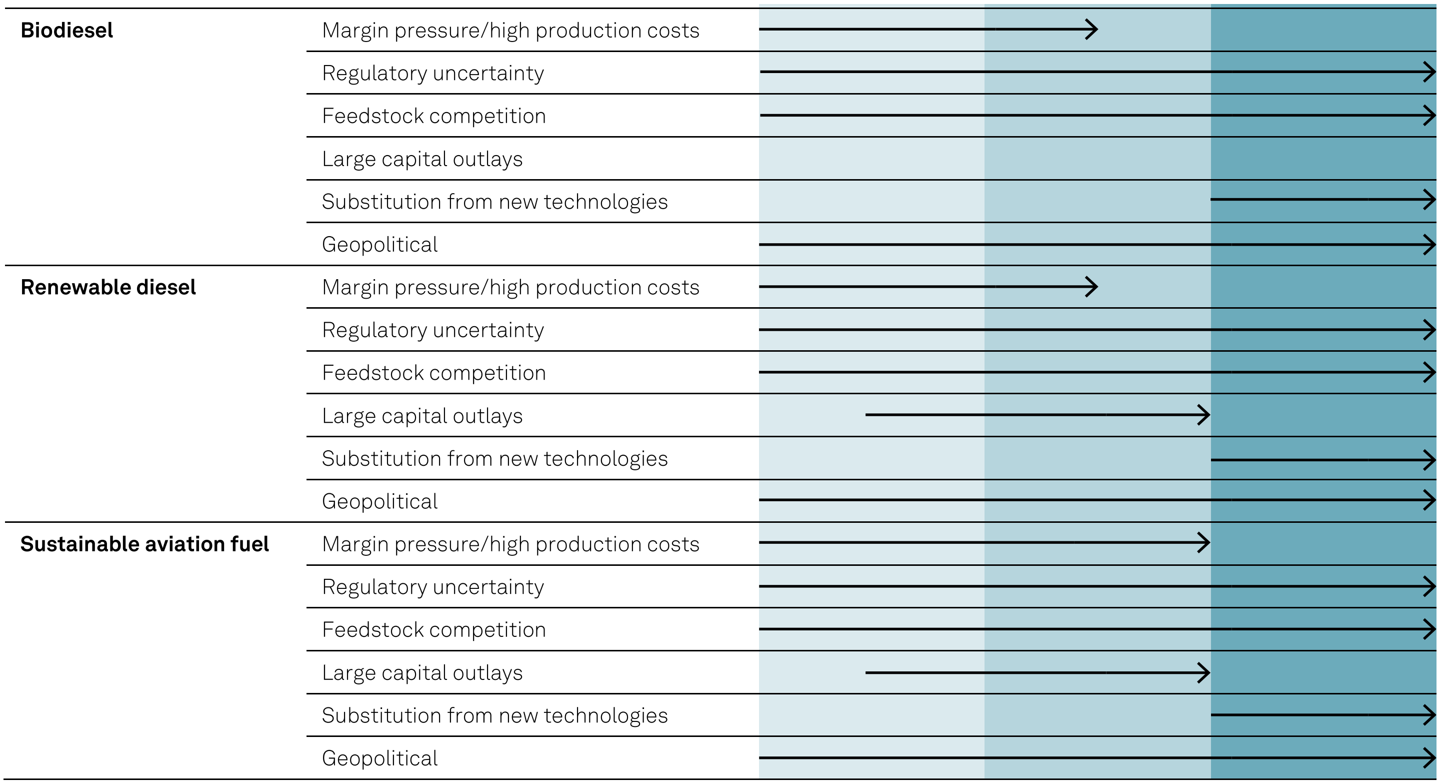
Credit Considerations: Higher Costs, Competing Feedstocks, And Uncertain Capital Investment

Six potential risk drivers could influence credit materiality in the biofuels value chain. We consider them to be different across the four main biofuel types that will play a role in the fuel mix to 2050. Here, we outline how they each could become relevant (Table 2).

Table 2

Projected materiality of select credit risks by biofuel type

		Credit materiality		
Biofuel	**Credit risks**	**Through 2030**	**2030-2040**	**Beyond 2040**
Ethanol	Margin pressure/high production costs		→	→
	Regulatory uncertainty			
	Feedstock competition	→	→	→
	Large capital outlays			
	Substitution from new technologies			→
	Geopolitical	→	→	→



Source: S&P Global Ratings.

