



Outlook and Implications of Surging Biofuel Demand On the US Soyoil Market¹

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Summary

Demand for and production of renewable forms of biodiesel has begun to surge due to demand from biofuel mandates outpacing supply of soy and canola oil agricultural feedstocks. This market imbalance has caused edible oil prices to nearly triple and markets are anticipating supply shortages in upcoming quarters.

Advanced Economic Solutions (AES) projects that renewable diesel production will double from 2020 to 2021 to reach 1.0 B gallons, thus straining already significant demand for vegetable oils as feedstocks for various forms of biodiesel fuels. Beyond 2021, significant refining capacity expansion and resulting demand driven by federal and state biofuel mandates is expected to drive domestic renewable diesel production to 3-4 B gallons, triple the current level of production.

Background

Growth in the use of soyoil to produce biofuels has risen sharply over the past ten years, initially to produce biodiesel and more recently renewable diesel. The key drivers of rising demand for soyoil and other fats/oils are the federal Renewable Fuel Standard (RFS) and state mandates such as California's Low-Carbon Fuel Standard (LCFS).

During the October-September 2021/22 year, USDA is forecasting that 11.5 B pounds of soyoil or 43% of total US soyoil demand will be used to produce biofuels.² This represents a 26% increase from a year ago. The 11.5 B pounds includes soyoil used in the production of both renewable diesel and biodiesel. AES estimates that more than one-third of the feedstock used to produce renewable diesel during 2021 will utilize refined (RBD) soyoil. Because RBD soyoil is required by both food users and a sizable share of renewable diesel producers, a severe availability problem for RBD soyoil has developed. Demand for RBD soyoil for renewable diesel will continue to trend higher over the next 12-24 months, creating a significant challenge in meeting both food and renewable diesel demand for RBD soyoil. In the coming years, a growing share of the total advanced biofuel will be renewable diesel due to its higher impact upon reducing greenhouse gases and other credits under biofuel programs. An already extremely tight supply/demand situation for US soyoil would be exacerbated if the EPA does not adjust advanced biofuel renewable volume obligations (RVOs) for 2021 and 2022 beyond the 2020 mandated level (5.09 B gallons).

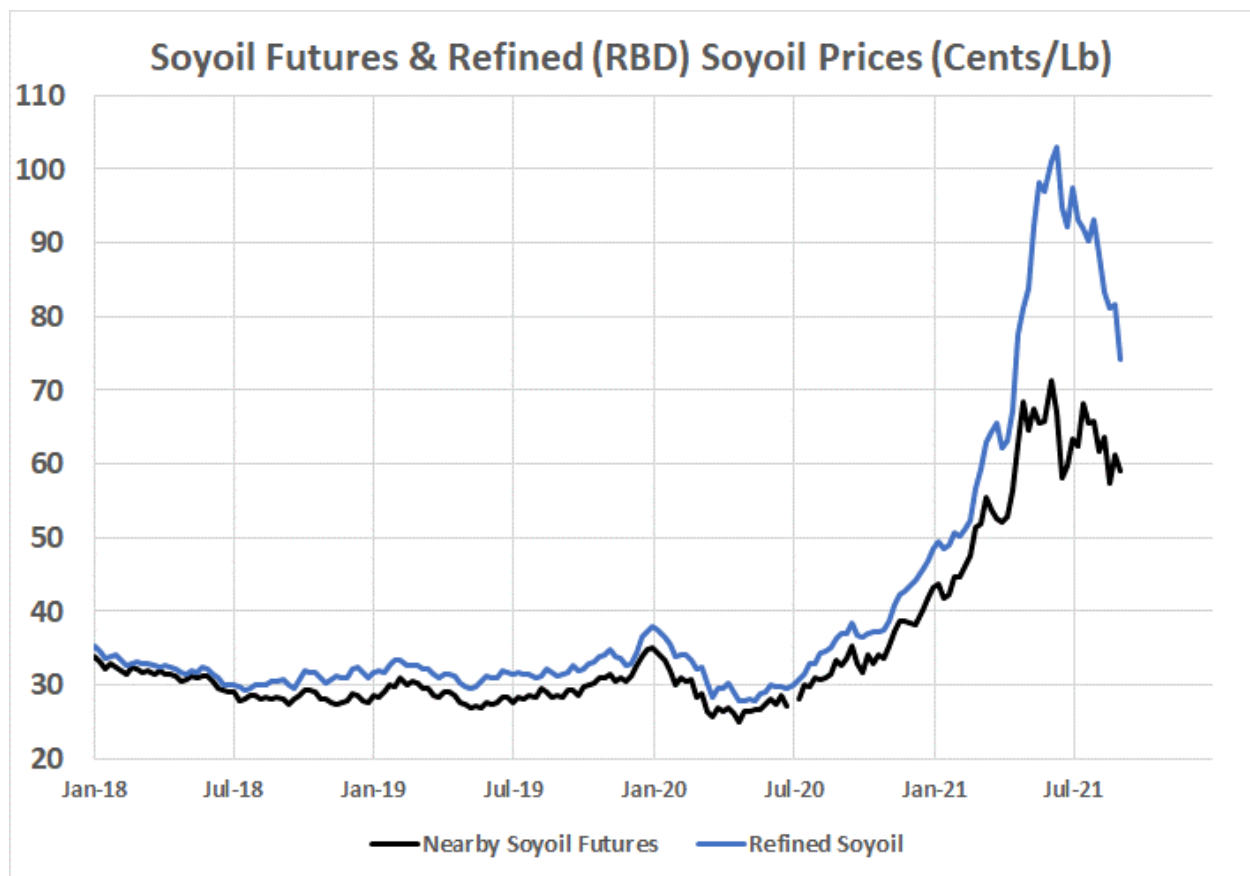
As an indication of these market disruptions, soyoil prices, including both futures and RBD soyoil, have surged in response to a sharp increase in the amount of soy used to produce biodiesel and renewable diesel. After reaching a peak of \$1.03 per pound during early June, RBD soyoil prices have relaxed into a \$.70-80 range as of early September, but are still double year ago levels. Without changes in state or

¹ Revised September 6, 2021

² USDA World Agricultural Supply and Demand Estimates, August 12, 2021

federal biofuel policy, vegoil prices are expected to remain at unprecedented high levels during the coming year. Further, in the case of RBD soyoil there remains significant availability issue that should not be overlooked. Without a reduction in state or federal mandates for biofuel usage, the bidding tension for RBD soyoil between food interests and renewable diesel producers is likely to become even more pronounced over the next 12-24 months.

