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Renewable Diesel and Biodiesel Supply Trends over 2011-2022

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April 12, 2023

***farmdoc daily* (13): 68**

Recommended citation format: Gerveni, M., T. Hubbs, and S. Irwin. "Renewable Diesel and Biodiesel Supply Trends over 2011-2022." *farmdoc daily* (13): 68, Department of Agricultural and Consumer Economics, University of Illinois at Urbana-Champaign, April 12, 2023.

Permalink: https://farmdocdaily.illinois.edu/2023/04/renewable-diesel-and-biodiesel-supply-trends-over-2011-2022.html

The renewable diesel boom in the U.S. began in earnest during 2021, driven by federal and state policies, including the Low Carbon Fuel Standard (LCFS) in California. As shown in a previous article, growth in renewable diesel production capacity has been dramatic, with capacity in just the last two years expanding by 1.8 billion gallons, or 225 percent (*farmdoc daily*, March 8, 2023). Total nameplate capacity was 2.6 billion gallons at the end of 2022. Further expansion of renewable diesel capacity may be large in the next several years (*farmdoc daily*, March 29, 2023). The boom in renewable diesel production raises numerous questions about the impact on biofuel, grain, and oilseed markets. Assessing these impacts requires a clear understanding of supply and demand trends. The purpose of this article is to examine supply trends for renewable diesel and FAME biodiesel. Each component of supply—production, imports and beginning stocks—will be first analyzed separately and then in total. This is the sixth in a series of *farmdoc daily* articles on the renewable diesel boom (see the complete list of articles here).

Analysis

The two main types of biomass-based diesel (BBD) fuels used to comply with the U.S. Renewable Fuel (RFS) mandates are "renewable diesel" and "FAME biodiesel." Although renewable diesel and FAME biodiesel are produced with the same organic oil and fats feedstocks, their production process differs substantially, resulting in the creation of two fundamentally different fuels (for details see *farmdoc daily*, February 8, 2023).

This article focuses on analysis of the supply side of the BBD balance sheet:

Total Supply = Production + Imports + Beginning Stocks

We start by examining the trends in each supply component for renewable diesel and FAME biodiesel separately, and end with a review of the supply trends for total BBD. Our analysis is based on monthly

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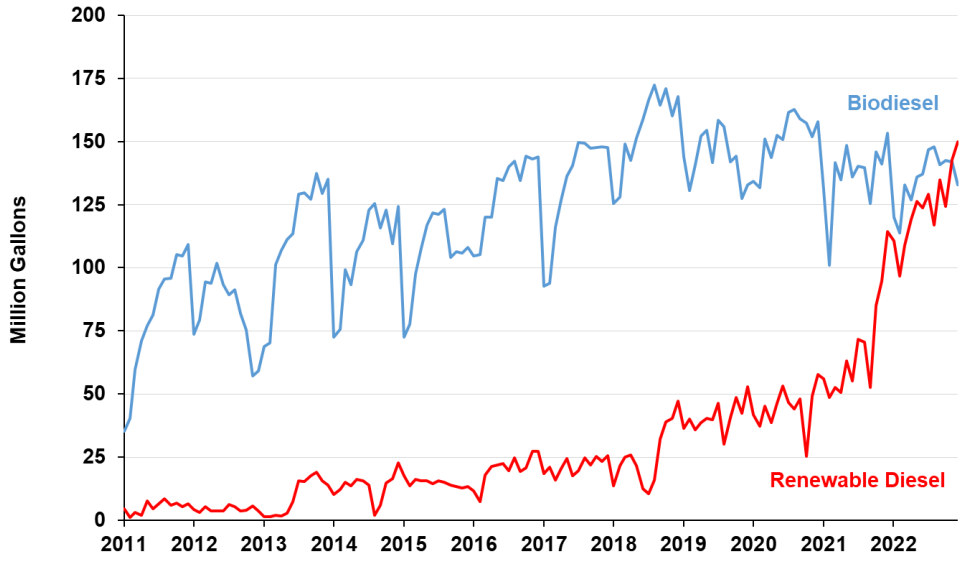
data available from the U.S. Energy Information Administration (EIA) in its monthly Energy Review over January 2011 through December 2022.

