EXECUTIVE SUMMARY | MARCH 2020

Biomass-Based Diesel: A Market and Performance Analysis

United States biomass-based diesel (BBD) consumption has increased rapidly in a relatively short time span to become the leading source of alternative transportation fuel. The diesel fuel that is used by motor vehicles in the country contained an average BBD content of approximately 5% by volume (vol%) in 2018 compared to 0.5 vol% in 2010. The last decade has also seen biodiesel complimented by the arrival of renewable diesel, and combined U.S. consumption is on track to increase to 10 vol% as early as 2022 as new renewable diesel capacity comes online. BBD's widespread acceptance in the U.S. can be attributed to its broad compatibility with the U.S. transportation fuel infrastructure and positive environmental attributes.

This report provides a comprehensive overview of the U.S. BBD markets and performance.

OVERVIEW OF U.S. BBD SUPPLY

The majority of U.S. biodiesel supply is sourced from within the U.S. The PADD 2 region is the source of the majority of U.S. biodiesel production due to its number of relatively large biodiesel production facilities and abundant supply of oilseed feedstocks.

U.S. biodiesel production increased from 516 million gallons in 2009 to 1,855 million gallons in 2018. The rising production volumes were made possible by increased utilization of existing capacity. In 2018, the U.S. hosted 2,400 million gallons of biodiesel capacity across 96 operational facilities that were registered with the U.S. Environmental Protection Agency (EPA).

The U.S. renewable diesel sector is substantially less developed than the U.S. biodiesel sector. The country's first commercial-scale renewable diesel production facility did not become operational until 2010. Only five such facilities were operational at the end of 2018.

U.S. renewable diesel production capacity increased from 78 MMGY to 397 MMGY between 2010 and 2018 and is expected to increase to almost 3,000 MMGY by 2022. The additional capacity will be spread across every PADD region except the PADD 1 region, and the PADD 5 region is expected to have a plurality of U.S. renewable diesel production capacity by 2022. U.S. renewable diesel imports have also increased rapidly and contributed an additional 173 million gallons to U.S. supply in 2018.

BBD DISTRIBUTION, BLENDING AND DEMAND

Not commonly shipped via pipeline like petrodiesel, BBD is moved from the production facility to a bulk terminal via truck, rail, or barge. From there, it has historically been "splash blended" by fuel jobbers, but more frequently this is being replaced by more advanced blending techniques at bulk terminals with manifold or rack blending systems. Both types of terminal blending systems are capable of achieving more accurate BBD blend rates and more homogenous BBD blends than are achieved via splash blending. Small volumes of BBD have been moved from BBD production facilities to refineries in recent years, blended onsite, and then moved through pipelines to terminals as ≤5 vol% blends.

FIGURE ES-8: U.S. ANNUAL BBD CONSUMPTION VOLUMES (2009-2018) AND AVERAGE BLEND RATES AS PERCENTAGE OF MVNRLM DIESEL FUEL CONSUMPTION

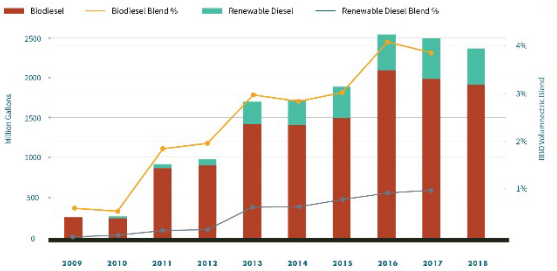
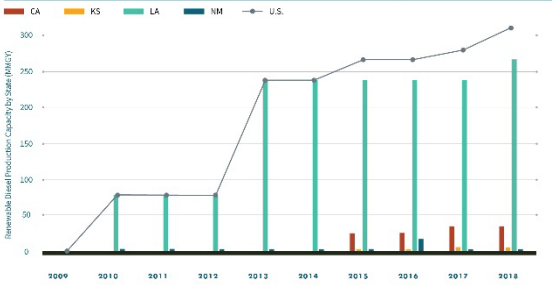


FIGURE ES-4: U.S. RENEWABLE DIESEL PRODUCTION CAPACITY BY STATE, 2009-2018



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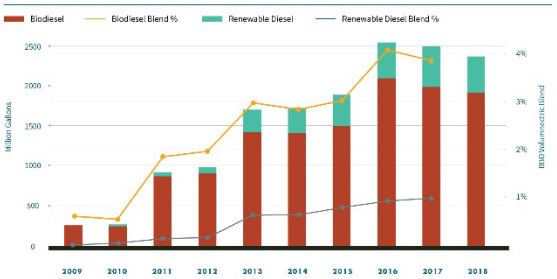

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U.S. BBD consumption matches supply due to the cost-competitiveness of BBD blends with pure petrodiesel at retail stations. Biodiesel is the primary form of BBD consumption, although renewable diesel's share of the total has increased over the last decade. U.S. motor vehicle, non-road, locomotive, and marine (MVNRLM) diesel fuel contained an average BBD blend of approximately 5 vol% in 2017.

