



Renewable Diesel and Biodiesel Usage Trends over 2011–2022

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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](#)). The expansion of renewable diesel supply may be even larger in the next several years (*farmdoc daily*, [March 29, 2023](#)). The boom in renewable diesel production and use raises numerous questions about the impact on biofuel, grain, and oilseed markets. Assessing these impacts requires a clear understanding of supply and demand trends. Our previous article (*farmdoc daily*, [April 12, 2023](#)) provided a thorough analysis of the supply side of historical renewable diesel and FAME balance sheets. The purpose of this article is to examine historical usage trends for renewable diesel and FAME biodiesel. Each component of total use—implied domestic use, exports and ending stocks—will be first analyzed separately and then in total. This is the seventh 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 use side of the BBD balance sheet:

$$\text{Total Use} = \text{Implied Domestic Use} + \text{Exports} + \text{Ending Stocks}$$

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We start by examining the trends in each use component for renewable diesel and FAME biodiesel separately, and end with a review of the use trends for total BBD. Our analysis is based on data available from the U.S. Energy Information Administration (EIA) in its monthly [Energy Review](#) over January 2011 through December 2022.

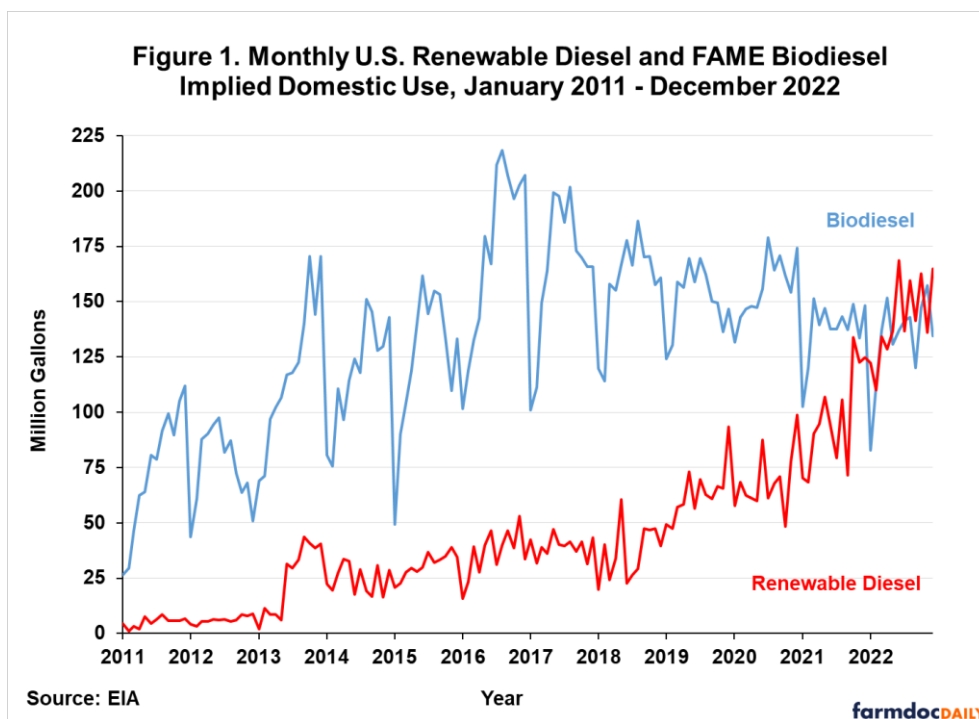
Among the three use components of the BBD balance sheet, implied domestic use is a natural starting point for discussion. Since there is no direct survey estimate of domestic consumption for renewable diesel or FAME biodiesel, domestic use is implied based on the BBD balance sheet as follows:

Implied Domestic Use =

Beginning Stocks + Production + Imports - Exports - Ending Stocks

One issue when making this calculation for renewable diesel is that is that the EIA did not conduct a survey to estimate renewable diesel exports until very recently. Consequently, we assume that renewable diesel exports are zero when estimating implied domestic use historically. We will discuss renewable diesel exports in more detail later in this article. Also, note that this is not an issue for FAME biodiesel because the EIA has historically tracked FAME exports.