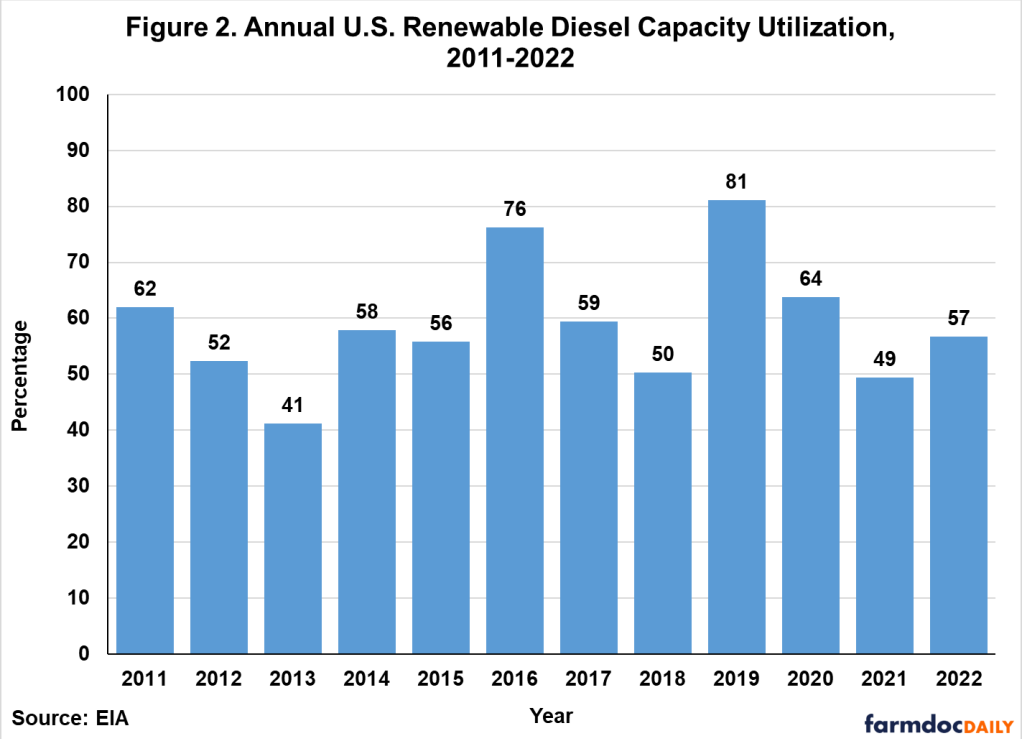
Among the three supply components of the BBD balance sheet, production is a natural starting point for discussion. Thus, we begin with Figure 1, which shows monthly U.S. renewable diesel and FAME biodiesel production. Until recently, FAME biodiesel production was significantly larger than renewable diesel. FAME production showed a healthy increase through August 2018, when it reached a monthly peak of 172 million gallons. Beginning in mid-2021, renewable diesel production began an impressive surge, with FAME biodiesel going down at the same time. This was driven by the opening of a number of new renewable diesel plants (*farmdoc daily*, March 8, 2023). It is especially interesting to notice a milestone in the production patterns of the two fuels—renewable diesel production surpassed FAME biodiesel production for the first time in November 2022.