Over the next 24-36 months, the high prices and reduced availability of soyoil (and particularly RBD soyoil) will require an increase in supplies through increased domestic production (plantings) and imports,³ as well as a reduction in the demand for soyoil for uses other than renewable diesel. In the short-term, the combination of federal and state mandates, as well as tax credits, has led to a bidding war between biofuel producers and food user. The resolution of the shortfall in supply will be challenging, and several critical assumptions/risks that could compound the availability problem need to be recognized – these include weather disruptions, expansion of biofuel mandates to other states and an expansion of federal RFS annual volume mandates.



³ US soyoil imports are currently subject to a 19.1% import duty.

Key Take-Aways

1. The price of refined soyoil has more than doubled over the past year, rising from \$.35 per pound to over \$.70⁴. Availability of adequate supplies of refined soyoil to meet demand for traditional food use as well as rising demand for renewable diesel remains a concern during 2022 and beyond.
2. It is notable that the United Nations' FAO Food Price Index reports that in August their vegetable oil sub-index is 68% higher than a year earlier. This is further indication that increased biofuel production is impacting vegoil markets beyond the US.
3. US soyoil used to produce biofuel – both biodiesel and renewable diesel – is forecast by USDA to rise to 11.5 B pounds during the 2021/22 year, a surge of 26% from a year earlier. This means that US soyoil used to produce transportation fuel will represent 43% of total usage – in other words nearly half of edible soy food crop is being combusted in vehicles.
4. The recent surge in soyoil demand, and the resulting supply shortage, is being driven by federal and state mandates to produce transportation fuel made from fats and oils. A reduction in the RVOs would allow for the vegoil markets to “catch up” with the sharp increase in demand.
5. AES expects that the demand for soyoil (and other fats and oils) to produce renewable diesel will at least triple over the next three years based on already robust renewable fuel mandates increased by expanded renewable diesel production to meet more stringent mandates.
6. Higher prices for soyoil and other fats/oils are expected to lead to market adjustments, including reduction in demand for other uses, as well as increased supplies of soyoil and imported canola oil. However, these adjustments will take time, and in the interim vegoil prices are expected to trade at historically high levels, with availability/shortages remaining a risk.
7. Rising vegoil prices are impacting the cost of food production: the July 2021 producer price index for fats and oils is 47% higher than a year earlier. Although the consumer price index for fats and oils during July 2021 is only up 4.0% from a year earlier, inevitably higher vegoil prices being incurred by producers will be passed on to consumers.

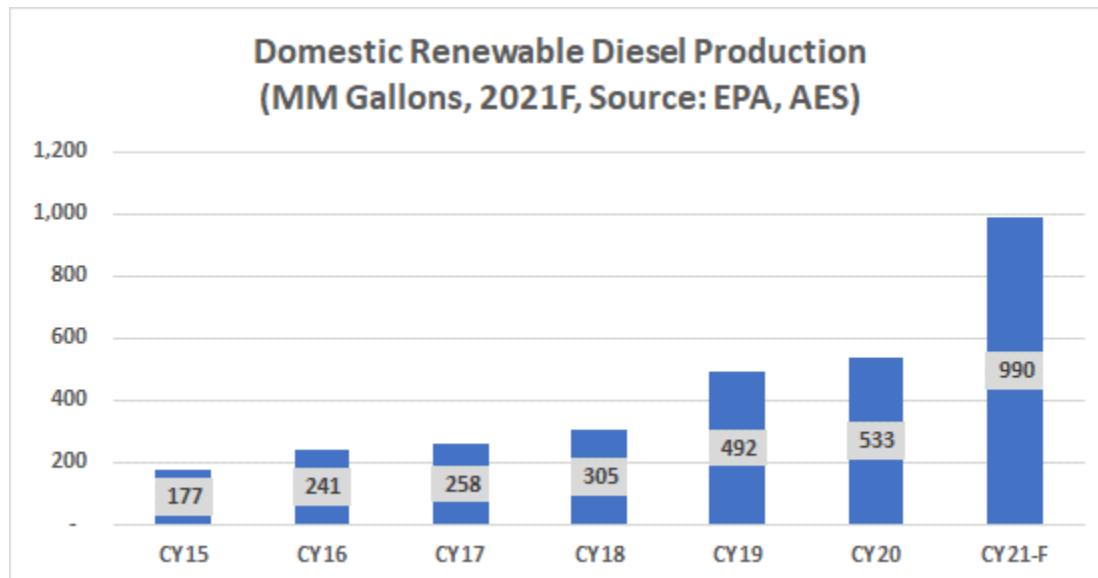
Renewable Diesel Production Surging

Demand for and production of renewable diesel has been growing in recent years and is poised to surge during 2021 and beyond. EPA RIN data shows that domestic renewable diesel production tripled between 2015 and 2020, rising from 177 mm gallons to 533 mm gallons. AES estimates that renewable diesel production will nearly double between 2020 and 2021 to 1.0 B gallons. Based upon EPA RIN data, year-to-date production during January-July 2021 is 39% above year-ago levels.⁵ Beyond 2021,

⁴ The Jacobsen

⁵ EPA EMTS data and EIA production data

significant refining capacity expansion and further tightening of biofuel mandates is expected to drive domestic renewable diesel production to 3-4 B gallons, more than double the projected 2021 forecast.



The dramatic increase in renewable diesel production and related investments has been driven by the need to meet the requirements of California's Low-Carbon Fuel Standard (LCFS).⁶ The LCFS took effect in January 2011, with the ultimate goal of reducing the carbon intensity of California's transportation fuel by 6.25% during 2019 (relative to 2010), increasing linearly to a reduction of at least 20% by 2030.

