Appendix A

Aug 2013 Waiver Petition w/ NERA and MathPro Reports

AFPM
American
Fuel & Petrochemical
Manufacturers

energy API

August 13, 2013

The Hon. Gina McCarthy
Administrator
United States Environmental Protection Agency
1200 Pennsylvania Avenue, NW
Washington, D.C. 20460

Re: Petition for Partial RFS Mandate Waiver

Dear Administrator McCarthy:

The American Petroleum Institute ("API") and the American Fuel & Petrochemical Manufacturers ("AFPM") (collectively the "Petitioners") respectfully submit this petition to the U.S. Environmental Protection Agency ("EPA" or "the Agency") for a partial waiver of the 2014 applicable volumes of the Renewable Fuel Standard ("RFS") pursuant to section 211(o)(7)(A) of the Clean Air Act.[1] Petitioners represent numerous refiners and importers of transportation fuel and, in that capacity, are "person[s] subject to the requirements" of section 211(o)(2) and entitled to petition for a waiver. Petitioners are trade associations that appear on behalf of their members before Congress, administrative agencies, and the courts on a wide range of issues, including the U.S. supply of transportation fuels.[2] Unless this petition for waiver is granted, the RFS will result in inadequate domestic supplies of gasoline and diesel fuel and severe economic harm to consumers and the economy. EPA must take action to avoid the disastrous consequences of the RFS blendwall.

<u>Introduction</u>

a. The Blendwall Will Limit Domestic Supplies of Gasoline and Diesel Fuel Causing Severe Economic Harm.

Fundamentally, this Petition seeks to avoid the critical threats that the RFS presents to consumers and the entire U.S. economy. This year, the United States hit the "blendwall"—the point at which the RFS attempts to force the use of more renewable fuels than can be consumed in the United States, due to

[1] *See* 42 U.S.C. § 7545(o)(7)(A).

[2] The RFS directly implicates the interests of the Petitioners and their members, threatening—as discussed herein—"certainly impending" injuries that are "fairly traceable" to agency action. *Clapper v. Amnesty Int'l USA*, 133 S. Ct. 1138, 1143 (2013).

fundamental constraints imposed by fueling infrastructure and problems of gasoline engine incompatibility. Unless EPA exercises its authority to waive the mandates, the ultimate and unavoidable outcome of the RFS-imposed "blendwall" will be significant increases in the cost of fuel and substantial fuel supply shortages in the United States—resulting in undeniably severe economic harm to consumers and the economy.

Because of the blendwall, the RFS limits the supply of gasoline and diesel fuel for U.S. consumption. Compliance with the RFS is demonstrated through Renewable Identification Numbers ("RINs"). In effect, RINs operate like permits to sell specific quantities of gasoline and diesel for U.S. consumption. The number of RINs available for compliance depends on the consumption of renewable fuels in U.S. transportation fuels. Therefore, as the RFS mandates exceed the ability of the underlying fuel supply and vehicle and infrastructure compatibility to accommodate additional amounts of renewable fuels, there will be a shortage of RINs for compliance. This will in turn limit supplies of gasoline and diesel for U.S. consumption, resulting in severe economic harm to consumers and the overall economy.

b. E15, E85, and Biodiesel Cannot Supply Enough of the Needed RINs.

As explained in more detail below, there are no options beyond EPA's waiving of the requirements that can avert the potentially disastrous implications of the blendwall. There is no option that can realistically supply the necessary RINs to enable the continued adequate supply of gasoline and diesel fuel for U.S. consumption. Both E85 and E15 are only compatible with approximately 5 percent of the existing vehicle fleet, and the vast majority of retail infrastructure is not compatible with ethanol above 10 percent volume. In addition, over 95 percent of all retail gasoline stations are independently owned and operated—*i.e.*, they are not owned and operated by the RFS obligated parties. Moreover, biodiesel cannot fill the gap because of limitations on biodiesel supply resulting from feedstock constraints. Quite simply, there is no option other than an EPA waiver to avoid the adverse impacts that the RFS will have on domestic supplies of gasoline and diesel fuel.

c. The Shortage of RINs Will Cause an Inadequate Domestic Supply of Gasoline and Diesel Fuel.

Because the number of RINs available for compliance depends on the consumption of renewable fuels in U.S. transportation fuels, constrained consumption will result in a shortage of RINs. Indeed, the volumes of renewable fuels currently required by the RFS in 2013 are unachievable—the "blendwall"—and can be satisfied only through the use of previously banked RINs. The problem becomes more acute in 2014. Although the RFS requires industry to blend 14.4 billion gallons of corn-based ethanol, and hundreds of millions of gallons of imported sugarcane-based ethanol in 2014, the effective, practical limit imposed by the existing domestic distribution infrastructure and vehicle fleet will cap the amount of ethanol that can actually be blended into our gasoline supply at roughly 13 billion gallons.[3] "Therefore, after exhausting all other available options for compliance, individual obligated parties, each acting independently," will have no practical option but "to reduce their RIN obligation by decreasing the volume of transportation fuel supplied to the domestic market—either by reducing production," reducing imports, or increasing exports.[4] Obligated parties can legally supply only as much gasoline and diesel as they have permits (*i.e.*, RINs) to supply.

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[3] U.S. ENERGY INFORMATION ADMINISTRATION, *SHORT TERM ENERGY OUTLOOK* Table 4a (July 2013).
[4] NERA ECONOMIC CONSULTING, ECONOMIC IMPACTS RESULTING FROM IMPLEMENTATION OF THE RFS2 PROGRAM 2 (2012) (hereinafter NERA STUDY) (Attachment 1).

d. An Inadequate Domestic Supply of Gasoline and Diesel Fuel Will Severely Harm Consumers and the Economy.

As domestic fuel supplies decrease, large increases in transportation fuel costs would impose significant costs on society.[5] As the RFS mandate is ratcheted up every year, the annual increase in the mandates will further exacerbate the decreased fuel availability and increased fuel costs to society.[6] These increased fuel costs will have a broad impact across the economy and will increase over time as this process repeats itself yearly.[7] "As domestic supply continues to decline, the blending percentage obligation becomes increasingly untenable."[8]

The severe economic impact is seen most acutely first in the diesel fuel market. "The tightening of the diesel supply (up to 15% decline in 2015)" likely will cause "large fuel cost increases to ripple through the economy, adversely affecting employment, income, consumption, and GDP."[9] This disruption in fuel supply will result in severe economic harm to consumers and to the overall economy of the United States.[10] "By 2015, the adverse macroeconomic impacts" are estimated to "include a $770 billion decline in GDP and a corresponding reduction in consumption per household of $2,700."[11] EPA can avert this outcome by exercising its authority to grant the partial waiver requested in this Petition.

e. EPA's Issuance of a Waiver Will Provide Relief Because It Will Remove the Limitation on Gasoline and Diesel Supplies Resulting From the RIN Shortage.

EPA has previously considered two other requests for waivers of the RFS standards. In both cases, the Agency denied the waivers primarily because issuance of the waiver would not likely have impacted the amount of ethanol blended during the waiver period and therefore would not have had any real world impact. Now that the blendwall has been reached, that underlying reason no longer applies. Here, a waiver would have a very clear and necessary practical impact—it would lift the limitations on gasoline and diesel supplies that arise due to the blendwall.

f. Specific Relief Requested

To avoid the inevitable severe economic harm described herein, Petitioners respectfully request that EPA partially waive the RFS 2014 applicable volumes. Due to the nested nature of the four renewable fuel categories, this waiver request comprises the following elements:

- <u>Biomass-Based Diesel</u>: Biodiesel production is expected to meet the 1 billion gallon statutory minimum volumetric requirement, and EPA need not waive this obligation at this time provided other renewable requirements are waived in accordance with this Petition.[12]

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[5] *Id.*
[6] *Id.*
[7] *Id.*
[8] *Id.* at 3.
[9] *Id.*
[10] *Id.*
[11] *Id.*
[12] For purposes of this waiver request, Petitioners assume that EPA's mandate for 1.28 billion gallons of biomass-based diesel will be fulfilled. This amount of biomass-based diesel would create 1.92 billion RINs. Petitioners filed for reconsideration of the 2013 biomass-based diesel mandate, in addition to filing for review with the U.S. Court

- Cellulosic Biofuels: Because actual production of cellulosic biofuels remains minimal (less than 75,000 gallons have been produced in 2013 as of this petition), the 2014 cellulosic biofuel mandate of 1.75 billion gallons is impossible to meet and therefore EPA should use its authority to reduce the cellulosic mandates to reflect actual production.

- Advanced Biofuels: EPA is on record before Congress as identifying a 2013 advanced biofuels domestic supply shortfall of 666 million gallons. This shortfall will increase in 2014 as the advanced biofuel statutory mandate increases. Because the *domestic* supplies of advanced biofuels (*e.g.*, biomass-based diesel) and cellulosic biofuels are inadequate, a waiver of at least 1.83 billion gallons from 3.75 billion gallons to 1.92 billion gallons is necessary in 2014. This number represents the actual supply of biomass-based diesel and cellulosic biofuels expected to be produced in 2014. As EPA reduces the cellulosic mandate, EPA must reduce the advanced category by the commensurate amount.

- Total Renewables: Waiving the cellulosic and advanced nested biofuel mandates, along with a corresponding downward adjustment to the total renewable fuel mandate, would be insufficient to overcome the severe economic harm caused by the E10 blendwall and thus EPA must reduce further the 2014 total renewable requirement. Based on the EIA 2014 gasoline consumption estimate of 132.8 billion gallons, the maximum amount of ethanol that can be blended into the gasoline supply at levels that are safe, effective, and practical given the existing vehicle fleet and distribution systems, is 13.28 billion gallons (*i.e.*, 10 percent ethanol levels, or E10). To avoid severe economic harm resulting from a breach of the E10 blendwall, the total renewable fuel volume must be reduced by 3.35 billion gallons – from 18.15 billion gallons to 14.8 billion gallons. This number represents the total amount of ethanol, drop-in cellulosic gasoline, cellulosic diesel, and biomass-based diesel that can be safely blended into U.S. transportation fuels in 2014. Given the variability of approximately 3 percent in EIA's projections, total ethanol usage (*i.e.*, the sum of corn, advanced, and cellulosic) should not exceed 9.7% of EIA's projected gasoline demand.[13]

Congress explicitly authorized EPA to waive the RFS mandates, under Section 211(o)(7) of the Clean Air Act, in whole or in part, where there would be *either* (1) an inadequate domestic supply *or* (2) severe adverse consequences to the U.S. economy. As this Petition demonstrates below, the inadequate supply and severe economic consequences projected to occur in 2014 independently establish *both* grounds for a waiver. In 2014, there will be an inadequate supply of RINs—as already definitively recognized by EPA—to satisfy the various mandates of the RFS, forcing the overall reduction of supplies of gasoline and diesel for U.S. consumption. This will result in an inadequate domestic supply of

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of Appeals for the D.C. Circuit. Petitioners maintain their arguments that the Agency failed (a) to apply properly the statutory criteria set forth at section 211(o)(2)(B)(ii) when promulgating the 2013 biomass-based diesel mandate and (b) to take into account the fraudulent RINs that affected the biomass-based diesel industry.

[13] The E10 blendwall reflects the technological limitations of existing gasoline engines and fuel dispensing equipment. To avoid the harmful economic effects described herein, however, the maximum amount of ethanol mandated should be no more than 9.7 percent (*i.e.*, 12.88 billion gallons). This level reflects the normal variability in gasoline consumption forecasted by EIA, as well as the need to accommodate some continuing sales of E0, account for geographic areas where it is not practical to blend ethanol, and provide a small cushion to ensure RIN liquidity.

gasoline and diesel fuel. The impact of this fuel shortage will create severe harm across the economy, establishing the second ground for granting a waiver.

As set forth more fully below, the RFS will result in inadequate domestic supplies and severe economic harm. Moreover, and also more fully set forth below, no option other than EPA's granting of a partial waiver can avoid the potentially disastrous implications of the blendwall. Granting a waiver will alleviate the adverse impacts of the RFS on gasoline and diesel supplies and the severe adverse economic impacts of the blendwall.

I. Enforcement of Existing Renewable Volume Obligations Will Result in Inadequate Domestic Supplies of Gasoline and Diesel in 2014.

Section 211(o)(7)(A)(ii) authorizes the Administrator to issue a waiver of the RFS upon a determination "that there is an inadequate domestic supply."[14] The blendwall will result in an inadequate domestic supply of gasoline and diesel fuel. The domestic supply of fuels will be dramatically curtailed under the current RFS because of various factors outside the control of the obligated parties. Put simply, domestic demand for fuels has dropped in a way that no one anticipated when Congress passed the Energy Independence and Security Act ("EISA") in 2007. This drop in demand is reflected globally and has been predicted to peak at a level of less than 92 million barrels per day in the next few years.[15] Furthermore, the consumption of higher blends of ethanol (*i.e.*, E15 and E85) depends on a multitude of factors beyond the control of obligated parties: (1) only 5 percent of vehicles on the road are compatible with such fuels; (2) the majority of retail infrastructure is not compatible with ethanol blends above 10 percent volume; and (3) obligated parties do not own the vast majority of retail stations and, therefore, cannot make the necessary infrastructure upgrades. As the GAO noted in 2011, federal safety standards do not allow ethanol blends over E10 to be dispensed with existing equipment at most retail fueling locations.[16] Because of that drop in demand, and vehicle and infrastructure compatibility issues, there will be insufficient RINs to maintain adequate domestic supplies of gasoline and diesel fuel.

"Inadequate domestic supply" can take the form of (1) an insufficient supply of RINs, (2) an insufficient supply of transportation fuel such as gasoline and diesel, or (3) an insufficient supply of certain renewable fuels required by the RFS. All three supply impacts are "certainly impending"—indeed, they are actually present.

A. The Inability To Consume the Statutory Amounts of Renewable Fuels Leads to an Inadequate Domestic Supply of RINs, and Therefore an Inadequate Domestic Supply of Gasoline and Diesel Fuel.

EPA has already determined that insufficient RINs can be the basis for a finding of an inadequate domestic supply. Former Administrator Jackson plainly stated that "[f]or most biofuels EPA believes that a demonstration by a petitioner that there were insufficient RINs available from the previous year (subject to the 20% carryover limitation) and the current year's production to allow for compliance with

[14] 42 U.S.C. § 7545(o)(7)(A)(ii).
[15] *See Yesterday's Fuel*, THE ECONOMIST, Aug. 3, 2013, at 12.(citing studies by Citi).
[16] U.S. GOV'T ACCOUNTABILITY OFFICE, GAO-11-513, BIOFUELS - CHALLENGES TO THE TRANSPORTATION, SALE, AND USE OF INTERMEDIATE ETHANOL BLENDS 23 (2011).

the standard could be a basis for finding that there was an 'inadequate domestic supply.'"[17] This situation is precisely what we face today.

Obligated parties must report (retire) RINs to demonstrate compliance with their respective Renewable Volume Obligations ("RVOs") in any given year. As long as RVOs are realistic, obligated parties can meet them by using the requisite quantity of renewable fuel—detaching and reporting RINs as the fuel is used. Surplus RINs generated by the fuel can be banked for later use by the obligated party, or put on the RINs trading market where they can be purchased by other obligated parties who require additional RINs to meet their own RVOs.

