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The Renewable Fuel Standard (RFS): An Overview

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Summary

The Renewable Fuel Standard (RFS) requires U.S. transportation fuel to contain a minimum volume of renewable fuel each year. The RFS—established by the Energy Policy Act of 2005 (P.L. 109-58; EPA05) and expanded in 2007 by the Energy Independence and Security Act (P.L. 110-140; EISA)—began with requiring 4 billion gallons of renewable fuel in 2006 and was scheduled to ascend to 36 billion gallons in 2022. The total renewable fuel annual target specified in statute consists of both conventional biofuel and advanced biofuel. Since 2014, the total renewable fuel statutory target has not been met.

The U.S. Environmental Protection Agency (EPA) administers the RFS and is responsible for several related tasks. For instance, using the statutory criteria, EPA evaluates which renewable fuels are eligible for the RFS program. EPA also monitors compliance with the RFS requirements using a system of tradable credits referred to as renewable identification numbers (RINs). From the program's inception through 2022, EPA established the amount of total renewable fuel that refiners and importers had to account for in the coming year based on statutory targets, fuel supply, and other conditions. EPA exercised its waiver authorities to reduce volumes when necessary. For the last nine years (i.e., the latter half) of the program's statutory annual requirements, EPA set the total renewable fuel volume below the statutory amount—using its waiver authorities—mainly due to underproduction of advanced biofuels.

The RFS began a new phase in 2023 as the EPA has statutory authority and an obligation to determine the annual volume requirements after 2022. EPA is to determine the volume requirements, in coordination with the Secretaries of Energy and Agriculture, based on a review of program implementation for prior years, and an analysis of various criteria (e.g., the impact of renewable fuels on the energy security of the United States). EPA has used this authority previously. EPA determined the volume amounts for biomass-based diesel from 2013 to 2022 via the rulemaking process after the annual statutory targets for biomass-based diesel ended in 2012.

In July 2023, EPA published the final rule—referred to as the “set rule”—for the RFS volume requirements for 2023-2025, which contains a number of actions. EPA increased the total renewable fuel volume by 1.5% in 2023 (20.94 billion gallons), by 4.4% in 2024 (21.54 billion gallons), and by 8.2 % in 2025 (22.33 billion gallons) from the 2022 final volume of 20.63 billion gallons (not including the supplemental standard of 250 million gallons for 2022 to partially address a court remand). EPA maintained the 15.0-billion-gallon cap for conventional biofuel—which has been statutorily mandated since 2015—for all three years. EPA did not finalize the proposed revisions for the renewable electricity component of the program (i.e., eRINs) and reports that it will “continue to work on potential paths forward for the eRIN program.” The final rule adds a supplemental volume of 250 million gallons of total renewable fuel for 2023 to partially address a court decision. The final rule contains other actions including modifications to the regulatory provisions for biogas-derived renewable fuels, enhancements of the third-party oversight provisions of the program, and revising the conversion factor in the formula for calculating the percentage standard for biomass-based diesel.

Congress has expressed ongoing interest in various facets of the RFS, including annual volume amounts, the implementation of the renewable electricity component of the program, EPA approval of fuel pathways, RFS compliance, small refinery exemptions, and how the program performs overall (e.g., environmental effects). For years, some in Congress have debated various aspects of the RFS, including program management, transparency, and certainty. Further, there have been repeated efforts by some Members to amend the RFS, while other Members have acted to maintain the status quo.

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Introduction

Established by Congress as an amendment to the Clean Air Act, the Renewable Fuel Standard (RFS) mandates that U.S. transportation fuels contain a minimum volume of renewable fuel.¹ The mandated minimum volumes specified in statute increased annually from 2006 through 2022 and generally were met using both conventional biofuel (e.g., corn starch ethanol) and advanced biofuel (e.g., cellulosic ethanol).² For a renewable fuel to be applied toward the mandate, it must be used for certain purposes (i.e., fuel used in on-road motor vehicles, jet fuel, or heating oil) and meet certain environmental and biomass feedstock criteria. The Environmental Protection Agency (EPA) administers the program.

The statute outlines annual volume requirements—listed in tables for specific years—for four fuel categories: total renewable fuel, total advanced biofuel, cellulosic biofuel, and biomass-based diesel.³ The total renewable fuel statutory volume required for any given year equates to the sum of conventional biofuel (which is unspecified in statute) and advanced biofuel (which is specified in statute).⁴ Both cellulosic biofuel and biomass-based diesel are subcategories of advanced biofuel (both of which are specified in statute). There is also a third advanced biofuel category—other advanced biofuels (which is unspecified in statute).⁵

The statutory volume requirements for both total renewable fuel and total advanced biofuel for the RFS have not been met since 2013. The EPA Administrator had the authority to waive the statutory RFS requirements, in whole or in part, if certain conditions outlined in statute occurred.⁶ EPA used this waiver authority multiple times to reduce the volumes obligated parties must blend into transportation fuel. For instance, the 2022 targets set by EPA for total renewable fuel and for total advanced biofuel were approximately 57% and 27% of the statutory targets, respectively.⁷ A variety of factors, such as infrastructure limitations, technological development, and limited federal assistance for developing biofuels, have contributed to challenges in meeting the total volume requirement established by Congress. These challenges have also included a lack of cellulosic biofuel production and the amount of time it takes EPA to approve fuel pathways for the program.⁸ Oil prices, consumer demand for transportation fuel, and circumstances related to the COVID-19 pandemic from the last few years may have also contributed to the challenges in meeting the more recent total statutory volume requirements.

Two fuel categories consistently have met their statutory targets for either the entire term of the program thus far, or most of the entire term: conventional biofuel (which has an implied target)

¹ 42 U.S.C. §7545(o). The term renewable fuel is defined in statute as “fuel that is produced from renewable biomass and that is used to replace or reduce the quantity of fossil fuel present in a transportation fuel.” 42 U.S.C. §7545(o)(1)(J).

