Congressional Budget Office

Testimony

The Renewable Fuel Standard: Issues for 2015 and Beyond

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Subcommittee on Environment and the
Subcommittee on Oversight
Committee on Science, Space, and Technology
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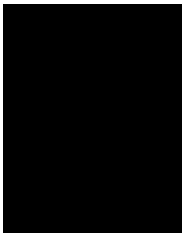


Contents

Chairman Bridenstine, Chairman Loudermilk, Ranking Member Bonamici, Ranking Member Beyer, and Members of the Committees, thank you for the opportunity to testify about the Renewable Fuel Standard. This testimony updates the Congressional Budget Office's report from 2014 on that topic.[1]

Summary

The Renewable Fuel Standard (RFS) establishes minimum volumes of various types of renewable fuels that suppliers must blend into the United States' supply of fuel for transportation. Those volumes—as defined by the Energy Independence and Security Act of 2007 (EISA)—are intended to grow each year through 2022. In recent years, the requirements of the RFS have been met largely by blending gasoline with ethanol made from cornstarch. In the future, EISA requires the use of increasingly large amounts of "advanced biofuels," which include diesel made from biomass (such as soybean oil or animal fat), ethanol made from sugarcane, and cellulosic biofuels (made from converting the cellulose in plant materials into fuel).

Policymakers and analysts have raised concerns about the RFS, including whether complying with the standard will be feasible, whether it will increase prices for food and transportation fuels, and whether it will lead to the intended reductions in greenhouse gas emissions. Because of those concerns, some policymakers have proposed repealing or revising the Renewable Fuel Standard.

In this testimony, CBO assesses how much the supply of various types of renewable fuels would have to increase over the next several years to comply with the RFS. CBO also examines how prices for food and fuel would vary in an illustrative year, 2017, under three scenarios for the Renewable Fuel Standard:

- *The 2016 volumes scenario*, in which the Environmental Protection Agency (EPA)—which implements the RFS and has some discretion to modify the mandates of EISA—would keep the RFS requirements for 2017 at the same amounts it has proposed for 2016;
- *The EISA volumes scenario*, in which fuel suppliers would have to meet the total requirement for renewable fuels, the requirement for advanced biofuels, and the cap on corn ethanol that are stated in EISA for 2017—but not the requirement for cellulosic biofuels, because the capacity to produce enough of those fuels is unlikely to exist by 2017; and
- *The repeal scenario*, in which lawmakers would immediately abolish the RFS.

The repeal scenario would require Congressional action. In the absence of such action (or of legal restrictions), CBO considers the 2016 volumes scenario much more likely than the EISA volumes scenario, which would require a large and rapid increase in the use of advanced biofuels and would cause the total percentage of ethanol in the nation's gasoline supply to rise to levels that would require significant changes in the infrastructure of fueling stations. As a result, CBO uses the 2016 volumes scenario as a reference case against which to measure the effects of the other two scenarios. If EPA used its discretion to set standards for volume in 2017 lower (or higher) than the proposed 2016 volumes, then the effects of repealing the RFS on food and fuel prices would be correspondingly smaller (or larger).

Full Compliance With the Mandates in EISA Poses Significant Challenges

The rising requirements in EISA would be very hard to meet in future years because of two main obstacles, which relate to the supply of cellulosic biofuels and the amount of ethanol that older vehicles are said to be able to tolerate. Fuel suppliers have had trouble meeting the annual requirements for cellulosic biofuels because making such fuels is complex, capital-intensive, and costly. Although production capacity is expanding, only a few production facilities are currently operating. The industry's capacity in coming years is projected to fall far short of what would be necessary to achieve the very rapid growth in the use of cellulosic biofuels required by EISA.

Ethanol is the most common form of renewable fuel; however, adding increasing volumes of it to the U.S. fuel supply could be difficult. Currently, most gasoline sold in the United States is actually a blend (referred to as E10) that contains up to 10 percent ethanol—the maximum concentration that is feasible to avoid corrosion damage to the fuel systems of older vehicles. EISA's increasing requirements for the total gallons of renewable fuels to be used each year, combined with a projected decline in

1. Congressional Budget Office, *The Renewable Fuel Standard: Issues for 2014 and Beyond* (June 2014), www.cbo.gov/publication/45477.

gasoline use, suggest that the average concentration of ethanol in gasoline would have to rise to well above that 10 percent "blend wall," potentially increasing to about 25 percent by 2022. More ethanol could be accommodated in the fuel supply if motorists who drive "flex-fuel" vehicles, which can run on blends that contain as much as 85 percent ethanol (referred to as E85), bought larger amounts of such fuel. But at present, only a little more than 2 percent of filling stations in the United States sell high-ethanol blends.

Because of the challenges described above, EPA has been eliminating or greatly reducing the annual requirements for cellulosic biofuels, advanced biofuels, and total renewable fuels in its final and proposed rules in recent years. Although scaling back those standards addresses existing compliance problems and decreases compliance costs in the short run, it also reduces incentives for companies to invest in production capacity for cellulosic and other advanced biofuels and to expand the availability of high-ethanol blends.

Using the Total Volumes of Advanced Biofuels Specified in EISA Would Require Extremely Large Increases in the Production of Those Fuels

For the scenario in which fuel suppliers would have to comply with the total volumes of advanced biofuels and of renewable fuels as a whole stated in EISA, CBO assumed that EPA would allow suppliers to substitute other forms of advanced biofuels for cellulosic biofuels, as it has done in the past. Fuel suppliers would probably do so by using two types of advanced biofuels: biomass-based diesel (mostly produced in the United States) and sugarcane ethanol (nearly all imported from Brazil). However, relying on that strategy for 2017 would necessitate extremely large increases in the production of those fuels. For example, even a 60 percent increase in the projected U.S. production of biomass-based diesel in 2017 and a 50 percent increase in Brazil's projected production of sugarcane ethanol would not provide enough additional gallons of advanced biofuels to meet the higher volumes required in the EISA volumes scenario than in the 2016 volumes scenario.

Food Prices Would Be Similar Whether the RFS Was Continued or Repealed

Roughly 40 percent of the U.S. corn supply is used to make ethanol. To the extent that the Renewable Fuel Standard increases the demand for corn ethanol, it will raise corn prices and put upward pressure on the prices of foods made with corn—ranging from corn-syrup sweeteners to meat, poultry, and dairy products. Corn ethanol use in 2017 would be about 7 percent (or 1 billion gallons) higher under the EISA volumes scenario than under the 2016 volumes scenario. CBO estimates that the resulting increase in the demand for corn would raise the average price of corn by about 3 percent. However, because corn and food made with corn account for only a small fraction of total U.S. spending on food, that total spending would increase by about 0.1 percent.

CBO expects that, if lawmakers repealed the RFS, the amount of corn ethanol used in 2017 would be smaller by less than 1 billion gallons than if the 2017 requirements were equal to EPA's proposed 2016 volumes. Suppliers would probably find it cost-effective to use a roughly 10 percent blend of corn ethanol in gasoline in 2017 even in the absence of the RFS. Therefore, food prices would be only slightly lower in 2017 (by less than 0.1 percent) if the RFS was repealed than under the 2016 volumes scenario.

Compared With the 2016 Volumes Scenario, Meeting the Requirements in the EISA Volumes Scenario Would Have Significant Effects on Prices of Transportation Fuels

Under the EISA volumes scenario, fuel suppliers would have to use more than twice as many gallons of advanced biofuels than under the 2016 volumes scenario, and they would have to add much more ethanol to the gasoline supply than could be accommodated by selling only a 10 percent blend. The cost of boosting consumption of high-ethanol blends (such as E85) would fall on the producers and consumers of gasoline and diesel. Specifically, the policy would increase the price of petroleum-based fuels and lower-ethanol blends (such as E10) while lowering the price of E85. (Under both scenarios, CBO anticipates that EPA would sharply reduce the requirement for cellulosic biofuels, given the limited production capacity for those fuels expected to exist in 2017.)

In this analysis, CBO used a range of estimates of the price premium necessary to encourage sufficient additional supplies of advanced biofuels and the price subsidy necessary to motivate sufficient sales of E85. The agency estimates that, compared with the 2016 volumes scenario, complying with the EISA volumes scenario would have the following effects on the prices—rounded to the nearest 5 cents—of three key types of transportation fuels in 2017:

- The price of petroleum-based diesel would rise by 25 cents to 45 cents per gallon;
- The price of E10—which is currently the most commonly used transportation fuel in the United States—would increase by 15 cents to 30 cents per gallon; and
- The price of E85 would decline by $0.80 to $1.20 per gallon.

Because the changes in the production and use of renewable fuels required under the EISA volumes scenario are so large—and because little information is available about how the supply of and demand for renewable fuels respond to changes in their price—those estimates are highly uncertain. Actual price changes could fall outside the ranges described above.

Compared With the 2016 Volumes Scenario, Repealing the RFS Would Have Very Modest Effects on Prices of Transportation Fuels

CBO estimates that repealing the RFS would have only small effects on prices in comparison with the 2016 volumes scenario. Specifically, CBO estimates that repealing the RFS would have essentially no effect on the 2017 price of E10, would lower the 2017 price of petroleum-based diesel by roughly 5 cents, and would increase the 2017 price of E85 by about 15 cents. The effect on fuel prices of repealing the RFS is limited because a significant quantity of renewable fuels would continue to be used even in the absence of the mandate.