Production costs are not immaterial and can weigh on margins. Many competing factors can influence margins and ultimate profitability of making a gallon of biofuel. The economics of renewable fuels in the U.S. are mainly propped up by a complex web of tax credits, mandates, and state and federal regulation outside of a refinery's control. In Europe, high gas prices compared to the U.S. and local regulation that goes beyond EU targets (notably in Nordic states) have accelerated the transition to non-hydrocarbon production, partially fueled by state aid. We first focus on what in the process is within a refiner's ability to control and perhaps to even differentiate operations and competitive advantage. A refiner's investment in renewable diesel or SAF production requires it to consider feedstock procurement and pretreatment technologies for agricultural triglyceride feedstocks, a key input to the renewable fuel process.

For example, the production of renewable diesel can be divided into two major steps: pretreatment unit (PTU) and renewable diesel unit (RDU). The PTU process uses water, heat, and pressure to reduce metals and other contaminants in the feedstock material to an acceptable level. It's typically dictated by the catalyst used within the RDU and other metallurgical constraints for process equipment due to the type and feedstock composition. The cost of a PTU is not inconsequential, typically in the $200 million-$300 million range, but also not nearly as expensive as building a coker unit or fluid catalytic cracking unit for processing heavy crudes at complex refineries for $1 billion or more. We believe refining companies that make the upfront investment in a pretreatment facility rather than buy pretreated feedstocks from a third party could benefit over the longer term. They can develop an expertise and in-house proficiency of a particular agricultural feedstock interaction with the RDU. Likewise, we think companies that have partners in biofuel joint ventures—Valero and Darling Industries, and Marathon Petroleum and Neste—could have a slight edge on those that do not. The partners bring competence to the process shared with the refinery.

Regulatory uncertainty can add to market volatility and delay investment. Government subsidies and regulation not only enable renewable diesel to compete with petroleum diesel, but also make profitable what would otherwise be an unprofitable investment if left to free market forces. However, the various government credits that make biofuels profitable in markets such as the U.S.—California's LCFS credit, Renewable Identification Number (RIN) credit, and the blenders tax credit—at times can cut both ways because of simple supply and demand. This has significant consequences for refining economics. The increased supply of renewable diesel to the California market increased the LCFS credit supply relative to generated deficits, reducing the price of the credit. California could attempt to reverse this trend by tightening carbon-intensity requirements more quickly or cap certain feedstock types with higher carbon intensity scores, such as soybean oil. However, any action also has consequences that may not benefit refiners, such as the higher cost of alternative feedstocks.

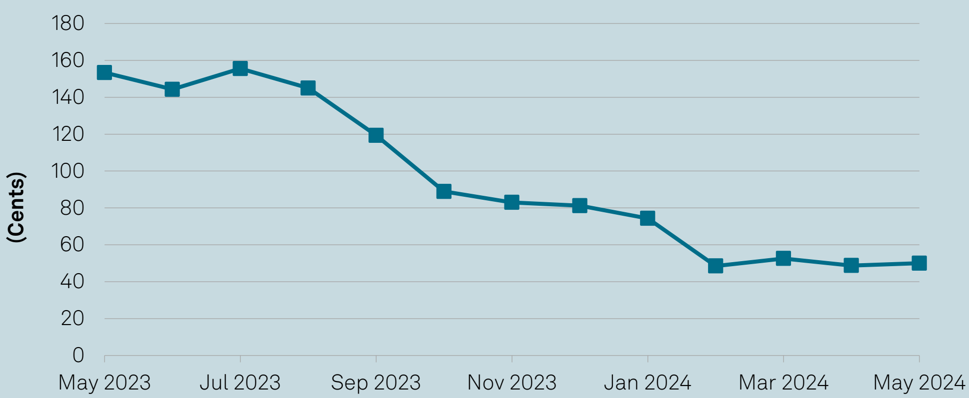
EPA Mandates Raise Uncertainty And Credit Risks

The EPA's announced production mandates in June 2023, which were below expectations, are a recent example of regulatory uncertainty adding to credit risk. RIN prices recently fell 45% year over year through the first quarter of 2024 and have yet to fully recover (Chart 3). RINs are production credits that biofuel producers sell to obligated parties, which use them to meet renewable fuel obligations. RIN prices typically rise in value when market participants believe industry capacity to meet production mandates will be tight, and vice versa. Higher RIN prices encourage investment to meet increasing demand.

Chart 3

Renewal identification number prices

D4 - Biomass-based diesel RIN, past 24 months



Source: S&P Global Commodity Insights.

