



Short-Term Energy Outlook: Biofuels Forecasts

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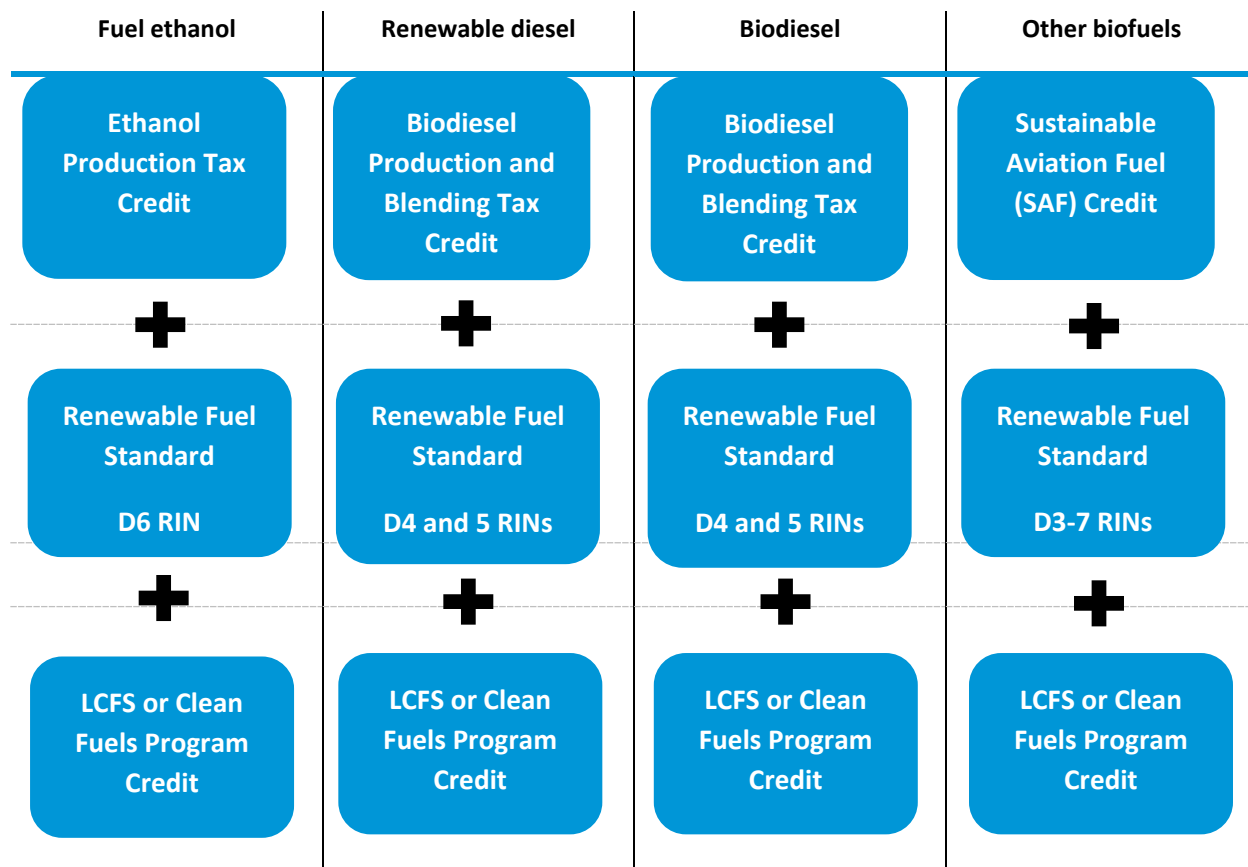
1. Introduction

Biofuels are liquid fuels produced from biomass materials—such as vegetable oils, animal fats, and cellulose—called feedstocks. Most biofuels are used as transportation fuels, but they may also be used for heating and electricity generation. The *Short-Term Energy Outlook* (STEO) forecasts consumption, production, and net imports for the following biofuels categories:

- Fuel ethanol
- Renewable diesel
- Biodiesel
- Other biofuels

Production and consumption of biofuels in the United States have generally increased each year since the early 1980s. The increases largely reflect various [government policies and programs](#) intended to reduce the use of transportation fuels made from fossil fuels by promoting or requiring the use of biofuels. Among these government programs is the Renewable Fuel Standard (RFS), which requires the incorporation of renewable fuels into the nation’s transportation fuel supply and is administered by the U.S. Environmental Protection Agency (EPA). In addition to federal legislation incentivizing biofuel use, biofuels are used to comply with [California’s Low Carbon Fuel Standard \(LCFS\)](#), [Oregon’s Clean Fuels Program](#), and [Washington State’s Clean Fuels Program](#).