The number of RINs available for compliance with the RFS depends on the consumption (not production) of renewable fuels in the U.S. transportation system.[18] As the mandates in the law exceed the ability of the transportation system to consume the mandated levels of renewable fuel, the number of RINs available for compliance falls short of the mandated levels. Basic law of supply and demand, not surprisingly, anticipates this scarcity of RINs will be reflected in the market price of RINs. Indeed, the recent volatility in RIN prices suggests that the blendwall has arrived.

The system becomes more complex when the renewable fuel requirements exceed what is realistic (*e.g.*, requiring 1.75B gallons of cellulosic biofuel in 2014 when virtually none physically exists) or what can be accommodated by banked RINs and the RINs trading market. For example, although EPA's final RFS for 2013 requires ethanol use that will exceed the E10 blendwall, EPA has stated that it believes a sufficient number of banked or traded RINs from 2012 are available for obligated parties to ensure compliance with the RFS for 2013. In other words, rather than exceed the E10 blendwall in 2013, manufacturers can continue to produce gasoline with a 10 percent ethanol blend and fulfill their higher RVO mandates by drawing down on banked or market-traded RINs.

But this complexity devolves into near impossibility as RVOs continue to increase in 2014 and beyond. With overall demand for gasoline falling, the number of RINs being generated and made available in the RINs trading market is insufficient to fulfill the mandates under the RFS.

The 2013 Annual Energy Outlook ("AEO 2013") projects a continuing decline in motor gasoline consumption, due to a combination of a sluggish economy in the short term, more stringent CAFE standards, increased use of diesel, and an increasing number of natural gas-powered vehicles.[19] Motor vehicle gasoline consumption is projected to decline by approximately 1.6 million barrels per day from 2011 to 2040 in AEO 2013's Reference Case.[20] EIA projects gasoline consumption in 2014 to reach only 132.8 billion gallons.[21] Assuming that E10 represents the primary means of RFS compliance for 2014, the maximum amount of ethanol that refiners could practically blend is 13.28 billion gallons. The RFS conventional biofuel (*i.e.*, corn-based ethanol) implied statutory requirement is 14.4 billion gallons,

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[17] Letter from Lisa P. Jackson, U.S. EPA, to Robert Greco III, API Group Director of Downstream and Industry Operations, and Letter from Lisa P. Jackson, U.S. EPA, to Charles Drevna, AFPM President, denying petitions for reconsideration of portions of the December 9, 2010 RFS Rule and requests to waive the 2011 RFS cellulosic biofuel standard, at 17 (May 22, 2012).

[18] *See* 40 CFR § 80.1401. Under the RFS, U.S. transportation fuels generally exclude jet fuel, heating oil, and fuel consumed in the State of Alaska.

[19] U.S. ENERGY INFORMATION ADMINISTRATION, DOE/EIA -0383 (2013), ANNUAL ENERGY OUTLOOK 2013 2.

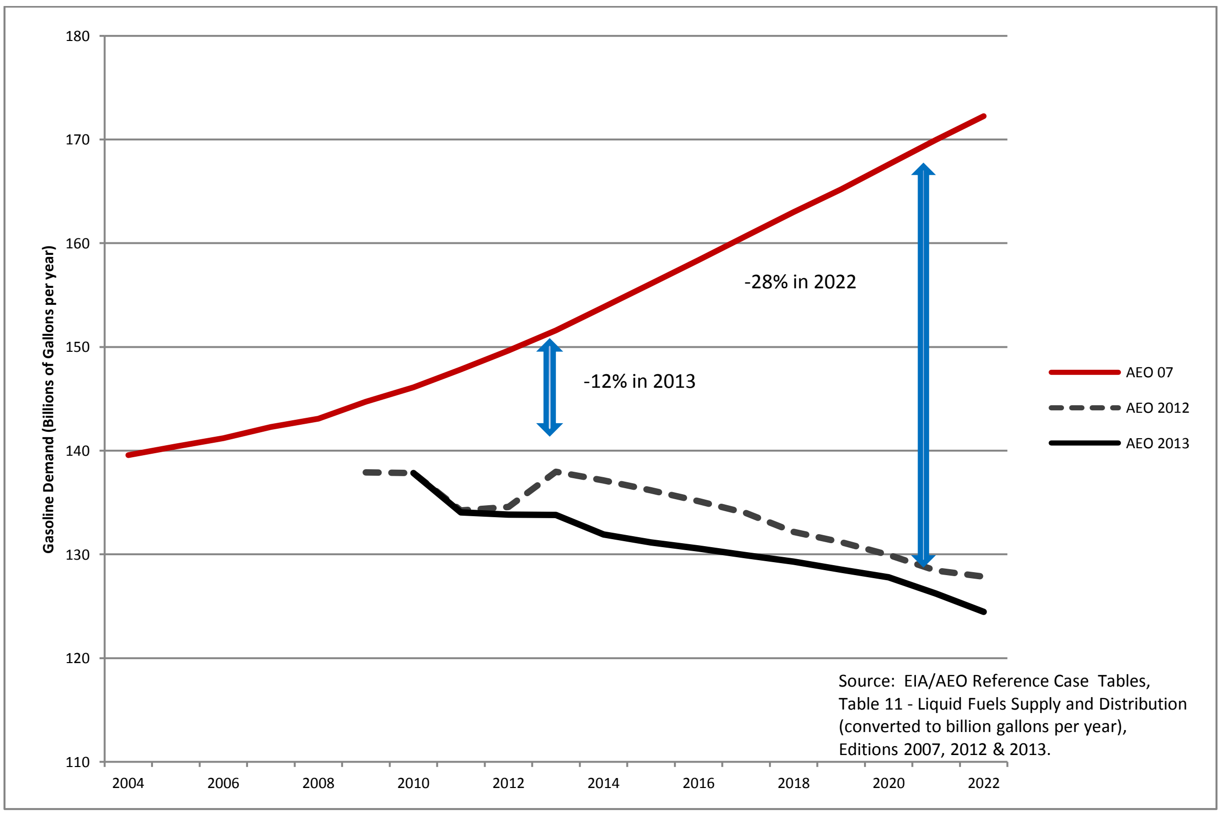
[20] *Id.* at 80.

[21] U.S. ENERGY INFORMATION ADMINISTRATION, *SHORT-TERM ENERGY OUTLOOK* Table 4a (July 2013).

which in and of itself is beyond the 10 percent ethanol saturation point.[22] Add a small amount of cellulosic ethanol and hundreds of millions of gallons of sugarcane ethanol needed to meet the advanced biofuel requirement, and obligated parties are faced with too much ethanol to fit into the gasoline supply.

Tellingly, the AEO 2013 reveals fundamental inaccuracies in earlier projections of energy demand on which the RFS was initially based and subsequently amended. Estimates available at the time EISA was enacted in 2007 projected gasoline demands for 2013 and 2022 that are 12 percent and 28 percent higher than what is projected today.[23] AEO 2013's updated data highlight the incorrect assumptions underlying the renewable volumes mandated for 2013, 2014, and 2015. AEO 2013 now projects that this downward trend will continue for years, with projected gasoline demand falling by approximately 625,000 barrels per day from 2011 to 2022:

Drastic Unanticipated Drop in Gasoline Demand



Because of this demand drop illustrated above, refiners cannot physically meet the 2014 RFS total renewable fuel volume of 18.15 billion gallons.[24] While some have argued that refiners can simply blend either E15 or E85 in order to avoid the blendwall (at least for a year or two), neither offers a viable

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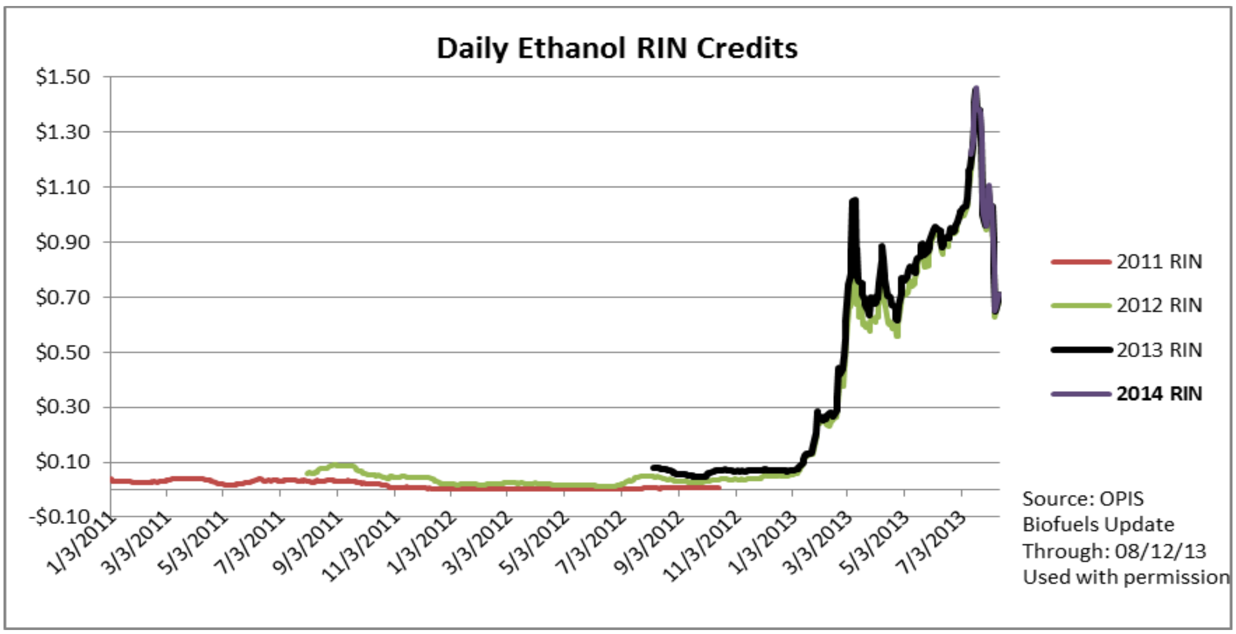
[22] The implied corn-based ethanol mandate is calculated by subtracting the advanced biofuel mandate from the total RFS mandate. In 2014, the implied corn-based ethanol mandate is 14.4 billion gallons (18.15 – 3.75).

[23] *See* U.S. ENERGY INFORMATION ADMINISTRATION, ANNUAL ENERGY OUTLOOK 2013 84 Figure 102.

[24] Even if one assumes that there will be 2 billion biomass-based diesel RINs, the 2014 total RFS volume of 18.15 billion gallons would require more than 16 billion gallons of ethanol, which cannot be practically folded into the nation's existing gasoline pool.

solution as discussed further below. The availability of surplus RINs in 2014 will be extremely limited. In fact, EPA already has expressed concerns that the RIN supply in 2014 will not be sufficient to avoid the blendwall, and NERA also projects that surplus RINs may be depleted in 2014. As the number of available RINs for compliance is depleted, one would expect their price to rise with their growing scarcity. This will in turn likely result in increased exports, reduced imports, and reduced production for domestic consumption, as supplying transportation fuels for U.S. consumption becomes less economic and increasingly infeasible.[25] Then, as the RIN supply becomes even tighter as the mandates continue to escalate in disproportion to vehicle use and infrastructure, refiners and importers will be left with no practical option but to reduce their RFS obligation by reducing supplies of gasoline and diesel for U.S. consumption.[26]

This year, conventional biofuel RIN prices have increased by as much as 2,700 percent.[27]



The chart referenced above from the Oil Price Information Service ("OPIS") illustrates this dramatic rise in conventional biofuel D6 RIN prices.[28] Recent drastic increases in the price of RINs serve as objective market-derived evidence that there is an inadequate domestic RIN supply relative to demand (*i.e.*, when expected supply is lower than expected demand, RIN prices increase).[29]

In light of the projected demand decline, there will simply not be enough RINS and not be enough fuel sold to meet the RFS mandates in the Clean Air Act.[30] The conditions described above more than meet

[25] NERA Study, *supra* note 4, at 36-37.
[26] *Id.*
[27] *See* Robert Wagner, *Ethanol RIN Prices Up 2740% Year To Date*, Seeking Alpha (July 19, 2013), http://seekingalpha.com/article/1558892-ethanol-rin-prices-up-2740-year-to-date?source=bloomberg.
[28] Oil Price Information Service, "Biofuels Update" (Aug. 12, 2013).
[29] USDA Economic Research Service, FDS-13d-SA, *High RIN Prices Signal Constraints to U.S. Ethanol Expansion* 1 (Apr. 12, 2013) (stating that "as for any product, prices for RINs reflect underlying supply and demand factors.").
[30] *See* University of Illinois, *Exploding Ethanol RINs Prices: What's the Story?* http://farmdocdaily.illinois.edu/2013/03/exploding-ethanol-rins-prices.html (Mar. 8, 2013) (stating that "The

the statutory test for an "inadequate domestic supply." Indeed, RINs need only be "insufficient" in number and availability to authorize the exertion of the EPA's waiver authority under section 211(o)(7) of the Clean Air Act. Moreover, EPA's authority for the current RIN system is based on section 211(o)(5), which provides for the generation of an appropriate number of credits for (1) persons that refine, blend, or import gasoline, (2) biomass-based diesel, and (3) small refiners.[31] This section authorizes EPA to issue regulations providing for the generation, use, and transfer of credits for the purpose of complying with RFS volume requirements. RINs are, therefore, inextricably linked to the production, use, and supply of renewable fuel, in addition to the need to have a fungible supply of RINs allowing for compliance in all geographical areas of the United States.[32] Where this supply is challenged or threatened—as here—the exercise of EPA's waiver authority is necessary to avoid severe economic harm resulting from obligated parties' continued compliance with the RFS.

B. The Scarcity of RINs Leads to an Inadequate Domestic Supply of Diesel and Gasoline.

As discussed above, obligated parties can only supply as much gasoline and diesel fuel as they have RINs to meet the obligations that supplying such fuel incurs. Each gallon of gasoline and each gallon of diesel fuel supplied for U.S. consumption incurs an obligation under each of the four RFS mandate categories—biomass based diesel, cellulosic, advanced, and general renewable. The number of RINs available for compliance depends on the consumption of the renewable fuels in the U.S. transportation system. As the mandated levels of renewable fuel exceed the ability of the vehicles and infrastructure to consume the renewable fuel, a shortage of RINs relative to the mandated levels occurs, which in turn limits the amount of gasoline and diesel fuel that can be legally supplied for U.S. consumption.

The blendwall problem likely will be seen most acutely in the diesel market.[33] This is because ethanol comprises the vast majority of current U.S. biofuels and ethanol cannot be blended into diesel. An obligated party's total RVO is derived from its production of both gasoline and diesel fuel. For each gallon of diesel fuel produced or imported, however, a RIN deficit is incurred. For example, to meet the 2012 RFS, each gallon of gasoline and each gallon of diesel fuel produced or imported incurred a 9.23 percent RIN obligation.[34] Diesel fuel can only be blended with biomass-based diesel to meet the RFS, but the RFS biomass-based diesel requirement was only 0.91 percent or roughly 10 percent of the 9.23 percent overall requirement, leaving a deficit of 8.32 percent.[35]

This diesel deficit requires diesel manufacturers to purchase excess ethanol RINs. When the renewable mandate was less than the blendwall, excess ethanol RINs were available from gasoline blending of ethanol, but as the mandate approaches and exceeds the blendwall, the RINs surplus shrinks. With surplus RINs disappearing and RINs prices increasing rapidly, that compliance option is becoming costly and increasingly infeasible, which results in a significant incentive to reduce diesel fuel supplied to the

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prospect of not being able to meet ethanol blending mandates with physical blending and prospects for a rapid decline in the stock or RIN credits in the very near future has substantially increased the value of D6 RINs.").