² The U.S. Energy Information Administration (EIA) defines biofuels as “liquid fuels and blending components produced from biomass feedstocks, used primarily for transportation.” U.S. Energy Information Administration, *Glossary—Biofuels*, 2022.

³ See 42 U.S.C. §7545(o)(2)(B) for the statutory tables.

⁴ Conventional biofuel equates to the difference between the total renewable fuel category and the advanced biofuel category.

⁵ Other advanced biofuel is computed by subtracting both the cellulosic biofuel category and the biomass-based diesel category from the total advanced biofuel category.

⁶ For more information, see CRS Report R44045, *The Renewable Fuel Standard (RFS): Waiver Authority and Modification of Volumes*, by Kelsi Bracmort.

⁷ U.S. Environmental Protection Agency, “Renewable Fuel Standard (RFS) Program: RFS Annual Rules,” 87 *Federal Register*, July 1, 2022.

⁸ For an explanation and discussion of fuel pathways, see the “Administering Agency” section of this report.

and biomass-based diesel (which has an explicit target).⁹ Also, since 2014, two advanced biofuel pathways—renewable compressed natural gas and renewable liquefied natural gas—have constituted the majority of the cellulosic biofuel volume requirements as finalized by EPA.¹⁰

A multitude of factors affect the conditions under which the RFS operates—some external to RFS policy and some internal. The impact of these factors can be challenging to both identify and quantify in a timely manner (e.g., commodity supply and pricing, agricultural trade issues, consumer buying power, and crude oil and gasoline prices). It is also uncertain how the program will fare currently given that the EPA Administrator has the discretion to determine the volume amounts for all fuel categories from 2023 onward.¹¹

Challenges to implementing the RFS have led to scrutiny of the program in Congress and to litigation about EPA's regulations.¹² Largely due to concerns about the implementation and feasibility of the RFS, some Members of Congress have expressed their perspectives on EPA's rulemakings as well as EPA's implementation of the program.¹³ They also have questioned whether to amend or repeal the RFS or whether to maintain the status quo.¹⁴ This report provides an overview of the RFS, including some of the widely discussed policy issues related to it.¹⁵

The Statute

The RFS was established by the Energy Policy Act of 2005 (P.L. 109-58; EPAct05).¹⁶ It was expanded in 2007 by the Energy Independence and Security Act (P.L. 110-140; EISA) (see the text box in this section for a discussion of the differences between the 2005 RFS and the 2007 RFS). The RFS mandate requires that transportation fuels sold or introduced into commerce in

⁹ U.S. Environmental Protection Agency, *Public Data for the Renewable Fuel Standard Data*, July 7, 2023.

¹⁰ Ibid. EPA defines renewable compressed natural gas as biogas or biogas-derived pipeline quality gas that is compressed for use as transportation fuel and meets the definition of renewable fuel. EPA defines renewable liquefied natural gas as biogas or biogas-derived pipeline quality gas that goes through the process of liquefaction in which it is cooled below its boiling point, and which meets the definition of renewable fuel. See 40 C.F.R. §80.1401.

¹¹ 42 U.S.C. 7545(o)(2)(B)(ii).

¹² Since 2010, there have been numerous congressional hearings about the RFS. Additionally, there have been multiple legal challenges regarding EPA's administration of the RFS. In some cases, courts have found against EPA's rules for various reasons; in others, courts have affirmed EPA's authority.

¹³ See, for example, Sen. Carper, "Carper Statement on EPA's Final Renewable Fuel Standard Rule," press release, June 21, 2023; Sen. Coons, "Senator Coons Statement on EPA Release of Final Renewable Fuel Standard Rule," press release, June 21, 2023; Sen. Ricketts, "Ricketts Comments on New Renewable Fuel Standard Set Rule," press release, June 21, 2023; Sen. Stabenow, "Statement of Chairwoman Debbie Stabenow (D-Mich.) on EPA New Renewable Fuel Standard Final Rule," press release, June 21, 2023; Sen. Booker, "Booker, Gillibrand, Sanders, Warren, Markey Urge EPA and USDA to Limit New Incentives for Factory Farm Biodigesters," press release, August 24, 2022 and Sen. Grassley, "Grassley-Cornyn Bill Pulls Plug on Latest Biden Boon for EVs," press release, May 18, 2023.

¹⁴ Legislation has been introduced in the 118th Congress that would repeal, amend, or further support the RFS (see, for example, H.R. 2778 and H.R. 3337). For a brief discussion about potential legislative reform for the RFS, see CRS In Focus IF10842, *The Renewable Fuel Standard: Is Legislative Reform Needed?*, by Kelsi Bracmort.

¹⁵ For additional discussion, see CRS Report R40155, *Renewable Fuel Standard (RFS): Overview and Issues*, by Kelsi Bracmort.

¹⁶ More specifically, Section 1501 (Renewable Content of Gasoline) of EPAct05 amended Section 211 of the Clean Air Act (CAA) by adding a Renewable Fuel Program. Section 1501 directed the EPA Administrator to ensure that gasoline sold or introduced into commerce in the United States contained a minimum volume of renewable fuel. This "original" 2005 RFS required 4.0 billion gallons of renewable fuel for 2006, ascending to 7.5 billion gallons by 2012. The amount of renewable fuel was prescribed in EPAct05 for the years 2006 through 2012. Beginning in 2013, the annual volume of renewable fuel was to be determined by the EPA Administrator and the Secretaries of Agriculture and Energy. Additionally, the RFS established in EPAct05 would have required that at least 250 million gallons of the renewable fuel be derived from cellulosic biomass starting in 2013.

the United States contain an increasing volume of a predetermined suite of renewable fuels. The statute required 4.0 billion gallons of renewable fuel in 2006, ascending to 36.0 billion gallons required in 2022, with EPA determining the volume amounts after 2022 in future rulemakings.