Overview of the Renewable Fuel Standard and Its Implementation

Lawmakers enacted the Renewable Fuel Standard in 2005 and expanded its requirements in 2007 in the Energy Independence and Security Act. The standard is imposed on suppliers (generally refiners or importers) of gasoline and diesel fuels used for transportation. It aims to foster greater use of fuels made from plants, plant products, and other renewable sources, thereby reducing the United States' dependence on petroleum and the greenhouse gas emissions that are released when petroleum-based fuels are burned and contribute to climate change. EISA requires that the emissions associated with a gallon of renewable fuel be at least a certain percentage lower than the emissions associated with the gasoline or diesel fuel that the renewable fuel replaces. Advanced biofuels and the subcategory of cellulosic biofuels are required to meet more stringent emission standards than those that apply to corn ethanol. The Environmental Protection Agency is charged with implementing the standard and ensuring compliance.

What the RFS Requires

The Energy Independence and Security Act sets minimum volumes of renewable fuels that suppliers must blend into the nation's supply of transportation fuel each year. Except for corn ethanol made in certain facilities, the renewable fuels used to comply with the RFS must be certified by EPA as having greenhouse gas emissions that are at least 20 percent lower than the emissions associated with the fuels that they replace. The total minimum volume of renewable fuels specified in EISA rises each year through 2022 (see Figure 1) and EISA requires that an increasing share of that volume be met with advanced biofuels, which must have greenhouse gas emissions that are at least 50 percent lower than those of conventional fuels.

So far, fuel suppliers have been able to comply with the RFS largely by blending gasoline with corn ethanol, which is made from the starch in corn kernels. By 2022, EISA requires the use of 36 billion gallons of renewable fuels. Of those, at least 21 billion gallons must be advanced biofuels, including the following:

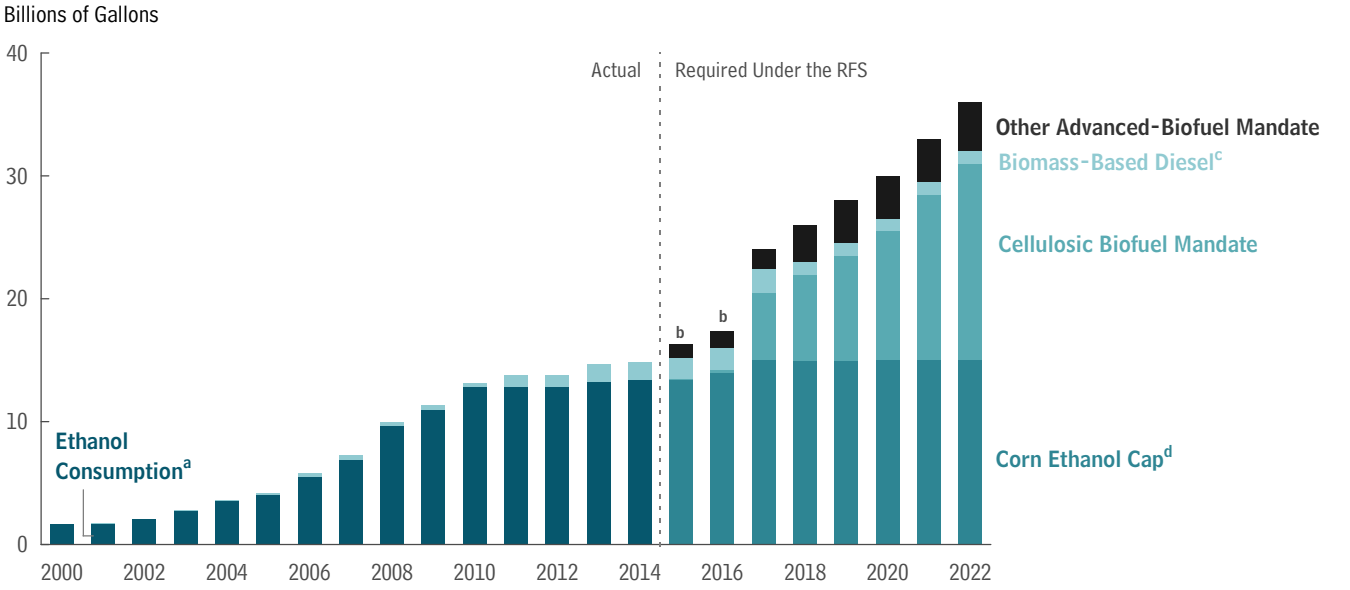
- At least 16 billion gallons of cellulosic biofuels, which are made from the cellulose in various plant materials, including grasses and corn stover (the residue left after corn is harvested). Cellulosic biofuels must have greenhouse gas emissions that are at least 60 percent lower than their petroleum-based counterparts.
- At least 1 billion gallons of biomass-based diesel (typically made from soybean or other vegetable oils). EPA has the discretion to set the mandate for biomass-based diesel at a higher level.[2]

The other 4 billion gallons (or less) can consist of any type of advanced biofuel that meets the 50-percent-lower

2. Unless otherwise indicated, the amounts of biomass-based diesel discussed in this report are measured in "compliance-equivalent gallons." Under EISA, 1 gallon of biomass-based diesel is considered equivalent to 1.5 gallons of ethanol for purposes of complying with the RFS.

Figure 1.

Past Use of Renewable Fuels and Future Requirements of the Renewable Fuel Standard



Source: Congressional Budget Office based on data for 2000 to 2014 from Energy Information Administration, *Monthly Energy Review,* DOE/EIA-0035(2015/10) (October 2015), www.eia.gov/totalenergy/data/monthly, and requirements for 2015 to 2022 from the Energy Independence and Security Act of 2007; and EPA, "Renewable Fuel Standard Program: Standards for 2014, 2015, and 2016 and Biomass-Based Diesel Volume for 2017: Proposed Rule," Federal Register vol. 80, no. 111 (June 10, 2015).

Note: EPA = Environmental Protection Agency; RFS = Renewable Fuel Standard.

a. Most of the ethanol used in the United States in the past consisted of corn ethanol, although relatively small amounts of sugarcane ethanol and other types of advanced biofuels, either produced domestically or imported, were also used.

b. The requirements shown for 2015 and 2016 are those recently proposed by EPA, which are lower than those called for under EISA. EPA has proposed reducing the requirement for cellulosic biofuels from 3 billion gallons to 106 million gallons in 2015 and from 4.25 billion gallons to 206 million gallons in 2016; reducing the requirement for advanced biofuels from 5.5 billion gallons to 2.9 billion gallons in 2015 and 7.25 billion gallons to 3.4 billion gallons in 2016; and, by reducing the mandate for total renewable fuels from 20.5 billion gallons to 16.3 billion gallons in 2015 and 22.25 billion gallons to 17.4 billion gallons in 2016, EPA proposes to reduce the cap on the amount of corn ethanol that can be used to meet the total requirement for renewable fuels from 15 billion gallons in 2015 and 2016 to 13.4 billion gallons in 2015 and 14 billion gallons in 2016. EPA has also proposed increasing the requirement for biomass-based diesel from 1 billion gallons to 1.7 billion gallons in 2015, to 1.8 billion gallons in 2016, and to 1.9 billion gallons in 2017.

c. The amounts of biomass-based diesel shown here for 2018 and later years reflect the minimum requirement of 1 billion gallons specified in EISA. EPA will set the actual requirement for each year through future rulemaking.

d. The cap on corn ethanol represents the maximum amount of such ethanol that can be used to meet the total requirement for renewable fuels under EISA.

emission standard, such as noncellulosic ethanol made from sugarcane.

The portion of the RFS that does not have to be met with advanced biofuels—in 2022, up to 15 billion gallons—can be met with other qualifying renewable fuels, such as corn ethanol. Thus, the requirements for cellulosic biofuels and for biomass-based diesel are nested within the requirement for advanced biofuels, which in turn is nested within the overall requirement for renewable fuels.[3]

The total volume of renewable fuels mandated by EISA increases much faster than the projected growth in the use of gasoline and diesel. As a result, under the RFS, renewable fuels would make up a greater share of the U.S. supply

3. Cellulosic feedstocks can be used to make diesel or gasoline as well as to make biofuels. A gallon of cellulosic diesel would count toward satisfying either the cellulosic biofuel mandate or the biomass-based diesel mandate.

of transportation fuel over time, rising from about 7 percent in 2013 to about 18 percent in 2022 (see Figure 2).

How EPA Implements the RFS

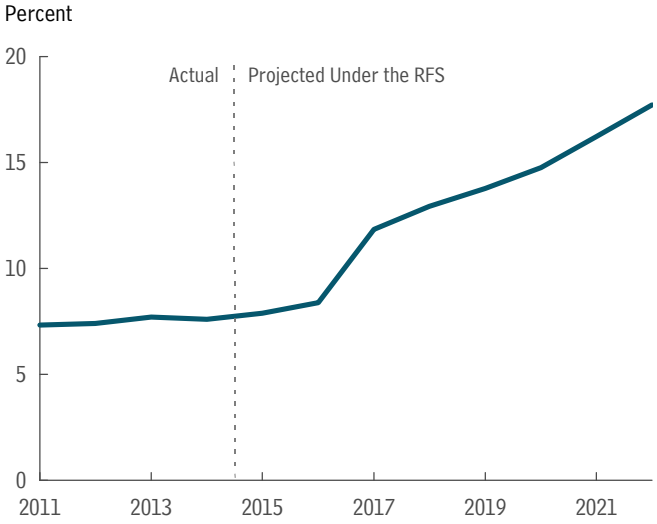
To ensure that fuel suppliers use the mandated volumes of renewable fuels, the Environmental Protection Agency translates the yearly volume requirements in EISA into percentage standards (sometimes called blend requirements) that are based on projections of the total amount of gasoline and diesel that will be used in that year. For example, if the projected amount was 100 billion gallons and the total renewable fuel requirement was 14 billion gallons, EPA would set a 14 percent blend requirement. Further, if the nested mandates for advanced biofuels and for biomass-based diesel were 4 billion gallons and 2 billion gallons, respectively, EPA would establish a 4 percent blend requirement for advanced biofuels and a 2 percent requirement for biomass-based diesel.