Biodiesel has been broadly approved under U.S. on-road diesel engine warranties for use in blends of up to 20 vol% with petrodiesel. It is also approved for use as blends of up to 5 vol% in most other diesel fuel applications. Renewable diesel that meets the ASTM D975 specification can be used in blends of up to 100 vol% in almost all diesel fuel applications. Average blend rates do not remain steady throughout the year but instead increase from March to August/September before declining through the end of the year. This annual pattern exists due to a combination of seasonal and policy factors.

BBD PERFORMANCE

Biodiesel's technical performance is comparable to that of petrodiesel in commercial applications. Pure biodiesel's energy content is lower than that of petrodiesel due to the former's oxygen content. However, the effect of this on engine power is largely offset by biodiesel's higher fuel density and the prevalence of biodiesel blends that are ≤20 vol%. Biodiesel's primary technical disadvantage is its high cloud point, which is the temperature at which the fuel begins to freeze, relative to petrodiesel. Biodiesel blends do offer some performance advantages over ULSD in the form of higher cetane numbers and improved lubricity.

Pure renewable diesel offers multiple advantages over both petrodiesel and biodiesel. Renewable diesel is a hydrocarbon and, as such, has an energy content comparable to that of petrodiesel, even in a 100 vol% blend. Renewable diesel's cold point can be reduced to or below that of No. 1 ULSD, although doing so causes the production pathway's renewable diesel yield to be reduced in favor of higher naphtha yields. Renewable diesel's cetane number is also higher than that of petrodiesel.

BBD consumption results in lower life cycle greenhouse gas (GHG) emissions than petrodiesel. The amount of the reduction is a function of the specific BBD production pathway employed, but BBD that is derived from residue and waste feedstocks achieves larger reductions (up to 80-90%) relative to petrodiesel than does BBD that is derived from agricultural crops.

BBD ECONOMICS

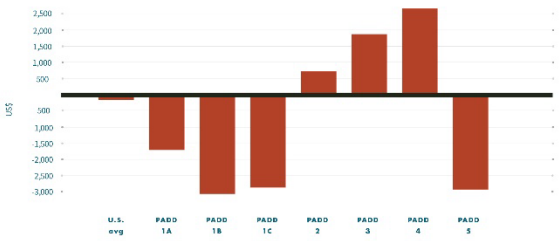
Biodiesel production economics operate as a function of input costs and the price of biodiesel that is paid to producers by blenders. The wholesale biodiesel price is also determined by the presence of government incentives such as the RFS, the BTC, and the LCFS. Biodiesel production margins have been positive for most of the last decade, although they have not always exceeded producers' costs of capital. The price of soybean oil explains most of the variation in the biodiesel breakeven price over the last decade.

The renewable diesel pathway's production economics have not been as well-studied as those of biodiesel due to the former's comparative lack of development. Both pathways have similar production economics in that they utilize similar feedstocks and inputs to yield similar products. Renewable diesel's production costs are higher than those of biodiesel, but the former also has a higher market value due to its superior energy content and technical performance. The limited data that is available for renewable diesel suggests that its production margins have been substantially more favorable than those of biodiesel over the last five years.

The incentives available for BBD result in blenders willing to pay a premium for the fuel. The existence of the BBD premium does not mean that BBD blends have a correspondingly more expensive retail price. The average retail price of the blend for which data is available (20 vol% biodiesel) was 9% higher than that of petrodiesel on an energy-equivalent basis over the last decade. BBD has been cost-competitive with ULSD because the value of the incentives generated by blenders has offset the higher production cost of biodiesel relative to petrodiesel.

The difference between the retail prices of petrodiesel and 20 vol% biodiesel blends varies widely across PADD regions due to regional differences in biodiesel production costs, petrodiesel retail prices, and the presence of many different state-level fuel excise tax credits for biodiesel blends that petrodiesel is not eligible for.

FIGURE ES-15. AVERAGE ANNUAL FUEL COST DIFFERENCE OF USING 20 VOL% BIODIESEL BLEND RELATIVE TO ULSD BASELINE. Assumes a fully loaded Class 8 tractor-trailer truck, a mixed drive cycle with fuel consumption of 17.2 gallons per 100 miles for both petrodiesel and a 20 vol% biodiesel blend, and 68,155 average annual vehicle miles. Based on average prices from January 2015 to December 2018.



About the Fuels Institute

Founded by NACS in 2013, the Fuels Institute is a nonprofit tax-exempt social welfare organization under section 501(c)(4) of the Internal Revenue Code. We are dedicated to evaluating issues affecting the vehicles and fuels markets. We commission comprehensive, fact-based research projects that are designed to answer questions, not advocate a specific outcome. Our reports address the interests of industry stakeholders—from business owners making long-term investment decisions to policymakers considering legislation and regulations that affect these markets.

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