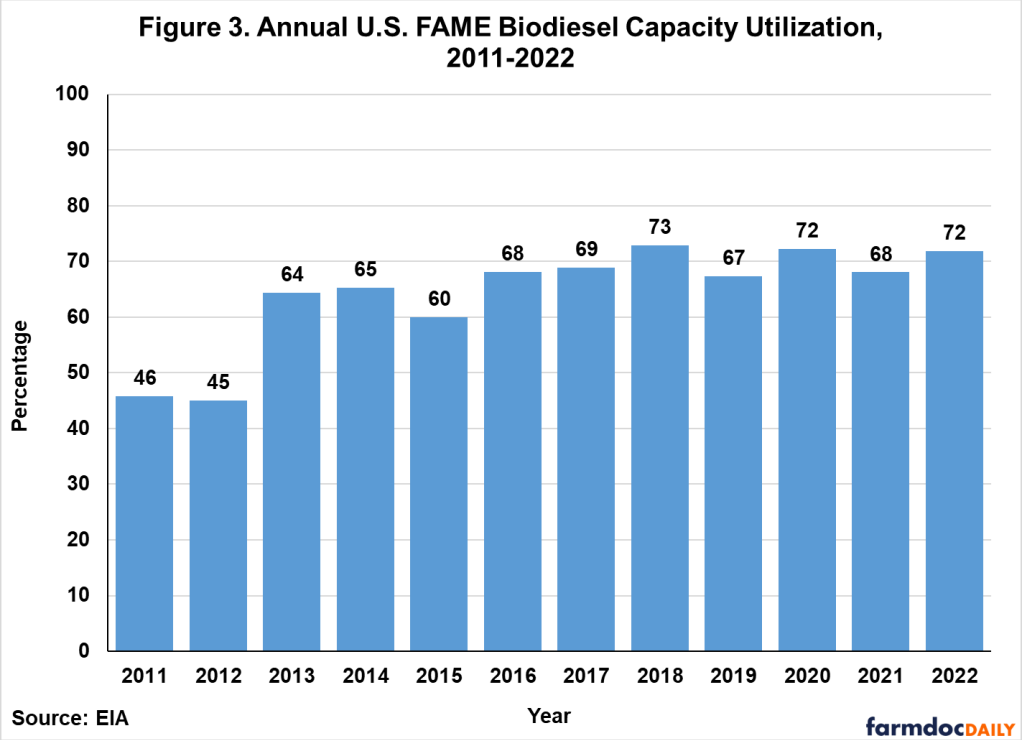
Figure 1. Monthly U.S. Renewable Diesel and FAME Biodiesel Production, January 2011 - December 2022



Thus, within the last decade there have tremendous changes in the production of these two important biofuels. For example, total FAME biodiesel production in 2012 was almost 1 billion gallons and renewable diesel was just 52 million gallons. Fast-forwarding to 2022, total annual production of renewable diesel reached almost 1,483 million gallons, only 137 million gallons less than FAME. Consequently, renewable diesel accounted for 48 percent of total BBD production in 2022, when just one decade ago it accounted for only 5 percent of BBD production.