[31] 42 U.S.C. § 7545(o)(5).

[32] *See* 42 U.S.C. § 7545(o)(2)(A)(ii).

[33] NERA STUDY, *supra* note 4, at 3.

[34] 77 Fed. Reg. 1320, 1341 Table III.B.3-3 (Jan. 9, 2012).

[35] A similar situation is required for 2013. The 2013 total renewable obligation is 9.74 percent, whereas the biomass-based diesel requirement is only 1.13 percent, leaving diesel refiners and importers with a deficit of 8.61 percent. *See* EPA, 2060-AR43, *REGULATION OF FUELS AND FUEL ADDITIVES: 2013 RENEWABLE FUEL STANDARDS,* pre-publication copy at 88 (Aug. 6, 2013)(hereinafter 2013 RFS Final Rule) (to be codified at 40 CFR § 80.1405(a)(4)).

U.S. market below the level that the market currently demands.[36] This diesel deficit is another example of inadequate domestic supply that would support EPA's granting of this Petition request. In this case, there is an inadequate supply of biomass-based diesel needed to generate a sufficient quantity of RINs to support the sale of diesel fuel in quantities demanded by consumers. To address this problem, EPA must waive the total RFS requirement, as described herein.

II. Unless Waived, the RFS Will Cause Severe Economic Harm.

As discussed above, RINs effectively function as a permit to supply gasoline and diesel in the United States. If a refiner cannot secure enough RINs to meet its RVOs, then the refiner is limited in the amount of gasoline and diesel it may supply for U.S. consumption. Consequently, the inadequate supply of RINs leads to an inadequate domestic supply of gasoline and diesel fuel for U.S. consumption and presages severe economic consequences stemming from the RFS.

A. The Blendwall Will Force Obligated Parties To Supply Less Fuel for U.S. Consumption, Setting Off a Chain of Events That Causes a Massive Decline in GDP.

The fuels market already is experiencing the economic effects of the impending blendwall. Starting early this year, prices for ethanol D6 RINs skyrocketed, rising from an average of below 4 cents per RIN in years prior to 2013 to over a $1.40 per RIN in July 2013. A significant price spike occurred in conjunction with EPA's announcement of the proposed renewable fuel volumes for 2013. The current ethanol RIN price is now many multiples of the average ethanol RIN price experienced in the five years since the volume requirements for renewable fuels contained in section 211(o)(2)(B) were increased to their current level.

While the near term economic effects of higher RIN prices are troublesome enough, the arrival of the blendwall in 2013 and depletion of banked RINs in 2014 likely will force obligated parties to take drastic measures to comply with the law. NERA Economic Consulting has projected the economic impacts that the blendwall will impose on consumers and the U.S. economy through 2015.[37] NERA's model projects a $1,300 decline in average household consumption and an aggregate GDP loss of $270 billion in 2014.[38] If these effects are not somehow avoided by changes to the current implementation of the RFS, NERA concluded that the aggregate economic impacts by 2015 will be a loss of a staggering $770 billion in GDP.[39]

The decrease in GDP, projected by NERA, results from a combination of (1) structural problems within the RFS itself and (2) technical constraints that prevent the development and deployment of higher ethanol blends that could forestall the blendwall.[40] With regard to the structural problems, the RFS requires each obligated party to meet an annual RVO, which is calculated as a percent of their total annual volume of gasoline and diesel produced or imported for sale in the United States by that obligated party during the year.[41] Thus, the final RVO in a given year for an obligated party will fluctuate based on its own fuel production and imports. As the RFS-mandated volumes increase in the face of

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[36] NERA STUDY, *supra* note 4, at 31.
[37] *Id.* at 38-39.
[38] *Id.* at 38-39 and Table 14.
[39] *Id.* at 8, 38-39.
[40] *Id.* at 4.
[41] 40 C.F.R. § 80.1407.

declining gasoline demand and infrastructure and vehicle incompatibility constraints—and the blendwall is hit—obligated parties will need more RINs than they can get from E10. That is to say, the volumes of RINs associated with corn-based and sugarcane-based ethanol that the obligated parties need to comply with the RFS will exceed RINs they purchase from downstream entities that blend 10-percent ethanol in gasoline. Thus, obligated parties will need to draw down previously banked RINs; there will be no "excess" RINs generated for compliance. Existing and available RINs now are likely being held or used for compliance, rather than being sold in the marketplace, and obligated parties needing to buy RINs to comply in 2014 will face a lack of feasible options to sustain their level of gasoline or diesel production and imports.[42] Because RINs effectively operate as a permit to sell specific quantities of gasoline and diesel, when obligated parties cannot acquire RINs, they must reduce the amount of gasoline and/or diesel they sell in the United States to remain in compliance with RFS.

With regard to the technical constraints, the U.S. fuel market lacks the physical infrastructure, compatible vehicles, and consumer demand to support enough sales volumes of ethanol-blended fuels other than E10 to meet the growing mandate. While it is legally permissible to blend ethanol in gasoline to produce E85 or E15 blends, simply because EPA has removed one legal impediment to the production of these blends does not mean that local regulations allow the use of these fuels, or that the market and consumers can or will accommodate their use.

Without an adequate supply of RINs, obligated parties will turn to the other compliance options available to them: (1) a decrease in fuel production; (2) a decrease in transportation fuel imports; and/or (3) an increase in gasoline/diesel exports.[43] These alternatives reduce the number of RINS an obligated party needs to demonstrate compliance with the RFS. A decrease in transportation fuel supplied to the domestic economy over and above the current and projected decrease in demand for transportation fuels will likely result in higher fuel costs and will have effects throughout the U.S. economy as manufacturers, distributors, and suppliers adjust to higher fuel costs.[44] The market's response to obligated parties' attempt to meet their RVOs and comply with the RFS ultimately will force individual households to decrease consumption at the pump and elsewhere.[45]

As detailed in the NERA Study, the overall effect of hitting the blendwall without viable compliance alternatives beyond reducing supply will be a contraction of multiple sectors of the U.S. economy that will ultimately result in a massive decrease in GDP, totaling $770 billion in 2015. This severe adverse economic impact would be extraordinarily harmful to tens of millions of Americans and far exceeds any level necessary to constitute "severe economic harm" under CAA section 211(o)(7).

Importantly, in the context of considering the harms that will result in 2014 and 2015, nothing in the Clean Air Act requires that the severe economic harm occur in the same year that EPA issues the waiver.[46] EPA itself recognized that it has discretion when determining what time period to examine with respect to a severe economic harm analysis in its denial of North Carolina's and Arkansas's waiver petitions.[47] While EPA previously declined to examine impacts beyond the current calendar year due to

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[42] NERA STUDY, *supra* note 4, at 30.
[43] *Id.* at 27.
[44] *Id.* at 7.
[45] *Id.*
[46] *See* 42 U.S.C. § 7545(o)(7)(A).
[47] *See* 77 Fed. Reg. 70,752, 70,757 (Nov. 27, 2012).

an inability to properly assess the relevant variables, such a limitation is data-driven, not a function of the requirements of section 211(o)(7).[48]

The NERA Study fully accounts for fluctuations in fuel prices and availability, and it provides sufficient certainty to conclude severe economic harm will result from reaching the blendwall in the years following 2013.[49] Existing infrastructure cannot support the higher-ethanol blend fuels required to avoid the blendwall. Thus, the NERA Study forms a more than sufficient basis for EPA to waive the requirements of section 211(o)(2) in 2014 and subsequent years.

B. The Harms Detailed in the NERA Study Are Unprecedented.

The E10 blendwall has arrived, making 2014 unlike any other year that EPA previously examined. As explained in the NERA Study, infrastructure, technological, and market limitations will restrict the ability of obligated parties to market ethanol blends higher than E10 for use in conventional vehicles.[50] As a result, the only practical compliance strategy for obligated parties will be to reduce the amount of fuel produced for the U.S. market, causing sharp declines in fuel availability and associated increases in fuel prices.[51] In 2014, the ultimate result will be a decrease in average household consumption of $1,300 and a net GDP loss of $270 billion. The severe economic harm becomes worse in 2015 with a decrease in average household consumption of $2,700 and a net GDP loss of $770 billion.[52] EPA's issuance of a waiver here will help ameliorate these effects of the blendwall because it would remove the existing, rather than theoretical, limitation of the supply of gasoline and diesel—thus, this situation differs from earlier waiver situations, where the waiver's impact was not as clear.

The harms calculated in the NERA Study as the result of the blendwall are immediate and unprecedented. In denying the RFS waiver request of several States and other parties in 2012, EPA relied upon Iowa State University's model to evaluate the impact of a potential waiver on corn prices, food prices, feed prices, and fuel prices.[53] EPA's denial of the 2012 waiver request expressed the result of the Iowa State model in terms of avoided costs and concluded that the waiver would have decreased annual household expenditures on fuel just $1.98-$17.40.[54] In EPA's denial of Texas's 2008 waiver petition, EPA relied on the same Iowa State model and concluded implementation of the RFS would increase annual household expenditures only $3.43-$34.29.[55] Unlike those years, the country has run out of practical options because vehicle and refueling infrastructure compatibility is at the blendwall. In

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[48] *Id.*
[49] *See id.* at 70,758 (noting that a waiver petition based on the blendwall itself could provide a proper analysis of all the relevant factors required to grant a petition based on severe economic harm occurring in a year different than the year of the petition's filing).
[50] The issues associated with E15 and E85 compliance options are discussed in detail in Sections III.B and III.C, *infra*.
[51] NERA STUDY, *supra* note 4, at 2.
[52] *Id.* at 8 Table 3.
[53] 77 Fed. Reg. at 70,761. Petitioners do not suggest that the projected levels of harm in the 2008 and 2012 waiver requests, in addition to other information submitted for EPA's consideration, were insufficient to justify the Administrator's exertion of RFS waiver authority, only that the economic harms detailed in the NERA Study present adverse economic impacts of another magnitude altogether than the effects EPA projected in the 2008 and 2012 waiver decisions.
[54] *Id.* at 70,765.
[55] 73 Fed. Reg. 47,168, 47,179 (Aug. 13, 2008).

contrast to these rather small, previously projected effects, the NERA Study finds that the blendwall will significantly increase costs for both fuel and finished goods in 2014.[56]

In stark contrast with prior waiver petitions to the EPA, the economic harms that will occur here (absent waiver) not only are "certainly impending," they are immediate, unprecedented, widespread, and severe. Indeed, as detailed by NERA, the adverse economic impacts will be felt by virtually every American household and by most of the U.S. economy. Petitioners respectfully submit that the ultimate cost—a massive decrease in GDP totaling $770 billion in 2015—far exceeds any level necessary to constitute "severe economic harm" under CAA 211(o)(7).

III. Severe Harms Flowing From the RFS Can Be Avoided Only Through A Waiver.

Having established that the blendwall will result in an inadequate supply of RINs and thereby lead to severe economic harm, we now turn our attention to potential alternative mechanisms to delay or avoid the arrival of the blendwall, and explain why they are in fact unavailing and do not defeat this Petition. The only solution to the blendwall problem that will avoid inadequate domestic supplies and severe economic harm is the issuance of a waiver. Unlike previous waiver request situations, in this case, issuance of a waiver will provide relief from the binding nature of the RFS and avoid the harms of the blendwall because it will remove the limitation on the supply of gasoline and diesel fuel that currently exists.

A study titled "Renewable Fuel Standards and the Ethanol Blendwall" was recently conducted by MathPro and is attached in its entirety in Attachment 2 of this waiver petition.[57] MathPro developed a spreadsheet-based model ("Software Tool") to assess specified compliance approaches for various schedules of annual renewable fuel volumes that EPA might establish.[58] The spreadsheet used EIA's 2013 Annual Energy Outlook of transportation energy demand (AEO 2013).[59] MathPro then assessed hypothetical scenarios involving assumed schedules of annual renewable fuel volumes and various compliance approaches using this tool.[60]

Scenario 1 represents the most aggressive case, and assumes that EPA leaves the total renewable fuel and advanced biofuel standards unchanged from the EISA volume schedule.[61]

- Scenario 1A: EISA volume standards, unrestricted expansion of FAME, no expansion of E85, AEO cellulosic biofuel volumes.
- Scenario 1B: EISA volume standards, expansion of E85, no expansion of FAME, AEO cellulosic biofuel volumes.
- Scenario 1C: EISA volume standards, expansion of E85, expansion of FAME to 5 percent, AEO cellulosic biofuel volumes.

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[56] NERA STUDY, *supra* note 4, at 8.
[57] MATHPRO, RENEWABLE FUEL STANDARDS AND THE ETHANOL BLENDWALL (Aug. 13, 2013) (hereinafter MATHPRO STUDY) (Attachment 2).
[58] *Id.* at 2.
[59] *Id.*
[60] *Id.*
[61] *Id.* at 10.

Scenario 2 assumes that EPA modifies the annual total renewable fuel and advanced biofuel volume standards to account for cellulosic biofuel being available in volumes significantly lower than contemplated in EISA.[62] Annual cellulosic biofuel volume standards (and the split between ethanol and diesel) are set at the volumes forecast in the AEO 2013 Reference Case.[63]

- Scenario 2A: Adjusted EISA volume standards, unrestricted expansion of FAME, no expansion of E85, AEO cellulosic biofuel volumes.
- Scenario 2B: Adjusted EISA volume standards, expansion of E85, no expansion of FAME, AEO cellulosic biofuel volumes.
- Scenario 2C: Adjusted EISA volume standards, expansion of E85, expansion of FAME to 5 percent, AEO cellulosic biofuel volumes.

Scenario 3 assumes a RFS schedule that maximizes ethanol use without exceeding the E10 blendwall.[64]

- Scenario 3A: Maximum ethanol without exceeding the E10 blendwall, no FAME expansion, no cellulosic biofuel volumes.
- Scenario 3B: Maximum ethanol without exceeding the E10 blendwall, no FAME expansion, and AEO cellulosic biofuel volumes.

The key conclusions from the MathPro study are summarized below:[65]

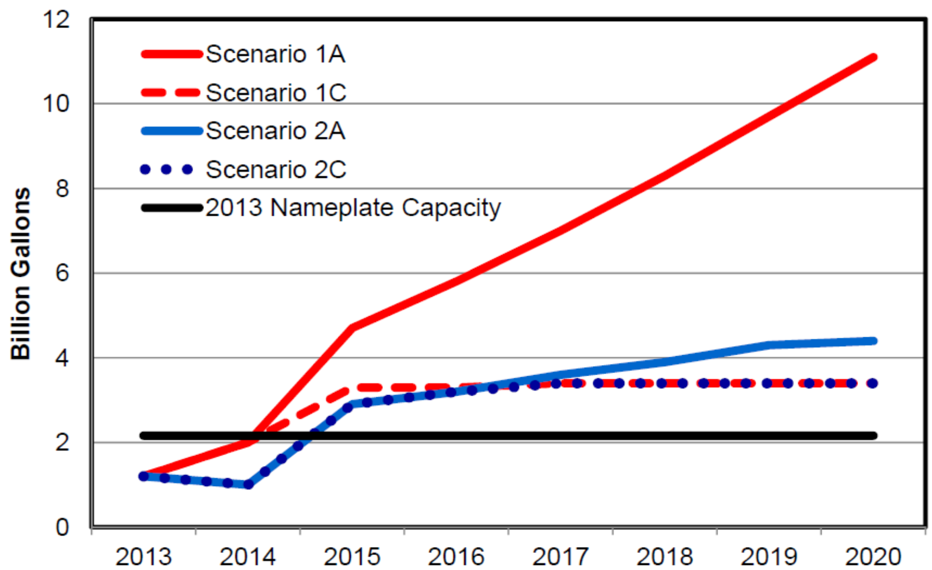
- Use of carryover RINs alone can delay some of the consequences of the ethanol blendwall to 2014, but not beyond.
- Subsequently, steep and likely unattainable increases in either E85 use or biomass-based diesel ("FAME") use would be required to meet the RFS volume standards.
- Expanded use of FAME, to generate excess D4 RINs, could delay reaching the ethanol blendwall after carryover RINs are exhausted. But the likelihood and extent of the delay depends on the annual volume standards established by EPA and the extent to which FAME production and use can be increased.
- With FAME use limited to 5 percent of the distillate pool, ethanol blendwall would be reached in 2015.
- When the ethanol blendwall is reached (with limited FAME expansion), the volume of E85 necessary to generate sufficient RINs for compliance with the renewable fuel volume standards would require rapid, large expansion in the availability of E85 and in the number of FFVs using E85. In most of the cases studied, the necessary expansions would be beyond what might be considered feasible.
- Annual volume standards can be set that maximize ethanol use subject to the practical constraints imposed by the E10 blendwall. Such volume standards would facilitate compliance with RFS requirements.