The statute centers on four renewable fuel categories—total renewable fuel, advanced biofuel, cellulosic biofuel, and biomass-based diesel—each with its own target volume.¹⁷ A key part of the statutory definition of each fuel category is whether the fuel achieves certain greenhouse gas (GHG) reductions relative to gasoline and diesel fuel. Each fuel is assigned a lifecycle GHG emission threshold (in proportion to baseline lifecycle GHG emissions for gasoline and diesel).¹⁸

The total renewable fuel requirement under the RFS is met with the combination of fuels from two renewable fuel categories: conventional biofuel and advanced biofuel. The requirement for advanced biofuel, in general, can be met with the combination of three types of advanced biofuel: cellulosic biofuel, biomass-based diesel, and other advanced biofuels. To date, the total annual volumes required have been met mostly with conventional biofuel (e.g., corn starch ethanol). Beginning in 2015, the statutory renewable fuel volume tables implicitly capped the conventional biofuel volume amounts while increasing the requirement for advanced biofuels.¹⁹ For instance, the RFS total advanced biofuel requirement specified in the statutory volume tables increased over time from approximately 7% of the total renewable fuel requirement in 2010 to 58% of the total renewable fuel target in 2022.²⁰

Differences Between the 2005 (“RFS 1”) and the 2007 (“RFS 2”) Laws

There are at least five major changes in the RFS as expanded in 2007 by EISA:

- larger annual volume targets specified in statute for an extended period of time (i.e., through 2022),
- the establishment of separate requirements for different classes of biofuels (e.g., cellulosic, advanced),
- the addition of greenhouse gas accounting requirements,
- a different renewable biomass definition (as explained below), and
- an expansion of EPA’s waiver authority to lower RFS volumes.

The renewable biomass definition for the RFS under EISA does not make the majority of woody biomass on federal lands available for use as a renewable feedstock. Further, the 2007 RFS waiver authority directs the EPA Administrator to set the annual standard for cellulosic biofuels under the RFS for the following year by November 30 of each year, and to lower the cellulosic biofuel standard if projected U.S. production is less than the volume in the statute. The 2007 RFS waiver authority also allows the EPA Administrator to reduce the renewable fuel and advanced biofuel requirements of the standard, if the cellulosic biofuel requirement is lowered.

¹⁷ The statute defines the four renewable fuels. 42 U.S.C. §7545 (o)(1). *Conventional biofuel* is corn starch ethanol. *Advanced biofuel* is renewable fuel, other than corn starch ethanol, with lifecycle greenhouse gas emissions of at least 50% less than lifecycle greenhouse gas emissions from its gasoline or diesel counterpart. *Cellulosic biofuel* is renewable fuel derived from cellulose, hemicellulose, or lignin that is derived from renewable biomass, with lifecycle greenhouse gas emissions of at least 60% less than lifecycle greenhouse gas emissions from its gasoline or diesel counterpart. *Biomass-based diesel* is biodiesel or other renewable diesel with lifecycle greenhouse gas emissions of at least 50% less than lifecycle greenhouse gas emissions from its diesel counterpart. Additionally, biofuel from new facilities—those built after enactment of the 2007 law—must achieve at least a 20% GHG reduction to qualify as a conventional renewable fuel. New facilities are facilities that commence construction after December 19, 2007. 42 U.S.C. §7545 (o)(2)(A)(i).

¹⁸ For more discussion, see CRS Report R40460, *Calculation of Lifecycle Greenhouse Gas Emissions for the Renewable Fuel Standard (RFS)*, by Brent D. Yacobucci and Kelsi Bracmort.

¹⁹ Starting in 2015, the statutory tables cap conventional biofuel at 15 billion gallons. From 2015 onward, the increase in the total renewable fuel statutory target stems from the increase in the advanced biofuel statutory target.

²⁰ Calculations include the annual mandate required by statute in 2007 and do not take into account EPA’s revision of the biofuel mandates for 2010 through 2018.

The statute directs the EPA Administrator to determine the volume amounts for calendar years not identified in the statutory volume tables (e.g., 2013 and onward for biomass-based diesel, 2023 and onward for total renewable fuel).²¹ The EPA Administrator is to determine the volume amounts, in coordination with the Secretaries of Energy and Agriculture, based on a review of the implementation of the program for the calendar years identified in the statutory volume tables and on an analysis of the following six factors:

1. the impact of the production and use of renewable fuels on the environment, including on air quality, climate change, conversion of wetlands, ecosystems, wildlife habitat, water quality, and water supply;
2. the impact of renewable fuels on the energy security of the United States;
3. the expected annual rate of future commercial production of renewable fuels, including advanced biofuels in each category (cellulosic biofuel and biomass-based diesel);
4. the impact of renewable fuels on the infrastructure of the United States, including deliverability of materials, goods, and products other than renewable fuel, and the sufficiency of infrastructure to deliver and use renewable fuel;
5. the impact of the use of renewable fuels on the cost to consumers of transportation fuel and on the cost to transport goods; and
6. the impact of the use of renewable fuels on other factors, including job creation, the price and supply of agricultural commodities, rural economic development, and food prices.

There are other conditions associated with the determination of the annual volumes for the calendar years not identified in the statutory volume tables. For example, the EPA Administrator must establish the volumes under this authority no later than 14 months before the first year for which the volumes will apply. The applicable volume for advanced biofuel must be at least the same percentage of the applicable volume of renewable fuel for calendar year 2022. Also, the applicable volume of cellulosic biofuel is to be set based on the assumption that the EPA Administrator will not need to issue a cellulosic biofuel waiver.

Statutory Compliance

EPA regulates compliance with the RFS using a tradable credit system.²² Obligated parties (generally, refiners and importers) submit credits—called renewable identification numbers (RINs)—to EPA for each gallon of fuel in their annual obligation.²³ (Thus, generally, each gallon of fuel produced to meet the obligation generates its own unique RIN.²⁴) In short, the annual obligation for an individual refiner or importer, referred to as the renewable volume obligation (RVO), is the obligated party’s total gasoline and diesel sales multiplied by the annual renewable

²¹ 42 U.S.C. §7545(o)(2)(B)(ii).

²² 42 U.S.C. §7545(o)(5).