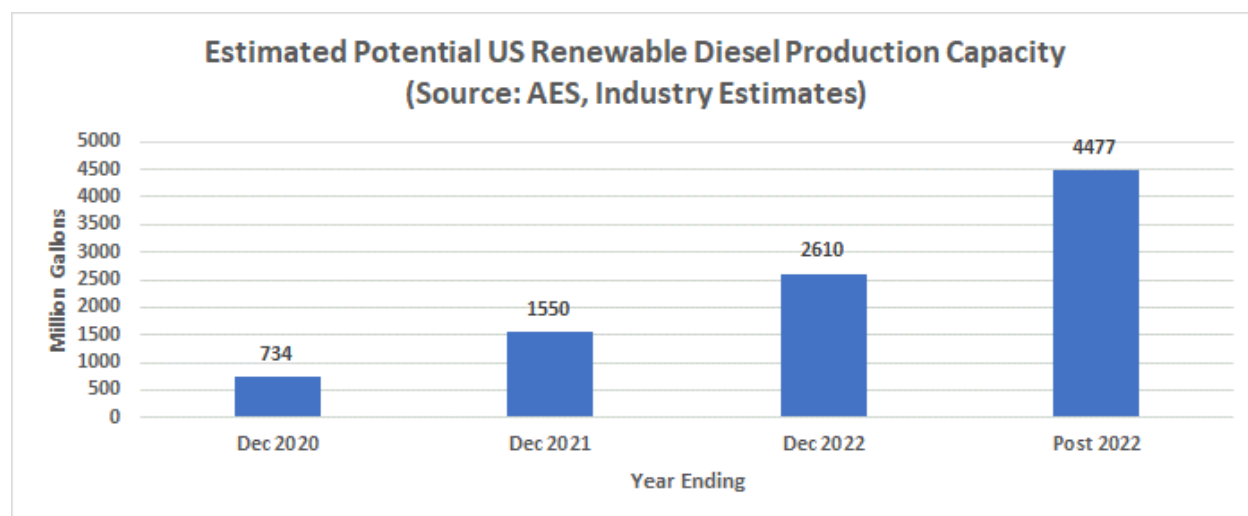
Carbon Intensity Benchmarks for Gasoline and Diesel Fuel and their Substitutes

Year	Gasoline Average CI (gCO ₂ e/MJ)	Diesel Average CI (gCO ₂ e/MJ)
2019	93.23	94.17
2020	91.98	92.92
2021	90.74	91.66
2022	89.50	90.41
2023	88.25	89.15
2024	87.01	87.89
2025	85.77	86.64
2026	84.52	85.38
2027	83.28	84.13
2028	82.04	82.87
2029	80.80	81.62
2030 onwards	79.55	80.36

⁶ <https://ww2.arb.ca.gov/sites/default/files/2020-09/basics-notes.pdf>

The net result of the biofuel mandates has been a surge in investment in renewable diesel capacity in recent years, with additional capacity expected in the coming years. Based upon survey of industry participants, AES estimates that biofuel refining industry capacity will increase from 734 mm gallons to 1,550 mm gallons by the end of 2021 and increase by an additional 68% to 2,610 mm gallons by December 2022. AES has identified nine renewable diesel plants that are currently in operation, with annual operating capacity as large as 275 mm gallons. By the end of 2022, AES estimates that a total of 19 plants will be in operation, capable of producing over 2.6 B gallons.

Beyond 2022, there are at least nine additional projects that are planned and have been announced that would increase industry capacity to produce renewable diesel to well over 4 B gallons. AES believes that several of these announced projects will not materialize, and that it is possible that domestic renewable diesel capacity will ultimately peak at 3-4 B gallons.



Role of the Renewable Fuel Standard in Driving Increased Soybean Demand

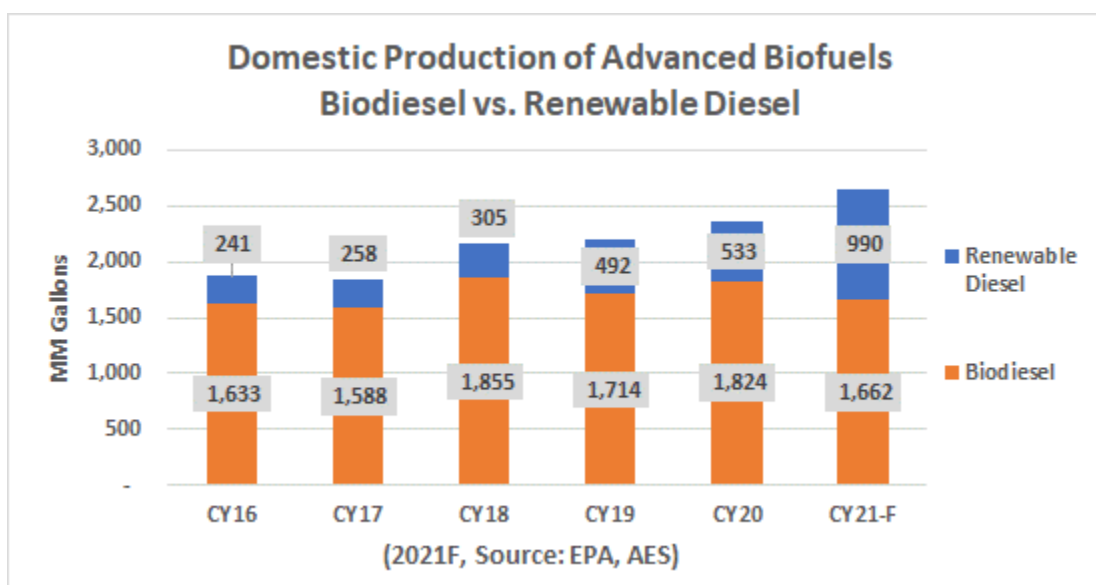
The Renewable Fuel Standard (RFS) was established by Congress via the Energy Policy Act of 2005 (P.L. 109-58) and expanded in 2007 by the Energy Independence and Security Act (P.L. 110-140). Both of these statutes amended the Clean Air Act to create the RFS which requires that transportation fuels sold in the U.S. contain a certain volume of renewable fuels. The U.S. Environmental Protection Agency (EPA) administers annually the required volume obligations (RVO) under the RFS by setting minimum volumes to be included in the annual fuel supply.