However, the multiplier effect in RIN markets has added to excess supply. For example, one gallon of renewable diesel also generates 1.7 D4 RINs (compared with one gallon of ethanol generating one D6 RIN). The increasing supply has been partly to blame for lower RIN prices. As a result, some refiners have changed their strategies by cutting back on renewable fuel production. Vertex Energy intends to idle renewal diesel production at its Mobile, Ala., facility because it can generate stronger margins returning to hydrocarbon production. Others, such as CVR Energy, are considering switching feedstocks to improve margins. Chevron is also looking to focus on renewable diesel in the long term after closing two biodiesel facilities in the U.S. midcontinent due to weak profitability.

Similar regulatory uncertainty affects other jurisdictions as well. In Europe, a key tenet around biofuels under the Renewable Energy Directive is that it does not source from non-crop-land acres and certain feedstock not deemed renewable such as palm oil, which may be difficult to verify. The viability of producers meeting aggressive mandates is another concern. Certain countries have reversed course on their targets. For example, Sweden cut its targets last year over concerns of rising fuel costs, particularly in winter months when fuel blends require costly additives for cold-weather driving. India too reversed course in December on an initial ban of certain sugar-based feedstocks for ethanol production in response to a smaller sugar harvest for the current 2023-2024 marketing year. This created volatility in sugar markets at the start of 2024. These actions also indirectly affected Brazilian ethanol refiners making ethanol less competitive to sugar, leading Brazilian refiners to shift their production mix from ethanol (most sugar mills can produce upward of 60% of their capacity for ethanol).

Feedstock competition adds to earnings volatility. The increasing demand for renewable diesel is shifting the market share and price of bio-feedstocks supply. While competition for feedstocks is nothing new for refineries, which run their proprietary optimization programs and compete daily on the different slates and price of crude oils, bio-feedstocks add additional complexity. Refiners will continue to consider price, but also must consider carbon intensity. For example, in the U.S., feedstock with a lower carbon intensity will make the fuel produced eligible for more LCFS subsidies and 45z production tax credits under the Inflation Reduction Act (IRA).

Bio-feedstock markets have shifted during the last few years. According to RBN Energy, soybean oil's market share dropped to 35% in December 2023 from about 55% in January 2022 as alternatives such as UCO and animal fats from beef tallow gained ground. Both are potentially more attractive alternatives to soybean oil because of their lower carbon intensity and production cost. They will also be eligible for a higher federal tax credit under the IRA beginning in 2025. The market share of UCO (20%) and beef tallow (15%) now equals that of soybean oil in the last two years, according to RBN Energy.

These market shifts affect feedstock prices. Soybean prices have come down but are still well above 2020 levels. Increasing renewable diesel demand would also require new upstream investments in crushing capacity, which has yet to materialize.

Changing vehicle stocks will likely lower biofuel demand beyond 2040. We expect EV sales to continue taking global unit share from internal combustion engine vehicles over time (see "China Delivering Ahead In Electric Mobility", published May 29, 2024). Although the EV share of new vehicle sales was a modest 12% in 2023, S&P Global Mobility projects that to more than triple to over 40% by 2030 and exceed 60% by 2035. We expect biofuel growth in the automotive sector to slow beyond 2030, but not reverse until after 2040. Automotive biofuel demand can continue to expand through 2040 because of a shift in fuel consumption from fossil fuel-based gasoline and diesel to biofuels, demand for combustible fuels from internal combustion engine vehicle stock, and growth of hybrid vehicles. Moreover, regulatory changes are vital in accelerating EV adoption. For example, the EU passed a ban on selling diesel- and gas-powered cars beginning in 2035, which would further accelerate electrification of road transportation and pressure demand for biofuels. This explains why large investments in Northern Europe tend to focus on SAF, which has better long-term prospects.

Geopolitical risk related to trade is another key factor. Based on current regulatory targets, large biofuels markets such as the U.S., and Europe in particular, will likely rely on imports to meet production targets. This can lead to excess supply and possibly trade disputes. The EU launched an antidumping investigation last year into Chinese UCO imports, causing prices to fall about 15% at the start of the year from their September 2023 highs. Still, trade disputes may become commonplace given how supply demand imbalances can quickly emerge as producers are likely to frequently get ahead of demand in this still evolving market.

Potential Credit Impacts Vary By Sector, Geography

We expect credit materiality may steadily increase for the agribusiness, refining, and aviation sectors, albeit over different time horizons. Demand for biofuel feedstocks and their abundant supplies is already affecting the agribusiness sector's profitability. Moreover, we expect increasing feedstock demand to continue to support margins and sales volume at least over next five years and likely the next 10 years. Although refiners are beginning to invest more in biofuels, credit materiality will take longer given our expectation that refining volumes will remain heavily weighted to fossil fuel-based gasoline and diesel at least over the next five years, while capital outlays for biofuel production will remain a fraction of total capital expenditure (capex) budgets. Technological hurdles remain before jet fuel pathways can be produced at scale. Therefore, we don't expect credit materiality for the aviation sector to take hold until beyond 2035. Credit quality for adjacent sectors that indirectly affect biofuel production and demand, such as the automotive and maritime transportation, will not likely change because of biofuel growth.