²³ EPA defines an obligated party as any refiner that produces gasoline or diesel fuel within the 48 contiguous states or Hawaii, or any importer of gasoline or diesel fuel into the 48 contiguous states or Hawaii during a compliance period (40 C.F.R. §80.1406(a)(1)). A renewable identification number (RIN) is a unique 38-character number that is issued (in accordance with EPA guidelines) by the biofuel producer or importer at the point of biofuel production or the port of importation (40 C.F.R. §80.1425). There are five different RIN types which are assigned based on a fuel’s “D-code” depending upon the specific type of fuel (40 C.F.R. §80.1425). For more information, see CRS Testimony TE10026, *Background on Renewable Identification Numbers under the Renewable Fuel Standard*, by Brent D. Yacobucci.

²⁴ As will be discussed later in this section, some renewable fuels can generate more RINs per gallon of fuel.

fuel percentage standards announced by EPA.²⁵ The RVO is used by an obligated party to determine how many RINs they are to submit to EPA at the end of a given year to be in compliance with the mandate.

In general, the RIN lifecycle can be described in three steps:

1. a RIN is attached to a gallon of qualifying renewable fuel once that fuel is produced,
2. the RIN is separated once the renewable fuel is blended with gasoline or diesel fuel or used unblended, and
3. the separated RIN may be submitted for compliance, traded, or banked for future use.

RINs are valid for use to demonstrate compliance in the year they are generated and the following year.²⁶ RINs may be used by the party that generates them or they may be traded with other parties. The EPA Moderated Transaction System (EMTS) is used to register RIN transactions.

An obligated party incurs a deficit if they are unable to submit enough RINs to meet their RVO for that compliance period. An obligated party may carry a deficit due to a variety of reasons (e.g., financial constraints for purchasing RINs, an obligated party miscalculating how much gas or diesel they would produce). Obligated parties may carry a deficit from one year to the next, but in the year following the deficit, the obligated party must meet compliance for that year's renewable fuel volume requirement and purchase or generate enough credits to satisfy the deficit from the previous year.²⁷

Different biofuels are not treated equally within the RFS. The categories are nested within each other, such that some fuels qualify for multiple categories (e.g., cellulosic ethanol), while others (mainly corn starch ethanol) may only be used to meet the overall RFS but not the advanced category or its nested subcategories.²⁸ For example, a gallon of cellulosic biofuel may be used to meet the cellulosic biofuel mandate, the advanced biofuel mandate, or the total renewable fuel mandate, possibly making it a more highly valued fuel.²⁹

In addition, some biofuels generate more RINs per volume than others because of the difference in the fuel's energy content. This difference is accounted for by a metric referred to as the equivalence value (EV) of the biofuel.³⁰ The EV of a renewable fuel represents the number of gallons that can be claimed for compliance purposes for every physical gallon of renewable fuel used, and it is generally the ratio of the energy content of a gallon of the fuel to a gallon of

²⁵ The statute requires the EPA Administrator to express the annual renewable fuel obligation in percentages. 42 U.S.C. 7545(o)(3). For 2023, EPA reports the overall renewable fuel percentage standard is 11.96%, the advanced biofuel percentage standard is 3.39%, the biomass-based diesel percentage standard range is 2.58%, and the cellulosic biofuel percentage standard range is 0.48%. U.S. Environmental Protection Agency, "Renewable Fuel Standard (RFS) Program: Standards for 2023-2025 and Other Changes," 88 *Federal Register* 44468-44593, July 12, 2023. If applicable, the annual RVO calculation for an obligated party may include a carry-over deficit from the previous year.

²⁶ 40 C.F.R. §80.1427(a)(6)(i) in the EPA RFS regulations.

²⁷ 42 U.S.C. §7545(o)(5)(D).

²⁸ Although a gallon of a biofuel may be used to fulfill individual sub-requirements or the overall requirement, each gallon counts only once against the overall renewable fuel use obligation.

²⁹ The value of any biofuel within the RFS depends on the RIN price at a given time. As different categories of RINs are used to meet the various standards, there is often a price difference between RINs (e.g., advanced biofuel RINs are generally more expensive than conventional biofuel RINs). However, there is no public market for RINs, so real-time price data are difficult to obtain. EPA does provide historical weekly RIN price data. Environmental Protection Agency, *RIN Trades and Price Information*, July 7, 2023.

³⁰ 40 C.F.R. §80.1415.

ethanol. For example, non-ester renewable diesel has an EV of 1.7 when being used as an advanced biofuel, so 1,000 physical gallons of biodiesel would equal 1,700 RIN gallons of advanced biofuels.³¹

The 2023, 2024, and 2025 Final Rule

EPA announced the final rule—referred to as the “set rule”—for the 2023, 2024, and 2025 RFS volume requirements in June 2023.³² EPA increased the total renewable fuel for all three years from what was finalized in 2022 (see **Table 1**). EPA reports it is setting standards for three years “to strike an appropriate balance between improving the program by providing increased certainty over a multiple number of years and recognizing the inherent uncertainty in longer-term projections.”³³ **Table 2** shows the percentage increases for the fuel categories relative to the 2022 final volume requirements.

The final rule contains other actions. For instance, EPA reports it is not finalizing the renewable electricity provisions (i.e., eRINs) that it proposed for the program at this time. EPA reports it “will continue to work on potential paths forward for the eRIN program.”³⁴ EPA also reports “that there are not likely to be small refinery exemptions (SREs) for 2023–2025 based on the information available at the present time.”³⁵ EPA addresses a court remand of the 2014–2016 final rule by adding a second supplemental volume obligation of 250 million gallons for 2023. EPA also finalized several regulatory changes including modifying the regulatory provisions for biogas-derived renewable fuels, enhancing the third-party oversight provisions of the program, revising the conversion factor in the formula for calculating the percentage standard for biomass-based diesel, and addressing flexibility for RIN generation. Lastly, in the final rule EPA references recent legislative changes (e.g., P.L. 117-169, commonly known as the Inflation Reduction Act) and transportation, energy, and environment landscape changes as well as stakeholder perspectives, among other things, that it says will be used to inform future rulemaking decisions for the program.