Under the RFS, EPA sets an overall volume for based on target volumes for conventional biofuel such as corn-based ethanol, and an advanced biofuel mandated volume. Each advanced biofuel is assigned a lifecycle greenhouse gas (GHG) emission value threshold relative to the baseline lifecycle GHG emissions for gasoline. This value is measured in ethanol equivalent gallons to standardize the RVO requirements across different types of fuel. Each gallon of biodiesel equates to 1.5 ethanol-equivalent gallons, while each gallon of renewable diesel equates to 1.7 ethanol-equivalent gallons toward meeting the advanced biofuel requirement. Biodiesel and renewable diesel comprise most of the advanced RVO quota, with cellulosic and various other advanced biofuels filling the balance.

The advanced biofuel RVO for 2020 was established by EPA at 5.09 billion ethanol-equivalent gallons. To meet this volume, 1.8 billion physical – or “wet” – gallons (2.7 billion ethanol equivalent gallons) of

biodiesel and 530 million wet gallons (900 million ethanol-equivalent gallons) were produced in the U.S. Together biodiesel and renewable diesel supply represent about two-thirds of the advanced RVO. The balance was made up by cellulosic and the various other types of advanced renewable fuels.⁷

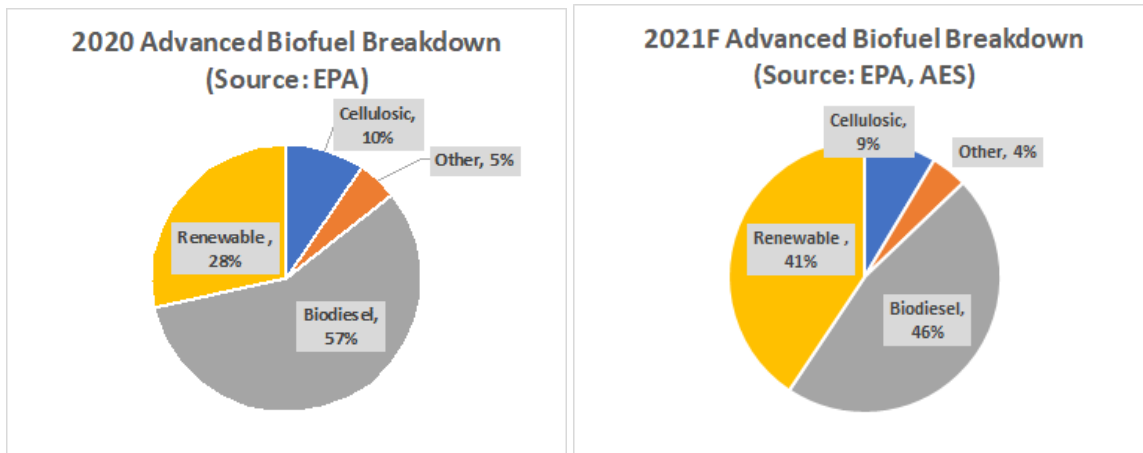
Historically, a majority of renewable fuel produced in the U.S. to meet the advanced biofuel RVO has been biodiesel. In the coming years, however, a growing share of the total advanced biofuel will be renewable diesel due to its higher ethanol-equivalency and other credits granted under state low carbon fuel programs. Based upon EPA RINs data, domestic biofuel production during January-July 2021 rose by 3.5% to 1,373 mm gallons – this includes a 2.5% decline in biodiesel and a 39% increase in renewable diesel production. AES is forecasting 2021 domestic biodiesel production to total 1,662 mm gallons (-9%), offset by an 86% increase in renewable diesel production to 990 mm gallons. A key unknown over the remainder of 2021 and 2022 is the size of EPA RVOs for advanced biofuels, which as of early September 2021 have yet to be proposed or established.



Combined, in calendar 2021, AES estimates that a total of 20.5 B pounds of feedstock will be used to produce biodiesel and renewable diesel, an increase of 16% from 2020. This includes an estimated 9.2 B pounds of soyoil.

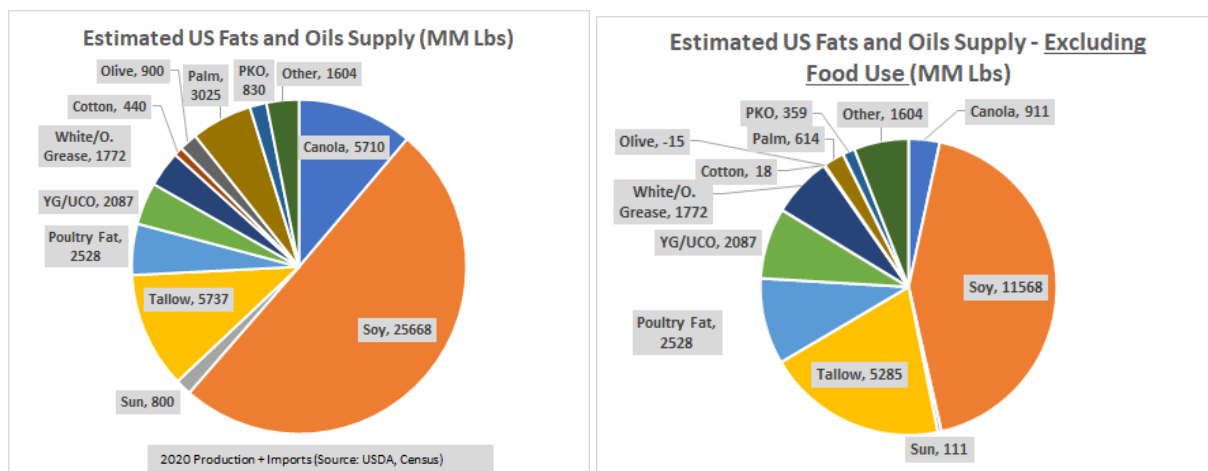
Looking ahead, an already extremely tight supply/demand situation for US soyoil would be exacerbated if the EPA elects to increase the advanced RVOs for 2021 and 2022 beyond the 2020 level.