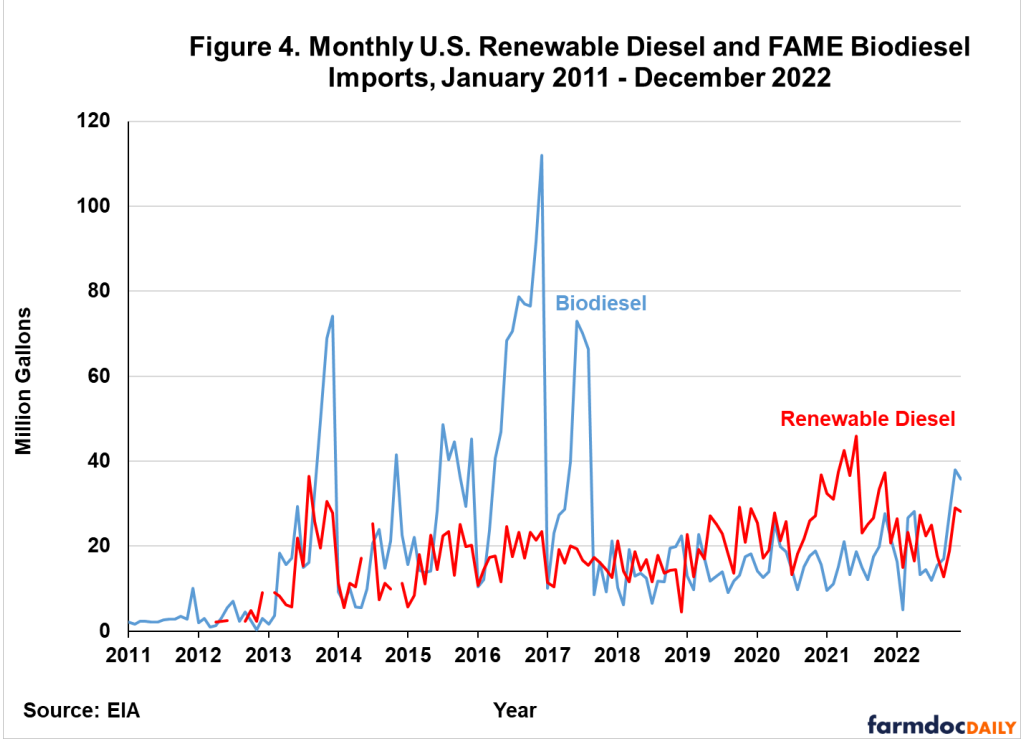
These significant changes in the production of renewable diesel and FAME biodiesel follow a similar pattern as their respective nameplate production capacities (*farmdoc daily*, February 22, 2023; March 8, 2023). An interesting and related question is "How much of the nameplate capacity is actually being utilized every month"? It is helpful to provide insight regarding the part of capacity that is used for production. Figures 2 and 3 present annual capacity utilization of renewable diesel and FAME biodiesel, respectively, over 2011 through 2022. Capacity utilization is computed as the ratio of actual production over nameplate capacity. We obtain the total annual production of renewable diesel and biodiesel by summing the monthly production observations presented in Figure 1. The nameplate capacity for each fuel is obtained from two sources. In the case of renewable diesel, capacity for 2011-2021 was estimated by the EIA and shared with the authors (Troderman and Shi, 2023). We supplemented these estimates with our own survey for 2022 as reported in the *farmdoc daily* article of March 8, 2023. In the case of biodiesel, capacity for 2011-2018 is the January estimate found in the monthly EIA U.S. Biodiesel Production Capacity Report, and capacity for 2019-2022 is obtained from the EIA annual January 1 survey published in the U.S. Biodiesel Plant Production Capacity Report.





The capacity utilization rate for renewable diesel and FAME biodiesel shown in Figures 2 and 3 averages 59 and 64 percent, respectively. It is interesting to observe that the average capacity utilization for renewable diesel is lower than that for FAME biodiesel, with the difference being even more pronounced since 2021. One of the reasons for the low capacity utilization rate for renewable diesel is likely slow start ups for new renewable diesel plants relative to their nameplate production capacity. We expect to see the renewable diesel capacity utilization rate increase in the future as more plants begin to operate closer to their full capacity. Nonetheless, there is a consistent tendency towards excess capacity for both renewable diesel and FAME biodiesel.

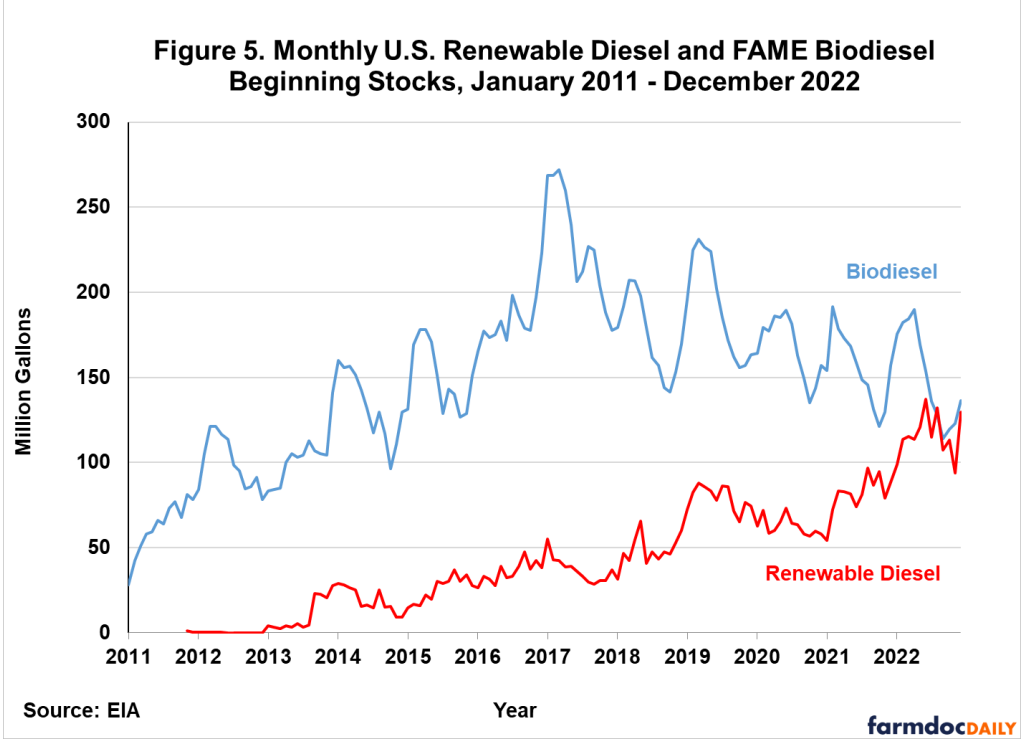
Having analyzed production trends, we now discuss imports, the second component of the supply side of the BBD balance sheet. Figure 4 presents monthly U.S. renewable diesel and FAME biodiesel imports. The average level of imports for the two BBD fuels is comparable at around 20 million gallons a month, except for a few spikes in biodiesel imports over 2013 to 2017.