To monitor suppliers' compliance with the requirements, EPA assigns a unique "renewable identification number" (RIN) to each qualifying gallon of renewable fuel. Every RIN includes a code that identifies which of the four RFS requirements—for total renewable fuels, advanced biofuels, cellulosic biofuels, or biomass-based diesel—the gallon satisfies. Each fuel supplier, regardless of what kind of fuel it produces or imports, must meet all of the blend requirements for a given compliance year. The supplier can do that by using the required amounts of renewable fuels itself and submitting the corresponding RINs to EPA to demonstrate compliance, by purchasing RINs from other suppliers that have excess RINs to sell, by submitting RINs that it acquired in the previous year and saved for future use, or by borrowing RINs that it expects to acquire in the following year.[4] With the hypothetical requirements above, each fuel supplier would have to submit 14 RINs (including 4 for advanced biofuels and 2 for biomass-based diesel) for each 100 gallons of gasoline or diesel that it sold. Suppliers with excess biomass-based diesel RINs could either sell them or apply them toward their advanced-biofuel requirement.

4. If a fuel supplier that is obligated to meet the RFS is out of compliance at the end of a year (after accounting for its RINs and its use of renewable fuels), EPA may fine the supplier as much as $32,500 per day, plus the savings to the supplier that result from its noncompliance. Those penalties are specified in sections 205 and 211(d) of the Clean Air Act, 42 U.S.C. §§7524, 7545(d) (2013).

Figure 2.

Renewable Fuels as a Share of the Total U.S. Supply of Transportation Fuels



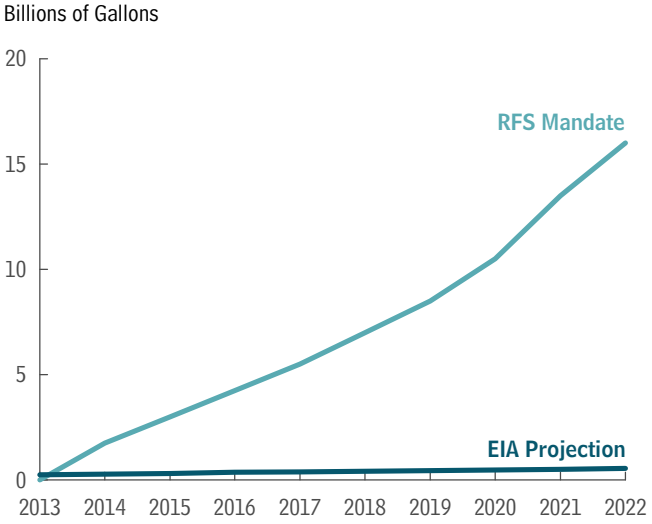
Source: Congressional Budget Office based on Energy Information Administration, *Annual Energy Outlook 2015, With Projections to 2040,* DOE/EIA-0383(2015) (April 2015), www.eia.gov/forecasts/aeo, and *Monthly Energy Review,* DOE/EIA-0035(2015/10) (October 2015), www.eia.gov/totalenergy/data/monthly.

Notes: CBO's calculations are based on the Energy Information Administration's (EIA's) most recent projections of the use of blended gasoline and diesel fuel and EPA's recent proposal to modify 2015 through 2017 mandates specified in the Energy Independence and Security Act of 2007 (EISA). EIA projects that in 2022, less renewable fuel will be used than required under the mandates specified in EISA. For the analysis in this figure, CBO assumed that total use of renewable fuels would rise to the level mandated by that law, although total energy consumption of transportation fuels would remain the same. In addition, because part of the overall mandate for renewable fuels will be met with biomass-based diesel and the specific requirement for such diesel is set annually, CBO assumed that consumption of biomass-based diesel is equal to the mandated volume proposed by EPA for years 2015 to 2017. CBO also assumed that consumption of biomass-based diesel in later years would be equal to either 1.28 billion gallons (the current requirement, which is equal to 1.92 billion compliance-equivalent gallons for the purposes of meeting the total mandate for renewable fuels) or 25 percent of the requirement for advanced biofuels, whichever is greater.

EPA = Environmental Protection Agency; RFS = Renewable Fuel Standard.

Figure 3.

Projected Use of Cellulosic Biofuels, Compared With the Use Mandated by the Renewable Fuel Standard



Source: Congressional Budget Office based on Energy Information Administration, *Annual Energy Outlook 2013, With Projections to 2040,* DOE/EIA-0383(2013) (April 2013, EIA's most recent publicly available long-term projection of cellulosic biofuel use), Figure 100, www.eia.gov/forecasts/archive/aeo13, and Regulation of Fuels and Fuel Additives: 2013 Renewable Fuel Standards, 78 Fed. Reg. 49794 (August 15, 2013), https://federalregister.gov/a/2013-19557.

Notes: The Energy Independence and Security Act of 2007 set annual requirements for cellulosic biofuels starting in 2010; however, the Environmental Protection Agency virtually eliminated the requirements before 2013 because of a lack of commercial production capacity for cellulosic biofuels.

EIA = Energy Information Administration; RFS = Renewable Fuel Standard.

Challenges in Meeting the Renewable Fuel Requirements of EISA

Complying with the Renewable Fuel Standard has raised several challenges, and EPA has modified the requirements of the RFS in past years in response to them. In particular, meeting the requirements for advanced biofuels specified in the Energy Independence and Security Act has posed two difficulties:

- The supply of cellulosic biofuels is limited because such fuels are complex and expensive to produce.
- The use of renewable fuels is constrained by a practical limit on the total amount of ethanol that can be blended into the fuel supply, given the technologies used by older vehicles and the existing fueling-station infrastructure. That limit was not a significant constraint in the past, but it is becoming one as the requirements of EISA increase and the use of transportation fuel grows more slowly than anticipated.

The way in which EPA has responded to those challenges has made it less costly for fuel suppliers to comply with the RFS. But at the same time, that response has lessened the incentives that the RFS provides for investment in renewable fuel infrastructure and for the development of improved technologies for producing advanced biofuels.

Limited Supply of Cellulosic Biofuels

To date, the greatest challenge in meeting the requirements specified in EISA has been the small supply of cellulosic biofuels. The industry that produces those fuels is in its infancy, and the volumes required by EISA far outstrip the projected growth in the industry's production capacity. EISA first set requirements for cellulosic biofuels in 2010, mandating the use of 100 million gallons in that year and larger amounts in each subsequent year. Before 2013, however, no commercial plants to produce cellulosic biofuels were in operation, and EPA virtually eliminated the requirements until that year.

By the middle of 2015, four commercial plants had begun making cellulosic biofuels, and half a dozen more plants are expected to begin operating by 2017. Even so, the gap between production capacity and the volumes of cellulosic biofuels mandated in EISA is expected to widen quickly. The Energy Information Administration forecasts that production of cellulosic biofuels will increase only to 327 million gallons by 2022, a small fraction of the 16 billion gallons required by EISA in that year (see Figure 3).[5]

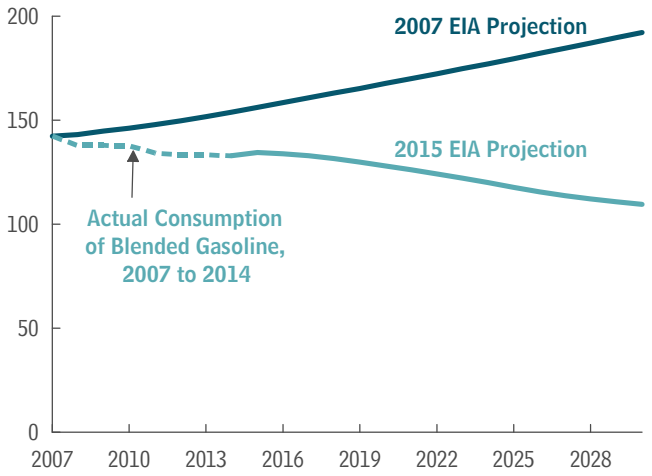
Production capacity has been slow to expand for several reasons. Producing ethanol from cellulose is more complex than producing it from cornstarch, entails higher

5. See Energy Information Administration, *Annual Energy Outlook 2013, With Projections to 2040*, DOE/EIA-0383(2013) (April 2013), Figure 100, www.eia.gov/forecasts/archive/aeo13. (This is EIA's most recent publicly available long-term projection of cellulosic biofuel use.)

Figure 4.

Changing Expectations About the Future Consumption of Blended Gasoline

(Billions of gallons)



Source: Congressional Budget Office based on Energy Information Administration, *Annual Energy Outlook 2007, With Projections to 2030,* DOE/EIA-0383(2007) (February 2007), www.eia.gov/oiaf/archive/aeo07, and *Annual Energy Outlook 2015, With Projections to 2040,* DOE/EIA-0383(2015) (April 2015), www.eia.gov/forecasts/aeo.