Figure 1 shows monthly U.S. renewable diesel and FAME biodiesel implied domestic use over January 2011 through December 2022. Until recently, FAME biodiesel implied domestic use was significantly larger than renewable diesel, reflecting a similar pattern in the respective fuels' production levels (*farmdoc daily*, [April 12, 2023](#)). FAME domestic use showed a healthy increase through February 2017, when it reached a monthly peak of 272 million gallons. Beginning in mid-2021, renewable diesel domestic use begun an impressive surge, with FAME biodiesel going down at the same time. This surge in renewable diesel use is driven by federal and state policies, most notably the Low Carbon Fuel Standard (LCFS) in California. It is especially interesting to notice a milestone in the implied domestic use patterns of the two fuels—renewable diesel domestic use surpassed FAME biodiesel domestic use for the first time in January 2022.

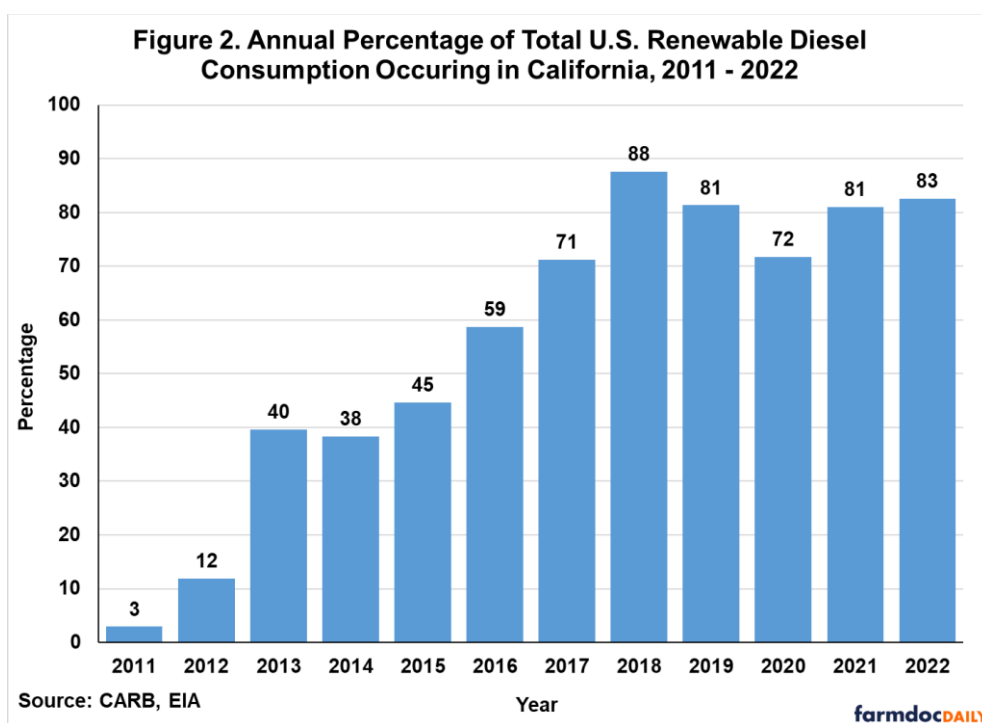


Within the last decade there have been tremendous changes in the implied domestic use of these two important biofuels. For example, total FAME biodiesel domestic use in 2012 was 900 million gallons and renewable diesel was just 74 million gallons. Fast-forwarding to 2022, total annual domestic use of renewable diesel reached 1,700 million gallons, surpassing FAME by 107 million gallons. Consequently,