The Exhibits below from the MathPro study summarize the scenario results.[66] In the case of FAME, note that the required volumes far exceed the nameplate capacity of 2.2 billion gallons per EIA. In the case of

[62] *Id.* at 13.
[63] *Id.*
[64] *Id.* at 14.
[65] *Id.* at 16.
[66] *Id.* at Exhibits 4 and 5.

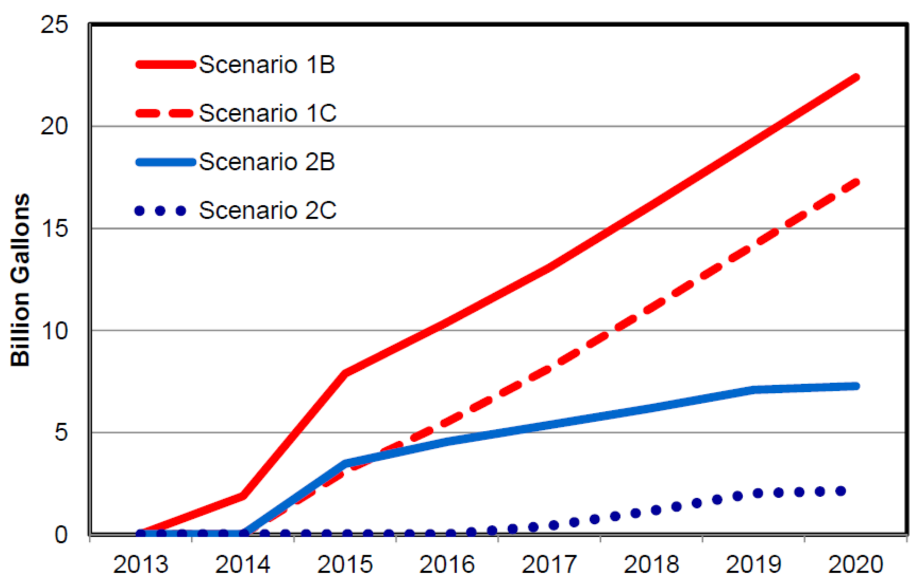
E85, note that the required volumes far exceed the current use of 0.1 billion gallons per EIA (too small of a number to appear on the graph).

Exhibit 4: FAME Volume, by Scenario



Note: 2013 nameplate capacity from EIA website.

Exhibit 5: E85 Volume, by Scenario



Note: E85 use in 2012 was on the order of 0.1 B gallons (*AEO 2013*).

A. Carryover RINs Will Not Prevent the Market Imbalance Caused by the Blendwall.

EPA itself noted the imminence of the RFS blendwall in the preamble to its proposed RFS volumes for 2013. In its proposed rule, EPA stated its belief that the economic effects from the blendwall would likely be averted in 2013 because there are sufficient carryover RINs that can be used for compliance.[67] EPA expressed doubts, however, that such a surplus will be available to forestall the blendwall in 2014.[68] Moreover, concerns related to RIN market volatility should call into question EPA's belief that sufficient quantity of RINs exist for the entire regulated community to avoid the blendwall. According to many experts, the scarcity of valid RINs has led to a rapid rise in the price of RINs due to increasing demand in the face of inability to increase surplus RINs.[69] Based on these concerns, EPA must reassess its projections that sufficient carryover RINs will be available to supplement the 2013 market to ensure compliance with the RFS mandates, and EPA also must further evaluate the projected shortfall of RINs in 2014.

The blendwall effects may be avoided in 2013 only if obligated parties have sufficient carryover RINs to meet their requirements under the RFS—a questionable conclusion given the current volatility of the RIN trading market.[70] Several economists have stated that the RIN carryover will be reduced significantly by the end of 2013 and will be insufficient to meet the 2014 RFS mandates.[71] Charles River Associates completed a study in 2011 that concluded that the market would encounter the E10 blendwall by 2013.[72] The study concluded that efforts to increase E85 or E15 and to decrease the presence of E0 (neat gasoline) in the domestic market could not be implemented economically or quickly enough to forestall the blendwall.[73] Additionally, EPA's original estimates of when the market would reach the blendwall were based on fuel consumption estimates found in the AEO 2009,[74] while the Charles River Study's fuel consumption estimates come from the AEO 2011.[75] The difference in the projection of when the blendwall will be reached can be explained in part by an examination of the *Annual Energy Outlook* reports, which show declining estimates of transportation fuel consumption in successive years.[76] Lower fuel consumption requires that a higher percentage of ethanol be blended into gasoline in order to meet the renewable volume targets and accelerates the arrival of the

[67] 78 Fed. Reg. 9282, 9301 (Feb. 7, 2013).

[68] *Id. See also* USDA ECONOMIC RESEARCH SERVICE, FDS-13d-SA, *HIGH RIN PRICES SIGNAL CONSTRAINTS TO U.S. ETHANOL EXPANSION* 1, 3 (Apr. 12, 2013) (stating that "This shortfall in meeting the conventional ethanol RFS will soon transmit to a shortfall in the availability of conventional RINs relative to the demand for RINs for RFS compliance, likely to occur in 2014 once carryover RINs are no longer sufficient to fill the gap.").

[69] Since January 7, 2013, RIN prices rose from 7.1 cents per credit to over $1.00 per credit, representing an increase of over 2700 percent in the price of RINs. *See* Robert Wagner, *Ethanol RIN Prices Up 2740% Year To Date*, Seeking Alpha (July 19, 2013), http://seekingalpha.com/article/1558892-ethanol-rin-prices-up-2740-year-to-date?source=bloomberg.

[70] Most refiners do not blend ethanol and are dependent upon purchasing RINs for compliance. Some refiners do not have a supply of "banked RINs" and now may be unable to acquire sufficient RINs at reasonable prices. *See e.g.*, Frank Pici, Monroe Energy Letter to EPA, Docket ID No. EPA-HQ-OAR-2012-0546-0110 (Apr. 7, 2013).

[71] *See, e.g.,* University of Illinois, *Exploding Ethanol RINs Prices: What's the Story?* Table 1 http://farmdocdaily.illinois.edu/2013/03/exploding-ethanol-rins-prices.html (Mar. 8, 2013).

[72] *See* HARRY FOSTER, ROBERT BARON, AND PAUL BERNSTEIN, IMPACT OF THE BLENDWALL CONSTRAINT IN COMPLYING WITH THE RENEWABLE FUEL STANDARD, CHARLES RIVER ASSOCIATES 5 (Nov. 2, 2011) [hereinafter CHARLES RIVER STUDY].

[73] *Id.*

[74] EPA, RENEWABLE FUEL STANDARD PROGRAM (RFS2) REGULATORY IMPACT ANALYSIS 238 (2010) [hereinafter RFS2 RIA]; *see* U.S. ENERGY INFORMATION ADMINISTRATION, DOE/EIA-0383(2009), ANNUAL ENERGY OUTLOOK 2009 ("AEO 2009").

[75] CHARLES RIVER STUDY, *supra* note 63, at 15.

[76] *See, e.g.* U.S. ENERGY INFORMATION ADMINISTRATION, ANNUAL ENERGY OUTLOOK 2012 EARLY RELEASE OVERVIEW 5 (Jan. 23, 2012); *compare with* U.S. ENERGY INFORMATION ADMINISTRATION, ANNUAL ENERGY OUTLOOK 2013EARLY RELEASE OVERVIEW 1, 6 (Dec. 5, 2012).

blendwall.[77] Regardless of these differences, both studies support the undeniable fact that the blendwall will be reached in 2013.

Unlike the earlier work, the MathPro study takes into account the RIN carryover and uses the most up-to-date energy demand from AEO 2013.

B. E15 Is Not a Viable Solution to the Blendwall.

EPA has approved the sale of E15 for sale for use in model year 2001 and later vehicles. That approval was based exclusively on a Department of Energy study indicating that E15 would not adversely affect emissions control systems in a select group of on-road vehicles.[78] Petitioners question, but do not attempt to challenge, the E15 waiver decision in this Petition. The DOE study looked at other electronic and mechanical systems (*e.g.*, engines, fuel systems) essential for vehicle functionality, but this was a cursory, last-minute, approach that was inappropriate for extrapolation.[79]

The fact that only two vehicle manufacturers have approved of E15, and have only done so for vehicles produced in the most recent two model years, demonstrates just how radically the widespread use of E15 would impact the existing fleet. EPA's approval was based on their limited analysis of emissions control systems. E15 creates numerous concerns for consumers, refiners, ethanol producers, fuel retailers, and auto manufacturers. E15 is not a viable mechanism for the transportation sector to absorb more ethanol-blended fuels (and thereby also generate additional RINs), nor does it do anything to prevent—or even delay—the blendwall. Instead, E15 merely provides one limited, problematic avenue for additional RFS compliance that is insufficient to surmount the issues that the blendwall creates.

1. E15 Is Incompatible With the Existing Vehicle Fleet.

For automobiles built before 2011, automobile manufacturers are unanimous. They have stated that the use of E15 may damage vehicle engines and will void warranties.[80] In the face of these public pronouncements, the sale of E15 creates concerns over not only consumer dissatisfaction and brand reputational harm, but also potential liabilities for obligated parties, fuel distributors, ethanol producers, and engine manufacturers.[81] The Coordinating Research Council ("CRC") conducted extensive studies

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[77] *See* CHARLES RIVER STUDY, *supra* note 63, at 15-16.

[78] *See* 75 Fed. Reg. 68,094 (Nov. 4, 2010) (providing E15 waiver for vehicles model year 2007 and after for light duty motor vehicles); 76 Fed. Reg. 4662 (Jan. 26, 2011) (providing E15 for vehicles model year 2001-2006 for light duty motor vehicles).

[79] EPA should have used tests specifically designed by automotive engineers to evaluate those effects—the approach that the Coordinating Research Council took.

[80] *See* Letter from Representative James Sensenbrenner to Lisa Jackson, Administrator, Envtl. Protection Agency (July 5, 2011), *available at* http://sensenbrenner.house.gov/uploadedfiles/e15_auto_responses.pdf (summarizing comments from automakers on the use of E15 and expressing concern for the effects of E15 on vehicles); *see also* Gary Strauss, *AAA Warns E15 Gasoline Could Cause Car Damage*, USA TODAY, Nov. 30, 2012, *available at* http://www.usatoday.com/story/news/nation/2012/11/30/aaa-e15-gas-harm-cars/1735793/ (noting statements by BMW, Chrysler, Nissan, Toyota, and Volkswagen that their warranties will not cover fuel-related claims caused by E15, and statements from Ford, Honda, Kia, Mercedes-Benz, and Volvo that E15 use will void warranties).

[81] *See Overview of the Renewable Fuel Standard: Stakeholder Perspectives: Hearing Before the Subcomm. on Energy and Power of the H. Comm. on Energy and Commerce, 133th Cong.* 5 (2013) (statement Shane Karr, Vice President for Federal Government Affairs, Alliance of Automobile Manufacturers) [hereinafter Alliance Testimony].

examining the potential effects of E20 and E15 use on motor vehicle engines and fuel system components across a sample set of commonly-used post-2001 model year light duty vehicles.[82] The studies found that some vehicles—ones that EPA approved for use with E15 after reviewing effects on emissions—experienced fuel pump system failures or other mechanical damage from operating on intermediate-level ethanol blends.[83] Moreover, the fuel pump systems that failed or exhibited other effects during testing on E15 are used in a substantial number of the 29 million 2001-2007 model year vehicles represented in the studies.[84] The engine durability study showed that two popular gasoline engines used in light-duty automotive applications of 2001-2009 model year vehicles failed with mechanical damage when operated on E15 and E20.[85] The damage that E15 will inflict on a significant number of vehicles translates to a significant potential liability for multiple entities throughout the fuel supply chain.

Furthermore, consumer organizations including AAA fear that the public's unfamiliarity with E15 will lead to misuse and vehicle damage.[86] In a recent survey, AAA found that "[a]n overwhelming 95 percent of consumers surveyed have not heard of E15, a newly approved gasoline blend that contains up to 15 percent ethanol."[87] Based on this finding and the fact that less than 5 percent of the vehicles on the road are approved by their manufacturers to use E15, AAA urged EPA to halt the sale of E15.[88] Even Public Citizen has come out in opposition to E15. In a recent *amicus* brief filed in the U.S. Supreme Court, Public Citizen identified the harm to consumers that will result from E15: (1) incompatibility with vehicles, and the likely damage to many vehicles for which E15 has been approved; (2) the potential for misfueling; (3) reductions in gas mileage; and (4) greater fueling and food costs.[89]

The fuel segregation and labeling requirements attendant to the marketing of E15 depend on market and consumer acceptance. In fact, EPA itself recognized the potential dangers resulting from the improper use of E15 when it approved the E15 waivers.[90] EPA determined that the use of product transfer documents to track the distribution of E15 and "attention" labels on fueling stations were necessary to minimize the risk of vehicle damage caused by misfueling.[91] Thus, E15 is far from a "drop

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[82] *See* COORDINATING RESEARCH COUNCIL, INTERMEDIATE-LEVEL ETHANOL BLENDS ENGINE DURABILITY STUDY (Apr. 2012), *available at* http://www.crcao.org/reports/recentstudies2012/CM-136-09-1B%20Engine%20Durability/CRC%20CM-136-09-1B%20Final%20Report.pdf; *see also* COORDINATING RESEARCH COUNCIL, DURABILITY OF FUEL PUMPS AND FUEL LEVEL SENDERS IN NEAT AND AGGRESSIVE E15 (Jan. 2013), *available at* http://www.crcao.org/reports/recentstudies2013/CRC%20664%20[AVFL-15a]/AVFL%2015a%20[CRC%20664]%20Final%20Report%20only.pdf.

[83] COORDINATING RESEARCH COUNCIL, DURABILITY OF FUEL PUMPS AND FUEL LEVEL SENDERS IN NEAT AND AGGRESSIVE E15 1-3 (Jan. 2013), *available at* http://www.crcao.org/reports/recentstudies2013/CRC%20664%20[AVFL-15a]/AVFL%2015a%20[CRC%20664]%20Final%20Report%20only.pdf.

[84] *Id*. at 3.