Figure 1. Government incentives for biofuels, as of March 2023



Data source: U.S. Energy Information Administration

Note: LCFS=credits from California’s Low Carbon Fuel Standard, RINs= Renewable Identification Number credits from the Renewable Fuel Standard (RFS).

2. Categories of Biofuels

2.1. Fuel ethanol

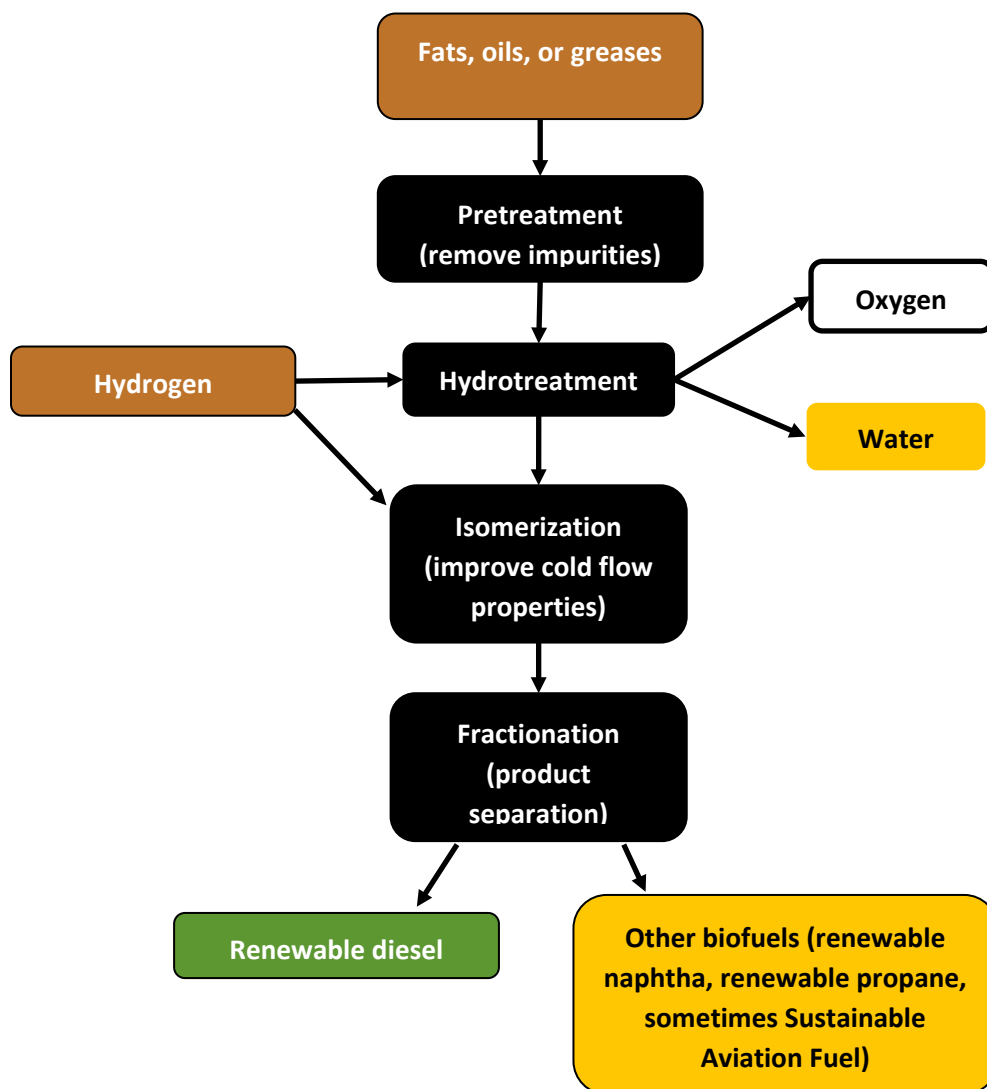
Fuel ethanol is an alcohol fuel made by fermenting the sugar in the starches of grains such as corn that is blended with petroleum gasoline for use in vehicles. Most gasoline sold in the United States is a blend of 90% petroleum-based gasoline and 10% ethanol (E10). Smaller amounts of gasoline sold in the United States are E15, a gasoline blend of 15% fuel ethanol, and E85, a gasoline blend that contains between 51% and 83% fuel ethanol. Most fuel ethanol in the United States is produced in the Midwest.

