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Overview of the U.S. Renewable Fuel Standard

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In a previous *farmdoc daily* article (February 15, 2023), we argued that the renewable diesel boom could not be understood without understanding the policies driving the boom. More to the point, the renewable diesel boom is entirely policy driven. The reason is that renewable diesel is substantially more expensive to produce than the petroleum diesel that it replaces. The implication is that little, if any, renewable diesel would be produced and consumed in the U.S. without significant policy incentives. It is not a stretch to think of the market for renewable diesel as a "policy market." In this article, we provide an overview of the U.S. Renewable Fuel Standard, which is foundational to understanding the policy incentives driving the renewable diesel boom. This is the 10th in a series of *farmdoc daily* articles on the renewable diesel boom (see the complete list of articles here).

The RFS

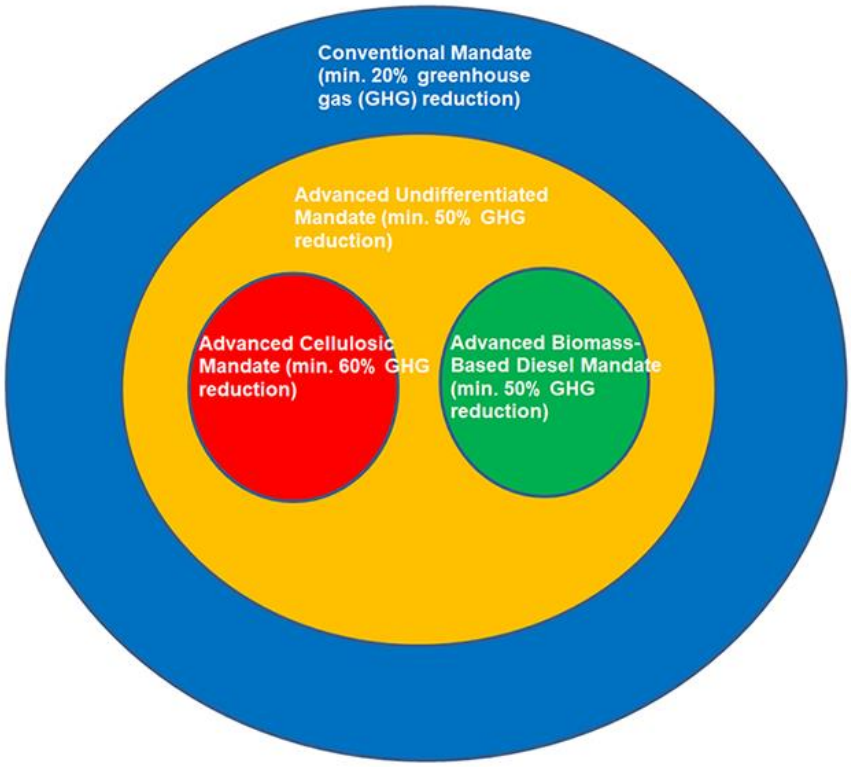
The U.S. Renewable Fuel Standard (RFS) was introduced in the Energy Policy Act of 2005 and expanded in both scope and duration in the Energy Independence and Security Act of 2007. The RFS program has three primary policy goals (Irwin and Stock, 2018). These are: i) enhance energy security through additional domestic production of biofuels, ii) expand the development and production of second-generation low-greenhouse gas transportation fuels, and iii) support rural economies by expanding the demand for agricultural products.

The RFS specifies volumetric mandates, called Renewable Volume Obligations (RVOs), for renewable fuels to be blended into U.S. surface transportation vehicle fuels. As a result, the RFS is a market-forcing policy that increases demand for renewable fuels (*farmdoc daily*, March 7, 2018). The U.S. Environmental Protection Agency (EPA) is responsible for proposing and enforcing the annual RVOs. Specifically, the EPA converts the statutory mandate volumes, where provided, into percentage standards through annual rulemakings. The resulting annual percentage standards specify that for every gallon of petroleum fuel sold into the surface transportation sector, a specified fraction of a gallon of renewable fuel must be blended into the surface transportation fuel pool.

The RFS statutes require annual volume mandates to be established for four categories of biofuels: cellulosic, biomass-based diesel, total advanced (which includes cellulosic and biomass-based diesel), and renewable (referred to as conventional here). These categories are defined in terms of i) reductions in life-cycle emissions of greenhouse gasses (GHGs) relative to petroleum, ii) feedstock, and iii) fuel characteristics (diesel or non-diesel). The total advanced mandate is a higher volume than the sum of the cellulosic and biomass-based diesel mandates. This difference is referred to as the undifferentiated advance mandate, which can be satisfied by a combination of qualified advanced biofuels. Conventional biofuels are generally assumed to be corn-based ethanol, but this is not explicitly required by the RFS legislation.