Note: EIA = Energy Information Administration.

capital costs, and poses logistical problems. For example, commercial-scale use of cellulosic feedstocks requires that systems and equipment be developed to harvest the often-bulky materials and transport them to production facilities; for year-round production, seasonal feedstocks would also require ample storage space.

Difficulties in Using the Required Volume of Renewable Fuels

Ten percent is effectively the maximum ethanol content that blended fuel can contain and still be used by virtually all vehicles now on the road. That limit protects vehicles built before 2001, whose engines and fuel systems are thought to be vulnerable to corrosion from ethanol concentrations greater than 10 percent. For that reason, 10 percent constitutes a practical constraint, or blend wall, on how much ethanol most blended gasoline can accommodate. Many states limit ethanol concentrations to 10 percent, except in fuels intended for flex-fuel vehicles, which can run on blends of as much as 85 percent ethanol.[6]

The challenges posed by the blend wall are expected to increase. When EISA was enacted, in 2007, use of blended gasoline in the United States totaled about 140 billion gallons a year and was projected to grow (see Figure 4). Thus, rising requirements for renewable fuels were not expected to raise concerns about the blend wall. Instead of growing, however, use of blended gasoline has declined slightly, to about 137 billion gallons a year, and the Energy Information Administration now projects that it will fall to about 127 billion gallons in 2022 and then continue to drop, to around 108 billion gallons per year by 2040).[7] (The agency's 2007 projection did not anticipate the decline in total annual vehicle-miles traveled and the increase in average fuel economy that have since occurred.)

If the latest projections prove accurate, the renewable fuel requirements of EISA will gradually increase the average ethanol content of the U.S. gasoline supply (including high-ethanol blends for flex-fuel vehicles) to well above 10 percent. Using illustrative assumptions about the extent to which fuel suppliers would comply with the requirement for advanced biofuels by using biomass-based diesel, CBO estimates that full compliance with the EISA mandates could require the average ethanol content of blended gasoline to reach about 25 percent by 2022 (see Figure 5). For retail gasoline markets to accommodate that much ethanol—while limiting the ethanol content of the blended gasoline that most drivers use to 10 percent—a very large increase in the use of high-ethanol blends would be necessary.

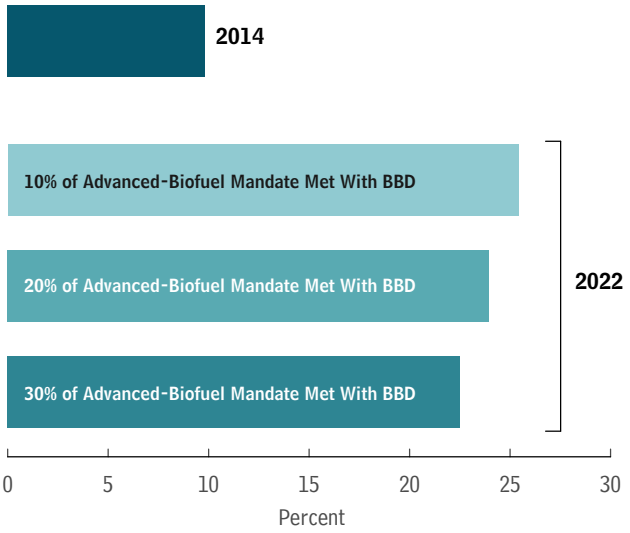
One possibility for raising the total amount of ethanol that the market can accommodate is to boost both the number of flex-fuel vehicles on the road and the extent to which drivers of those vehicles refuel with E85 rather than with conventional blends, such as E10. Flex-fuel technology is relatively inexpensive—adding a few hundred dollars to

6. Flex-fuel vehicles are identical to ordinary passenger vehicles except for slight differences in their fuel systems and, in many cases, an identifying badge on a fender or rear panel. According to the Department of Energy, many owners of flex-fuel vehicles are not aware that their vehicles can run on blends of more than 10 percent ethanol. See Department of Energy, "Alternative Fuels Data Center—Flexible Fuel Vehicles" (October 3, 2013), www.afdc.energy.gov/vehicles/flexible_fuel.html.

7. See Energy Information Administration, *Annual Energy Outlook 2015, With Projections to 2040*, DOE/EIA-0383(2015), www.eia.gov/forecasts/aeo/.

Figure 5.

Ethanol as a Percentage of Blended Gasoline Under Different Assumptions About the Future Use of Biomass-Based Diesel



Source: Congressional Budget Office based on Energy Information Administration, *Annual Energy Outlook 2015, With Projections to 2040,* DOE/EIA-0383(2015) (April 2015), www.eia.gov/forecasts/aeo.

Notes: CBO's calculations are based on the Energy Information Administration's most recent projection of the use of blended gasoline. CBO's estimate of the percentage of ethanol in blended gasoline depends on how much biomass-based diesel is used to comply with the mandate for advanced biofuels. In evaluating the effects of different amounts of use, CBO assumed that the total energy consumption of blended gasoline would remain the same.

BBD = biomass-based diesel.

the manufacturing cost of a new vehicle—and many such vehicles are currently on the road because automobile manufacturers received compliance credits under the Corporate Average Fuel Economy (CAFE) standards for selling flex-fuel vehicles (even if drivers of those vehicles never actually fill up their tanks with E85). However, substantially increasing the use of E85 would also require increasing the number of filling stations that offer such fuel. Only a little more than 2 percent of stations in the United States currently sell E85, although the number has been rising steadily in recent years (it grew fivefold between 2005 and 2014, to more than 2,650 stations).[8] The Biofuel Infrastructure Partnership, a new initiative funded by the Department of Agriculture, with matching funds provided by 21 states and private entities—aims to nearly double the number of renewable-fuel pumps in the United States.[9] Another factor limiting sales of E85 is its price: Although E85 costs less than regular E10 gasoline, it also has a lower energy content, meaning that it offers fewer miles per gallon. Drivers who could use E85 would be willing to buy it only if its price was low enough relative to the price of E10 to compensate for its lower energy content and potentially for the need to drive farther to find an E85 fueling station.

Although consumption of E85 has been expanding rapidly in recent years, it still accounts for only a tiny fraction of the fuel that passenger vehicles use. Recent projections indicate that annual consumption of E85 will reach just 0.6 billion gallons by 2022 (and 1.1 billion gallons by 2024), out of a total of 127 billion gallons of blended gasoline projected to be used in that year.[10]

Another possibility for raising the average concentration of ethanol in the fuel supply above 10 percent is to make blended gasoline with up to 15 percent ethanol content (E15) widely available. EPA has certified that vehicles built since 2001—roughly 80 percent of vehicles now on the road—can run on E15 without risking corrosion damage to their fuel lines and engine parts.[11] Many automakers disagree and have discouraged their customers from using E15.[12] However, some major manufacturers—including

8. See U.S. Department of Energy, Alternative Fuels Data Center, "Ethanol Fueling Station Locations" (accessed October 30, 2015), www.afdc.energy.gov/fuels/ethanol_locations.html. See also Kristi Moriarty, "E85 Deployment" (presentation prepared for the Energy Information Administration's biofuels workshop by the National Renewable Energy Laboratory, March 20, 2013), www.eia.gov/biofuels/workshop/presentations/2013.

9. See Department of Agriculture, "Biofuel Infrastructure Partnership—State Table" (accessed November 1, 2015), http://go.usa.gov/caqrz.

10. See Energy Information Administration, *Annual Energy Outlook 2015, With Projections to 2040*, DOE/EIA-0383(2015), www.eia.gov/forecasts/aeo/.

11. See Oak Ridge National Laboratory, *Transportation Energy Data Book* (September 2015), Chapter 3, Tables 3.8 and 3.9, http://cta.ornl.gov/data/chapter3.shtml.

12. Industry groups challenged EPA's certification of E15 in court. In 2013, the Supreme Court dismissed those challenges, which prompted the Alliance of Automobile Manufacturers to assert that "vehicles [built since 2001] were never designed to run on this more corrosive fuel. Automakers continue to urge consumers to check their owner's manuals for the recommended fuel to use safely in their vehicles." See Alliance of Automobile Manufacturers, "Alliance Response to Supreme Court Decision Today to Dismiss Challenges to EPA's E15 Decision" (June 24, 2013), http://tinyurl.com/q8um8eg.

Ford and General Motors—have stated that their models from 2012 or 2013 and later can use E15 without risk.

Experience with vehicles running on E15 has been limited because, until mid-2012, no filling stations offered that fuel. In recent years, the Department of Agriculture provided funding (through the Rural Energy for America Program) for installing pumps that can dispense either E10 or E15; currently, a small number of stations have E15 pumps.[13] But because filling stations that would like to offer both blends would incur costs to acquire new pumps and underground storage tanks, the growth of E15 sales is expected to be slow. In addition, some station owners may be concerned about potential liability claims arising from drivers who inadvertently refuel a pre-2001 vehicle with E15.

A final possibility for addressing the blend wall is to rely more on "drop-in" fuels made from cellulose. The same sorts of cellulosic feedstocks that are used to make biofuels can also be used to produce gasoline or diesel. Those drop-in fuels are identical to conventionally made gasoline and diesel and can substitute for them in full, rather than having to be blended into conventional fuel. The technologies for making any kind of cellulosic fuel are new, however, and production remains costly. (In addition, only a fraction of the cellulosic production plants projected to open in the next few years are expected to make drop-in fuels.) Nevertheless, to the extent that production of cellulosic gasoline and diesel grows, using more of those drop-in fuels can increase the renewable content of the nation's supply of transportation fuel without exacerbating concerns about the blend wall.