⁷ Based upon data from the EPA Moderated Transaction System (EMTS).



Implications for US Fats and Oils Availability

The annual U.S. supply of fats and oils is estimated to total 51.1 B pounds.⁸ This includes both production and imports during the 2020/21 year. Of this total, soyoil represents 25.7 B pounds or 50% of the total. Excluding food use, the U.S. has a total available fats and oils supply of 26.8 B pounds to meet all other demand components – renewable diesel, biodiesel, exports and feed/industrial use.



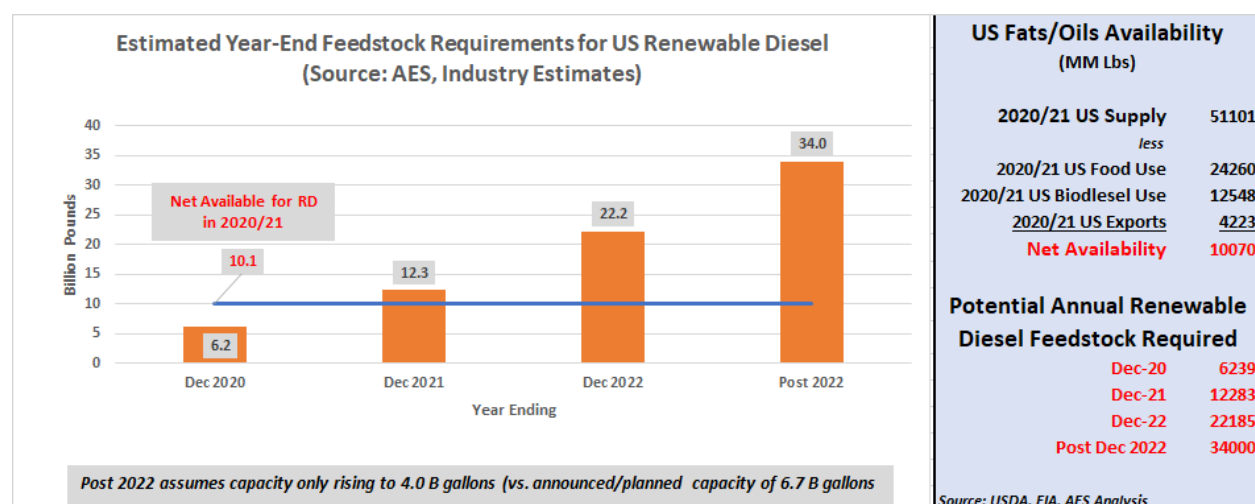
Overall availability of U.S. fats and oils to meet renewable diesel requirements is already very limited and will become an even greater challenge in the next two years. Based upon estimated 2020/21 U.S. fats and oil supplies, renewable demand will exceed the net available supply (total excluding food and biodiesel usage) by mid-2022.⁹

With industry capacity rising to 2.6 B gallons by the end of 2022, renewable diesel feedstock requirements could rise to over 20 B pounds – compared to 4.1 B during 2020 and an estimated 8.4 B during 2021. Further expansion of industry diesel refining capacity toward 4 B gallons or more will **make**

⁸ USDA Foreign Ag Service, The Jacobsen

⁹ Based upon USDA FAS and Jacobsen data; assumes 8.5 pounds of feedstock per gallon of renewable diesel.

the challenge even greater. Markets are already attempting to adjust to the shortfall, but the outlook for US fats and oils availability is forecast by AES to be extremely tight.¹⁰



Implications for Soybean Availability and Prices

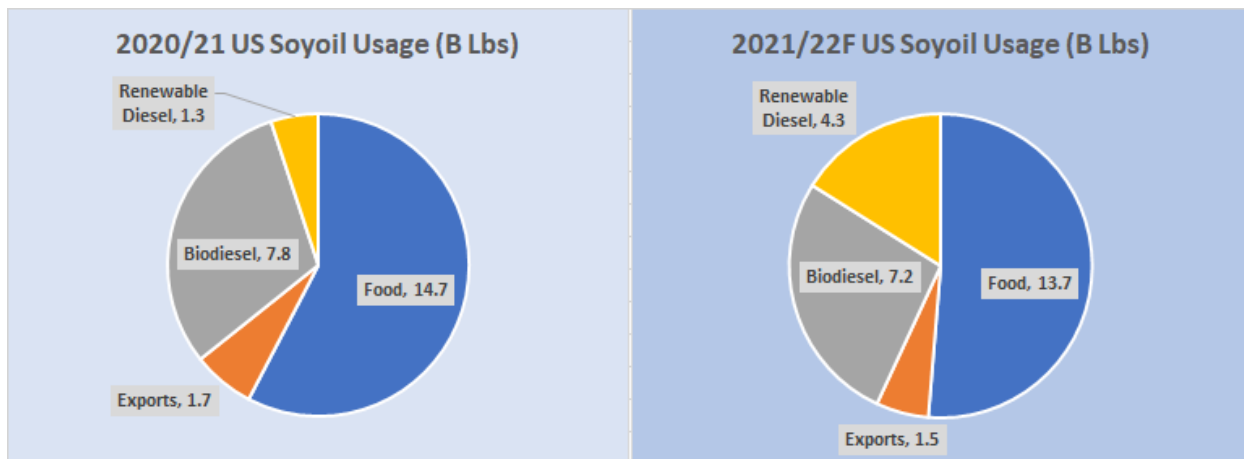
Total U.S. soybean usage during the October-September 2020/21 crop year is forecast to total 25.5 B pounds, roughly equal to total supply (production plus imports). The breakdown of forecast soybean usage during 2020/21 includes 14.7 B pounds (58% of total usage) for food use, 7.8 B pounds for biodiesel (31%), 1.3 B pounds (5%) for renewable diesel and 1.7 B pounds for exports (7%).¹¹

Due to the growth in renewable demand, the breakout of usage is forecast by USDA to change significantly during the 2021/22 crop year. Renewable diesel usage is forecast rise by 230% to 4.3 B pounds. Each of the other usage categories are forecast to decline – food use declining 7% to 13.7 B pounds, biodiesel declining 10% to 7.2 B pounds and exports declining 15% to 1.5 B pounds.