EPA provided an additional resource when it released the set rule: a Model Comparison Exercise (MCE) Technical Document.³⁶ There has been an ongoing conversation about the adequacy of the modeling used by EPA to assess the lifecycle GHG emissions of renewable fuels for the RFS.³⁷ EPA acknowledges that its “previous [lifecycle analysis] framework is comparatively old, and that a better understanding of these newer models and data is needed.”³⁸ EPA reports there were various goals associated with conducting the MCE, including to “advance the science in the area of analyzing the lifecycle greenhouse gas emissions impacts from increasing use of biofuels.”³⁹

³¹ All equivalence values (EVs) are in relation to the energy content of ethanol. The EV for ethanol is 1.0. One gallon of non-ester renewable diesel contains roughly 1.7 times the energy of one gallon of ethanol, and thus has an EV of 1.7.

³² U.S. Environmental Protection Agency, “Renewable Fuel Standard (RFS) Program: Standards for 2023-2025 and Other Changes,” 88 *Federal Register* 44468-44593, July 12, 2023.

³³ *Ibid.*

³⁴ *Ibid.*

³⁵ *Ibid.*

³⁶ U.S. Environmental Protection Agency, *Model Comparison Exercise*, EPA-420-R-23-017, June 2023.

³⁷ Sen. Grassley, “Grassley, Joins Bipartisan Letter Urging Biden Administration to Strengthen Renewable Fuel Standard,” press release, April 14, 2023; Renewable Fuels Association, *RFA to EPA: Use Current Data and GREET Model to Update Corn Ethanol GHG Analysis*, April 4, 2022; Sen. Thune, “Thune, Klobuchar Reintroduce Bill to Recognize Environmental Benefit of Biofuels, Efficient Farming,” press release, February 3, 2021.

³⁸ U.S. Environmental Protection Agency, *Model Comparison Exercise*, EPA-420-R-23-017, June 2023.

³⁹ *Ibid.*

EPA included five models in its comparison exercise: the Greenhouse Gases, Regulated Emissions, and Energy Use in Technologies Model (GREET), Global Biosphere Management Model (GLOBIOM), Global Change Analysis Model (GCAM), Global Trade Project (GTAP) model, and Applied Dynamic Analysis of the Global Economy (ADAGE) model. EPA reports that it drew several broad conclusions from the MCE, including the following.

- Supply chain lifecycle analysis models, such as GREET, produce a fundamentally different analysis than economic models, such as ADAGE, GCAM, GLOBIOM, and GTAP;
- Estimates of land use change (LUC) vary significantly among the models used in this study; and
- Differences in model assumptions, parameters, and structure impact the results from each of the models.

EPA is seeking comment from stakeholders and researchers about the results of its MCE. EPA also states that it hopes the MCE will “lend itself to informing the scientific discussion on which and to what extent biofuels contribute to reduced environmental harm in comparison to consuming petroleum-based fuels.”⁴⁰

⁴⁰ Ibid.

Table I. Renewable Fuel Standard Statute and EPA Final Volumes
(billions of gallons)

Year	Statute or Final	Total Renewable Fuel	Amount from Advanced Biofuels			Cap on Conventional Biofuel	Due Date and Actual Date of Final Rule
			Total Advanced Biofuels	Cellulosic Biofuel	Biomass-Based Diesel		
2010	S	12.95	0.95	0.1000	0.65	12.00	Nov. 2009
	F	12.95	0.95	0.0065	1.15	12.00	Feb. 2010
2011	S	13.95	1.35	0.2500	0.80	12.60	Nov. 2010
	F	13.95	1.35	0.0060 ^a	0.80	12.60	Nov. 2010
2012	S	15.20	2.00	0.5000	1.00	13.20	Nov. 2011
	F	15.20	2.00	0.0105 ^b	1.00	13.20	Dec. 2011
2013	S	16.55	2.75	1.0000	≥1.00	13.80	Nov. 2012
	F	16.55	2.75	0.0008	1.28	13.80	Aug. 2013
2014	S	18.15	3.75	1.7500	≥1.00	14.40	Nov. 2013
	F	16.28	2.67	0.0330	1.63	13.61	Nov. 2015
2015	S	20.50	5.50	3.0000	≥1.00	15.00	Nov. 2014
	F	16.93 ^c	2.88	0.1230	1.73	14.05	Nov. 2015
2016	S	22.25	7.25	4.2500	≥1.00	15.00	Nov. 2015
	F	18.11 ^c	3.61	0.2300	1.90	14.50	Nov. 2015
2017	S	24.00	9.00	5.5000	≥1.00	15.00	Nov. 2016
	F	19.28	4.28	0.3110	2.00	15.00	Nov. 2016
2018	S	26.00	11.00	7.0000	≥1.00	15.00	Nov. 2017
	F	19.29	4.29	0.2880	2.10	15.00	Nov. 2017
2019	S	28.00	13.00	8.5000	≥1.00	15.00	Nov. 2018
	F	19.92	4.92	0.4180	2.10	15.00	Nov. 2018
2020	S	30.00	15.00	10.5000	≥1.0	15.00	Nov. 2019
	F	17.13	4.63	0.51	2.43	12.50	Jul. 2022
2021	S	33.00	18.00	13.5000	≥1.00	15.00	Nov. 2020
	F	18.84	5.05	0.56	2.43	13.79	Jul. 2022
2022	S	36.00	21.00	16.0000	≥1.00	15.00	Nov. 2021
	F	20.63 (+ 0.25) ^d	5.63	0.63	2.76	15.00	Jul. 2022
2023	F ^e	20.94 (+ 0.25) ^d	5.94	0.84	2.82	15.00	Jul. 2023 ^f
2024	F ^e	21.54	6.54	1.09	3.04	15.00	Jul. 2023 ^f
2025	F ^e	22.33	7.33	1.38	3.35	15.00	Jul. 2023 ^f

Source: Energy Independence and Security Act of 2007 (EISA; P.L. 110-140); Final rules are available at U.S. Environmental Protection Agency, *Regulations and Volume Standards for Renewable Fuel Standards*, July 7, 2023,

<https://www.epa.gov/renewable-fuel-standard-program/regulations-and-volume-standards-renewable-fuel-standards>.