Table 3

Factors affecting credit materiality

	Credit materiality		
Sector	**Through 2030**	**2030-2040**	**Beyond 2040**
Agribusiness	→	→	→
Aviation		→	→
Automotive			
Maritime			
Power generation			
Refining		→	→

Source: S&P Global Ratings.

Credit uplifts should be more material for industries involved in biofuel production, not consumption. Increasing demand will primarily benefit producing industries, of which grain/oilseed processors and refiners are the two main beneficiaries. For agribusiness, a new demand source for plant-based and other renewable feedstocks is a boost to aggregate demand. For refiners, biofuels are a sustainable alternative to continue refining combustible fuels using similar manufacturing processes already developed. Therefore, expanding into biofuel offers the refining sector a less disruptive path through which to transition its production from fossil fuel-based offerings.

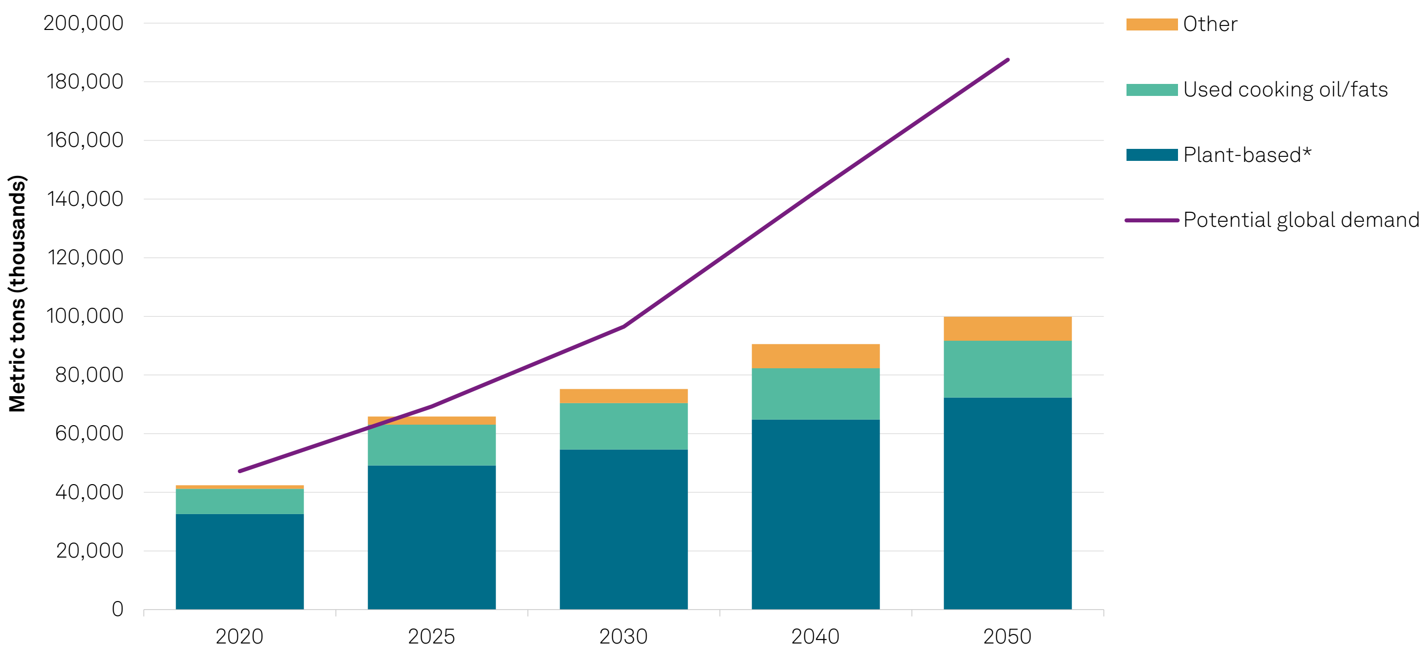
By contrast, consuming industries (largely transportation) will benefit only on the margin from incentives such as tax credits and other subsidies to increase the use of biofuels in their fuel mix. Still, fuel consumption will likely remain an important operating cost for the sector. An increased mix of biofuels does not readily offer a shift opportunity to more cost-effective fuels that will meaningfully transform their cost structures. Beyond transportation, biofuels do not supply other energy intensive industries because they are not critical feedstocks for supplying power grids and industrial manufacturing.