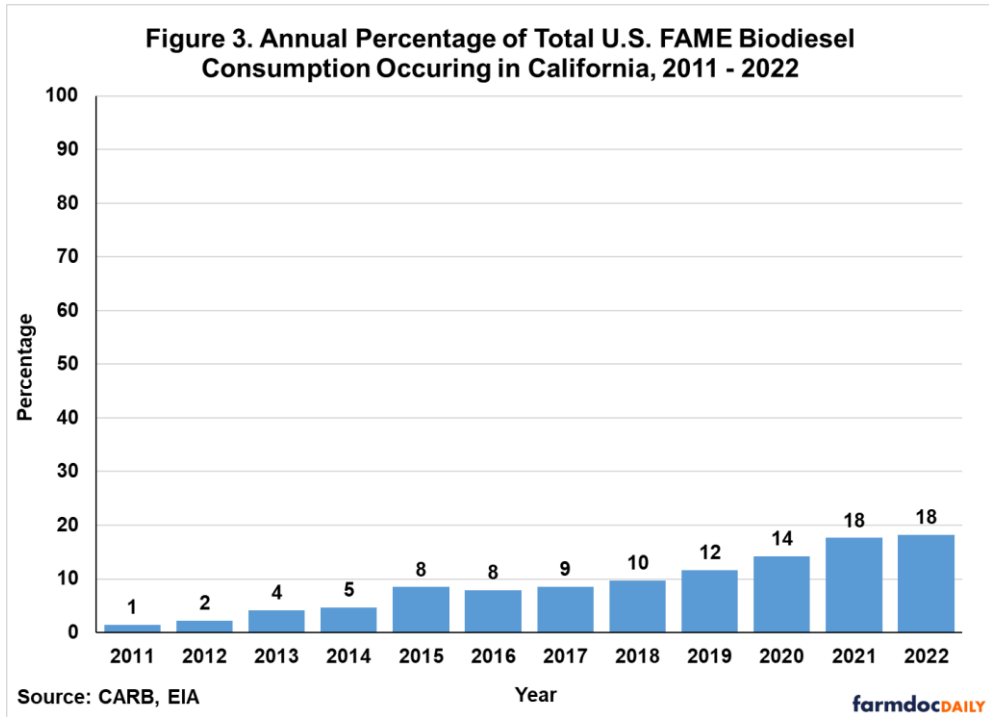
renewable diesel accounted for 52 percent of total domestic BBD use in 2022, when just one decade ago it accounted for only 8 percent of domestic BBD use.

As noted above, one of the main reasons behind the surge in consumption of renewable diesel is the Low Carbon Fuel Standard (LCFS) in California, which is designed to decrease the carbon intensity of California's transportation fuel sector by increasing use of low-carbon and renewable fuels at the expense of petroleum fuels. Renewable diesel is a prime example of how the LCFS incentivizes substitution of renewable fuels for petroleum fuels (CARB, 2023). Hence, it is interesting to examine the percentage of total U.S. renewable diesel and FAME biodiesel consumption that occurs within California. We present these percentages on an annual basis in Figures 2 and 3, respectively. Total annual U.S. use of renewable diesel and biodiesel is found by summing the monthly domestic use observations presented in Figure 1. Consumption for each fuel is tracked by the California Air Resources Board (CARB) and made available on a quarterly basis in the [Low Carbon Fuel Standard Reporting Tool Quarterly Summary](#). The latest available data is through the third quarter of 2022, so we compute total U.S. renewable diesel and biodiesel use as a summation of the first nine months of the 2022 calendar year.