EPA's Response to Compliance Challenges

The Energy Independence and Security Act requires that EPA evaluate the Renewable Fuel Standard's requirements each year and adjust them, if necessary, on the basis of market conditions. EPA's response to the gap between the RFS mandate governing use of cellulosic biofuels and actual production of those fuels has been to use its waiver authority to significantly alter that mandate.

For 2010, the first year the cellulosic biofuel mandate was in effect, EPA reduced the requirement of 100 million gallons stated in EISA to 6.5 million gallons—the target that fuel suppliers could meet using RINs they had obtained in previous years by exceeding those years' requirements. (The earlier requirements were based on a broader definition of cellulosic biofuels, as described in the Energy Policy Act of 2005.) For 2011 and 2012, EPA initially reduced the cellulosic biofuel mandates significantly. However, after negligible production of cellulosic biofuels in those years and court challenges by the petroleum industry, EPA eliminated the mandate for 2012 and has retroactively proposed doing so for 2011, but the proposal has not yet been officially accepted.[14] In addition, the agency lowered the 2013 requirement from 1 billion gallons to less than 1 million gallons (reflecting the industry's production capacity in that year).[15] EPA did not also reduce the requirements for total renewable fuels or for advanced biofuels when it lowered those cellulosic mandates; fuel suppliers were able to make up for the lack of cellulosic biofuels mainly by using biomass-based diesel and noncellulosic ethanol made from sugarcane.[16]

EPA has proposed reducing the cellulosic biofuel requirement from 1.75 billion gallons to 33 million gallons for 2014, from 3 billion gallons to 106 million gallons for 2015, and from 4.25 billion gallons to 206 million gallons for 2016.[17] (Although EPA announced its proposal for the 2014 requirement in November 2013 and revised the proposal in June 2015, it has not yet issued a final rule. Under the proposed rule, the compliance deadline for the 2014 mandate would be June 1, 2016.) The proposed rule for 2014 marks the first time that EPA has also proposed decreasing the RFS mandates on total advanced

13. See Department of Energy, Alternative Fuels Data Center, "E15" (June 16, 2015), www.afdc.energy.gov/fuels/ethanol_e15.html.

14. For the legal decision about the 2012 mandate, see *API v. EPA*, 706 F.3d 474 (D.C. Cir. 2013). For a discussion of the proposed repeal for 2011, see Environmental Protection Agency, *EPA Proposes Renewable Fuel Standards for 2014, 2015, and 2016, and the Biomass-Based Diesel Volume for 2017,* EPA-420-F-15-024 (May 2015), Table 1, p. 3, http://go.usa.gov/cxhem (PDF, 233 KB).

15. See Environmental Protection Agency, *EPA Issues Direct Final Rule for 2013 Cellulosic Standard*, EPA-420-F-14-018 (April 2014), http://go.usa.gov/9rd3 (PDF, 151 KB).

16. EPA has not relieved suppliers of their compliance obligations for those years but instead has allowed them to satisfy the obligations in a different way. Specifically, whenever EPA has reduced the RFS mandate on cellulosic biofuels, it has offered credits for sale to fuel suppliers in an amount equal to the new, revised mandate. If suppliers plan to substitute some other advanced biofuel for cellulosic biofuel, they must buy a waiver credit from EPA as well as the gallon of that other fuel. EPA determines the price of waiver credits on the basis of the previous year's wholesale price of gasoline.

17. See Environmental Protection Agency, *EPA Proposes Renewable Fuel Standards for 2014, 2015, and 2016, and the Biomass-Based Diesel Volume for 2017,* EPA-420-F-15-024 (May 2015), Table 1, p. 3, http://go.usa.gov/cxhem (PDF, 233 KB).

biofuels and total renewable fuels: Those requirements would shrink by more than 1 billion gallons and by over 2 billion gallons, respectively (from 3.75 billion to 2.68 billion gallons of advanced biofuels and from 18.15 billion to 15.93 billion gallons of renewable fuels). EPA has made similar reductions in its proposals for 2015 and 2016. EPA's proposals reflect concern that the total renewable fuel requirements in EISA would cause the average ethanol content of the nation's gasoline supply to exceed the 10 percent concentration that many non-flex-fuel vehicles can use. To maintain a proportional cap on the use of corn ethanol, EPA has also proposed reducing the portion of the RFS that does not have to be met with advanced biofuels (for example, reducing it from 14.4 billion to 13.25 billion gallons in 2014).

The annual mandates for cellulosic biofuels specified in EISA through 2022 are so much greater than the industry's projected capacity that EPA will probably continue to reduce the mandate every year, rather than impose large fines on fuel suppliers that cannot meet the requirement because the fuels are not available. However, granting fuel suppliers a waiver for cellulosic biofuels is likely to have the unintended effect of slowing the growth of production capacity for such fuels by weakening incentives for the private sector to invest in building that capacity. Similar effects would occur for other advanced biofuels if the mandates for those fuels were reduced. In addition, if EPA continues to lower the annual requirements for total renewable fuels to avoid exceeding the blend wall, it will lessen incentives to expand the number of filling stations that offer E85, even though such expansion would help retail gasoline markets accommodate more ethanol in the fuel supply.

The Use of Renewable Fuels Under Three Scenarios

To illustrate how the Renewable Fuel Standard—and potential changes to it—might affect the use of renewable fuels over the next several years, CBO estimated the amount of renewable fuels that would be consumed in 2017 under three alternative scenarios: if the requirements for 2017 were set at the amounts currently proposed for 2016, if fuel suppliers had to comply with the requirements stated in EISA (other than the cellulosic biofuel mandate), and if lawmakers immediately repealed the RFS.

2016 Volumes Scenario

For the 2016 volumes scenario, CBO assumed that the requirements for various types of renewable fuels in 2017 would be set at the same volumes that EPA has proposed for 2016. Total U.S. consumption of transportation fuels is projected to be similar in 2017 and 2016, so this scenario would make the Renewable Fuel Standard about as stringent in 2017 as it would be in 2016.

In the absence of Congressional action or legal restrictions, CBO considers this scenario much more likely than the EISA volumes scenario, which would require a large and rapid increase in the use of advanced biofuels and would cause the total percentage of ethanol in the gasoline supply to rise to levels that would require significant changes in the infrastructure of fueling stations.

Under the 2016 volumes scenario, fuel suppliers would be required to use the following in 2017 (see Table 1):

- 17.4 billion gallons of renewable fuels in all, including
- 3.4 billion gallons of advanced biofuels, of which 2.7 billion compliance-equivalent gallons would have to be biomass-based diesel, and
- No more than about 14 billion gallons of corn ethanol.

Under this scenario, fuel suppliers would have to use about 700 million gallons of advanced biofuels in addition to 2.7 billion gallons of biomass-based diesel (reported here in compliance equivalent gallons and corresponding to 1.8 physical gallons). Suppliers would probably meet that requirement by using slightly more biomass-based diesel (which is a subcategory of advance biofuels) than required and by importing some sugarcane ethanol.

EISA Volumes Scenario

The EISA volumes scenario represents what would be likely to occur if, for 2017, EPA did not alter the total requirement for renewable fuels, the advanced-biofuel mandate, the biomass-based diesel mandate, and the corn ethanol cap specified in EISA—for example, if the courts or lawmakers prevented EPA from making such modifications.

Table 1.

Use of Renewable Fuels in 2017 Under Three Alternative Scenarios for the Renewable Fuel Standard

	2016 Volumes Scenario[a]		EISA Volumes Scenario[b]		Repeal Scenario[c]
	Volume Requirement (Billions of gallons)	Blend Requirement (Percent)[d]	Volume Requirement (Billions of gallons)	Blend Requirement (Percent)[d]	Estimated Volume (Billions of gallons)
Advanced Biofuels					
Biomass-based diesel[e]	2.7	1.5	3.0	1.6	About 1
Other advanced biofuels	0.7	0.4	6.0	3.4	f
Subtotal	3.4	1.9	9.0	5.0	About 1
Corn Ethanol	14.0	g	15.0	g	13.4[h]
Total Renewable Fuels	**17.4**	**9.6**	**24.0**	**13.3**	**14 to 15**

Source: Congressional Budget Office based on section 202 of the Energy Independence and Security Act of 2007; Renewable Fuel Standard Program, 80 Fed. Reg. 33100 (proposed June 10, 2015); and Energy Information Administration, *Annual Energy Outlook 2015: With Projections to 2040* (April 2015), www.eia.gov/forecasts/aeo.

a. For this scenario, CBO assumed that the 2017 requirements for renewable fuels would be set at the same volumes that EPA has proposed for 2016. Thus, the 0.7 billion gallons of other advanced biofuels would have to include at least 206 million gallons of cellulosic biofuels. Total use of transportation fuels in the United States is projected to be similar in 2017 and 2016, so this scenario would make the Renewable Fuel Standard about as stringent in 2017 as it would be in 2016.

b. For this scenario, CBO assumed that fuel suppliers would have to comply with the total requirement for renewable fuels and the cap on corn ethanol that are specified for 2017 in the Energy Independence and Security Act of 2007 (EISA). Those requirements mean that fuel suppliers would also be required to use 9 billion gallons of advanced biofuels, with specific quantities consisting of biomass-based diesel and cellulosic biofuels. The Environmental Protection Agency (EPA) has not yet specified the requirement for biomass-based diesel for 2017 (EISA mandates that it be at least 1.5 billion gallons, measured in compliance-equivalent gallons). For illustrative purposes, CBO assumed that fuel suppliers would be required to use 2.0 billion gallons of biomass-based diesel (which count as 3.0 billion compliance-equivalent gallons)—slightly more than EPA has required under the proposed rule for 2016. The 6.0 billion gallons of advanced biofuels not composed of biomass-based diesel would include a minimum quantity of cellulosic biofuels, which has not yet been specified by EPA.