Two additional features of the RFS mandates should be highlighted. The first is that the standards are nested based on lifecycle greenhouse gas (GHG) emission reductions relative to petroleum fuels. Biofuels with the largest GHG reductions have the highest rank, and this is reflected in the ordering from the inner to the outer rings in Figure 1. The two highest ordered biofuels are cellulosic and biomass-based diesel, with minimum GHG reduction of 60 and 50 percent, respectively. Cellulosic biofuels are eligible to meet their own mandate, the undifferentiated mandate, and the conventional mandate, but not the biomass-based diesel mandate. Similarly, biomass-based diesel is eligible to meet its own mandate, the undifferentiated mandate, and the conventional mandate, but not the cellulosic mandate. Conventional biofuels can only meet the conventional mandate and none of the other mandate categories.

Figure 1. The RFS Biofuel Nesting Scheme



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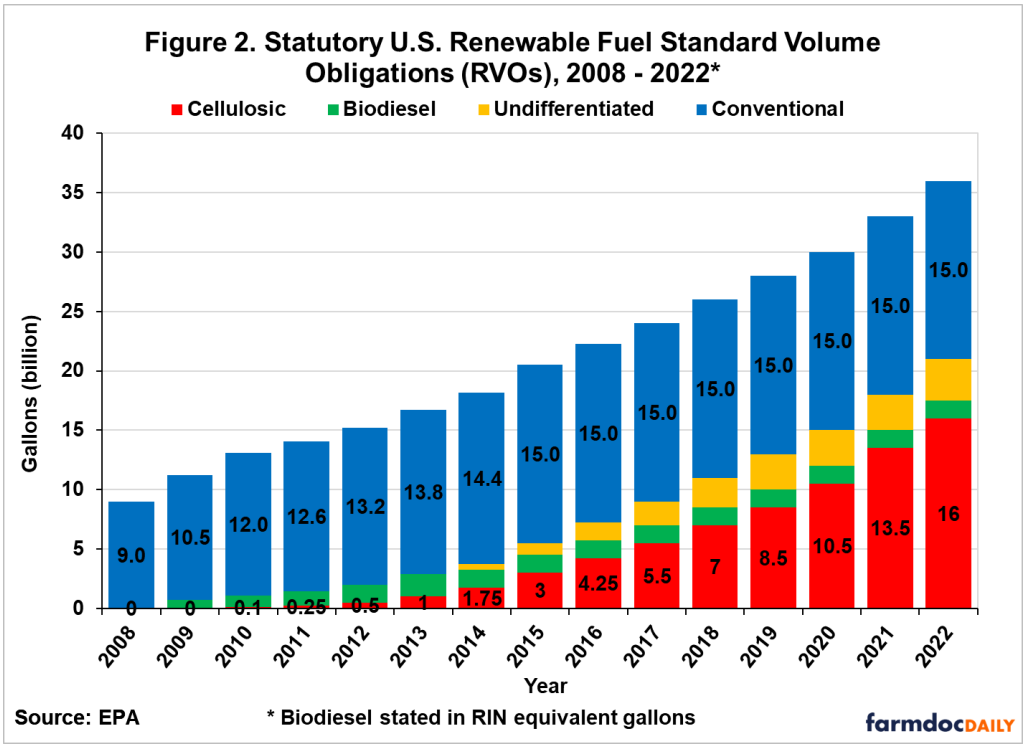
The second notable feature is that equivalence values are assigned to the various biofuels based on energy content per gallon. For example, a gallon of ethanol has about 67 percent of the energy content of a gallon of petroleum gasoline, and a gallon of biodiesel has approximately 93 percent of the energy content of petroleum diesel. Further, a gallon of biodiesel has about 150 percent of the energy content of a gallon of ethanol. To place the biofuels on a comparable footing when implementing compliance standards, the EPA assigns to each biofuel an energy-equivalence value relative to a gallon of ethanol. Specifically, ethanol has an equivalence value equal to one, biodiesel has a value equal to 1.5, and renewable diesel has a value equal to 1.6 or 1.7.

The 2007 RFS statute specified the level of volumetric standards through 2022. These standards are presented in Figure 2. The basic logic behind the standards was to rely almost entirely on "first generation" conventional biofuels in the early years and then transition to greater reliance on "second generation" advanced biofuels in later years. This is seen in the cap on conventional biofuels at 15 billion gallons starting in 2015 and the increase in cellulosic from 1 billion gallons in 2013 to 16 billion gallons in 2022. The total RFS mandate for biofuels maxed out in 2022 at 36 billion gallons. Note that the biodiesel mandate was established as a minimum of one billion (physical) gallons per year from 2012 through 2022, with larger amounts subject to EPA approval.