Fuel ethanol is used as an oxygenate in gasoline. Oxygenates are hydrocarbons with one or more oxygen atoms that are added to gasoline to make it burn more cleanly, thereby reducing toxic tailpipe pollution. Oxygenates were initially required by the 1990 amendments to the Clean Air Act, which resulted in the proliferation of methyl tertiary-butyl ether (MTBE) as the primary oxygenate in reformulated gasoline. In 2005, that mandate was replaced by the RFS program, which requires the blending of fuel ethanol but not MTBE (which is now generally banned because of health concerns) and has resulted in fuel ethanol becoming the primary source of oxygenate in gasoline.

2.2. Renewable diesel

Renewable diesel is a transportation and heating fuel that is chemically equivalent to petroleum diesel but is produced using fats, oils, or greases rather than petroleum. Renewable diesel is considered an interchangeable, drop-in replacement for petroleum-based diesel fuel (meaning it can be used in diesel engines without modification). Renewable diesel feedstocks are typically processed via a hydrotreating process that occurs at both standalone renewable diesel plants and petroleum refineries that co-process renewable diesel. Renewable diesel can be transported through the same pipelines as petroleum diesel but also is transported via rail, ship, and truck. Renewable diesel has been the fastest-growing biofuel in terms of production growth. As of 2022, the product is primarily consumed in the West Coast region.

Figure 2. Renewable diesel hydrotreatment flow chart

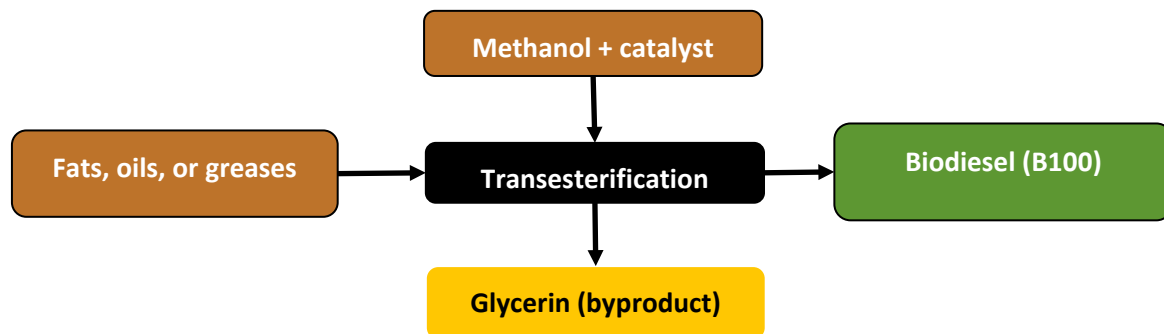


Data source: U.S. Energy Information Administration and [Valero Basics of Refining and Renewable Diesel, Slide 25](#)

2.3. Biodiesel

Biodiesel is a transportation and heating fuel produced through the [transesterification](#) of fats, oils, and greases. Whereas renewable diesel is considered an interchangeable, drop-in replacement for petroleum-based diesel fuel, biodiesel is considered a blending fuel because of its more substantive chemical differences from petroleum diesel. Biodiesel is typically blended with petroleum diesel in concentrations of 2% to 20% and is produced at facilities devoted to biodiesel.

Figure 3. Biodiesel transesterification flow chart



Data source: U.S. Energy Information Administration

2.4. Other biofuels

Other biofuels includes other liquid fuels derived from biomass feedstocks and include the following:

- Renewable heating oil
- Renewable jet fuel (sustainable aviation fuel)
- Renewable naphtha and gasoline
- Biobutanol
- Other biofuels and intermediates

Other biofuels can be produced at renewable diesel facilities or facilities focused on sustainable aviation fuel (SAF). As of 2022, they are produced exclusively at renewable diesel facilities. The hydrotreating process that produces renewable diesel commonly produces two other biofuels as byproducts or coproducts: renewable naphtha and renewable propane (LPG). With facility adjustments, the outputs of the hydrotreating process can be shifted to reduce renewable diesel production in favor of producing SAF and more renewable naphtha and LPG.