Notes: S = Statute, F = Final. All volumes are ethanol equivalent, except for biomass-based diesel, which is actual. The 2010 biomass-based diesel requirement of 1.15 billion gallons equals the 0.5 billion gallon requirement for 2009 plus the 0.65 billion gallon requirement for 2010. Cap on Conventional Biofuel = Total Renewable Fuel – Total Advanced Biofuel. The total advanced biofuel requirement equals the sum of cellulosic biofuel and biomass-based diesel (both of which have annual volume targets provided in statute and are identified in **Table I** in italics) plus other advanced biofuel (which does not have an annual volume target provided in statute).

- a. EPA rescinded the 2011 cellulosic biofuel standard.
- b. RFS Final Rule 2012, *Federal Register*, January 9, 2012. Subsequently vacated under *American Petroleum Institute v. EPA*, D.C. Cir., No. 12-1139, 1/25/13.
- c. The D.C. Circuit Court vacated EPA’s 2016 total renewable fuel volume requirement and remanded the 2015 final rule to EPA for reconsideration. *Americans for Clean Energy v. EPA*, No. 16-1005, 2017 U.S. App. LEXIS 13692, at *4-5 (D.C. Cir. July 28, 2017).
- d. Supplemental standard of 250 million gallons for 2022 and 2023 to partially address court remand of 2016 standard. U.S. Environmental Protection Agency, “Renewable Fuel Standard (RFS) Program: RFS Annual Rules,” 87 *Federal Register*, July 1, 2022. U.S. Environmental Protection Agency, “Renewable Fuel Standard (RFS) Program: Standards for 2023-2025 and Other Changes,” 88 *Federal Register* 44468-44593, July 12, 2023.
- e. Volume amounts determined by the EPA Administrator. The EPA Administrator is to coordinate with the Secretaries of Energy and Agriculture and take into account an analysis of certain factors to determine the volume amounts. 42 U.S.C. §7545(o)(2)(B)(ii).
- f. July 2023 is the actual date of the final rule. The EPA Administrator must establish the volumes under this authority no later than 14 months before the first year for which the volumes will apply. 42 U.S.C. §7545(o)(2)(B)(ii).

Table 2. Renewable Fuel Percentage Increase from 2022 Final Volume Requirement

Year	Total Renewable Fuel	Portion from Advanced Biofuels			Conventional Biofuel
		Total Advanced Biofuels	Cellulosic Biofuel	Biomass-Based Diesel	
2023	1.50%	5.51%	33.33%	2.17%	0%
2024	4.41%	16.16%	73.02%	10.14%	0%
2025	8.24%	30.20%	119.05%	21.38%	0%

Source: EPA final rules for the RFS program.

Notes: Comparison to 2022 final volume requirement does not include the supplemental standard of 250 million gallons for 2022 and 2023 to partially address a court remand.

RFS Implementation Issues

Implementation of the RFS has been complex, and compliance with some of its parts has been challenging, according to some stakeholders. This section briefly explains some of the general concerns and challenges with implementing the RFS.

Administering Agency

EPA administers the RFS.⁴¹ This responsibility includes evaluating renewable fuel pathways eligible for the RFS.⁴² In addition, EPA is required to evaluate the ability of the biofuel industry to produce enough fuel to meet the annual volume standard, release an annual volume standard based on its research findings,⁴³ and ensure that annual compliance by obligated parties is met. All of the above were required to be completed annually for the calendar years identified in the statutory volume tables, in compliance with any directives from court decisions and taking into consideration comments from other government agencies and the public. Going forward, EPA is to continue many of the above-mentioned responsibilities, as well as the responsibilities associated with determining the volume amounts for calendar years not identified in the statutory volume tables. These responsibilities could be viewed as an addition to EPA's regulatory workload and have required EPA to develop new capabilities to carry them out.

In the years following the 2010 issuance of the amended RFS final rule,⁴⁴ EPA has used its waiver authorities to set annual volume requirements for cellulosic biofuel, total advanced biofuel, and total renewable fuel below the amounts stated in the statute.⁴⁵ Legal challenges have been brought against EPA regarding some of these annual fuel volume requirements and the projections on which they were based. For instance, the American Petroleum Institute objected to EPA's 2012 cellulosic biofuel production projection methodology, among other things, and challenged it in court. The federal court vacated the 2012 cellulosic biofuel standard and provided principles for EPA to apply to future annual projections.⁴⁶ Likewise, Americans for Clean Energy and other petitioners challenged various aspects of the final rule that set the volume requirements and projections for 2014-2016 and 2017 for biomass-based diesel, including EPA's interpretation of "inadequate domestic supply" in exercising its general waiver authority to reduce the total volume requirements. The D.C. Circuit held that EPA's interpretation of "inadequate domestic supply" was not reasonable and that EPA had improperly exercised its waiver authority as a result. It vacated EPA's 2016 total renewable fuel volume requirement and remanded the final rule to EPA for reconsideration consistent with the court's decision.⁴⁷

⁴¹ Although the RFS is administered by EPA, programs under other federal departments may indirectly assist biofuel production that may be used to meet the mandate. For example, the U.S. Department of Agriculture (USDA) provides resources and support for biofuel feedstock development and supply, biofuel infrastructure development, advanced biofuel production, and more (e.g., Rural Energy for America Program, Advanced Biofuel Payment Program, and Higher Blends Infrastructure Incentive Program). For more information on energy programs administered by USDA, see CRS Report R45943, *The Farm Bill Energy Title: An Overview and Funding History*, by Kelsi Bracmort.