Agribusiness should benefit from looming tight feedstock availability. Despite current soft pricing for agricultural feedstocks, the expected ongoing expansion of additional renewable diesel production capacity should benefit grain and oilseed processors over the next 5-10 years. S&P Global Commodity Insights projects global production of hydrogenated vegetable oils and hydroprocessed esters and fatty acids (HEFA) to increase at a 20% compound annual rate over the next five years based on announced projects. Although renewable feedstocks from waste and fats are preferred over crop-based feedstocks because of low carbon intensity, increasing biofuel use nonetheless supports more demand for agriculturally grown feedstocks such as soybean oil and other plant-based vegetable oils, unless regulations tighten to support second-generation fuels.

Underpinning this is the looming feedstock shortage to meet target biofuel production goals. S&P Global Commodity insights project feedstock demand for biofuels will exceed supplies by 2030, which will benefit grain and oilseed producers (Chart 4). Moreover, the need to materially invest in new production capacity is less pronounced given that companies can leverage facilities that already produce edible oils and feed to produce biofuels without exclusively relying on more capital-intensive greenfield investments.

Chart 4

Projected biofuel demand and feedstock supplies



*Soybean oil, rapeseed oil, palm oils, and distillers corn oil. Sources: IHS Markit (feestock data), S&P Global Commodity Insights (demand).

The U.S. refining industry remains cautious about overall capital spending, which is unlikely to be a credit threat in this decade. It has dedicated a greater portion of overall capacity for renewable fuel production in the last several years. Refiners are looking for ways to reduce their carbon footprint and mitigate the longer-term risks to their business models and the production of hydrocarbon-based fuels. While we believe the shift to more renewable fuels will happen gradually, the process and impact on creditworthiness are fraught with uncertainty and risk.

We expect biofuel production to increase in the next decade. That said, North American refiners' renewable fuel capacity will remain smaller than total hydrocarbon production capacity. Therefore, in the next 3-5 years, it will likely have a limited influence on credit quality for the companies that we rate. The current pathways slated for growth by North American refiners are renewable diesel and SAF. Current capacity in operation and under construction is just under 4 billion gallons per year, which accounts for about 1.4% of daily total refining capacity of 18.4 million barrels per day (774 million gallons or 282.5 billion gallons per year).

Table 4

Planned and current renewable capacity

Refiner	Asset	In service	Mil. gallons/year	Capital expenditure (mil. $)
CVR Energy Inc.	Wynnewood	2022	100	273
HF Sinclair Corp.	Artesia/Cheyenne/Sinclair	2022	383	225
Marathon Petroleum Corp.	Martinez JV	2023	730	600
Par Petroleum LLC	Hawaii SAF	2025	61	90
PBF Holding Co. LLC	St Bernard JV	2023	320	313
Phillips 66	Rodeo	2024	767	650
Valero Energy Corp.*	DGD Port Arthur SAF	2025	235	158
	DGD JV	2013	1200	1,825
Preem	Lysekil	2027	460	1,000
Neste	Porvoo	2030	990	2,500
	Rotterdam expansion	2026	430	2,000
Repsol	Cartagena	2024	80	270
	Puertollano	2025	78	130
TotalEnergies	GrandPuits	2025	130	500
	La Mède	2019	165	350
Eni	Gela	2019	245	1,360
	Venice	2014	120	130
	Venice expansion	2024	N.M.	N.M.

*1.2 billion gallons annually, includes 235 SAF, 935 of RD and 50 renewable naphtha. $1.825 billion capex is Valero's cumulative 50% share since 2011. N.M.--Not meaningful. Sources: Company reports, S&P Global Ratings estimates.

How aggressively the aviation sector adopts biofuels will depend on supply availability and regulation, while cost management will become increasingly important. SAF remains central to aviation's decarbonization roadmap, but is expensive. Large-scale production will be challenging given competing uses and concerns about ethical land use. Most jet engines can already use SAF blended into jet kerosene, and in increasing proportions (see "Europe's Airlines To Bear Highest Carbon Costs"). However, SAF production costs are several times those of traditional jet fuel, and supply is extremely limited. Therefore, costs will rise for airlines, mostly where there are mandates to use SAF in increasing proportions (such as the EU and U.K.). We believe that an airline's ability to pass on these costs to consumers through higher ticket prices, including from regulatory support such as tax incentives, will be a rising competitive advantage.