Food use patterns for all vegoils are already being impacted by the surge in the use of soybean to produce renewable diesel. USDA is forecasting a decline of 7% in soybean food use to 13.7 B pounds. This will be offset in part by increased use of other oils, led by canola oil gaining 7% to 4.6 B pounds (despite drought in Canada). Overall usage of the nine major vegoils is forecast to decline by 0.6% to 24.2 B pounds, driven primarily by a lack of supply.

¹⁰ In January 2021, the Energy Information Agency began publishing feedstock usage for the production of biofuels – biodiesel and renewable diesel combined. The data indicates that during January-June 2021, 9.1 B pounds of feedstock was used – an annualized usage rate of over 18 B pounds. Soybean usage during these six months totaled 4.1 B pounds (45% of the total). <https://www.eia.gov/biofuels/update/>

¹¹ USDA World Ag Outlook Board, August 2021; breakdown between renewable diesel and biodiesel is an AES estimate



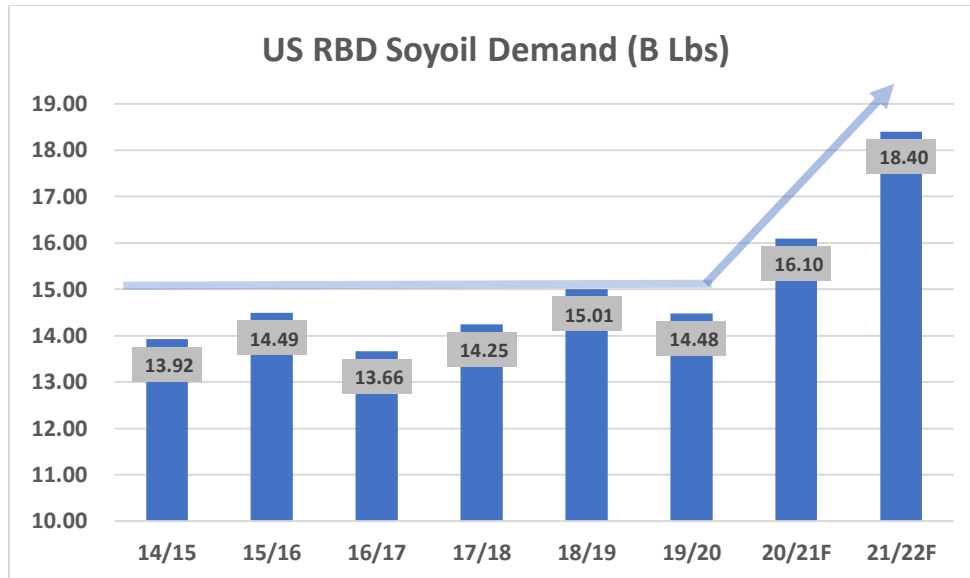
The impact of the dramatic growth in renewable diesel production has created an extremely tight U.S. supply/demand situation for soyoil as well as other fats and oils. This has led to a doubling in the price of soyoil futures over the past year.

Because a significant share of the renewable diesel plants requires refined (RBD) soyoil, an even greater concern has been availability of RBD soyoil. Because RBD soyoil is required by both food users and more than one third of renewable diesel producers, a severe availability problem for RBD soyoil has already developed.

AES expects renewable diesel plants currently requiring RBD soyoil will invest in “pre-treat” capabilities over the next 12-24 months – this will give these plants the latitude to use a wider variety of fats and oils. However, in the near-term, the demand for RBD soyoil for renewable diesel will remain large and continue to trend higher, creating a significant challenge in meeting both food and renewable diesel demand for RBD soyoil.

U.S. RBD soyoil total demand (food and renewable diesel) was steady between 2014/15 and 2019/20 averaging 14.3 B pounds. However, during 2020/21 RBD soyoil usage surged to 16.1 B pounds during 2020/21, driven entirely by a sharp increase in the use of RBD soyoil to produce renewable diesel.

Looking ahead, demand for RBD soyoil during 2021/22 is forecast to rise by 14% to 18.4 B pounds. While the use of soyoil for food during 2021/22 is expected to decline by 7%, this will be more than offset by an expected 230% increase in the use of soyoil to produce renewable diesel.



US soyoil refineries operate with limited excess capacity, and thus the surge in demand for RBD soyoil during 2020/21 has led to a sharp increase in the premium paid for RBD soyoil over futures (the “basis”). The basis for RBD soyoil is typically less than \$.04 per pound but has risen to as high as \$.30 per pound in recent months – a seven-fold increase from the long-term average premium.¹²