⁴² A fuel pathway consists of three components: a biomass feedstock, a biofuel production process, and a fuel type (e.g., ethanol made from corn starch using a dry mill production process). The fuel pathway is assigned to a renewable fuel category (known by its D code provided in Table 1 of 40 C.F.R. §80.1426 in the RFS regulations) which signifies which RIN the biofuel is eligible for to be in compliance with the RFS. EPA maintains a list of approved fuel pathway and fuel pathway petitions on its website (<https://www.epa.gov/renewable-fuel-standard-program/approved-pathways-renewable-fuel>).

⁴³ Frequently, EPA has approved annual standards for some biofuels different from what was originally scheduled in statute.

⁴⁴ EPA, "Regulation of Fuels and Fuel Additives: Changes to Renewable Fuel Standard Program; Final Rule," 75 *Federal Register* 14670, March 26, 2010.

⁴⁵ For more discussion, see CRS Report R44045, *The Renewable Fuel Standard (RFS): Waiver Authority and Modification of Volumes*, by Kelsi Bracmort.

⁴⁶ *American Petroleum Institute v. EPA*, 706 F.3d 474 (D.C. Cir. 2013). More discussion of this legal challenge is in CRS Report R41106, *The Renewable Fuel Standard (RFS): Cellulosic Biofuels*, by Kelsi Bracmort.

⁴⁷ *Americans for Clean Energy v. EPA*, 864 F.3d 691, 737 (D.C. Cir. 2017).

In some instances, the timing of EPA's RFS regulatory actions, such as the annual announcement of the renewable fuel volume requirements, has not met statutory deadlines (see **Table 1**).⁴⁸ A lack of timely rulemaking combined with inaccurate volume projections could affect private investment, according to some advanced biofuel producers.⁴⁹ Additionally, the amount of time it takes the agency to approve new fuel pathways and register new facilities has been raised in public comments to proposed RFS rules.⁵⁰ Slow approval could potentially stifle investment and production of new fuels.

Qualifying Biofuels

As noted above, there are a number of nested categories within the RFS; a fuel may qualify as a biofuel for one or more portions of the mandate.⁵¹ Difficulty by some advanced biofuel producers in understanding which advanced biofuels qualify for the RFS can lead to challenges in determining how compliance is being met.⁵²

Not all fuels from a renewable source are eligible under the RFS. The RFS operates as a biofuel standard, with priority assigned to liquid transportation fuels from biomass feedstocks.⁵³ Other renewable sources (e.g., wind) do not qualify. Before a fuel can generate RFS RINs, however, that fuel pathway must be approved by EPA;⁵⁴ according to some in Congress and some advanced biofuel producers, that process can take a considerable amount of time for some fuels.⁵⁵

⁴⁸ Under the Clean Air Act, each year's standards specified in the statutory volume tables are required to be announced by November 30 of the previous year. EPA's late announcement of the annual requirements may be due to the timeliness and availability of information for the analysis or to other factors.

⁴⁹ Written statement by Nebraska Governor Pete Ricketts, Chairman, Governors' Biofuels Coalition, *U.S. Environment Protection Agency, Public Hearing, Proposed Renewable Fuel Standard Program: Standards for 2018 and Biomass-Based Diesel Volume for 2019*, Washington, DC, August 1, 2017.

⁵⁰ EPA, *Renewable Fuel Standard Program—Standards for 2020 and Biomass-Based Volume for 2021: Response to Comments*, EPA-420-R-19-018, December 2019, p. 30-32; U.S. Environmental Protection Agency, *Renewable Fuel Standard (RFS) Program: RFS Annual Rules Response to Comments*, EPA-420-R-22-009, June 2022, p. 322.

⁵¹ Approved RFS fuels and feedstocks are provided by EPA at <https://www.epa.gov/renewable-fuel-standard-program/approved-pathways-renewable-fuel>.

⁵² For example, there were questions by some about the eligibility of algae-based biofuels for the RFS. For more information, see CRS Report R42122, *Algae's Potential as a Transportation Biofuel*, by Kelsi Bracmort.

⁵³ In July 2014, EPA approved new cellulosic and advanced biofuel pathways to include the production of compressed natural gas, liquefied natural gas, and electricity from biogas from landfills, municipal waste-water treatment facility digesters, agricultural digesters, and separated municipal solid waste digesters. Compliant fuels for the RFS also include heating oil and jet fuel. See EPA, "Regulation of Fuels and Fuel Additives: RFS Pathways II, and Technical Amendments to the RFS Standards and E15 Misfueling Mitigation Requirements; Final Rule," *79 Federal Register* 42128, July 18, 2014. EPA, "Regulation of Fuels and Fuel Additives: Modifications to Renewable Fuel Standard Program – Final Rule," *78 Federal Register* 62462, October 22, 2013.

⁵⁴ For more information on the fuel pathways for the RFS and the pathway petition process, see U.S. Environmental Protection Agency, *Fuel Pathways under Renewable Fuel Standard*, July 11, 2023, <https://www.epa.gov/renewable-fuel-standard-program/fuel-pathways-under-renewable-fuel-standard>.

⁵⁵ The Coalition for Renewable Natural Gas, "Waste Industry Groups, Lawmakers Vow To Continue Push for eRINs," press release, June 29, 2023; Biomass Power Association, "RFS Power Coalition Commends Rep. John Garamendi for Introducing Bill Requiring EPA Action on eRINs," press release, November 9, 2021; Sen. John Thune, "Thune, Shaheen Reintroduce Bill to Advance Renewable Fuel Technologies," press release, February 4, 2021; Rep. Cheri Bustos, "Streamlining Advanced Biofuels Registration Act of 2020," press release, November 17, 2020; Biotechnology Innovation Organization, "2018 RFS Volumes Set Back Growth in Cellulosic Biofuels," press release, November 30, 2017, <https://www.bio.org/press-release/2018-rfs-volumes-set-back-growth-cellulosic-biofuels>; "BIO Encourages EPA to Speed Approvals of New Biofuel Pathways," *Business Wire*, March 31, 2014, <https://www.businesswire.com/news/home/20140331006205/en/BIO-Encourages-EPA-Speed-Approvals-New-Biofuel>.