The statutory volumes shown in Figure 2 are only the starting point for the EPA in annual RVO rulemakings. The RFS provides the EPA with three separate authorities to modify or waive the statutory RVOs:

1. The cellulosic waiver authority allows the EPA to reduce the cellulosic RVO by the amount of a projected shortfall of cellulosic production below the statutory cellulosic RVO. The statute authorizes EPA to reduce the total advanced and total renewable RVOs by up to the amount of the cellulosic shortfall.

2. The general waiver authority allows EPA to waive any of the volumes if it finds either that failing to do so would "severely harm the economy or environment of a State, a region, or the United States" or if there is "inadequate domestic supply" of the relevant biofuel (e.g., *farmdoc daily*, October 12, 2017).

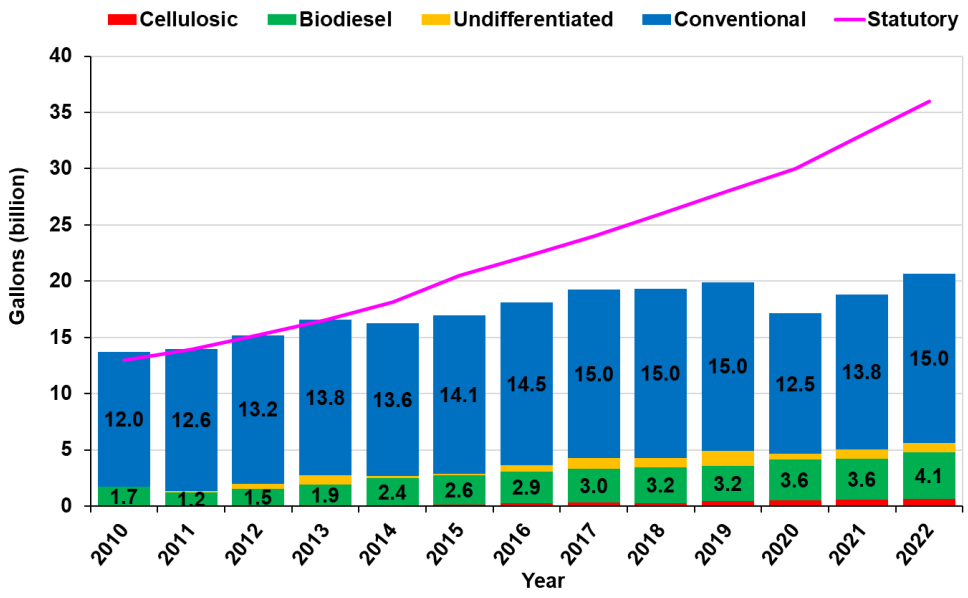
3. The biomass-based diesel (BBD) waiver authority allows the EPA to waive the BBD RVO by up to 15 percent of the applicable annual requirement for up to 60 days (e.g., *farmdoc daily*, October 19, 2017). The EPA must determine that there is a significant renewable feedstock disruption or other market circumstances that would make the price of BBD increase significantly in order to invoke this temporary waiver.

While not directly impacting statutory volumes like the waiver provisions discussed above, the RFS also includes a provision for granting temporary exemptions from RFS compliance for small refineries (e.g., *farmdoc daily*, December 6, 2017). Small refineries are defined as those with less than 75,000 barrels of crude oil throughput in a calendar year. The RFS initially included a blanket exemption for all small refineries through 2011, which was subsequently extended through 2013 by the EPA. In addition, the

RFS statutes also provided authority to EPA to grant an extension of the blanket exemption to individual small refineries. An exemption was to be based upon petition and due to "disproportionate economic hardship" to the refinery.

Figure 3 presents the final RFS RVOs for 2010 through 2022, along with total statutory RVOs (from Figure 2). The final RVOs shown in this chart were drawn from the final EPA rulemakings for each calendar year. Actual compliance with the annual RVOs usually differs from the final volumes in the rulemakings because the standards are enforced via percentages rather than absolute volumes. When gasoline and diesel usage differ from that forecast by the EPA for a given year, compliance volume automatically floats up or down because the standards are fixed in percentage terms. In addition, compliance can differ from the final RVOs depending on how small refinery exemptions are accounted for in the rulemaking process (e.g., *farmdoc daily*, July 12, 2018).

Figure 3. Final U.S. Renewable Fuel Standard Volume Obligations (RVOs), 2010 - 2022*



Source: EPA

*Biodiesel stated in RIN equivalent gallons

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It is evident from Figure 3 that total final RVOs for the RFS fell far short of the ambitious goals set in the RFS statutes. For example, the total RVO mandate in 2022 was a little more than 20 billion gallons when the statutory target was 36 billion gallons. The biggest reason for the shortfall can be traced to cellulosic biofuel production. The mandated targets for cellulosic biofuels were very aggressive from the outset, given that industrial-scale production was virtually non-existent when the RFS was passed in 2007. While several plants were built since then, cellulosic production struggled to reach even a few million gallons. The vast bulk of what has been produced in this category is captured landfill gas in liquid form ("biogas"), which qualifies as a cellulosic biofuel due to the breakdown of paper lignin in landfills. The low cellulosic production totals from all sources caused the EPA to use its RFS waiver authority to write down the cellulosic mandate to very low levels relative to statutory levels every year over 2007 through 2022. The total advanced biofuel mandate has also been written down in conjunction with the write down in the cellulosic mandate.