[85] COORDINATING RESEARCH COUNCIL, INTERMEDIATE-LEVEL ETHANOL BLENDS ENGINE DURABILITY STUDY, *supra* note 73, at 15.

[86] Press Release, AAA, New E15 Gasoline May Damage Vehicles and Cause Consumer Confusion (Nov. 30, 2012), *available at* http://newsroom.aaa.com/2012/11/new-e15-gasoline-may-damage-vehicles-and-cause-consumer-confusion/; *see also* Brief of Amicus Curiae Public Citizen, Inc., in Support of Petitioners, Alliance of Automobile Manufacturers v. U.S. Envtl. Protection Agency, 133 S. Ct. 2880 (2013) (No. 12-1167).

[87] Press Release, AAA, *supra* note 77.

[88] *Id.*

[89] *See* Brief of Amicus Curiae Public Citizen, *supra* note 77.

[90] *See* 75 Fed. Reg. at 68,049-50 (noting the difficulties of ensuring the proper labeling of E15 pumps due to the fact that most retail stations are independently operated).

[91] *Id.*

in" solution to the blendwall. The fuel's very use is conditioned by restrictions in state law, by acceptable light duty vehicle types, by labeling of the fuel, and through a continuing inability to use the fuel in any non-road vehicle engine or vehicle, including such ubiquitous consumer items as lawnmowers and hedge trimmers. EPA cannot reasonably rely on a potentially unsafe fuel source as a compliance option, especially when the manufacturers of those vehicles have warned their customers not to use E15.

2. E15 Impairs Vehicle Fuel Economy.

Relatedly, E15 also results in lower fuel economy due to the higher concentration of ethanol in the fuel. A Department of Energy study found that the use of E15 over E10 results in a 1.6 percent loss in fuel economy.[92] Particularly in the current economic climate, consumers are unlikely to choose a product that fails to deliver long-term savings at the pump.

3. E15 Is Incompatible With the Existing Refueling Infrastructure, the Vast Majority of Which Is Not Owned by Obligated Parties.

The E15 infrastructure is not under the control of the parties obligated to comply with RFS, given that *more than 95 percent of gasoline stations are independently owned*. While refiners and importers are obligated to comply with the mandates, they own less than 5 percent of the gasoline stations in the United States, and thus cannot completely control what fuel will be offered or not offered to consumers at the retail level. With limited exceptions, obligated parties cannot themselves decide to install infrastructure or carry a new type of fuel. Individual retail outlets will largely decide when to offer E15—or not. They will decide (1) whether to assume the risk of damaging their customers' gasoline engines and (2) whether and how to upgrade their facilities to replace tanks, dispensers, and related equipment to carry E15.[93] And their decisions are made more difficult by the fact that no one knows if consumers will actually purchase the product. For those obligated parties that operate retail facilities, the cost of retrofitting those facilities to store and dispense E15 is prohibitive. Retail fuel sales have been a low margin, highly competitive business that generally cannot afford the costs associated with hardening their fuel storage and dispensing systems to handle E15.

A study conducted by the National Renewable Energy Laboratory in 2010 evaluating retail fuel dispensing equipment types already approved for E10 found that the use of higher ethanol-blended fuels in both new and older equipment resulted in a reduced levels of safety and performance.[94] To ensure that the dispensing equipment is safe, federal regulations require only approved or "listed" devices may be used for dispensing motor fuel at fueling stations, which requires station operators who wish to offer ethanol blends higher than E10 to retrofit or to install new, specially designed pumps that are listed as compatible with higher blends of ethanol by a nationally recognized testing laboratory

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[92] ALTERNATIVE FUELS DATA CENTER, U.S. DEP'T OF ENERGY, *E15 Approved for Use in 2001 and Newer Vehicles*(Feb. 11, 2011), http://www.afdc.energy.gov/technology_bulletin_1210.html (last visited Mar. 12, 2013).

[93] *See Overview of the Renewable Fuel Standard: Stakeholder Perspectives, Hearing Before the Subcomm. on Energy and Power of the H. Comm. on Energy and Commerce*, 113th Cong. (July 23, 2013) (statement of Joseph Petrowski on behalf of the Society of Independent Gasoline Marketers of America and the National Association of Convenience Stores, *available at* http://docs.house.gov/meetings/IF/IF03/20130723/101184/HHRG-113-IF03-Wstate-PetrowskiJ-20130723.pdf [hereinafter SIGMA/NACS Testimony].

[94] *See* Kenneth Boyce & Thomas Chapman, NATIONAL RENEWABLE ENERGY LABORATORY*, Dispensing Equipment Testing With Mid-Level Ethanol/Gasoline Test Fluid* 16 (2010), *available at* http://www.nrel.gov/docs/fy11osti/49187.pdf.

(NRTL).[95] Prior to 2010, Underwriters Laboratories (the primary NRTL) had not listed a single dispenser as compatible with any ethanol concentration greater than 10 percent.[96] EPA states "[b]ecause it is common for tank owners to use their tanks for 30 years or more, most UST systems currently in use are likely to contain components not designed to store ethanol blends greater than 10 percent."[97] Selling E15 safely will require expensive investments in retail fueling equipment—which are beyond the control of obligated parties that own less than 5 percent of gasoline stations—and which may not be made unless sufficient demand for higher blend fuels exists to justify such expenditures.

The Society of Independent Gasoline Marketers of America ("SIGMA") and the National Association of Convenience Stores ("NACS") recently testified to Congress that potential liabilities associated with selling E15 prevent E15 from being a viable solution to the blendwall:

> Without regard to these unanticipated market realities, the required RFS volume targets continue to increase year after year. As a practical matter, these targets can only be met if more ethanol is blended into gasoline. The market is not able to do this at the present time, largely because (as discussed below) retailers fear that selling gasoline blends greater than 10 percent ethanol (so-called "E10") will increase their liability exposure.
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> * * * *
>
> As you are likely aware, EPA recently authorized the use of E15 in certain vehicles. However, this has so far done very little to expand the use of renewable fuels, due largely to a lack of consumer demand, as well as retailers' liability and compatibility concerns and state and local restrictions on selling E15. Indeed, EPA's decision to approve the sale of E15 serves to highlight the *limitations* that directly affect retailers and impede the implementation of the RFS.[98]

The costs associated with E15 dispenser and storage systems compatibility can be formidable.[99] Purchasing new E-15 compatible dispensers costs approximately $20,000 per dispenser, while retrofitting a dispenser, if even possible, can be done for $2,000-$4,000 per dispenser. Even if a retail establishment were willing to expend the capital to ensure E15 compatible dispensers, many stations will find it impossible to determine the compatibility of their underground storage systems and "[w]hen a retailer proceeds to crack open concrete to address underground equipment issues, costs can quickly exceed $100,000 per location."[100]

A recent survey by NACS found similar limitations for mid-level ethanol blends: "recent consumer input indicates that the market is not ready to accommodate sufficient volumes of these alternative fuel blends to satisfy the requirements of the RFS. Inadequate infrastructure and limited consumer demand

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[95] 29 C.F.R. 1910.106(g).
[96] SIGMA/NACS Testimony, *supra* note 84 at 5.
[97] EPA, Notice of Final Guidance, Compatibility of Underground Storage Tank Systems with Biofuel Blends, 76 Fed. Reg. 39,095, 39,096 (July 5, 2011),
[98] SIGMA/NACS Testimony, *supra* note 84, at 4-5. *See also* NACS "Challenges Remain Before E15 Usage is Widespread, http://www.nacsonline.com/YourBusiness/FuelsReports/GasPrices_2013/Pages/Challenges-Remain-Before-E15-Usage-Is-Widespread.aspx (last visited August 8, 2013).
[99] SIGMA/NACS Testimony, *supra* note 84, at 5-6,
[100] *Id.* at 6.

puts the future of the RFS in peril unless adjustments are made."[101] Moreover, "[r]etailers recognize this limitation in demand, with more than three-quarters (79%) of the NACS members surveyed citing lack of demand as the reason that they don't sell the fuel."[102] The NACS Survey also confirms the retail station operators' concerns over the potential legal risks of selling E15:

> Demand isn't the only issue limiting availability. Retailers also expressed concerns about the costs associated with upgrading or replacing equipment to legally store and sell these new fuels: 46% said that the costs to upgrade to sell E15 were a concern, and 44% said that the costs to upgrade for E85 were a concern. Failure to use certified equipment can expose retailers to potential liability. Retailers also expressed concerns over potential liability from misfueling: 46% and 44% cited liability concerns over E15 and E85, respectively.[103]

For these reasons, NACS believes that "the statutory increases in renewable fuel volumes sold each year must be revised to reflect the declining size of the overall gasoline market."[104]

State regulatory approvals stand as an additional obstacle to the introduction of E15 . DOE has noted that 90 state laws and regulations in more than 30 states limit the sale of E15, and it is not known when they will be revised or amended.[105] A Congressional Research Service report includes an overview of the various concerns:

> A key non-vehicle issue is whether existing infrastructure can support ethanol blends above E10. Like automobiles, while some existing gasoline tanks and pumps were designed and/or certified to handle up to E10, none to date have been designed or certified to handle higher ethanol blends. Even if the fuel is approved by EPA for use in motor vehicles, presumably fuel suppliers and/or retailers would be unwilling to sell the fuel unless they are confident that it will not damage their existing systems or lead to liability issues in the future. Otherwise, it seems doubtful that fuel suppliers and retailers would voluntarily upgrade their systems to handle the new fuel. Further, loan covenants and insurance policies would need to be modified to reflect the use of the higher ethanol blend.[106]

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[101] See NACS Survey: Evolve the Renewable Fuels Standard, Natl. Assoc. of Convenience Stores (June 11, 2013), http://www.nacsonline.com/News/Daily/Pages/ND0611131.aspx#.UeNKrZXLZUQ. "Only 26% of fuel consumers said that they are familiar with E15, and this lack of awareness significantly diminishes potential demand. After E15 was described to surveyed consumers, only 59% of them said that they would consider purchasing E15 if it were the same price per gallon as gasoline." *Id.*
[102] *Id.*
[103] *Id.*
[104] *Id.*
[105] *See* U.S. DEP'T OF ENERGY, E15, Alternative Fuels Data Center, http://www.afdc.energy.gov/fuels/ethanol_e15.html (stating that "[t]here are more than 90 state laws and regulations currently limiting sales of E15 in more than 30 states. Some state restrictions in conflict include a 10 percent ethanol blend cap, state biofuels mandates, technical fuel specification standards, and waivers. It is unknown when the update of laws and regulations to allow E15 sales will be completed").
[106] BRENT D. YACOBUCCI, CONG. RESEARCH SERV., R40445, INTERMEDIATE-LEVEL BLENDS OF ETHANOL IN GASOLINE, AND THE ETHANOL "BLEND WALL" 11-12 (2010) (footnote omitted).

Blendstock for E15 blending differs from blendstock for E10 blending, and would present its own infrastructure/storage issues at refineries/terminals. For instance, while E10-BOB benefits from a summertime 1 psi RVP waiver, E15-BOB does not. This would require that E10-BOB be segregated from E15-BOB during the volatility control season from the refinery all the way through the distribution system to retail. Further, producers of E15-BOB must have an EPA-approved E15 misfueling mitigation plan ("MMP") in place before its blendstock can be sold for blending E15. E10-BOB does not require an MMP to be in place. These differing suitability requirements will make it necessary that the two blendstocks be kept segregated downstream of the refinery year-round. Such segregation requirements make offering an additional blendstock specifically for E15 unworkable and impractical.

In its 2009 Federal Register notice, EPA acknowledged that the driving motivation behind the original petition for the E15 waivers was the need to find a fuel source that could delay the blendwall.[107] The original hope was that the use of E15 would provide time for the maturation of alternative sources that would ensure long-term, sustained compliance with the RFS. But that clearly has not happened. A waiver of the RFS in 2014 provides a reasonable, rational way to proceed in the face of the confluence of many different circumstances preventing E15 use for the foreseeable future.

The risks and potential liabilities presented by E15 in terms of vehicle and infrastructure incompatibility cannot be overstated and must not be ignored by EPA. This petition is not about the wisdom of RFS or ethanol particularly. It is about the simple facts and realities presented by the E10 blendwall. It is difficult to understand how or why the federal government would knowingly and intentionally enforce a rule that seeks to require the manufacture and sale of a fuel product (E15) that:

- will damage engines and other systems in millions of vehicles that have been "approved" by EPA for E15, but which are unapproved by the vehicle manufacturers and for which use may void the vehicle warranty;

- is illegal and unavailable for tens of millions of other automobiles, trucks, off-road vehicles, boats and small-equipment products, and which will decrease the availability of the gasoline required by owners of these products;

- results in fewer miles-per-gallon for most vehicles, thus reducing vehicle efficiency at a time when the federal government is promulgating aggressive vehicle efficiency standards;

- is incompatible with, and thus cannot legally be stored in or dispensed from, the vast majority of the existing gasoline retail distribution system, thus forcing thousands of small business owners to either incur enormous costs to upgrade their systems or run the economic and environmental risks posed by carrying an incompatible product; and

- requires obligated party manufacturers and importers, fuel suppliers, distributors and retailers, engine and vehicle manufacturers, and many others, to face potential liabilities and litigation all for complying with the federal mandate.[108]

[107] 74 Fed. Reg. 18,228, 18,229 (Apr. 21, 2009).
[108] Unlike the different fuel nozzle sizes required for unleaded and leaded gasoline (which themselves did not completely stop improper usage of leaded fuel), however, there are no physical safeguards to prevent consumer misuse of E15.

Accordingly, it is unreasonable to expect fuel suppliers to introduce E15 and assume these risks.

C. E85 Is Not a Viable Solution to the Blendwall.

Many of the factors that have prevented E15 from expanding in the domestic fuel market and slowing the arrival of the blendwall also prohibit E85 from serving as a solution to the blendwall problem. Moreover, there are simply not enough flex-fuel vehicles ("FFVs") to use enough ethanol to delay the blendwall. Under any reasonable assumptions relating to the growth of the market for FFVs, there will still not be enough FFVs to avoid the blendwall in the foreseeable future.

In the United States, there is a very limited market for E85—an ethanol/gasoline blend that in practice ranges from 51 percent to 83 percent denatured ethanol—which can be sold for use in FFVs. Even with very optimistic projections of the growth in E85 sales, the NERA Study concludes that E85 is an ineffective solution to prevent the blendwall from continuing into 2014.[109] E85 fails to provide a viable solution because of the significant market limitations and infrastructure constraints identified below.

The MathPro study shows that E85 is not a viable solution to the blendwall (see E85 graph on page 15).