3. Data Sources

Data for all biofuels appear in the [Petroleum Supply Monthly](#) (PSM). We publish PSM data with a two-month lag. For example, the PSM released at the end of March contains data through January. The PSM data for ethanol, renewable diesel, biodiesel, and other biofuels all come from the [Monthly Report of Biofuels, Fuel Oxygenates, Isooctane, and Isooctene \(EIA-819\) survey](#), which began in 2021.

You can also find data from Form EIA-819 and other surveys in the [Monthly Energy Review](#) (MER). Ethanol data are in [MER Table 10.3](#), biodiesel in [10.4a](#), renewable diesel in [10.4b](#), and other biofuels in

10.4c. We publish MER data with a three-month lag. The MER has historical data for renewable diesel and other biofuels production and consumption that predate the EIA-819 survey. For those years predating the EIA-819 survey, data come from a combination of EPA data and data for net imports, which we have been collecting since 2011.

STEO uses monthly estimates based on weekly data from our *Weekly Petroleum Status Report* (WPSR) to fill in ethanol data for the two most recent months in the WPSR data series. STEO uses model estimates for the most recent two months of historical data for renewable diesel, biodiesel, and other biofuels data that are not available in WPSR.

Net import values for renewable diesel and other biofuels are labeled as such to match the label we use for other liquid fuels. These series do not include exports and solely represent gross imports.

Table 1. Where to find production, consumption, and net import data for biofuels

	Fuel ethanol	Renewable diesel	Biodiesel	Other biofuels
Historical weekly	WPSR	N/A	N/A	N/A
Historical monthly	PSM	PSM	PSM	PSM
	MER Table 10.3	MER Table 10.4b	MER Table 10.4a	MER Table 10.4c
		Note: Exports not subtracted from net imports		Note: Exports not subtracted from net imports
Forecast	STEO Table 4a for production and consumption	STEO Data Browser	STEO Data Browser	STEO Data Browser
	STEO Data Browser			

Data source: U.S. Energy Information Administration

Note: PSM=*Petroleum Supply Monthly*, STEO=*Short-Term Energy Outlook*, MER=*Monthly Energy Review*, WPSR=*Weekly Petroleum Status Report*, N/A=not available.

4. Linear Regression Models

4.1. Fuel ethanol

For ethanol, we forecast production, consumption (measured as product supplied), net imports, ethanol share of gasoline, and inventories.

4.1.1. Fuel ethanol production and inventories

We compute our forecast for fuel ethanol production as a *balancing item* (using an accounting relationship) based on the forecasts for consumption, net imports, and inventory changes.

- Production = consumption – net imports + inventory increase

4.1.2. Fuel ethanol consumption

Fuel ethanol is blended with gasoline for use in internal combustion engine vehicles. The fuel ethanol increases the oxygen content of the fuel to allow for more consistent combustion and reduced carbon monoxide emissions. Fuel ethanol blending also helps meet volume obligations for the RFS. Because fuel ethanol is used almost exclusively in gasoline blends, our fuel ethanol consumption model is tied to our motor gasoline consumption model. The following variables are included in the fuel ethanol consumption model:

- Motor gasoline consumption
- Monthly dummy variables to capture seasonal effects
- A trend variable to reflect structural market changes
- A one-month lagged dependent variable to capture the effect of the previous month's consumption on the current month's consumption

4.1.3. Fuel ethanol net imports

The United States is historically a net exporter of fuel ethanol. Exports tend to be higher during the winter months and lower during the summer driving months, when domestic demand for ethanol is highest. We include the following variables in the fuel ethanol net import model:

- Monthly dummy variables to capture seasonal effects
- A one-month lagged dependent variable to capture the effect of the previous month's net imports on the current month's net imports

4.1.4. Fuel ethanol share of gasoline

This forecast is a function of our fuel ethanol consumption forecast and motor gasoline consumption forecast.

- Fuel ethanol share of gasoline = fuel ethanol consumption / motor gasoline consumption

4.2. Renewable diesel

For renewable diesel, we forecast production, consumption (product supplied), and net imports. [We began forecasting](#) these series in 2022.