c. For this scenario, CBO assumed that lawmakers would repeal the Renewable Fuel Standard in 2015, so fuel suppliers would not be subject to any requirements for the use of renewable fuels in 2017.

d. EPA translates the annual volume requirements in EISA into percentage blend requirements using projections of the total amount of gasoline and diesel that will be used in a given year. Those requirements specify the percentages of various renewable fuels that suppliers must blend into gasoline or diesel to comply with the EISA mandates. CBO estimated the percentage requirements for 2017 using the relationship between the volume requirements and blend requirements that EPA calculated for 2016 (because total U.S. consumption of gasoline and diesel is projected to be similar in those two years).

e. Figures for biomass-based diesel are measured in compliance-equivalent gallons. Under EISA, 1 gallon of biomass-based diesel is considered equivalent to 1.5 gallons of other types of advanced biofuels or of corn ethanol for the purposes of complying with the Renewable Fuel Standard. EPA's proposed standard for 2016 is 1.8 billion gallons of biomass-based diesel, which would equal 2.7 billion compliance-equivalent gallons.

f. If lawmakers repealed the Renewable Fuel Standard, fuel suppliers would probably continue to use small quantities of other advanced biofuels in addition to biomass-based diesel. Those quantities would include sugarcane ethanol used to meet state requirements for renewable fuel use as well as the small amounts of cellulosic biofuels that would continue to be produced at existing plants.

g. The volume specified for corn ethanol is an upper limit on its use rather than a minimum requirement, so EPA does not calculate a percentage blend requirement for corn ethanol.

h. This figure is based on the expectation that corn ethanol will make up roughly 10 percent of the 134 billion gallons of blended gasoline projected to be used in the United States in 2017.

Under the EISA volumes scenario, fuel suppliers would be required to use the following in 2017:

- 24 billion gallons of renewable fuels in all, including
- 9 billion gallons of advanced biofuels, of which roughly 3 billion compliance-equivalent gallons would have to be biomass-based diesel,[18] and
- No more than 15 billion gallons of corn ethanol.

In addition to those requirements, EISA mandates that 5.5 billion gallons of the advanced-biofuel requirement be met by using cellulosic biofuels. For this scenario, CBO assumed that EPA would continue to reduce the requirement for cellulosic biofuels to the amount that could be made from available production capacity—projected by the Energy Information Administration to be about 170 million gallons in 2017—and that fuel suppliers would be allowed to use other types of advanced biofuels to make up the remaining volume for the advanced-biofuel mandate.

The requirements of EISA outlined above imply that fuel suppliers would have to use 5.6 billion more gallons of advanced biofuels of some sort in 2017 than would be required under the 2016 volumes scenario. What types of fuel they would use to meet that goal is highly uncertain. To date, no more than 500 million additional gallons of advanced biofuels have been required under finalized rules (beyond the mandate for biomass-based diesel).[19] Suppliers have met that requirement by using slightly more biomass-based diesel than required and by importing sugarcane ethanol. Increasing the use of those types of advanced biofuels enough to use the additional 5.6 billion gallons of advanced biofuels required under the EISA volumes scenario (relative to the 2016 volumes scenario)—especially over just a few years—would probably be challenging and costly. For example, consider the following illustrative increases in advanced biofuels:

- The Energy Information Administration currently projects that the United States will use roughly 2.5 billion gallons of biomass-based diesel (measured in compliance-equivalent gallons) in 2017 and expects annual consumption to remain constant through 2040.[20] To use an additional 1.5 billion compliance-equivalent gallons of biomass-based diesel would mean a 60 percent increase in the projected supply of that fuel, which would most likely require a significant increase in its price.
- To import an additional 3 billion gallons of sugarcane ethanol from Brazil (the primary source of the sugarcane ethanol used in the United States) would require a 50 percent increase in Brazil's production from the amount projected for 2017.[21] Fostering such a large increase in production in a short time would be difficult—and would probably require a significant increase in the price of sugarcane ethanol—given the time lags involved in planting and harvesting a perennial crop such as sugarcane and the need for additional production capacity and transportation infrastructure.[22]

Even such large boosts in supply would leave more than 1 billion gallons to be filled by other types of advanced biofuels. Rising prices for advanced biofuels could

18. EISA allows EPA to set the requirement for biomass-based diesel at a volume not lower than 1 billion gallons. Each gallon of biomass-based diesel provides 1.5 RINs for the purposes of complying with the advanced-biofuel requirement, so the requirement for 1 billion gallons accounts for 1.5 billion gallons of compliance. EPA has not yet set that volume for 2017. For illustrative purposes, CBO assumed that it would be 3 billion compliance-equivalent gallons, only slightly more than the 2016 requirement.

19. In calculating that gap, CBO accounted for the fact that each gallon of biomass-based diesel provides 1.5 RINs for the purposes of complying with the advanced-biofuel requirement. So far, the largest gap occurred in 2012, when the requirement for advanced biofuels was set at 2 billion gallons and the requirement for biomass-based diesel was set at 1 billion gallons (1.5 billion on a compliance-equivalent basis).

20. See Energy Information Administration, *Annual Energy Outlook 2015, With Projections to 2040*, DOE/EIA-0383(2015), www.eia.gov/forecasts/aeo/.

21. That figure is CBO's estimate based on Energy Information Administration, *International Energy Outlook 2014*, *With Projections to 2040,* DOE/EIA-0484(2014) (September 2014), www.eia.gov/forecasts/ieo.

22. Some industry observers have speculated that larger U.S. imports of sugarcane ethanol from Brazil could be achieved not by encouraging increased production in Brazil but by exchanging sugarcane ethanol made in that country for corn ethanol made in the United States. (That type of swap has already taken place to a limited degree, as discussed in Energy Information Administration, *Biofuels Issues and Trends*, October 2012, www.eia.gov/biofuels/issuestrends.) CBO did not estimate the cost of that approach because it would impose large logistical challenges, and such an exchange would not increase the global use of advanced biofuels but would consume scarce resources and produce additional greenhouse gas emissions to transport the swapped ethanol supplies.

encourage the production of new supplies based on additional feedstocks, such as sorghum. However, at present, little information exists to project how large such supplies would be and how they could become available by 2017.

Repeal Scenario

The repeal scenario represents CBO's assessment of what would happen if lawmakers immediately eliminated the RFS. Under that scenario, fuel suppliers would have no requirements to use specific types or amounts of renewable fuels, and they would use such fuels only to the extent that doing so was cost-effective for them.

CBO estimates that in the absence of the Renewable Fuel Standard, in 2017 fuel suppliers would use roughly 1 billion gallons of biomass-based diesel (measured in compliance-equivalent gallons) or about 1.7 billion gallons less than the amount required in the 2016 volumes scenario. Although data are limited, the agency estimates that 1 billion gallons is about the amount of biomass-based diesel that could be cost-effectively produced in 2017 in the absence of the RFS mandates—primarily that which can be made from food waste. About half of the less than 2 billion gallons of biomass-based diesel fuel produced in 2013 was made from soybean oil, but available evidence suggests that the cost of producing diesel from soybean oil is higher than the wholesale price of petroleum-based diesel.[23] In contrast, biomass-based diesel produced from food waste would probably remain cost-effective even without the incentives created by the RFS because the materials are generally available at a relatively low cost.[24] If the other half of the 2013 production came from food waste and the amount of waste available for such production increased somewhat between 2013 and 2017, the amount of biomass-based diesel that could be cost-effectively produced would increase to roughly 1 billion gallons.

Consumption of corn ethanol would be 13.4 billion gallons under the repeal scenario, CBO estimates. Because ethanol is expected to cost less per gallon than gasoline in 2017, fuel suppliers would probably find it profitable to use 13.4 billion gallons of ethanol in that year—the volume that corresponds to the maximum blend of ethanol in gasoline (10 percent) that virtually all vehicles now on the road can use.[25] Even if ethanol did not have a price advantage, it would probably continue to be in demand to some extent because of its other benefits. In particular, adding ethanol helps suppliers ensure that their fuel meets emission limits for carbon monoxide (an air pollutant regulated by EPA) and octane requirements (for improved vehicle performance).

Over the longer term, the effect of a repeal on the use of ethanol could be greater. For example, the per-gallon price of corn ethanol might rise above that of gasoline, causing fuel suppliers to reduce the concentration of ethanol in gasoline below current levels. Another possibility is that future advances in technology could allow the development of cost-effective octane-enhancing substitutes for ethanol, which could cause fuel blenders to favor the use of those substitutes. If so, ethanol consumption under the repeal scenario could fall short of that under the other scenarios by growing amounts.

Prices and Spending for Food Under Three Scenarios

To the extent that the Renewable Fuel Standard raises the demand for ethanol made from cornstarch, it will increase corn prices and thus prices for the wide variety of foods that are produced with corn—ranging from corn syrup sweeteners to meat, dairy, and poultry products.[26] Some policymakers have expressed concern about the size of those potential price increases and their effects on households' food spending. Although food prices depend on many uncertain factors, CBO's analysis suggests that

23. See Scott Irwin and Darrel Good, "Recent Trends in Biodiesel Prices and Production Profits" (Department of Agricultural and Consumer Economics, University of Illinois Urbana-Champaign, September 18, 2013), http://farmdocdaily.illinois.edu/2013/09; and Don Hofstrand, "Tracking Biodiesel Profitability" (Iowa State University Extension and Outreach, July 2012), http://tinyurl.com/pwwx3ac.