Outside of the Nordic region, most European refiners have already closed many refineries or shifted downstream production

They've made the move from fossil fuels without large capital outlays. Moreover, their upstream activities further offset credit exposure to refining-related risks. Investments toward biofuels have been partially funded by healthy margins and strong cash generation driven by the spike in diesel prices because of Russian import limitations. This has benefitted companies in Nordic nations in particular, where biofuel expansion has been accelerated by more aggressive transition goals. Companies also have accelerated capex on the back of abnormally high margins (particularly on diesel) the past couple of years. The only global refiners that target net zero in their value chains by 2035 are Nordic-based (Preem and Neste), both of which have made large investments to fully transform the businesses to non-oil.

In 2010-2013, following the global financial downturn, about 1.4 million barrels per day of refining capacity was closed in Europe. It happened again in 2020 and 2021 as the COVID-19 pandemic slashed demand. Another, albeit smaller, cycle of capacity closures came just ahead of the market disruptions of 2022 from the Russia-Ukraine war (a year with no closures). Yet several of the 83 European refineries are still at risk of closures in the next downcycle due to cash margins. The alternative is to transform the site into a biorefinery, a route Eni and TotalEnergies have taken, for example, in La Mede (France) or in Venice and Gela (Italy). Most large European energy companies have limited exposure to refining (typically less than 20% for large energy companies such as Shell, BP, and TotalEnergies.). Typically, Upstream operations are relatively much larger. We therefore don't anticipate a major impact from biofuel regulation and investments in Europe for those players. For those with a larger share of refining such as Repsol, CEPSA, or MOL, investments into refineries and the prospects of sustaining or improving this business is more crucial. However, for high complexity refineries, margins in fossil fuel refining remain attractive. Therefore, under current regulation, we do not anticipate major shift in the next five years.

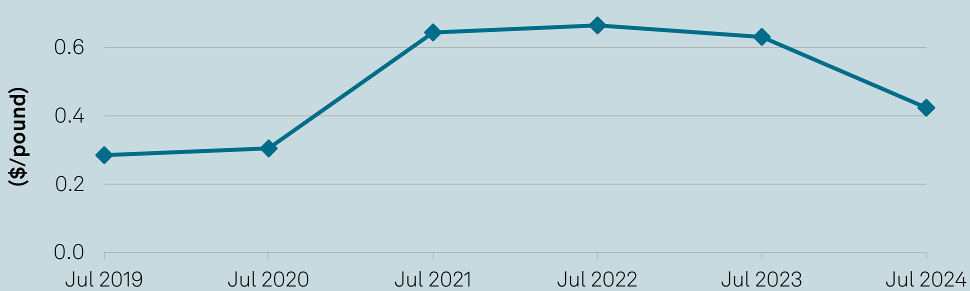
Emerging economies in Latin American and Asia-Pacific so far feel less regulatory burden to invest in biofuels, so credit risks are less pronounced. Certain emerging economies such as Brazil and India have already built significant ethanol production capacity given their global leadership in sugar production. But only recently have emerging economies introduced biofuel regulations outside of ethanol. Although agribusiness companies in these regions share the same credit materiality landscape as the sector in aggregate. Their exposure to global feedstock demand is no different, and biofuel production will continue to be less material for the refining sector in these regions given their still nascent investment cycle. Therefore, the risk to cash flow for large capital outlays is lower in these regions.

Oilseed Processing And Trading Remain Risky

After two straight years of record profit margins for (mostly U.S.-based) oilseed processors, driven in large part by biofuels, they have come under pressure in 2024 primarily because of increased availability of other renewable feedstocks for biofuels, particularly UCO out of China. This underscores the risks of price volatility and industry cyclicality. S&P Global Commodity Insights data shows soybean oil's share of biofuel feedstock demand is at a two-year low (Charts 5 and 6).