4.2.1. Renewable diesel production

The introduction of new renewable diesel plants has been driving renewable diesel production. We include the following variables in the renewable diesel production model:

- An internal judgment-based forecast for renewable diesel production capacity
- Monthly dummy variables to capture seasonal effects
- A one-month lagged dependent variable to capture the effect of the previous month's production on the current month's production

4.2.2. Renewable diesel consumption

Our forecast for renewable diesel consumption is a balancing item based on the forecasts for production and net imports.

- Consumption = production + net imports – inventory increase

4.2.3. Renewable diesel net imports

Because our surveys do not capture renewable diesel exports, this series only includes imports. We include the following variables in the renewable diesel net imports model:

- Monthly dummy variables to capture seasonal effects
- A trend variable to reflect structural market changes, such as domestic and international production and demand for renewable diesel
- A one-month lagged dependent variable to capture the effect of the previous month's net imports on the current month's net imports

4.3. Biodiesel

For renewable biodiesel, we forecast production, consumption (product supplied), and net imports. [We began forecasting](#) these series in 2022.

4.3.1. Biodiesel production

Like renewable diesel, biodiesel production has for the most part tracked with changes in production capacity. Biodiesel and renewable diesel compete for the same feedstocks, and biodiesel production capacity has generally decreased as renewable diesel production has increased. We include the following variables in the biodiesel production model:

- An internal judgment-based forecast for biodiesel production capacity
- The renewable diesel production forecast to capture the inverse relationship between the two fuels competing for limited feedstocks
- Monthly dummy variables to capture seasonal effects
- A one-month lagged dependent variable to capture the effect of the previous month's production on the current month's production

4.3.2. Biodiesel consumption

Our forecast for biodiesel consumption is a balancing item based on the forecasts for production and net imports.

- Consumption = production + net imports – inventory increase

4.3.3. Biodiesel net imports

Unlike the renewable diesel series, which only includes imports, biodiesel net imports includes both imports and exports. We include the following variables in the biodiesel net imports model:

- Monthly dummy variables to capture seasonal effects
- A one-month lagged dependent variable to capture the effect of the previous month's net imports on the current month's net imports

4.4. Other biofuels

For other biofuels, we forecast production, consumption (product supplied), and net imports. [We began forecasting](#) these series in 2022.

4.4.1. Other biofuels production

Production of other biofuels has historically been driven by increased renewable diesel production capacity because renewable diesel plants produce some biofuels as byproducts. If SAF plants begin to come online in the future or renewable diesel plants alter their equipment to produce more SAF, this forecast may become subject to more analyst judgment or new variables. As of March 2023, we include the following variables in the other biofuels production forecast:

- The renewable diesel production forecast to capture growth in byproducts of renewable diesel
- Monthly dummy variables to capture seasonal effects
- A one-month lagged dependent variable to capture the effect of the previous month's production on the current month's production

4.4.2. Other biofuels consumption

Our forecast for other biofuels consumption is a balancing item based on the forecasts for production and net imports.