24. See Ralph Groschen, *Overview of the Feasibility of Biodiesel From Waste/Recycled Greases and Animal Fats* (Minnesota Department of Agriculture, October 2002), http://tinyurl.com/l6222gb (PDF, 319 KB).

25. For expectations that ethanol will cost less per gallon than gasoline in 2017, see CME Group, "RBOB Gasoline Futures" and "CBOT Denatured Fuel Ethanol Futures" (accessed October 30, 2015), www.cmegroup.com. Although the current futures price of ethanol are somewhat higher than those of gasoline per British thermal unit (Btu) of energy content, analysts generally believe that for blends of 10 percent ethanol or less, fuel suppliers make choices based on the per-gallon cost of the two fuels rather than the per-Btu cost. See Scott Irwin and Darrel Good, "Ethanol Blending Margins, RFS2 Compliance, and the Price of Gasoline" (AgFax, April 3, 2012), http://tinyurl.com/qj6ltg7.

26. For an earlier study on that topic, see Congressional Budget Office, *The Impact of Ethanol Use on Food Prices and Greenhouse Gas Emissions* (April 2009), www.cbo.gov/publication/41173.

differences in food prices and spending under the agency's three scenarios for the RFS would probably be small. Specifically, expenditures on food would be slightly higher under the EISA volumes scenario than under the 2016 volumes scenario. CBO estimates that, compared with the 2016 volumes scenario, the increase in the demand for corn stemming from the increased production of corn ethanol under the EISA volumes scenario would boost spending on food by about $1.6 billion in 2017, or by roughly 0.1 percent of the approximately $1.8 trillion in spending on food expected in 2017.[27] Alternatively, CBO estimated that total U.S. food expenditures in 2017 would be slightly lower if the RFS was repealed than under the 2016 volumes scenario—by roughly $1.0 billion, or less than 0.1 percent of spending on food.[28]

How the RFS Affects the Use of Corn Ethanol

A key consideration when evaluating the effect of the renewable fuel mandates on food prices is the extent to which the use of corn ethanol differs among the scenarios. As described above, CBO expects that the use of corn ethanol would be about 7 percent (1 billion gallons) higher if fuel suppliers had to meet the 2017 requirements specified in EISA (15 billion gallons of corn ethanol) than in the 2016 volumes scenario. If, by contrast, the RFS was repealed, CBO estimates that ethanol consumption in the repeal scenario would be about 4 percent (about 600 million gallons) lower. Changes in the quantity of ethanol used—either higher or lower—in turn affects the demand for corn.

How the Demand for Corn Ethanol Affects the Price of Corn

Of the U.S. corn supply, roughly 10 percent is used for food products, 40 percent for animal feed, and 40 percent for ethanol production (the rest is exported). Thus, any significant change in the demand for corn ethanol that resulted from the RFS could have a noticeable effect on corn prices. The extent to which corn prices would be affected would depend on how sensitive the supply of and demand for corn are to changes in its price. Analysts have produced a range of estimates for that sensitivity (known as an elasticity). Using estimates that are in the middle of that range, CBO projects that consuming 15 billion gallons of corn ethanol as called for in the EISA volumes scenario would raise corn prices in 2017 by 12 cents per bushel relative to prices in the 2016 volumes scenario (an increase of roughly 3 percent). Alternatively, consuming 600 million fewer gallons of corn ethanol under the repeal scenario in comparison with the 2016 volumes scenario would lower corn prices in 2017 by about 7 cents per bushel (roughly 2 percent). Those estimates take into account the extent to which higher prices in the EISA volumes scenario (or lower prices in the repeal scenario) would boost (or lower) corn production and reduce (or raise) nonethanol uses of corn (such as for food or animal feed), both of which would limit some of the changes in price that would otherwise result.

The difference in corn prices between the repeal scenario and the 2016 volumes scenario could be larger over the longer term. If, after the repeal of the RFS, the ethanol content of the gasoline supply fell below 10 percent, the gap between ethanol use under the 2016 volumes scenario and the repeal scenario would widen. As a result, differences in the consumption of corn ethanol, and thus in the price of corn, between those scenarios would grow over time.

How the Price of Corn Affects the Cost of Food and Federal Spending Programs

Changes in corn prices affect food prices directly because of the large variety of food products that contain corn. Changes in corn prices would also operate indirectly through two different mechanisms. First, higher prices for corn used as animal feed would lead to price increases for meat, poultry, and dairy products. Second, higher corn prices would cause farmers to produce corn in place of other crops, such as soybeans, and decreased production of those crops would in turn raise their prices. Lower prices for corn would have the opposite effect: Lower prices for corn lead to decreases in prices for meat, poultry, and dairy products and for crops planted in place of corn.

27. An increase in the prices of certain types of food would cause consumers to reduce the amount of those foods that they purchased. But because the effects on food prices in this analysis are small, any reduction in the amounts of certain types of food consumed would also be small, and it would be offset at least in part by increased consumption of other types of food. Thus, CBO's calculations reflect the assumption that the increase in food prices would not affect the total quantity of food purchased.

28. The calculations used in this analysis are described in Congressional Budget Office, *The Renewable Fuel Standard: Issues for 2014 and Beyond* (June 2014), Appendix, www.cbo.gov/publication/45477.

Changes in food prices could affect federal programs that are linked to those prices, such as the Supplemental Nutrition Assistance Program, or SNAP (formerly known as Food Stamps), and various programs that provide meals to children at school and in other settings. Once a year, the government adjusts the benefits paid under SNAP and the child nutrition programs on the basis of shifts in food prices. As a result, changes in food prices would lead to roughly proportionate changes in spending on such benefits. Spending for farm price and income support programs also would be affected by changes in the price of corn. A higher corn price would probably lead to lower spending for those programs, whereas a lower corn price would increase such spending for a given program year.

Prices of Transportation Fuels Under Three Scenarios

The Renewable Fuel Standard boosts the use of renewable fuels by requiring fuel suppliers to obtain a specific number of RINs (with each RIN corresponding to a gallon of renewable fuel that has been blended into the fuel supply) for every gallon of petroleum-based gasoline or diesel that they use. How that requirement affects the prices of various fuels depends on a fuel's composition of petroleum-based and renewable elements. To better understand the potential size of those effects over the next several years, CBO estimated how the price of diesel fuel and E10—the two most commonly consumed transportation fuels—and the price of E85 would differ in 2017 among its three scenarios for the RFS.

The 2016 Volumes Scenario

Earlier this year EPA proposed RFS mandates for 2014, 2015, and 2016, with volume requirements gradually increasing each year. To implement the Renewable Fuel Standard, EPA translates the volume requirements into percentage blend requirements, which equal the mandated volume of each category of renewable fuel divided by the projected volume of gasoline and diesel that is subject to EISA, as discussed above. Those percentage obligations are applied to each fuel supplier's actual sales of gasoline and diesel to determine the number of RINs that the supplier must submit. Fuel suppliers obtain RINs by purchasing qualifying gallons of renewable fuels and blending them into the fuel they sell or by purchasing RINs from suppliers that have accumulated excess RINs by using more renewable fuel than the RFS requires.

Compliance Requirements. Given the percentage blend requirements of the 2016 volumes scenario, for each 100 gallons of diesel or gasoline that a fuel supplier used in 2017, it would need to submit 9.6 RINs to EPA, of which 1.9 would have to qualify as advanced biofuels (shown in Table 1 on page 11). Of those 1.9 advanced-biofuel RINs, at least 1.5 would have to be biomass-based diesel RINs. Thus, taking into account the nested nature of the standard, for each 100 gallons of diesel or gasoline it used, a fuel supplier would have to submit the following to EPA:

- 1.5 biomass-based diesel RINs,
- 0.4 advanced-biofuel RINs (the total of 1.9 advanced biofuel RINS minus the 1.5 met by biomass-based diesel), and
- 7.7 renewable fuel RINs (the total of 9.6 renewable fuel RINs minus the 1.9 advanced-biofuel RINs).

RIN Prices. Given the increase in volume requirements, for the purposes of this analysis, CBO estimated that complying with the 2016 volumes scenario in 2017 would result in RIN prices that are slightly more than 10 percent higher than those observed most recently.[29] Specifically, CBO estimated that RIN prices would be roughly as follows:

- 40 cents for a renewable RIN (those generated by corn ethanol),
- 55 cents for an advanced biomass-based diesel RIN, and
- 55 cents for an advanced biofuel RIN (generated by biomass-based diesel or other form of advanced biofuel, such as sugarcane ethanol).

CBO used those RIN prices to calculate the effects of the EISA volumes scenario and the repeal scenario on 2017 fuel prices relative to the 2016 volumes scenario.

The EISA Volumes Scenario

If EPA set the total requirement for renewable fuels and the cap on corn ethanol at the 2017 volumes stated in EISA, fuel suppliers would have to use about 6.6 billion

29. This is consistent with current RIN prices rising at a real (inflation-adjusted) annual rate of roughly 5 percent.

gallons more than they would use under the 2016 volumes scenario (including about 5.6 billion additional gallons of advanced biofuels).