Chart 5

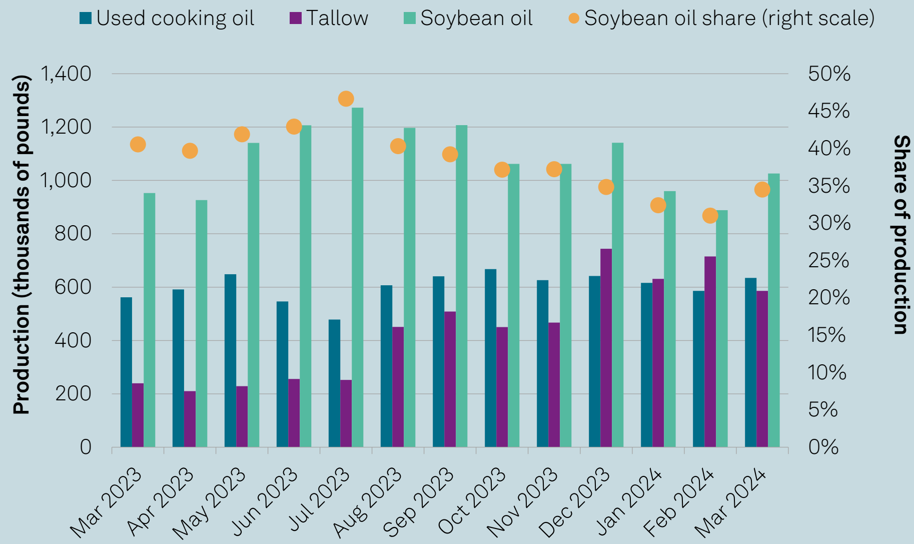
Soybean oil prices



Source: Chicago Mercantile Exchange July contract prices.

Chart 6

Feedstock shares of U.S. biodiesel production

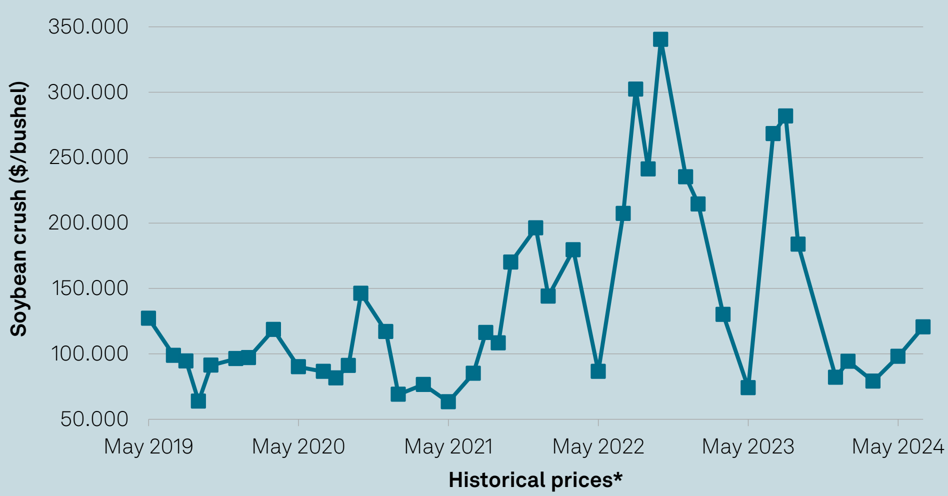


Source: S&P Global Commodity Insights.

Adding to margin pressure, robust harvests globally have reduced prices for grains and oilseeds this year. Moreover, increasing global crushing capacity as the industry expands to meet higher demand for biofuel feedstocks, coupled with Argentina's and Ukraine's crushing capacity returning to global markets, has lowered crush margins from the highs of the past two years. This has reduced oilseed prices and crush margins. Nearby soybean oil prices are trading at 45 cents per pound, down 48% from their peak of 86 cents per pound in May 2022. Soybean crush margins are down 73% from their October 2022 highs (Chart 7).

Chart 7

Soybean crush margin

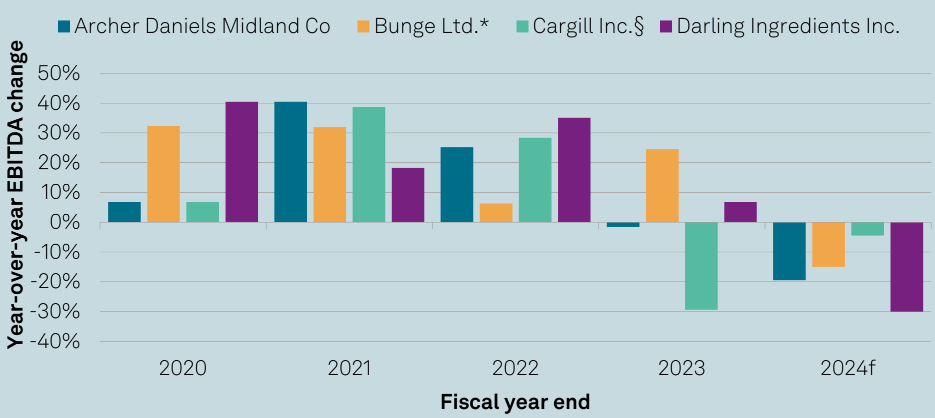


*Price of each historical year's respective contract on that contract's expiration date plus the current pricing for the July 2024 contract. Source: Chicago Mercantile Exchange.