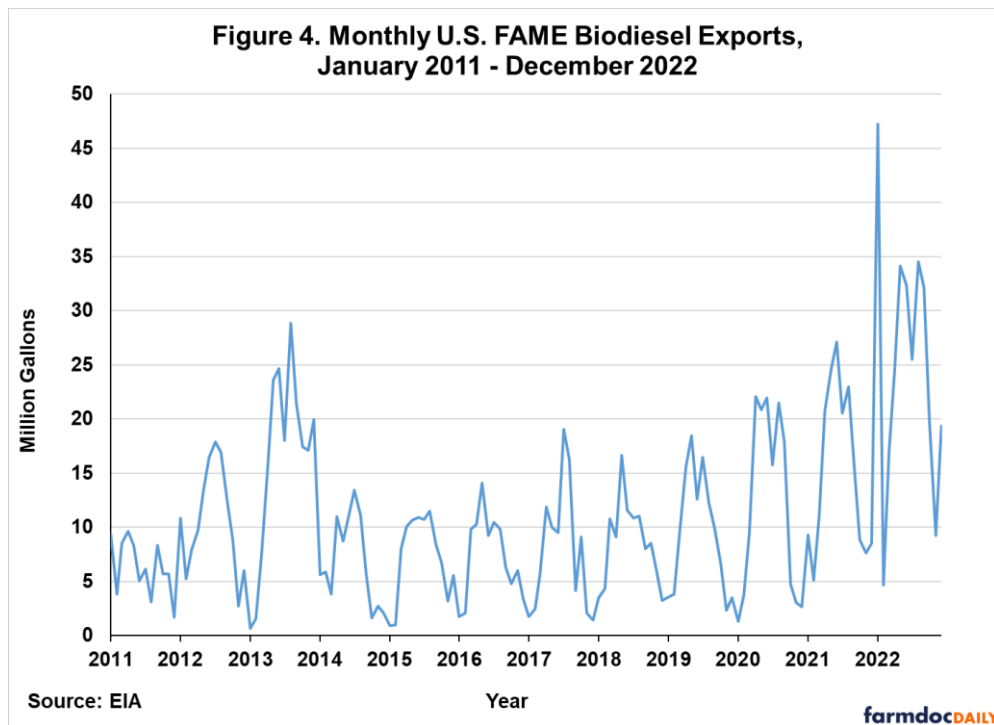
Figure 2 confirms that there has been a large increase in the percentage of renewable diesel consumed in California. Initially, renewable diesel use in California increased dramatically from 2011 through 2018, jumping from 3 to 88 percent of total U.S. consumption. Since 2018, California has consistently been by far the largest consumer of renewable diesel, averaging 81 percent of total annual use in the U.S. A significant fraction of renewable diesel usage not consumed in California is likely to be consumed in other states with low carbon fuel standards, such as Oregon and Washington.



By comparison, as shown in Figure 3, the percentage of biodiesel consumed in California is significantly lower than renewable diesel. From 2011 through 2018, FAME use in California was 10 percent or less of total U.S. biodiesel consumption. However, since 2019, biodiesel use in California has increased notably, from 12 to 18 percent of total U.S. biodiesel use. The most likely explanation for the recent surge in FAME biodiesel usage in California is blending with renewable diesel. While there is only anecdotal evidence in this regard, it appears that a popular blend is 80/20 renewable diesel and FAME biodiesel. One reason for blending FAME with renewable diesel is the beneficial lubricity properties of biodiesel (e.g., *farmdoc daily*, [February 8, 2023](#)). There are also likely economic benefits to blending in this manner.