There are two main factors driving the biodiesel import spikes. First, imports surge to elevated levels, varying from 40 to 110 million gallons, in years when the $1 per gallon biodiesel tax credits is scheduled to expire at the end of the year. When these credits are set to expire, obligated parties under the RFS blend extra FAME while they can get the credit, because they must meet mandated amounts in the future. During our sample period, the tax credit expired at the end of 2013 and 2016 (*farmdoc daily*, March 28, 2018; Irwin et al., 2020). Biodiesel imports also spiked significantly in 2017, as there was a race by exporters to send biodiesel in the U.S. before import duties were imposed on Argentinian and Indonesian FAME biodiesel. There have been no imports of biodiesel from these two countries since August 2017, when the import duties went fully into effect (*farmdoc daily*, March 28, 2018).

At this point it is important to clarify that U.S. import duties on biodiesel do not apply to renewable diesel. Since Argentina and Indonesia do not produce renewable diesel, this fuel has not experienced the same subsequent decline in its imports. Instead, the U.S. has been importing renewable diesel almost solely from Singapore since 2013, with Neste accounting for more than 99 percent of the total imported volume (Brown, 2020).

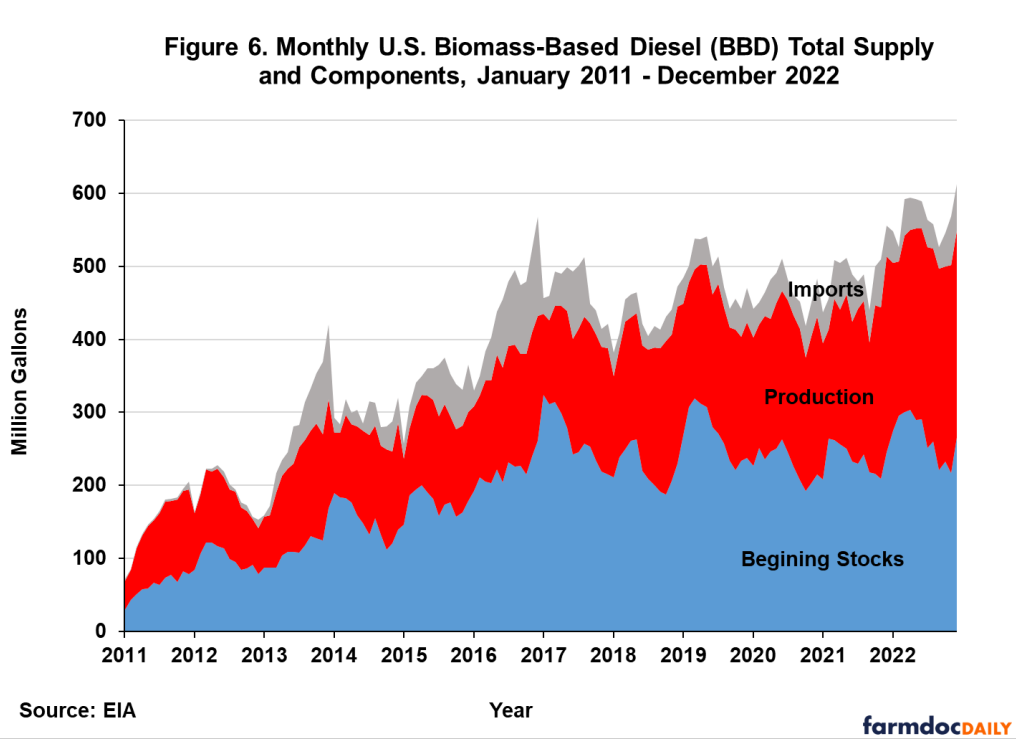
We can now discuss beginning stocks, the third component of the supply side of the BBD balance sheet. Figure 5 shows monthly U.S. renewable diesel and FAME biodiesel beginning stocks from January 2011 to December 2022. We note that beginning stocks of both renewable diesel and FAME have a positive relationship with production levels, as changes in the production affect and lead directly to “same direction” changes in the amount of beginning stocks as well.