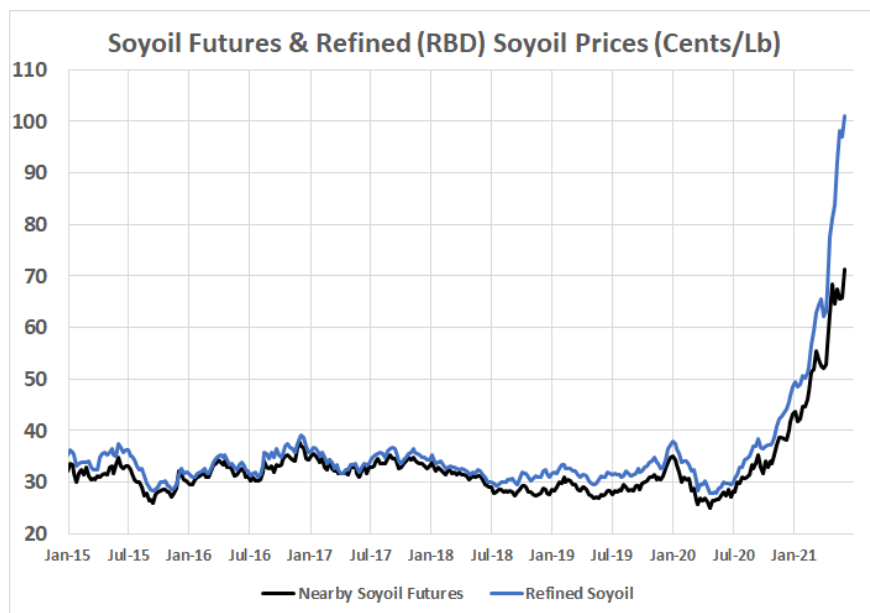
The shortfall in RBD soyoil is expected to become more extreme during 2021/22 as RBD soyoil demand is forecast to increase by an additional 14%. Eventually (12-24 months from now) the amount of renewable diesel requiring RBD soyoil may decline, as renewable diesel plants add “pre-treat” capabilities and are able to use a wider variety of feedstock. However, in the near-term, availability of RBD soyoil will remain a major challenge.

Soyoil prices, including both futures and RBD soyoil have surged in response to a sharp increase in the amount used to produce renewable diesel. Prices peaked in early June -- soyoil futures reached \$.713 per pound (+154% vs. a year earlier), while RBD soyoil reached a record was at a record \$1.04 per pound (+347% vs. a year earlier. Prices have eased in recent months but as of early September remain 80-100% higher than a year earlier.¹³

The current economics imply soyoil prices (both futures and RBD soyoil) will remain at extreme levels during the coming year. Further, in the case of RBD soyoil there remains an availability risk that should not be overlooked. The bidding war for RBD soyoil between food interests and renewable diesel producers is likely to continue for at least the next 12-24 months.

¹² The Jacobsen

¹³ Chicago Mercantile Exchange, The Jacobsen



Market Solutions: How and When Will Markets Adapt to Rising Renewable Diesel Production

As the use of soyoil and other fats and oils increases further in the coming year, prices have the potential to rise further and availability will remain a concern. End-users in both the food and renewable diesel sector have highly inelastic demand, as witnessed during the past year.

With soyoil prices rising dramatically, the current shortfall will eventually be resolved, but it will require 2-3 years of supply/demand adjustments. These include these seven expected adjustments:

Near-term – beginning to occur

- 1) Declining U.S. soyoil exports: As the U.S. has become uncompetitive in world markets, export demand for U.S. soyoil has begun to decline (2020/21 exports are forecast to decline by nearly half to 1.5 B pounds). The USDA is forecasting a 15% decline in export during 2021/22.
- 2) Reduced use of soyoil to produce biodiesel: From the 2020/21 total of 7.8 B pounds, use of soyoil to produce biodiesel is forecast by AES to decline to 7.2 B pounds during 2021/22. Achieving the forecast decline is predicated upon the EPA establishing a reduced annual advanced biofuel mandate for 2021 and 2022.

Medium-term – expected to occur during the next 12-24 months

- 3) Adding “pre-treat” capabilities at renewable diesel plants that currently require RBD soyoil: There currently are four plants in operation that require RBD soyoil, and an additional three plants that will initially require RBD soyoil to operate (total potential demand of 5.5 B pounds). Each of these plants is expected to invest in pre-treat capabilities, and eventually (in 12-24 months) have the capability to use a variety of feedstock in the production of renewable diesel.

Longer-term: 24 months and beyond

- 4) U.S. imports of Canadian canola/canola oil: U.S. supplies of canola are expected to increase modestly during 2021/22 (+0.4 B pounds vs. 2020/21). However longer term, Canada has already announced plans to increase their crush capacity from 11.0 MMT to 15.6 MMT by 2023/24 – enough to add over 4 B pounds to the North American vegoil supply. The additional canola oil will be used to displace soyoil in food use and renewable diesel production.
- 5) Additional U.S. crush capacity: U.S. producers have announced plans to add over 100 mm bushels of crush capacity over the next 2-3 years, increasing the supply of US soyoil by 1.1 B pounds.
- 6) Development of other non-food oilseeds: Several alternative oilseeds that produce inedible oil are under discussion (e.g., camelina and jatropha). These hold longer-term potential, but the scale and timetable are uncertain.

Soyoil (and particularly RBD soyoil) is expected to remain in extremely tight supply for the next 24 months. Beyond that, over the next 24-36 months, the high prices and reduced availability of soyoil (and particularly RBD soyoil) is expected to be largely “remedied,” primarily through the seven economic dynamics outlined above if current estimates hold true. Supply and demand adjustments should eventually make the availability challenges diminish.

However, the resolution of the shortfall in U.S. soyoil supply over the next 24-36 months is not certain, and several critical assumptions/risks that could compound the availability problem need to be recognized:

- Weather: if U.S. soybean or Canadian canola production is reduced due to adverse weather, the availability and price challenges in the vegoil markets will continue
- Expansion of LCFS to Other States: Currently only California has implemented a LCFS program, but other states (OR, WA, MN, MO), as well as Canada, are implementing or considering adopting a program similar to the LCFS. If the LCFS expands beyond California, the availability and price challenges facing the vegoil market would become greater.
- Maintaining or Expanding RFS Mandate Levels: If the EPA maintains or increases the annual Renewable Volume Obligations (RVOs) from 2020 levels (particularly for advanced biofuels), the federal requirements will drive demand for soyoil and other fats and oils higher, and thus exaggerate the already tight supply of soyoil.