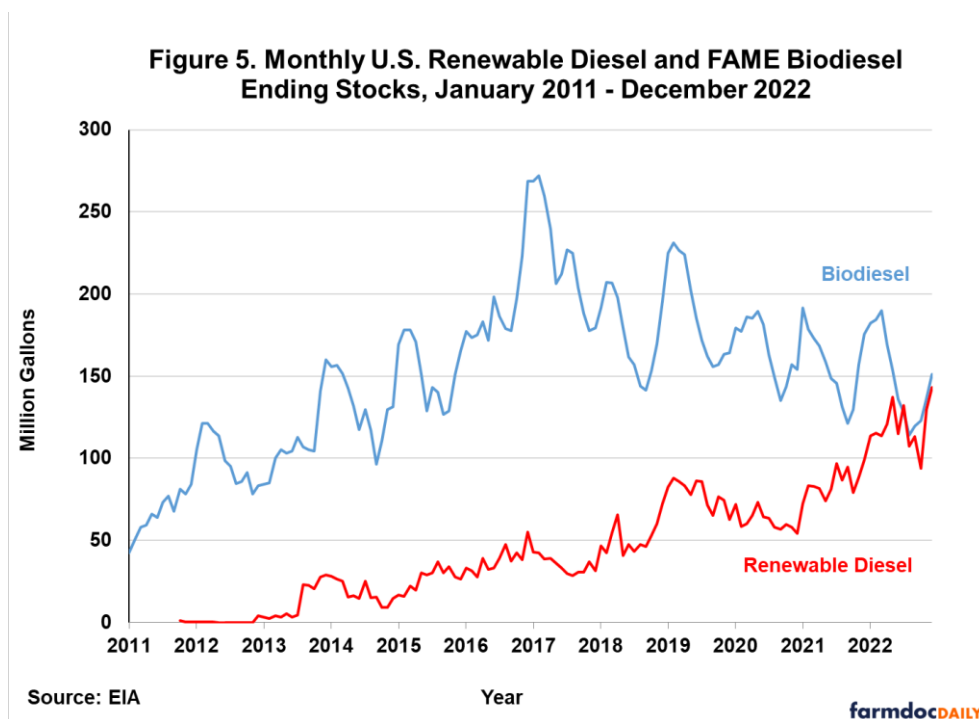


Having analyzed domestic use trends, we now turn to exports, the second component of the use side of the BBD balance sheet. As discussed above, the EIA conducts a monthly survey to estimate FAME biodiesel exports data. Figure 4 presents monthly U.S. FAME biodiesel exports over January 2011 through December 2022. The average level of exports for FAME is relatively small at 11 million gallons per month over the entire sample period. There is also a distinct seasonality to biodiesel exports, with export volumes peaking in late spring or early summer in almost every calendar year. Given that Canada is by far the largest export destination for U.S. produced FAME biodiesel, the seasonal pattern is logical. FAME biodiesel can be susceptible to gelling problems in cold temperatures (*farmdoc daily*, [February 8, 2023](#)), therefore it makes sense for U.S. exports to Canada to be concentrated in warmer weather months.