Although we believe higher biofuel adoption will be a long-term demand tailwind over the next decade for grain processing, and oilseed processing in particular, we don't believe it reduces the inherent volatility and cyclicality associated with agricultural commodity trading and processing. The strong cycle of the past 12-18 months resulted in more than 20% year-over-year operating profits for many issuers that we rate. We now forecast an annual decline in 2024 of between 15% and 20% for these issuers (Chart 8). This volatility is not unprecedented, reflected in our agribusiness industry risk assessment. Recent performance and our profit expectations focus on its inherent cyclicality, margin sensitivity to underlying capacity, and commodity price volatility due to ever-changing supply and demand conditions. In our view, the additional demand from biofuels is not likely to change this.

Chart 8

Grain trader and feedstock supplier EBITDA volatility



*2024 Forecast is Bunge Ltd Standalone. §Cargill's fiscal year ends in May Source: S&P Global Ratings Adjusted EBITDA

Appendix

Table 5

Select national biofuel policies and regulations

Country/region	Regulations	Targets
Argentina	Regulatory framework on biofuels coving the production storage and blending of biofuels updated in 2022.	Mandatory blending of 7.5% of biodiesel until 2030.
Brazil	- RenovaBio/Brazilian National Biofuel Policy includes a 10-year target at national level, targets for fuel distributors, and a certification process. - Biodiesel blending program. - Ethanol export tax credits.	Target to reduce carbon intensity of fuels: - 2018 – 73.5g CO_2e/MJ - 2030 – 66g CO_2e/MJ
EU	- Renewable Energy Directive sets targets for biofuel use in across transport, either as a percentage of total or reduction in greenhouse gas emissions. - Separate sustainable aviation and marine fuel targets. - Biofuels produced from 2016 need to demonstrate a 65% reduction compared to the reference fossil fuel.	- By 2030, member states achieve either a 29% share of renewable energy (of which biofuels is included) in transportation or a 14.5% reduction in carbon intensity across transport. - By 2025, a 1% share of advanced biofuels, biogas, and renewable fuels of non-biological origin (RFNBO). - By 2030, a 5.5% share of advanced biofuels, biogas, and RFNBO. - SAF share requirements as per ReFuelEU Aviation regulation: - 2025 – 2% - 2030 – 6% - 2035 – 20% - 2040 – 35% - 2045 – 42% - 2050 – 70% Maritime energy intensity targets: - 2025 – 2% reduction - 2030 – 6% - 2035 – 14.5% - 2040 – 31% - 2045 – 62% - 2050 – 80%
India	- National Policy on biofuels sets overall framework for blending of biofuels in road transportation. - Ethanol blending program targets increasing shares of ethanol in road vehicle fuel mix. Although the program isn't mandatory has achieved some of the goals early. - National Biofuels Coordination Committee has also identified targets for use of sustainable aviation fuel.	- Ethanol blending in petrol: 2022 – 10%; 2025/6 – 20% - Biodiesel blending target of 5% by 2030 - SAF share targets: 2027 – 1%; 2028 – 2%
Indonesia	- Regulation concerning the provision, utilization, and trading administration of vegetable fuel (biofuel) as other fuel sets blending targets.	35% biodiesel blending from 2023.
U.S. (federal)	- Renewable fuel standards set annual targets for biofuel blending to meet a renewable volume obligation. - Numerous production incentives (including those in the Inflation Reduction Act) covering tax credits, grants and loan guarantees which support feedstock and refining developments. - SAF grand Challenge sets objectives for increasing biofuel share in aviation. - 20%, 50%, or 60% reduction in life cycle emissions required depending on the type of biofuel.	Renewable Fuel Standards volumes (set on a rolling basis): - 2022 – 20.6 bil gallons - 2023 – 20.9 bil gallons - 2024 – 21.5 bil gallons - 2025 – 22.3 bil gallons SAF volume targets: - 2030 – 2 bil gallons - 2050 – 35 bil gallons (100% share)
U.S. (state: California)	- Cap-and-trade program to reduce emissions from the transportation sector by setting carbon intensity standards/benchmarks for gasoline, diesels, and the fuels that replace them.	Reduce carbon intensity of the transportation fuel pool at least 20% by 2030 (from a 2010 baseline).

Related Research

- Decarbonizing Hard-To-Abate Sectors: Credit Quality Implications And Six Key Observations, June 25, 2024
- China Ahead In Delivering Affordable Electric Mobility, May 29, 2024
- E-fuels: A Challenging Journey To A Low-Carbon Future, March 25, 2024
- Hydrogen: New Ambitions and Challenges, Feb. 15, 2024
- Europe's Airlines To Bear Highest Carbon Costs, April 3, 2023

Editor

Jeff Domingues

Digital Designer

Joe Carrick-Varty