- Consumption = production + net imports – inventory increase

4.4.3. Other biofuels net imports

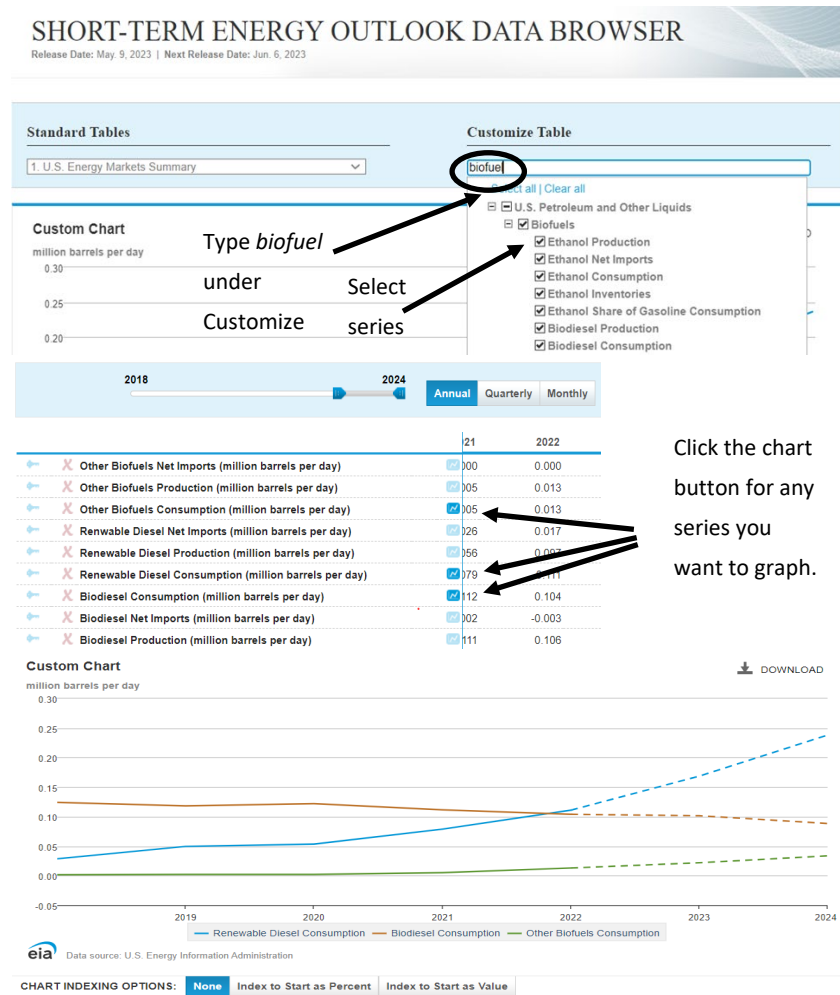
Because our surveys do not capture other biofuels exports, this series only includes imports. Through 2022, the United States very rarely imported other biofuels. We include the following variables in the other biofuels net imports model:

- Monthly dummy variables to capture seasonal effects
- A trend variable to reflect structural market changes, such as domestic and international production and demand for other biofuels
- A one-month lagged dependent variable to capture the effect of the previous month's net imports on the current month's net imports

5. Biofuels Data in STEO

Biofuels forecasts can be found in STEO Tables 4a and 4b and on the [STEO Data Browser](#). However, the way we present the consumption data differs between the two sources.

Figure 4. STEO Data Browser



Click the chart button for any series you want to graph.

Data source: U.S. Energy Information Administration

Table 4a shows forecasts for production, consumption, net imports, and stocks of fuel ethanol and other hydrocarbons and oxygenates, including renewable diesel, biodiesel, and other biofuels. In Table 4a, consumption (product supplied) of other hydrocarbons and oxygenates does not include refiner and blender net inputs of renewable diesel, biodiesel, and other biofuels, which are listed in Table 4b. By definition, product supplied should only represent the amount of fuel directly supplied to the market. If a biofuel is blended with a petroleum-based fuel, it should be considered a refiner and blender net input of that fuel and included in the product supplied of the petroleum-based fuel. For example, ethanol blended into motor gasoline is shown in Table 4a as a subcomponent of total motor gasoline product supplied. Most renewable diesel, biodiesel, and other biofuels are blended into petroleum fuels. Currently, only a very small share are consumed directly. However, because our survey data does not capture all biofuels that are blended into petroleum diesel, STEO Table 4a likely overcounts product supplied of other hydrocarbons and oxygenates.

On the STEO Data Browser, consumption of renewable diesel, biodiesel, and other biofuels reflects the sum of refiner and blender net inputs and product supplied. Regardless of whether biofuels are blended

or consumed pure, they are replacing consumption of petroleum fuels. Most analysts will be interested in the consumption series on the STEO Data Browser because it reflects the quantity of biofuels being consumed and so the quantity of petroleum fuels being replaced.

Our recommended method for calculating how much total distillate fuel oil is consumed (petroleum distillate fuel oil + renewable diesel and biodiesel) is to use [four series in the STEO Data Browser](#) (Biodiesel Consumption, Renewable Diesel Consumption, Distillate Fuel Oil Product Supplied, and Renewable Fuels Except Fuel Ethanol Refinery and Blender Net Inputs) and calculate the following:

- Consumption = distillate fuel oil product supplied + renewable diesel consumption + biodiesel consumption - renewable fuels except fuel ethanol refinery and blender net inputs