Lastly, some may view the RFS as a biofuel production mandate. The statutory language does not mandate the production of biofuels; rather, it mandates the use of biofuel. However, it can be argued that since it is not possible to use a fuel that is not being produced, the RFS indirectly creates a demand for certain biofuels and thus stimulates their production.

Other Factors

The RFS is not a stand-alone program. The implementation and impacts of the program are affected by many factors that are not easily predicted or controlled. For example, cellulosic biofuel production, at a minimum, requires conversion technology, which itself requires technical expertise and some of which are new to market and require time to ramp up to commercial scale. In addition, the annual statutory targets for cellulosic biofuel established by Congress were not met for various reasons, with EPA repeatedly granting cellulosic biofuel waivers. Going forward, cellulosic biofuel production may play a different role in the program, as the EPA Administrator is to determine the cellulosic biofuel volume amount so that a cellulosic biofuel waiver does not need to be issued. Also, the large quantity of biomass feedstocks needed to produce such biofuels requires factors such as appropriate weather conditions and an expectation of stable markets for feedstock commodities. Further, some types of biofuel production have been sensitive to the availability of tax incentives in order to be economically feasible (e.g., biodiesel).⁵⁶ Unexpected occurrences (e.g., drought, failed technology, tax incentive expiration, trade disputes) could potentially impact an entire industry, especially for some advanced biofuels in nascent industries compared to conventional transportation fuels. Lastly, the “blend wall” (i.e., the upper limit to the total amount of ethanol that can be blended into U.S. gasoline and still maintain automobile performance and comply with other provisions of the Clean Air Act) is another factor that may not play the same role in the program going forward as it has in the past. EPA reports “the nationwide average ethanol concentration has exceeded 10% since 2016” while also noting that “[t]he E10 blendwall remains a helpful point of reference in ascertaining the development of the gasoline market over time, especially since the vast majority of ethanol continues to be used as E10.”⁵⁷ There are multiple approaches that could alleviate blend wall concerns (e.g., fuel efficiency measures, and the use of higher ethanol-gasoline blends such as E15 and E85).

Congressional Issues

The RFS was established in 2005 at a time when Congress foresaw the need to diversify the country’s energy portfolio, strengthen the economy of rural communities that could contribute to biofuel production, bolster U.S. standing in an emerging segment of the energy technology market, and protect the environment, among other objectives. The RFS was subsequently expanded in 2007. Since then, some components of the RFS (e.g., corn starch ethanol, biomass-based diesel) have progressed steadily toward meeting statutory requirements and other components (e.g., cellulosic biofuel) have not.

There has been perennial legislative interest, executive activity, and litigation regarding the RFS. Several factors have led to congressional interest in the RFS—including the statutory requirements, the implementation process, stakeholder interests, complementary programs, actions of federal agencies, and agricultural trade issues, among other things. Further, the RFS is

⁵⁶ For example, see U.S. Energy Information Administration, *U.S. Biomass-Based Diesel Tax Credit Renewed Through 2022 in Government Spending Bill*, January 28, 2020.

⁵⁷ U.S. Environmental Protection Agency, *Renewable Fuel Standard (RFS) Program: Standards for 2023–2025 and Other Changes: Response to Comments*, EPA-420-R-23-014, June 2023.

a program with elements and objectives that are interpreted differently by the parties that must abide by the underlying statute.

Among the items Congress may opt to consider (in no particular order) as it continues to debate the merits and challenges of the RFS:

- **EPA discretion.** 2022 was the last year for which the RFS program had annual volumes specified in statute. Starting in 2023, the EPA Administrator determines the annual volume amounts.
- **Fuel pathways.** Fuel pathways must be approved by EPA in order for a fuel to be eligible for the RFS. The time it takes and the resources EPA has to approve the pathways are unclear.
- **Environmental impact.** EPA is to provide Congress with a report every three years that assesses the impact of the RFS on environmental issues and resource conservation issues, among other things.⁵⁸ There are various perspectives about the environmental impact of the RFS.⁵⁹
- **RFS compliance.** A tradeable credit system is used to ensure obligated parties comply with the RFS. At times, the availability and cost of the credits (i.e., RINs) and the transparency of the market have been a concern to some.⁶⁰
- **Small refinery exemptions.** Small refineries may petition the EPA Administrator for an exemption from the RFS mandate if they can prove compliance would subject them to disproportionate economic hardship.⁶¹ Some Members of Congress question how EPA evaluates the petitions and how EPA accounts for such exemptions, among other things.

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⁵⁸ EISA Section 204. In January 2023, EPA announced the public comment period for the draft document titled, “Biofuels and the Environment: Third Triennial Report to Congress.” U.S. Environmental Protection Agency, “Notice of Public Comment Period for the Biofuels and the Environment: Third Triennial Report to Congress External Review Draft,” 88 *Federal Register* 72, January 3, 2023; U.S. Environmental Protection Agency, *Biofuels and the Environment: The Second Triennial Report to Congress*, EPA/600/R-18/195, June 29, 2018. U.S. Environmental Protection Agency, *Biofuels and the Environment: First Triennial Report to Congress*, EPA/600/R-10/183F, December 2011.

⁵⁹ U.S. Government Accountability Office, *Renewable Fuel Standard: Information on Likely Program Effects on Gasoline Prices and Greenhouse Gas Emissions*, GAO-19-47, May 2019.

⁶⁰ For more information, see U.S. Energy Information Administration, *Renewable identification number prices for ethanol and biomass-based diesel remain high*, July 13, 2022 and U.S. Congress, House Committee on Energy and Commerce, Subcommittee on Environment, *Background on Renewable Identification Numbers under the Renewable Fuel Standard*, Testimony of Brent Yacobucci, 115th Cong., July 25, 2018.

⁶¹ For more information on small refinery exemptions, see CRS Report R46244, *The Renewable Fuel Standard (RFS): Frequently Asked Questions About Small Refinery Exemptions (SREs)*, by Kelsi Bracmort.

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