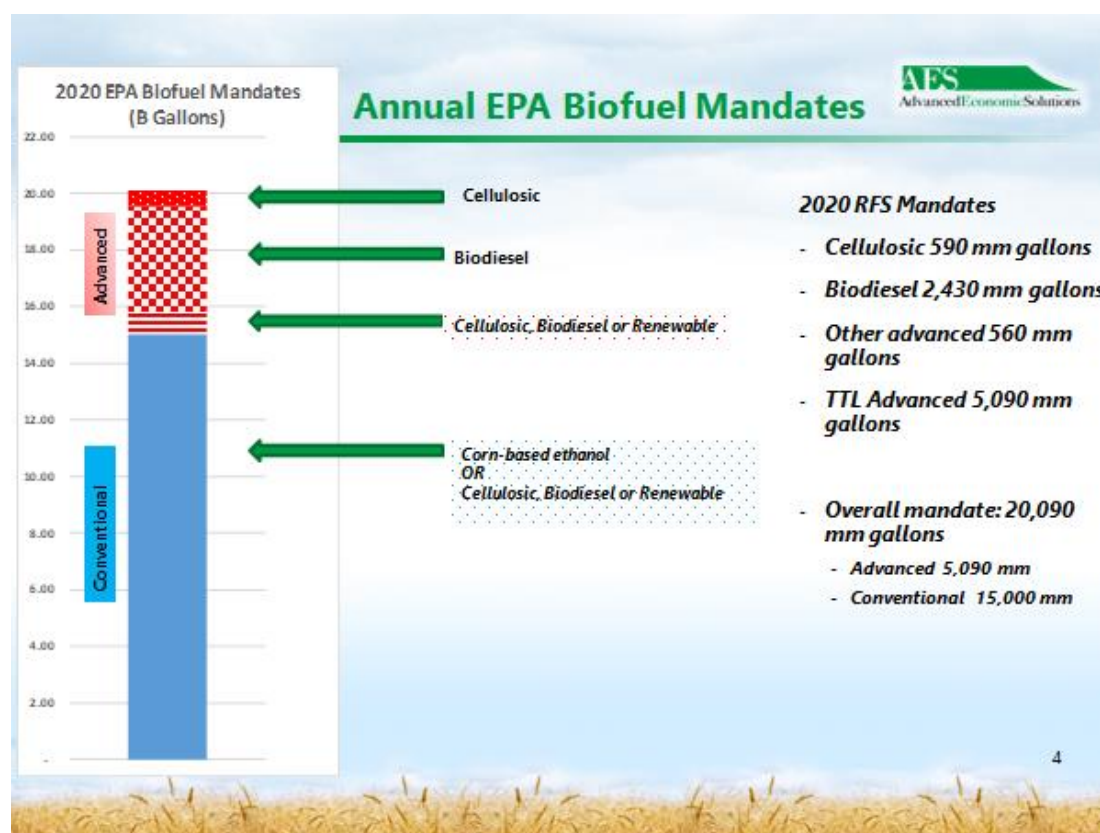
Appendix

What is Renewable Diesel:

Renewable diesel is a biomass-based diesel fuel that is chemically the same as petroleum diesel fuel. It may be used in existing petroleum pipelines, storage tanks, and diesel engines. It can be produced from a variety of biomass materials but is almost exclusively produced using fats and oils. It qualifies as an advanced biofuel under the Renewable Fuel Standard (RFS) program.

Renewable diesel is produced through various thermochemical processes such as hydrotreating, gasification, and pyrolysis. This differs from biodiesel (methyl ester), which is produced through a chemical process involving the introduction of a catalyst (methanol). Because renewable diesel is chemically the same as petroleum diesel, it may be used in its pure form (called R100) or mixed/blended with petroleum diesel.¹⁴

2020 EPA Renewable Volume Obligations



Renewable Diesel vs. Biodiesel

¹⁴ <https://www.eia.gov/energyexplained/biofuels/biodiesel-in-depth.php>

Renewable Diesel is not Biodiesel

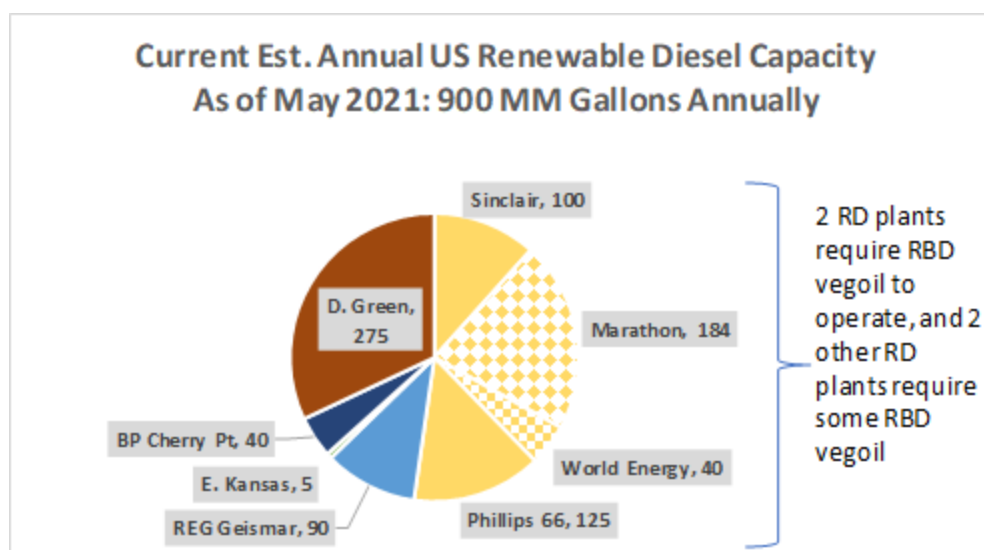


- Renewable diesel is produced through heat and pressure
 - Biodiesel (methyl ester) is produced through a chemical process
- Renewable diesel can be directly mixed with diesel fuel
 - There is chemically no difference between the renewable diesel and diesel fuel
 - Biodiesel is a blendstock, requiring the use of a blending station to be mixed at specific percentages with diesel fuel
- Both renewable diesel and biodiesel qualify as fuels that can be used to meet the federal Renewable Fuel Standard (RFS)
 - Renewable diesel earns 1.7 ethanol-equivalent RINs per gallon
 - Biodiesel earns 1.5 ethanol-equivalent RINs per gallon

June 21

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Current US Renewable Diesel Plants and Capacity



US Soyoil Usage: Food vs. Biofuel