In the scenario assuming no reduction in total renewable and advanced biofuel volumes in proportion to cellulosic biofuel reduction, the data in the MathPro study show that E85 fuel demand would need to grow from 0.02 billion gallons in 2013 to ~1.9 billion gallons in 2014 (over 9000 percent increase), to ~7.9 billion gallons in 2015, and to 22.4 billion gallons in 2020.[110] Such growth would be unprecedented for any industry. Furthermore, "[t]he ability of the prospective FFV fleet's [sic] to absorb E85 volumes would be exceeded by 2017 (even under the optimistic assumptions that FFV owners using E85 would use it exclusively). . . . This result implies that FFV sales would have to expand considerably beyond those projected in *AEO* 2013."[111]

In the scenario assuming a reduction in total renewable and advanced biofuel volumes in proportion to cellulosic biofuel reduction, the data in the MathPro study shows that E85 fuel demand would need to grow from 0.02 billion gallons in 2013 to ~3.5 billion gallons in 2015 (over 17,000 percent increase), to ~7.3 billion gallons in 2020. Similar to the previous case, such growth would be unprecedented. Also use of E85 fuel in FFVs would need to increase to over 50 percent of the time, when, according to EIA, consumers in the marketplace use E85 less than 5 percent of the time.[112]

1. The E85 Refueling Infrastructure Is Inadequate.

The over 2,300 E85 fueling stations currently in existence in the United States[113] represent only approximately 2 percent of domestic fueling stations. High investment costs prevent the rapid construction of new stations or the conversion of existing stations. New fueling tanks for E85 cost up to $200,000, a substantial investment for a product that lacks demonstrated demand in the

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109 NERA STUDY, *supra* note 4, at 32.
110 MATHPRO STUDY, *supra* note 57, at 11.
111 *Id.* at 12.
112 *Id.* at 13.
113 U.S. DEP'T OF ENERGY, *ETHANOL FUELING STATION LOCATIONS*, http://www.afdc.energy.gov/fuels/ethanol_locations.html (last visited 8/11/2013).

marketplace.[114] Moreover, most fueling stations contain two tanks one for regular gasoline and the other for premium gasoline, with mid-grade being produced by blending the two.[115] Retrofitting or converting an existing tank would result in a retailer losing an existing proven revenue stream in exchange for a product with speculative demand.[116] Given these impediments, it is not surprising that only 200 to 500 E85 dispensers are installed each year, representing a miniscule portion of the fueling station market.[117] This number pales in comparison to the over 156,000 gas stations [118]in the United States.[119] The costs associated with E85 infrastructure are important because, even though many gas stations sell "branded" fuel, obligated parties do not own the vast majority of retail gas stations across the country. In fact, more than 95 percent of all gas stations are owned by smaller businesses (non-obligated parties).[120] EPA cannot expect independently-owned businesses that operate on thin margins to risk installing expensive E85 dispensing equipment in the absence of strong consumer demand. Even if the number of stations continues to grow at a rate of 500 per year, E85 stations would still likely represent a mere 3 percent of the fueling station market by the end of 2013.[121] Because they are not obligated parties under the RFS, these small business owners also lack the regulatory incentive to make the costly investments in E85 infrastructure. We also note that distribution of E85 is concentrated in the Midwest and FFV access to E85 is even more limited than these numbers imply.

As the NERA Study points out, even an overly optimistic growth scenario still fails to produce enough E85 fueling stations to create a viable alternative to E10.[122] Although the number of FFVs in the market may continue to grow, sufficient infrastructure does not exist to encourage consumers to use E85 in these vehicles. Even if there were a significant expansion in E85 sales in the next two years—as assumed in the NERA Study—the study clearly demonstrates that E85 consumption would still be insufficient to avoid the adverse consequences of the blendwall in 2014.[123] Quite optimistically in comparison to the AEO 2011 forecast, NERA modeled the sale of over 1.6 billion additional gallons of

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[114] COMM. ON ECON. AND ENVTL. IMPACTS OF INCREASING BIOFUELS PROD., RENEWABLE FUEL STANDARD: POTENTIAL ECONOMIC AND ENVIRONMENTAL EFFECTS OF U.S. BIOFUEL POLICY 385 (The National Academies Press, 2011). EPA has previously made the following cost estimates: (1) the total cost of installing a two-nozzle E85 dispenser is $23,000; (2) the cost of automatic tank-level gauging equipment is $6,500; (3) the cost of installing a canopy addition to provide cover for an extra dispenser is $15,000; and (4) the cost of installing a new 15,000-gallon underground E85 storage tank is $102,000. Based on these figures, EPA estimated that an E85 installation with one dispenser would cost $131,000, an E85 installation with two dispensers would cost $154,000, an E85 installation with three dispensers would cost $177,000, and upgrading an existing E85 facility from one E85 dispenser to three E85 dispensers would costs $130,000. RFS2 RIA, *supra* note 65, at 781-82.

[115] NACS ONLINE, Challenges Remain Before E15 Usage Is Widespread, http://www.nacsonline.com/YourBusiness/FuelsReports/GasPrices_2013/Pages/Challenges-Remain-Before-E15-Usage-Is-Widespread.aspx.

[116] *Id.*

[117] CHARLES RIVER STUDY, *supra* note 63, at 12-13.

[118] *Third consecutive year station count drops*, NPN MAG., Oct. 2012, at 17 (counting 156,065 stations in 2012).

[119] U.S. DEP'T OF ENERGY, *ETHANOL FUELING STATION LOCATIONS*, http://www.afdc.energy.gov/fuels/ethanol_locations.html (last visited 8/11/2013).; *see also* John Mayes & Tom Hogan, *Market, Production Conditions will Prevent Meeting RFS*, OIL & GAS J. (Oct. 12, 2012), *available at* http://www.ogj.com/articles/print/vol-110/issue-10/processing/market-production-conditions-will-prevent.html.http://factfinder2.

[120] Robert Bradley, *It's Time to Repeal the Renewable Fuel Standard*, FORBES, Apr. 17, 2013, http://www.forbes.com/sites/robertbradley/2013/04/17/its-time-to-repeal-the-renewable-fuel-standard/.

[121] CHARLES RIVER STUDY, *supra* note 63, at 13.

[122] NERA STUDY, *supra* note 4, at 22.

[123] *Id.* at 26-38.

E85 in 2014.[124] The model's only constraint on the sale of E85 is the ability to build E85 fueling stations.[125] To determine station growth, the NERA Study examined the number of E85 stations built from 2005 to 2011—an average of 340 new stations a year—and then assumed a construction growth rate increase of 25percent per year.[126] Further contributing to the aggressiveness of NERA's modeling assumptions regarding E85 growth, the demand projections used in NERA's model assume that the volume of E85 sales per station will increase 2.5 times between 2012 and 2015—an assumption that predicts much stronger demand than the market constraints detailed above would indicate.[127] Yet even with these optimistic modeling assumptions about E85 station growth and consumption, NERA's analysis still projects a significant RIN shortfall in 2014.[128]

2. There Is Inadequate Consumer Acceptance of E85.

Of equal importance, consumers have rejected E85 even where the infrastructure exists. For example, Minnesota has the most extensive network of E85 stations in the United States.[129] A review of monthly E85 sales compared to the number of stations reveals that despite a growing number of E85 retail outlets in Minnesota, annualized average monthly sales of E85 *declined* by 1.5 percent between 2012 and 2013.[130] In fact, total volume sales of E85 in Minnesota have dropped from a peak of 22 million gallons in 2008 to 15 million gallons in 2012.[131] Further, adding to the challenge of entering the E85 market, the average monthly throughput since 2008 is consistently less than 5,000 gallons per month,[132] which is roughly 4 percent of the average gasoline station's throughput of 128,000 gallons per month.[133] The Minnesota market highlights weak consumer demand for E85 and suggests that building additional E85 stations on a national scale would fail to result in an appreciable (if any) increase in the use of E85.

EPA understands that E85 refueling rates are low, estimating that the current E85 refueling frequency rate is only 4 percent for FFVs with reasonable access to E85. EPA projects that this rate will need to increase to 58 percent to ameliorate the impact of the E10 blendwall.[134] The current low refueling rate highlights consumer reluctance to use E85 as a fuel even when it is an option, likely due to the fuel economy penalty.[135] To date, the drivers of FFVs have overwhelmingly refueled with gasoline and rarely chosen E85. The fuel for a FFV is a consumer choice. A potential requirement for the production of more FFVs will not necessarily result in a large increase in sales of E85 because drivers of FFVs have the option to select E10.

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[124] *Id.* at 23.
[125] *Id.*at 22.
[126] *Id.*
[127] *Id.*
[128] *Id.* at 26-38.
[129] CHARLES RIVER STUDY*, supra* note 64*,* at 22.
[130] MINN. DEPT. OF COMMERCE, *2013 Minnesota E85 + Mid-Blends Station Report*, *available at* http://mn.gov/commerce/energy/images/E-85-Fuel-Use-Data.pdf. The 2013 available data through June was doubled to create an annual figure.
[131] *Id.*
[132] *Id.*
[133] NACS ONLINE, 2013 NACS Retail Fuels Report: The U.S. Petroleum Industry: Statistics, Definitions, http://www.nacsonline.com/YourBusiness/FuelsReports/GasPrices_2013/Pages/Statistics-and-Definitions.aspx (last visited Aug. 10, 2013).
[134] 75 Fed. Reg. 14,670, 14,762 (Mar. 26, 2010).
[135] *See* Alliance Testimony, *supra* note 72, at 7 (stating that the "primary factors affecting the lack of E85 usage are pricing, availability, total full-tank range, and consumers' willingness to use the fuel").

EPA shares this perspective:

> Similarly, EPA believes it is not appropriate to assume that ethanol FFVs will primarily use E85, as there is no extra vehicle cost to purchase an FFV (typically a consumer does not choose between an FFV and a non-FFV of the same vehicle model), E85 fuel is no cheaper and in fact usually more expensive per mile, and use of E85 reduces overall vehicle range since there is only one fuel tank (as opposed to PHEVs and dual fuel CNG vehicles which have two fuel storage devices and therefore the use of the alternative fuel raises overall vehicle range). Further, even with approximately 10 million ethanol FFVs in the U.S. car and light truck fleet, fuel use data demonstrate that ethanol FFVs only use E85 less than one percent of the time.[136]

EPA acknowledged the uncertainty that surrounds E85 in the Agency's recent draft guidance for calculating compliance credits issued to auto manufacturers under the GHG tailpipe emission standards.[137] The GHG tailpipe emission standards provide auto manufacturers with a credit for certain vehicles, such as FFVs, calculated through the use of a weighting factor (the "F value"). Currently, EPA has set the F value for FFVs at 0.50, meaning that the agency assumes a FFV uses E85 fifty percent of the time. In the draft guidance, EPA noted that the limited usage of E85 in FFVs suggests a more appropriate F value closer to zero.[138] FFVs and E85 cannot represent a viable solution to forestalling the blendwall when EPA itself concludes that FFV-owners rarely fuel their vehicles with E85. The limitations of E85 as an RFS compliance option and a lack of viable compliance alternatives will only hasten the arrival of the blendwall. Moreover, low E85 sales translate to an inadequate supply of RINs, which does nothing to forestall the problems caused by the E10 blendwall.

Based on the limited use of E85, EPA reduced the F value from 0.50 to 0.20 for FFVs model years 2016-2019.[139] This drastic change in the F value creates a major disincentive for automakers to build FFVs. The draft guidance points out that there is a historic relationship between an incentive for FFV production, such as the compliance credit, and the production of FFVs, and yet EPA fails to explain how the reduced F value will not adversely affect FFV production.[140] EPA's actions in this arena highlight the inconsistencies that result from the interaction of the GHG tailpipe emission standards and the RFS. The RFS calls for refiners to blend ever-increasing amounts of ethanol with gasoline and now EPA proposes to remove the biggest incentive for auto manufacturers to build a vehicle fleet that can safely run on high-ethanol blends. The GHG tailpipe emission standards do not act in a vacuum and EPA's draft guidance will only serve to frustrate future compliance with the RFS.

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[136] EPA , EPA-420-R-12-017, 2017 AND LATER MODEL YEAR LIGHT-DUTY VEHICLE GREENHOUSE GAS EMISSIONS AND CORPORATE FUEL ECONOMY STANDARDS: RESPONSE TO COMMENTS 6-134 (Aug. 2012), *available at* http://www.epa.gov/otaq/climate/documents/420r12017.pdf.

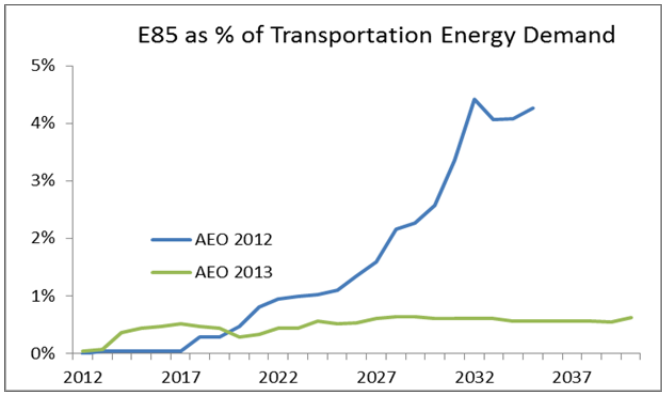
[137] *See* EPA, DRAFT GUIDANCE LETTER: E85 FLEXIBLE FUEL VEHICLE WEIGHTING FACTOR FOR MODEL YEAR 2016-2019 6 (Mar. 22, 2013), *available at* http://www.epa.gov/otaq/regs/ld-hwy/greenhouse/documents/draft-ffv-guidance-letter.pdf [hereinafter DRAFT GUIDANCE LETTER].

[138] *Id.*

[139] *Id.* at 1. Given the historical E85 usage, a 20 percent F value represents an arbitrarily high estimate for E85 refueling rates.

[140] *Id.* at 11.

The chart below shows EIA's projections in 2012 and 2013 of E85 fuel use as a percentage of transportation energy in the U.S. Note the sharp decrease in the projections – E85 fuel is expected to be *less than 1 percent* of transportation energy demand in the most recent AEO.



As if the foregoing were not sufficient to demonstrate the limitations on E85, automobile manufacturers caution drivers against repeatedly switching back and forth between E85 and gasoline due to concerns that constant shifts in the ethanol content of the fuel can damage car engines.[141] States with their own renewable fuel requirements also warn against fuel switching unless the vehicle requires half a tank or more of fuel, and not without first burning off the remaining original fuel in the tank.[142] Ultimately, this combination of market constraints and concerns related to long-term vehicle maintenance limit the ability of E85 to prevent the blendwall.

D. Biomass-Based Diesel Is Not a Viable Solution To Prevent the Blendwall.

Another purported alternative, biomass-based diesel, also fails to provide a viable solution to prevent the blendwall. There are two principal challenges to the increased use of biomass-based diesel. First, as explained above, there is a practical constraint in biomass-based diesel marketability that makes the introduction of blends above B5—a blend of 5 percent biodiesel and 95 percent conventional diesel—for most diesel-powered vehicles impossible; this constraint causes diesel production to incur an unavoidable RIN deficit.[143] Further, the use of biomass-based diesel is also limited by the lack of sufficient biomass-based diesel feedstocks to saturate the diesel pool at B5.[144] Indeed, biomass-based diesel feedstock constraints likely will continue for the foreseeable future, which sets up a diesel deficit as explained in Section I.B, *supra*.

The RFS regulations identify three separate categories of biomass-based diesel: biodiesel, renewable diesel that is not co-processed with petroleum, and cellulosic diesel.[145] Under the regulations, any

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[141] *See Tech Tips – E85 Fuel*, GENERAL MOTORS, http://www.gmfleet.com/content/dam/gmfleet/global/master/nscwebsite/en/Home/Shared_Resources/PDFs/GMC1-12-03142-262%20E85%20Ethanol%20Fluid.pdf (last visited Mar. 15, 2013).

[142] ILL. DEP'T OF TRANSPORTATION, *Frequently Asked E85 Questions*, http://www2.illinois.gov/gov/green/Documents/FAQ's%20E85%20ver3.pdf (last visited Aug. 12, 2013).

[143] CHARLES RIVER STUDY, *supra* note 63, at 35-36.

[144] University of Illinois, *The Ethanol Blend Wall, Biodiesel Production Capacity, and the RFS…Something Has to Give*, (Feb. 13, 2013), http://farmdocdaily.illinois.edu/2013/02/ethanol-blend-wall-biodiesel-RFS.html ("the increase in biodiesel feedstock requirements would simply overwhelm feedstock markets").