It is interesting to note of the extremely large beginning stock-to-production ratio for each of these fuels. Specifically, the ratio in FAME biodiesel surpasses 100 percent in most months. In the case of renewable diesel, the monthly stock-to-production ratio generally has been even higher, fluctuating between 100 to 200 percent. This is typical for continuously produced energy commodities. For example, over the same time period, the U.S. stock-to-production ratio for gasoline averages about 84 percent. In contrast, seasonally produced crops (e.g., corn and soybeans) have much lower beginning stocks, which fluctuate between roughly 5 and 15 percent of production (e.g., *farmdoc daily*, February 13, 2023). The high level of stocks is logical in a continuously-produced fuels system in order to smooth out variations in demand over time and space.

The last step of the analysis is to examine the total supply of the BBD balance sheet, as shown in Figure 6. We represent total BBD supply through a stacked area chart, in which the height of the topmost line (in the grey area of imports) corresponds to the total BBD supply when summing across all three components: beginning stocks, production and imports. The aggregated trends of total supply provide further insights into the BBD market.

There are three distinct periods with respect to total BBD supply in Figure 6. Initially, total BBD supply trended up significantly from 2011 through 2016, jumping from roughly 150 to 450 million gallons per month. Starting in 2016, total supply plateaued at approximately 500 million gallons per month. A new uptrend in total BBD supply began in 2021 at about the same time as the renewable diesel boom was taking off. However, the uptrend in total supply is rather modest, increasing by about 100 million gallons per month. This is much smaller than the boom in renewable diesel production over the same period. The reason for the divergence is straightforward. Total BBD supply has increased only modestly since 2021 because of an offsetting decrease in FAME biodiesel production (see Figure 1).



Implications

This article examines supply trends for renewable diesel and FAME biodiesel over 2011 through 2022. The biggest changes on the supply side have been in terms of production. For example, total FAME biodiesel production in 2012 was almost 1 billion gallons and renewable diesel was just 52 million gallons. Fast-forwarding to 2022, total annual production of renewable diesel reached almost 1,483 million gallons, only 137 million gallons less than FAME. Consequently, renewable diesel accounted for 48 percent of total biomass-based diesel (BBD) production in 2022, when just one decade ago it accounted for only 5 percent of BBD production. The average level of imports for renewable diesel and FAME biodiesel is generally comparable at around 20 million gallons a month, except for a few spikes in biodiesel imports over 2013 to 2017. Finally, it is important to note that the total supply of BBD has only increased modestly despite the boom in renewable diesel production. The reason is a concurrent and offsetting decrease in FAME biodiesel production.

The next article in this series will examine usage trends in renewable diesel and FAME biodiesel.

Disclaimer: *The findings and conclusions in this publication are those of the authors and should not be construed to represent any official USDA or U.S. Government determination or policy. This work was supported in part by the U.S. Department of Agriculture, Economic Research Service.*

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