Compliance Requirements. Given the percentage blend requirements of the EISA volumes scenario, for each 100 gallons of diesel or gasoline that a fuel supplier used in 2017, it would need to submit 13.3 RINs to EPA, of which 5 would have to qualify as advanced biofuels. Of those 5 advanced-biofuel RINs, at least 1.6 would have to be biomass-based diesel RINs. Thus, taking into account the nested nature of the standard, for each 100 gallons of diesel or gasoline it used, a fuel supplier would have to submit the following to EPA:

- 1.6 biomass-based diesel RINs,
- 3.4 advanced-biofuel RINs (the total of 5 advanced-biofuel RINs minus the 1.6 biomass-based diesel RINs), and
- 8.3 renewable fuel RINs (the total of 13.3 renewable fuel RINs minus the 5 total of advanced-biofuel RINs).

RIN Prices. Estimating the effects of the EISA volumes scenario on the prices of diesel, E10, and E85 requires estimating how the Renewable Fuel Standard would affect the price of each type of RIN. It also involves calculating RIN requirements on the basis of the percentages of petroleum-based and renewable fuels in the fuel that a supplier sells.

In a previous analysis, CBO estimated the RIN prices that would result if suppliers had to comply with the volumes stated in EISA for 2017 (but could meet the cellulosic requirement by using other advanced biofuels).[30] Updating that analysis, CBO finds that the RIN prices necessary to yield the total volume of renewable fuels mandated under the EISA volumes scenario would be roughly as follows:

- $1.55 to $2.10 for a renewable RIN ($1.15 to $1.70 more than under the 2016 volumes scenario), and
- $3.00 to $6.00 for both advanced biomass-based diesel RINs and other advanced-biofuel RINS (about $2.45 to $5.45 more than under the 2016 EISA volumes scenario).

The much higher RIN prices found under the EISA volumes scenario than under the 2016 volumes scenario reflect the substantially higher volumes of both advanced biofuels and total renewable fuels required under the EISA volumes scenario.

Meeting the EISA volumes requirements would necessitate a substantial and rapid increase in the use of E85. Such an increase would require a significant expansion in the number of stations providing E85 (with associated capital investment). Moreover, CBO estimates that the price of driving a mile with E85 would need to be roughly 40 percent to 60 percent lower than the cost of driving a mile with E10 to compensate for the lower energy content of E85 and the inconvenience that drivers would face because of needing to fill up their tanks more often and to go out of their way to find fueling stations that offer E85.

Meeting the larger advanced-biofuel requirement under the EISA volumes scenario (in comparison with the 2016 volumes scenario) would require a large and rapid increase in the supply of both biomass-based diesel and sugarcane ethanol, potentially entailing more than a 60 percent increase in U.S. production of biomass-based diesel and a 50 percent increase in Brazil's production of such ethanol (if Brazil's own consumption did not change), representing a more than eightfold increase in the country's exports of sugarcane ethanol from the 2014 level.[31]

Effect on the Prices of Transportation Fuels in the United States. Applying both the RIN prices and the blend requirements listed above, CBO estimated that complying with the EISA volumes scenario would alter fuel prices relative to the 2016 volumes scenario (CBO's reference case) in the following manner:

30. For a discussion of how those RINs prices were estimated, see Congressional Budget Office, *The Renewable Fuel Standard: Issues for 2014 and Beyond* (June 2014), www.cbo.gov/publication/45477.

31. Brazil exported about 1.4 million cubic meters (370 million gallons) of ethanol in 2014. The United States, South Korea, and China received the largest shares of those exports. See Brazilian Sugarcane Industry Association, "Monthly Report of Brazilian Ethanol Exports, Calendar Year 2015," http://tinyurl.com/ktawewp (accessed October 30, 2015).

- The price for petroleum-based diesel would rise by roughly 25 to 45 cents;
- The price for E10 would rise by about 15 to 30 cents; and
- The price of E85 would fall by roughly $0.80 per gallon to $1.20.

The methods that CBO used to derive these estimates are very similar to those used to examine the EISA scenario in CBO's report last year.[32]

The Repeal Scenario

If lawmakers were to repeal the RFS, fuel suppliers would probably continue to use 13.4 billion gallons of corn ethanol and about 1 billion gallons of biomass-based diesel. The decisions to use those amounts, however, would be driven by economics rather than by a mandate.

CBO finds that repealing the RFS would only have a very small effect on prices of E10 and petroleum-based diesel relative to the 2016 volumes scenario. In contrast, the price of E85 would increase by around 26 cents because the RFS-induced subsidies encouraging its use would be removed. (Although the 2016 volume scenario results in a somewhat significant subsidy to E85, the quantity of E85 consumed is so small in relation to the quantities of E10 and diesel consumed that the effect on the prices of E10 and petroleum-based diesel would be very small.)

Price of Petroleum-Based Diesel. CBO estimated the effect of the repeal scenario on the price of diesel fuel relative to the 2016 volumes scenario by applying the RIN prices described above for the 2016 volumes scenario to the additional cost components identified for suppliers of diesel. Thus, for each 100 gallons of diesel that a fuel supplier sold, the additional cost avoided by repeal would be the sum of the following:

- 1.5 × the $0.55 price of a biomass-based diesel RIN,
- 0.4 × the $0.55 price of an advanced-biofuel RIN, and
- 7.7 × the $0.40 price of a renewable fuel RIN.

Those costs would add about $4 for each 100 gallons of petroleum-based diesel, so eliminating them would lower the average cost of producing petroleum-based diesel in 2017 by about 5 cents per gallon.

Price of E10. For each 100 gallons of E10 that a fuel supplier sells, it uses 90 gallons of petroleum-based gasoline and 10 gallons of corn ethanol. Its RIN requirements are based only on its consumption of gasoline, so those requirements are 10 percent less than if it sold 100 gallons of purely petroleum-based gasoline. In addition to the RIN requirements associated with the 90 gallons of petroleum-based gasoline used, an E10 supplier would pay 3 cents more for each of the 10 gallons of corn ethanol that it used in 2017 under the 2016 volumes scenario (the price increase necessary to induce the extra 1 billion gallons of corn ethanol consumed in that scenario). In total, for each 100 gallons of E10 that the supplier sold, the lower cost resulting from repealing the RFS would be the sum of the following:

- 0.9 × (1.5 × the $0.55 price of a biomass-based diesel RIN),
- 0.9 × (0.4 × the $0.55 price of an advanced-biofuel RIN),
- 0.9 × (7.7 × the $0.40 price of a renewable fuel RIN), and
- 10 × the $0.03-per-gallon increase in the price of corn ethanol.

Removing those costs would subtract roughly $4 for each 100 gallons of E10. However, those lower costs would be partly offset by the lost value of RINs that the E10 supplier would have obtained along with each gallon of corn ethanol that it bought. Because the supplier would blend 10 gallons of corn ethanol into every 90 gallons of its fuel supply, it would have received 10 renewable fuel RINs. When that ethanol was blended into the fuel supply, each of those RINs would have been worth $0.40.[33] (The E10 supplier would use 6.9, or 0.9 × 7.7, of those renewable fuel RINs to meet its own compliance obligations—

32. Congressional Budget Office, *The Renewable Fuel Standard: Issues for 2014 and Beyond* (June 2014), www.cbo.gov/publication/45477.

33. That value includes the additional 10 cents per gallon that the fuel supplier would pay for each gallon of corn ethanol. Thus, the supplier would receive $1.45 to $2.00 of net revenue for any RIN that it sold. Likewise, the opportunity cost if the supplier used a RIN for its own compliance purposes would be $1.45 to $2.00.

offsetting the cost that it would otherwise incur to obtain RINs—and would sell the remaining 3.1.) The value of those 10 RINs would have roughly offset the blenders' compliance costs. As a result, relative to the 2016 volumes scenario, repealing the RFS would have only a very small effect on the price of E10.

Price of E85. The category of fuel referred to as E85 generally contains between 51 percent and 83 percent ethanol, depending on the season (winter blends have less ethanol to help vehicles start in cold weather). For this analysis, CBO anticipates that E85 will contain an average of 75 percent ethanol and 25 percent gasoline, consistent with recent projections by the Energy Information Administration.[34] Thus, for each 100 gallons of E85 that a fuel supplier sold, it would use 25 gallons of petroleum-based gasoline and 75 gallons of corn ethanol. Its RIN requirements under the RFS would be based only on its consumption of gasoline, so those requirements would be 75 percent less than if it sold 100 gallons of petroleum-based gasoline. The lower cost that suppliers would incur if the RFS was repealed would be the sum of the following:

- 0.25 × (1.5 × the $0.55 price of a biomass-based diesel RIN),
- 0.25 × (0.4 × the $0.55 price of an advanced-biofuel RIN),
- 0.25 × (7.7 × the $0.40 price of a renewable fuel RIN), and
- 75 × the $0.03-per-gallon increase in the price of corn ethanol.

Those effects would have subtracted about $13 for each 100 gallons of E85, but they would have been more than offset by the value of an E85 supplier's renewable fuel RINs. Because the supplier would mix 75 gallons of corn ethanol into every 100 gallons of its fuel supply, it would have received 75 renewable fuel RINs. Once that ethanol was blended into the fuel supply, each RIN would have had a value of 40 cents, providing the supplier with $30 of RIN value (75 × $0.40) for each 100 gallons of E85. Thus, on net, the repeal scenario would *increase* the average cost of a gallon of E85 by about 15 cents.

34. See Energy Information Administration, *Annual Energy Outlook 2015, With Projections to 2040*, DOE/EIA-0383(2015) (April 2015), Table A11, "Petroleum and Other Liquids Supply and Disposition," www.eia.gov/forecasts/aeo/.

About This Document

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