[145] *See* 40 C.F.R. § 80.1401 (defining "Biomass-based diesel" and "Cellulosic diesel").

combination of these fuels can be used to meet the biomass-based diesel, total advanced, and total renewable fuel mandates.[146] Because biomass-based diesel has an ethanol-equivalence value greater than 1.0,[147] each of these fuels also has the ability to generate additional RINs and could help forestall the blendwall.[148] This potential is offset, however, by significant limitations in the availability of the necessary feedstocks.

The most common type of biodiesel is "FAME" biodiesel, which is produced through the trans-esterification of plant and animal fats.[149] The resultant fuel is composed of fatty acid methyl esters ("FAME"), which are chemically distinct from petroleum fuels and possess different physical properties.[150] Because its production technology is mature and it requires a lower capital investment than other types of biomass-based diesel production, FAME biodiesel is likely to remain the primary biodiesel stock for the foreseeable future.[151] The availability of affordable feedstocks to produce FAME biodiesel, however, is limited.[152] While biodiesel can be made from a number of different plant and animal fats, soybean oil is the most common feedstock.[153] Because soybean oil and other feedstocks are commercially valuable commodities with numerous other uses, feedstock price and availability will be affected not only by soybean yield but also by market competition for feedstocks.[154]

In addition to feedstock limitations, there are a number of practical constraints to the widespread use of FAME biodiesel. For instance, FAME biodiesel is typified by significant variations in quality, which in turn leads to inconsistent performance, particularly at low temperatures. This leads to a seasonal pattern of acceptance. Further, FAME biodiesel presents its own logistic challenges. In particular, the potential for trailback into jet fuel precludes movements of blends containing FAME biodiesel on many common carrier pipelines. Finally, the vast majority of existing terminals do not currently have the infrastructure to receive, store, and blend FAME biodiesel. Even assuming the necessary infrastructure eventually can be developed, these facilities cannot realistically be constructed in the short term.

In contrast to FAME biodiesel, renewable diesel and cellulosic diesel are pure hydrocarbon fuels.[155] To date, due to economic/technological hurdles, production of renewable diesel and cellulosic diesel has lagged far behind the volumes required by the RFS.[156] In fact, in its proposed volumes for cellulosic and advanced biofuels for 2013, the EPA stated that it expects the vast majority of required volume of biomass-based diesel for 2013 (1.28 billion gallons) to be met by FAME biodiesel—which has its own

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[146] *See id.*; 40 C.F.R. § 80.1405 (setting forth Renewable Fuel Standards for "biomass-based diesel").
[147] *See* 40 C.F.R. § 80.1415(b) (assigning equivalence values to various renewable fuels).
[148] *See* CHARLES RIVER STUDY, *supra* note 63, at 32-33 (analyzing the increased use of biodiesel as blendstock as a potential method to delay breach of the E10 blendwall).
[149] *Id.* at 33.
[150] *Id.*
[151] *Id.* at 34.
[152] *Id.* at 37.
[153] *Id.*
[154] *Id.*
[155] *Id.* at 34.
[156] *See* Robert Wisner, *EPA's Proposed Biofuels Mandates for 2013 – Challenges for the Biofuels Industry*, AGRIC. MARKETING RESOURCE CENTER (Mar. 2013), http://www.agmrc.org/renewable_energy/biofuelsbiorefining_general/epas-proposed-biofuels-mandates-for-2013---challenges-for-the-biofuels-industry/ (discussing historical and future problems associated with meeting the RFS' requirements for biomass-based diesel and cellulosic diesel).

limitations, as noted above.[157] For these reasons, biomass-based diesel production does not provide a viable solution to avoid the blendwall.

The MathPro study shows that biomass-based diesel is not a viable solution to the blendwall (see FAME graph on page 15).

In the scenario assuming no reduction in the total renewable fuel and advanced biofuel volumes in proportion to cellulosic biofuel reduction, the MathPro data show that 2 billion gallons of FAME would be required in 2014 (~40 percent increase vs. 2013), 4.7 billion gallons of FAME would be required in 2015 (~300 percent increase vs. 2013) and by 2020 11.1 billion gallons of FAME would be required by 2020 (~825 percent increase vs. 2013).[158] Per MathPro, "[b]y 2015, the FAME volume would exceed (i) the current 5 vol% limit on FAME blending in diesel fuel, and (ii) the biodiesel industry's current nameplate capacity of about 2.2 B gal/yr. By 2020, FAME blending would have to account for about 16 vol% of the distillate pool to enable compliance with the volume standards."[159]

In the scenario where the total renewable fuel and advanced biofuel volumes is reduced in proportion to cellulosic biofuel reduction, the MathPro data show that "FAME use would begin to expand in 2015, by which time the gasoline pool is saturated with ethanol (2012) and carryover RINs have been exhausted (2014). By 2017, FAME blending would exceed the current 5% blending limit in diesel fuel, and FAME production would have to reach 3.6 B gal/y, over 50% higher than the reported current FAME nameplate capacity of about 2.2 B gal/y. By 2020, FAME would have to account for about 6.5 vol% of the distillate pool to enable compliance with the RFS volume standards, which exceeds the current blending limit of 5 vol%."[160]

E. Deficit Rollover Is Not a Solution to the Blendwall.

Some have suggested that the ability to roll a RIN deficit over in to the following year could be a solution to the blendwall problem. That is incorrect. In fact, when the first obligated parties opt to carry a deficit, it should be a signal to EPA that the RFS has become infeasible. Although it is permissible to roll a RIN deficit over for one year, EPA's rules state that the entire deficit and the entire obligation must be met in the second year. Given that the RFS mandates escalate year by year, rolling a deficit over from 2014 in to 2015 will not solve the problem. This is because the rapidly increasing mandated volumes will make it virtually impossible for a party in deficit ever to recover from the deficit. What options would the obligated party have in the second year to remain in compliance with the law except to severely curtail its obligation?

F. When Obligated Parties Reduce Domestic Production Because of the Blendwall, Systemic RIN Shortages Prevent Other Companies from Using It as an Opportunity To Increase Their Domestic Sales Volumes and Market Share.

In the RFS 2013 final rule, EPA incorrectly dismisses the potential for reduced domestic fuel supplies, resulting from increased fuel exports and/or decreased fuel imports.[161] According to EPA, domestic

[157] 78 Fed. Reg. at 9,285.
[158] MATHPRO STUDY, *supra* note 57, at Exhibit 1A.
[159] *Id.* at 11.
[160] *Id.* at 13.
[161] 2013 RFS Final Rule, *supra* note 35, at 66-67.

supply is unlikely to drop when certain obligated parties are unable to supply the market because other obligated parties would simply increase sales volumes in an effort to gain market share.[162] This reasoning represents a fundamental misunderstanding of the blendwall problem and ignores the fact that the blendwall affects the entire industry.[163] NERA explains that "the blending percentage standard for total renewable fuel will eventually exceed the maximum feasible level of renewable fuel that can be contained on average in a gallon of transportation fuel given the technological, market, and infrastructure constraints in the economy."[164] As a result, RINs will become scarce for everyone.[165] A scarcity of RINs likely will result in fewer gallons of gasoline and diesel that may be legally sold—a scenario that cannot be alleviated through the use of E15 or E85, as discussed elsewhere in this Petition. The contraction of the market is due to the fact that every batch of transportation fuel sold in the United States requires a specific percentage of RINs to be obtained. If surplus RINs are not available, no additional fuel may be sold in the domestic market.

As reported by NERA, there are limited compliance mechanisms, and they include reducing the RFS compliance obligation by reducing domestic fuel supplies (e.g., increasing exports, reducing production). NERA uses diesel as a specific example to illustrate how annual percentage standards, applied to both gasoline and diesel, could result in the tightening of the diesel supply initially, and then result in smaller gasoline and diesel supplies.[166]

In the RFS 2013 final rule, EPA also incorrectly asserts that high feedstock prices are a primary driver for RIN price increases.[167] One needs only point out that RINs prices were only a few pennies for years, while relative ethanol and petroleum prices varied, but only just recently shot up in 2013 while the ethanol and petroleum prices did not change significantly from prior year's variations. What has changed is the ethanol and gasoline consumption data that show we were nearing the blendwall. According to NERA, the cost of RINs depends on available supply, and RIN prices increase when there is an imbalance between supply and demand.[168] While the markets are certainly related, ethanol supply and demand is not necessarily a factor in RIN price. As noted in this Petition, compliance with the RFS is becoming more difficult due to blending requirements exceeding the amount of renewable fuel that can be folded into U.S. transportation fuels. It would be wrong to conclude that RIN prices are increased due to lack of ethanol supplies, especially during a period when the United States is a net exporter of ethanol. If the market demands more ethanol, then market signals via ethanol prices are sufficient.

Last, EPA indicates the impact of increasing RIN prices is not to increase overall transportation fuel costs, but rather to reduce the price of higher renewable content fuels (*e.g.*, E85) relative to the price of other fuels with a lower renewable content (e.g., E10). To use more E85, retailers must drop the price below

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[162] *Id.*

[163] EPA is confusing an initial competitive market dynamic as the blendwall approaches with the blendwall impact itself. All players do not run short of RINs at the same time. While some obligated parties are already constrained and exposed to the full market RIN costs, others have a RINs inventory and lower average RINs costs. Obligated parties with lower costs would be expected to gain market share at the expense of higher cost suppliers. But the supply of RINs relative to demand is shifting and will continue to tighten as the RINs inventory is drawn down and fewer are available for sale as the mandates increase and additional RINs must be found in the marketplace to demonstrate compliance.

[164] NERA STUDY, *supra* note 4, at 26.

[165] *Id.* at 26-30.

[166] *Id.* at 31-34.

[167] 2013 RFS Final Rule, *supra* note 35, at 66.

[168] *See* NERA STUDY, *supra* note 4, at 29-30.

that of gasoline to overcome the consumers' rejection of its efficiency loss and inconvenience. That has not occurred. According to the AAA, as of August 12, 2013, the national average retail price for E85 was selling at a 17-cent premium to regular gasoline on an energy-equivalent basis.[169] Moreover, the independently-owned retail service stations do not share the compliance burden that obligated parties bear to meet the RFS requirements. EPA's flawed logic assumes that obligated parties can overcome the blendwall merely by encouraging increased E85 consumption through dramatically reduced prices. As discussed in this Petition, this is not so.

IV. A Partial Waiver Can Avoid the Inadequate Domestic Supply and Avoid Severe Economic Harm.

A. The NERA Study Provides a Fundamentally New Analysis Than Studies Previously Considered by EPA.

The NERA Study differs in two fundamental respects from prior studies considered and rejected by EPA: (1) with respect to its assumptions about E10 production; and (2) in its economic modeling. In both divergences from prior studies, the NERA Study responds directly to EPA's stated criteria for analyzing waiver petitions.

In its 2008 denial of Texas's waiver petition, EPA explained that it believed the Iowa State model was the best available model to examine the impacts of a RFS waiver because it is a stochastic model and it captures the interaction between the agricultural and energy markets.[170] In its final notice of action, EPA dismissed several studies examining the ability of refiners to decrease ethanol blending because the studies failed to address whether the economics of ethanol and gasoline production would lead refiners to reduce blending rates in the event of a waiver.[171] The prior analyses assumed a departure from the production of E10 and decreased use of ethanol as oxygenate in the event of a waiver, which EPA deemed implausible under current market conditions.[172] In contrast, the NERA Study assumes that all refiners will continue to produce as much E10 as possible and examines a situation in which production of E10 alone is no longer sufficient to meet the RFS.[173] This reflects the actual blendwall that faces the United States now and is an important difference that distinguishes and validates the NERA Study, unlike the prior studies considered and rejected by EPA.

Further, in its prior waiver denials, EPA faulted studies for failing to model interactions between the fuel and agricultural sectors and for valuing ethanol on an energy equivalent, rather than a volumetric,

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[169] http://fuelgaugereport.aaa.com/?redirectto=http://fuelgaugereport.opisnet.com/index.asp (last visited Aug. 13, 2013).
[170] 73 Fed. Reg. at 47,174.
[171] *Id.*
[172] *Id.*
[173] EPA also expressed doubts about studies presented in the comment period on its denial of waiver requests in 2012. EPA found that there are a number of business and technical reasons that may prevent refiners from moving away from the production of E10. *See* 77 Fed. Reg. at 70,767. As with the doubts EPA expressed in its 2008 denial, these concerns have no place in the current evaluation, as the NERA Study makes no assumptions that refiners will shift away from the production of E10. In its prior denials of petitions for waivers under the RFS, the EPA declined to rely upon other studies offered by previous petitioners and other commenters, noting several shortcomings with the studies. The NERA report also does not suffer from these same alleged deficiencies, and its economy-wide analysis is sufficiently robust to serve as the basis of a determination that implementation of the RFS will cause severe economic harm.

basis.[174] EPA has also rejected commenters' submissions of studies on the impacts of the RFS on the livestock industry, finding that these studies "do not focus on the impacts directly related to the RFS."[175] The NERA Study is different because it is focused on the behavior of refiners in response to the blendwall and the cascading effects that such behavior will have on fuel prices and ultimately on the economy as a whole.[176] The study assumes that sufficient ethanol to meet the RFS's volume obligations will remain available and that virtually the entire gasoline pool will be E10. Further, the NERA Study relies upon a broad economic model that examines the interaction among five energy and seven non-energy sectors.[177] Therefore, the NERA Study is not subject to the same shortcomings that have caused EPA to question previous studies submitted by commenters in support of a waiver of the RFS.

B. The Rationales Supporting Previous Waiver Decisions Do Not Preclude Waiver of the 2014 RFS, and Immediate Action Is Necessary.

As explained above, this Petition is unlike those that have preceded it because—unlike the prior waiver petitions—the blendwall is now here, and a waiver is concretely necessary. Despite this key difference, it bears mention that EPA has at least twice considered the "standards" to be applied in evaluating whether a waiver petition under section 211(o)(7)(A) would relieve a severe economic harm cause by the RFS. In its 2008 denial of a waiver petition from the state of Texas, EPA first interpreted the language of section 211(o)(7)(A) and concluded that the Clean Air Act requires a "generally high degree of confidence that implementation of the RFS program would severely harm the economy of a State, region, or the United States."[178] EPA rejected the Texas' 2008 waiver petition, finding that a waiver of the RFS would have no impact on ethanol demand during the period of the waiver and therefore would not increase the feed and fuel prices that Texas alleged were the source of severe economic harm.[179] EPA considered a second waiver petition from the Governors of several states in 2012. In considering the 2012 petition, EPA invited comment on its 2008 interpretation of section 211(o)(7)(A).[180] EPA ultimately rejected the waiver petition, concluding that the evidence did not support that the RFS was causing severe economic harm because "the weight of the evidence shows that it is very likely that the RFS volume requirements will have no impact on ethanol production volumes in the relevant time frame, and therefore no impact on corn, food, or fuel prices."[181] In doing so, the EPA determined that its 2008 interpretation of the waiver provision was correct and that "EPA interprets 'severely harm' as specifying a high threshold for the nature and degree of harm."[182]

While Petitioners believe that EPA has, to date, adopted an unnecessarily narrow view of its discretion to issue waivers under section 211(o)(7)(A), that fact is immaterial here because the impacts described in the NERA Study unquestionably rise to the level of severe economic harm upon which a waiver can be based. EPA must immediately issue a waiver to avoid the inadequate domestic supply and severe adverse economic impacts that will be caused by the RFS. Nothing in the Clean Air Act requires that the severe economic harm serving as the basis for the waiver petition must occur in the same year that EPA

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[174] 73 Fed. Reg. at 47,174.
[175] *Id.* at 47,178.
[176] NERA STUDY, *supra* note 4, at 7 (explaining that NERA relies upon its transportation fuel and macroeconomic models in evaluating the impacts of the RFS).
[177] *Id.* at 14.
[178] 73 Fed. Reg. at 47,169.
[179] *Id.* at 47,168-69.
[180] 77 Fed. Reg. 52,715 (Aug. 30, 2012).
[181] 77 Fed. Reg. at 70,775.
[182] *Id.* at 70,756.

issues the waiver.[183] The statutory language governing the application of the severe economic harm test for a waiver provides "implementation of the requirement *would* severely harm the economy or environment of a State, a region, or the United States."[184] The use of the conditional tense rather than the present tense suggests that future harm is an appropriate basis for granting the waiver.