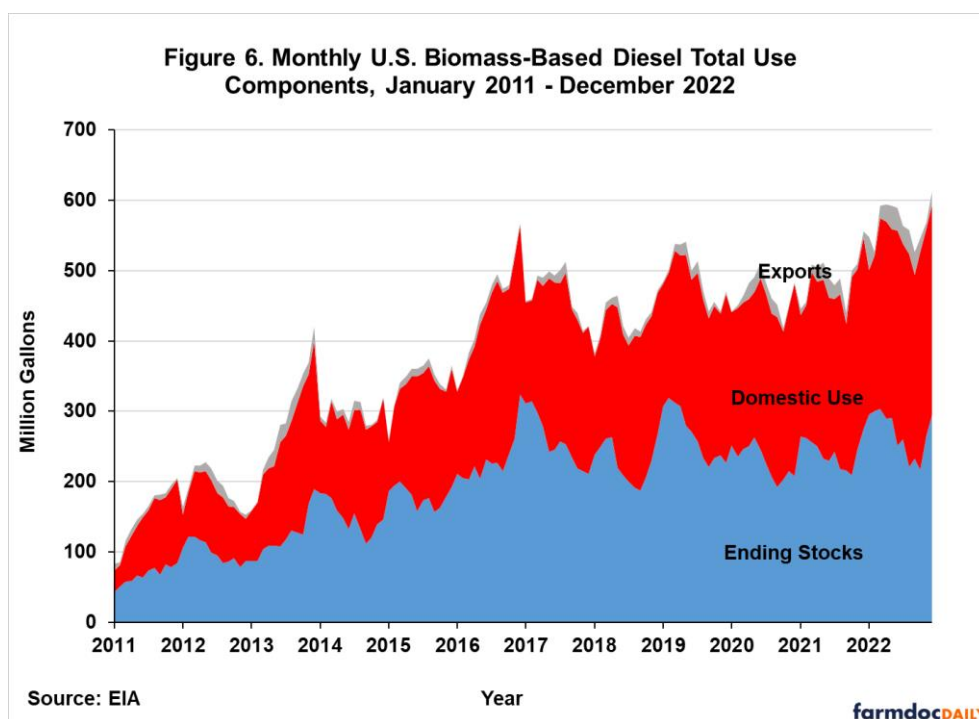


While we assumed earlier when computing implied domestic use of renewable diesel that exports of renewable diesel were zero, we know this is not literally true. For example, a [recent release](#) from the U.K. and Ireland Fuel Distributors Association announced the first imports of renewable diesel from the U.S. into the United Kingdom. The EIA did start [a report for renewable diesel exports by destination](#) in August 2022, but, curiously, no data values are available. We can place an upper bound on renewable diesel export volumes based on the data in Figure 2. Specifically, renewable diesel exports can be no larger than percentage of renewable diesel not consumed in California. This would place the upper bound for renewable diesel exports around 20 percent of U.S. domestic consumption in recent years. Since some renewable domestic consumption in the U.S. occurs outside of California, this upper bound is not likely to be a reasonable measure of exports. Given the large incentives for renewable diesel consumption in the U.S., one can reasonably expect renewable diesel exports to be far smaller than 20 percent. Something less than five percent of domestic consumption seems more in the ballpark, but we will have to wait for survey data from the EIA to know for sure.

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



The last step of the analysis is to examine total use of BBD, as shown in Figure 6. We represent total BBD use through a stacked area chart, in which the height of the topmost line (in the grey area of exports) corresponds to total BBD use when summing across all three components: ending stocks, implied domestic use and exports. The aggregated trends of total use provide further insights into the BBD market. We also note that total BBD use must, by definition, equal total BBD supply. Consequently, there are exactly the same three distinct periods with respect to total BBD use in Figure 6, as we discussed with respect to total BBD supply in our previous article (*farmdoc daily*, [April 12, 2023](#)). Initially, total BBD use trended up significantly from 2011 through 2016, jumping from roughly 150 to 450 million gallons per month. Starting in 2016, total use plateaued at approximately 500 million gallons per month. A new uptrend in total BBD use began in 2021 at about the same time as the renewable diesel boom was taking off. However, the uptrend in total use is rather modest, increasing by about 100 million gallons per month. This is much smaller than the boom in renewable diesel consumption over the same period. The reason for the divergence is straightforward. Total BBD use has increased only modestly since 2021 because of an offsetting decrease in FAME biodiesel domestic use (see Figure 1).



Implications

This article examines trends in usage for renewable diesel and FAME biodiesel over 2011 through 2022. The biggest changes on the use side of the balance sheet have been in terms of implied domestic use. For example, total FAME biodiesel domestic use in 2012 was almost 900 million gallons and renewable diesel was just 74 million gallons. Fast-forwarding to 2022, total annual domestic use of renewable diesel reached 1,700 million gallons, surpassing FAME by 107 million gallons. California is by far the largest consumer of renewable diesel in the U.S., representing an average of 81 percent of total U.S. renewable domestic use since 2018. This is a prime example of how the Low Carbon Fuel Standard (LCFS) in California incentivizes substitution of renewable fuels for petroleum fuels. The average level of exports for FAME biodiesel is relatively low at 11 million gallons a month, while to date there is no official data on renewable diesel exports. Finally, it is important to note that the total use of BBD has only increased modestly despite the boom in renewable diesel implied domestic use. The reason is a concurrent and offsetting decrease in FAME biodiesel domestic use.

The next article in this series will examine feedstock usage trends for 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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