The implementation of the annual RFS standards has been complicated by two additional factors. The first is the E10 "blend wall," which arises because regulation in the U.S. has traditionally limited the ethanol content of gasoline blends to a maximum of 10 percent by volume. Consequently, the theoretical maximum amount of ethanol that can be consumed is 10 percent of total gasoline consumption. At the time the RFS was passed in 2007, it was commonly projected that U.S. gasoline consumption by 2015 would be 150 billion gallons. So, it is no surprise that the cap on the conventional mandate in 2015 was set to 15 billion gallons, exactly 10 percent of projected gasoline consumption. The problem is that actual gasoline consumption began falling almost as soon as the RFS was passed due to the combined effects

of high real crude oil prices and the onset of the Great Recession. Consequently, the conventional mandate as specified in the RFS statute began to surpass the E10 blend wall by 2013. This, in turn, caused compliance costs, in the form of renewable identification number (RIN) prices, to increase sharply (e.g., *farmdoc daily*, July 19, 2013).

At this point, an intense political confrontation broke out between petroleum refiners and biofuel producers. On one side, refiners and their political allies argued that the "RFS was broken" and that the dramatic increase in compliance costs was substantially harming their operating profits. On the other side, biofuels and agricultural groups argued that the RFS was intended by Congress to be a technology forcing program and that high compliance costs reflected the unwillingness of the petroleum refining industry to make the investments that would lower the cost of breaching the blend wall via higher ethanol blends such as E15 and E85. This conflict has not been resolved to date.

The second complicating factor was the global COVID-19 pandemic that started in March 2020. This caused gasoline and diesel consumption in the U.S. to plunge dramatically (e.g., *farmdoc daily*, March 26, 2020). Considering this emergency, the EPA reduced the annual RVOs in 2020 and 2021, with the largest reductions falling on conventional RVOs.

Lastly, an important aspect of the RFS statute is that it does not "sunset." In other words, the EPA is required to continue issuing annual RVOs even though the statutes no longer specify volumetric mandate levels after 2022. Annual RVOs will continue in perpetuity until the U.S. Congress repeals or revises the RFS. The EPA was granted broad discretion in setting RVOs after 2022. The "reset" volumes are to be determined by analysis of: i) 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, ii) the impact of renewable fuels on the energy security of the United States, iii) the expected annual rate of future commercial production of renewable fuels, including advanced biofuels in each category (cellulosic biofuel and biomass-based diesel), iv) the impact of renewable fuels on the infrastructure of the United States, including deliverability of materials, goods, and products other than renewable fuels, and the sufficiency of infrastructure to deliver and use renewable fuels, v) the impact of the use of renewable fuels on the cost to consumers of transportation fuel and on the cost to transport goods, and vi) the impact of using renewable fuels on other factors, including job creation, the price and supply of agricultural commodities, rural economic development, and food prices. Last December, the EPA proposed annual RVOs for 2023, 2024, and 2025 based on these criteria for the first time. A final rulemaking is expected in June of this year.

Implications

The U.S. Renewable Fuel Standard (RFS) is key to understanding the policy incentives driving the renewable diesel boom. Without the policy incentives provided by the RFS it is doubtful that much, if any, renewable diesel would be produced and consumed in the U.S. The RFS specifies volumetric mandates, called Renewable Volume Obligations (RVOs), for renewable fuels to be blended into U.S. surface transportation vehicle fuels. The RVOs are applied to four categories of biofuels: cellulosic, biomass-based diesel, total advanced (which includes biomass-based diesel), and conventional. Renewable diesel and biodiesel are considered advanced biofuels and can be used to fulfill the biomass-based diesel mandate as well as the conventional mandate. Implementation of the annual RFS standards has been complicated by the failure of large-scale production of cellulosic biofuels to develop and the E10 blend wall. An important aspect of the RFS statute is that it does not "sunset." In other words, the EPA is required to continue issuing annual RVOs even though the statutes no longer specify volumetric targets after 2022. Last December, the EPA proposed annual RVOs for 2023, 2024, and 2025, with a final rulemaking expected in June of this year. The final outcome of this rulemaking will likely have a significant impact on the trajectory of the renewable diesel boom.

The next article in this series will examine the RIN compliance system for the RFS mandates.

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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