EPA itself recognized that the agency has "discretion in determining the appropriate time period to analyze" with respect to a severe economic harm analysis in its denial of North Carolina's and Arkansas's waiver petitions.[185] Indeed, EPA previously requested petitioners to file waiver petitions 6 months in advance to facilitate EPA's review of the petition.[186] By its own admission, EPA does not expect to wait 6 months from the time severe harm begins before granting a waiver.

Previously, EPA declined to examine impacts beyond the current calendar year due to an inability to properly assess the relevant variables.[187] The NERA Study fully accounts for fluctuations in fuel prices and availability, and it provides sufficient certainty to conclude severe economic harm will result from reaching the blendwall in the years following 2013.[188] Existing infrastructure cannot support the higher-ethanol blend fuels required to avoid the blendwall. Moreover, the fact that a waiver applies broadly to the entire regulated community—and not simply to an individual party—implies that the waiver provision is meant to serve as a tool to address structural issues that could affect the successful implementation of the RFS.

C. In Contrast to Earlier Waiver Request Situations, in This Instance, Issuance of a Waiver Will Provide Relief and Avoid the Harms Resulting From the Blendwall.

The fundamental problem is that RINs are effectively permits to supply gasoline and diesel fuel for U.S. consumption, and that as the mandates exceed the ability of the transportation system to consume the mandated levels of renewable fuel, this will result in a shortage of permits to supply gasoline and diesel fuel. By granting a waiver, EPA will solve this problem and avoid the potentially disastrous impacts of the blendwall by eliminating this limitation on gasoline and diesel fuels for U.S. consumption. EPA must take immediate action to avoid the severe harm that the blendwall will inflict on consumers and the economy. In contrast to earlier waiver requests, where EPA determined that issuance of the waiver would likely not have provided the relief the petitioners sought, in this case, issuance of a waiver will provide relief and avoid the harms that would be inflicted by the blendwall.

V. There Is an Inadequate Domestic Supply of Cellulosic and Other Advanced Biofuels.

The RFS contains mandates for total advanced biofuels and two subsets of total advanced fuels (biomass-based diesel and cellulosic fuels). Total advanced fuel requirements are greater than the sum of biomass-based diesel and cellulosic fuels. That surplus over and above biomass-based diesel and cellulosic fuels we will refer to as other advanced fuels. We note that there is little to no concrete

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[183] *See* 42 U.S.C. § 7545(o)(7)(A).
[184] *Id.* (emphasis added).
[185] *See* 77 Fed. Reg. at 70,757 ("In considering the time frame used for this technical analysis, EPA recognizes that we have discretion in determining the appropriate time period to analyze.").
[186] 73 Fed. Reg. at 47,184.
[187] 77 Fed. Reg. at 70,757-58.
[188] *See id.* at 70,758 (noting that a waiver petition based on the blendwall itself could provide a proper analysis of all the relevant factors required to grant a petition based on severe economic harm occurring in a year different than the year of the petition's filing).

evidence that the domestic supply of either cellulosic biofuels or other advanced biofuels will reach the designated statutory targets.

A. Inadequate Supply of Cellulosic Biofuels.

The data in the EPA Moderated Transaction System (EMTS) indicates that no cellulosic biofuel was produced in 2011 and very little was produced in 2012. EMTS data show less than 49,000 gallons of cellulosic biofuel production in 2013 to date.[189] These facts suggest that the cellulosic biofuel statutory mandate should be waived based on an inadequate domestic supply. A recent U.S. Court of Appeals decision required EPA to establish a realistic cellulosic biofuel standard pursuant to the Clean Air Act.[190] Even a complete waiver of this mandate, however, would not be enough to abate the crisis caused by the E10 blendwall.

B. An Inadequate Domestic Supply of Advanced Biofuels.

The 2014 statutory level for advanced biofuels is 3.75 billion gallons. The obligation to blend "advanced" biofuels exceeds the sum of biomass-based diesel and cellulosic biofuels, and EPA expects the difference to be made up with sugarcane-based ethanol and extra biomass-based diesel. A miniscule amount of sugarcane-based ethanol is produced domestically. Most is sourced from Brazil. The mandate results in imports of other advanced biofuels, which is contrary to the goals of EISA to promote energy independence and security. Drawing from the clear language of the section 211(o) waiver provision, only "domestic supply" should be considered when setting the advanced biofuel and total renewable volumes.

Domestic producers cannot meet the EISA's advanced biofuels requirements. In this regard, EPA recently identified Brazilian sugarcane ethanol as a potential source to meet the RFS advanced biofuel requirements.[191] EPA's reliance on Brazilian ethanol crowds out the development of domestic advanced biofuels and actually fosters dependence on a foreign fuel source—in direct conflict with the Congressional intent of EISA. More importantly for purposes of addressing the blendwall, Brazilian sugarcane ethanol is simply an ethanol derived from a different feedstock and, therefore, subject to the same blending constraints as corn-based ethanol. The mandate to incentivize the import of Brazilian sugarcane ethanol merely displaces domestically produced ethanol, but does not help address the ethanol blendwall crisis. The RFS has caused significant quantities of sugarcane-ethanol to be imported from Brazil to meet the advanced biofuel mandate, while corn-based ethanol is sent to Brazil to satisfy consumer demand in that country. This *fuel shuffling* between the U.S. and Brazil is an unintended consequence of the RFS.

Putting aside for a moment the fact that Brazilian sugarcane-derived ethanol neither helps the ethanol blendwall problem nor qualifies as a domestic fuel, significant uncertainty exists with respect to Brazil's ability to export increasing volumes of sugarcane ethanol. EPA's advanced biofuel volumes for 2013 rely on the import of 666 million gallons of sugarcane ethanol from Brazil.[192] Uncertainty exists whether Brazil can increase exports to actually meet this demand. Idled mills and poor harvests have led

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[189] EPA, 2013 RFS2 DATA – RIN GENERATION AND RENEWABLE FUEL VOLUME PRODUCTION BY MONTH, http://www.epa.gov/otaq/fuels/rfsdata/2013emts.htm (last visited July 30, 2013).
[190] *API v. EPA*, 706 F.3d 474 (D.C. Cir. 2013).
[191] 78 Fed. Reg. at 9285.
[192] *Id.*

Brazilian officials to acknowledge that the country most likely cannot increase production and export in 2013 to meet the needs created by EPA's new target levels.[193] Although production of sugarcane has recently increased,[194] local domestic programs, such as new ethanol mandates for gasoline sold in Brazil, may further constrain Brazil's supply of sugarcane ethanol made available for export. Starting June 1, 2013, all gasoline sold in Brazil must contain 25 percent ethanol, up from 20 percent.[195] Unlike in the United States, a large portion of the auto fleet is designed to run on gasoline containing more than 10 percent ethanol.[196] Reliance on imported advanced renewable fuel undermines the Energy Independence and Security Act's goals of enhancing domestic energy security.

The RFS Advanced Biofuel statutory target for 2014 is 3.75 billion gallons. It is likely that the available amount of cellulosic biofuel would be *de minimis*, and may be excluded from this calculation. The *domestic* supplies of biomass-based diesel and cellulosic biofuels are limited and require EPA to waive at least 1.83 billion gallons from 3.75 billion gallons in 2014.

> The EPA has the statutory authority to write the advanced mandate down to at least the existing biodiesel production capacity if not further. This may be the only realistic path for implementing the RFS in the next several years.[197]

Even if EPA exercises its authority to reduce the cellulosic biofuel mandate to zero and the advance biofuel mandate to 1.92 billion (representing the amount of biomass-based diesel RINs that can be feasibly produced), while simultaneously lowering the total RFS mandate by an equivalent amount, the ethanol blendwall problem would remain. To avoid this problem, EPA must go further and waive an even greater amount of the total RFS mandate than is represented by the shortfall in the cellulosic and advanced categories.

VI. Conclusion

As explained above, this Petition is unlike any that have come before it. The blendwall and its myriad attendant harms are certainly at hand as evidenced by a number of factors. The current RFS, based on projections of demand that have not materialized, directly threatens the economy and energy infrastructure of the United States, as well as the well-being of every American consumer. The EPA must exercise its authority under section 211(o)(7) to waive the requirements of section 211(o)(2) of the Clean Air Act in a manner that—at minimum—is sufficient to delay the ethanol blendwall beyond 2014. The economic impacts of maintaining the status quo are significant, and the harms outlined in this Petition are of a sufficient nature and severity to justify the waiver requested herein. In addition to the inadequate domestic supply of gasoline and diesel, the severe economic harm caused by the RFS volumes also justifies EPA's exercise of its waiver authority. Each of these harms is severe on a regional

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[193] Reese Ewing, *Analysis: Brazil Ethanol Returns to US as Biofuel Rules Pave Way*, REUTERS, Sept. 20, 2012, http://www.reuters.com/article/2012/09/20/us-ethanol-brazil-exports-idUSBRE88J14J20120920.

[194] Isis Almeida, *Brazil Sugar-Cane Use for Fuel Seen by Datagro Above Outlook*, BLOOMBERG, July 5, 2013, http://www.bloomberg.com/news/2013-07-05/brazil-s-sugar-cane-use-for-fuel-seen-by-datagro-beating-outlook.html.

[195] Erin Voegele, *Brazil to Increase Ethanol Blend Level to 25 Percent*, ETHANOL PRODUCER MAG., Mar. 7, 2013, http://www.ethanolproducer.com/articles/9628/brazil-to-increase-ethanol-blend-level-to-25-percent.

[196] *See Brazilian Transportation Fleet*, Sugarcane.org, http://sugarcane.org/the-brazilian-experience/brazilian-transportation-fleet (last visited Aug. 12, 2013).

[197] University of Illinois, *The Ethanol Blend Wall, Biodiesel Production Capacity, and the RFS…Something Has to Give*, (Feb. 13, 2013), http://farmdocdaily.illinois.edu/2013/02/ethanol-blend-wall-biodiesel-RFS.html.

or national scale, and each could be mitigated if EPA acts now to waive the RFS for 2014, giving farmers ample time to adjust their production decisions accordingly.

To be sure, delaying the ethanol blendwall until 2015 will not solve the underlying problem of accelerating RFS mandates. But EPA has clear authority to grant multiple waivers. Section 211(o)(7)(C) provides that waivers are limited to one year, but may be "renewed" by the Administrator after inter-agency consultation. Given the likelihood that production, supply, and market conditions described in this Petition will continue past 2014 barring a statutory change to the RFS, EPA should also give clear indication in the context of granting a waiver that the methodology used to determine RFS volume waived in 2014 will be used in subsequent years. A clear statement of intent to grant additional waivers if current conditions persist will send a clear message to the marketplace and allow for the most efficient resolution of this matter.

In sum, now is the time for EPA to act. The blendwall cannot realistically be forestalled, and its impact on the United States would be devastating. EPA has the authority to prevent this catastrophe. Petitioners urge EPA to do so by granting the requested waiver.

Petitioners thank EPA for considering this Petition and the information within and appended to it.

Respectfully submitted,

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Attachment 1

October 2012

Economic Impacts Resulting from Implementation of RFS2 Program

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The findings contained in this report may contain predictions based on current data and historical trends. Any such predictions are subject to inherent risks and uncertainties. In particular, actual results could be impacted by future events that cannot be predicted or controlled, including, without limitation, changes in business strategies, the development of future products and services, changes in market and industry conditions, the outcome of contingencies, changes in management, and changes in law or regulations. Neither API nor NERA accept responsibility for actual results or future events.

The opinions expressed herein are those of the authors and do not necessarily represent the views of NERA Economic Consulting or any other NERA consultant.

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TERMINOLOGY

AEO	Annual Energy Outlook. An annual publication from the EIA that offers projections that can be used as a basis for examination and discussion of energy production, consumption, technology and market trends and the direction they may take in the future. This study used AEO2011.
CARB	California Air Resources Board
CGE	Computable General Equilibrium
Biodiesel	A type of biomass-based diesel comprised of mono-alkyl esters of long chain fatty acids derived from vegetable oils or animal fats, and meeting the requirements of ASTM D 6751. A blend of biodiesel fuel with petroleum-based diesel fuel designated BXX, where XX represents the volume percentage of biodiesel fuel in the blend.
Biomass based diesel	Includes biodiesel and renewable diesel
Biofuel Producer or Importer	Generator of RINs at the point of biofuel production or the port of importation
Blending Percentage Standard	Ratio of renewable fuel volumes required by RFS2 and the total gallons of gasoline and diesel fuel that will be sold in the upcoming year
EIA	Energy Information Administration
EISA '07	Energy Independence and Security Act of 2007
EPA	United States Environmental Protection Agency
E0	Neat gasoline; 100% petroleum gasoline, does not contain ethanol
E10	A gasoline blend containing 10 percent ethanol by volume (E10)
E85	An ethanol/gasoline fuel blend containing a relatively high percentage of ethanol by volume and a relatively low percentage of petroleum hydrocarbons by volume. While its name connotes a blend of 85% ethanol and 15% gasoline, the ethanol content of E85 is seasonally adjusted to meet ASTM recommended specifications and to improve vehicle cold-start and warm-up performance. Following the EIA's practice, we will analyze E85 sales under the assumption that fuel sold as E85 consists of 74% ethanol and 26% gasoline by volume on a year-round average basis.

FFV	Fuel Flexible Vehicles: certified to use ethanol/gasoline blends containing up to 85 percent volume ethanol
N_{ew}ERA	NERA's proprietary macroeconomic model
Obligated Party	Companies that produce and/or import gasoline and/or diesel fuel
Reference Case	NERA Reference Case (no RFS2 mandate)
RFS2	Renewable Fuel Standard Per Energy Independence and Security Act of 2007
RINs	Renewable identification numbers (Credits for compliance with RFS2)
Scenario 1	NERA scenario with implementation of RFS2 and AEO Reference Case biodiesel supplies
Scenario 2	NERA scenario with implementation of RFS2 and AEO High Fuel Price case biodiesel supplies

Executive Summary

The American Petroleum Institute (API) commissioned NERA Economic Consulting (NERA) to conduct a study of the economics and compliance issues related to the implementation of the Renewable Fuel Standard (RFS2) per the Energy Independence and Security Act of 2007. NERA relied upon publically available information and NERA's proprietary economic modeling to develop the analysis. The study found that RFS2, in its current form, will likely become infeasible within the next three or four years, which would result in significant harm to the U.S. economy.

The RFS2 requires transportation fuel producers and importers (obligated parties) to incorporate specified volumes and categories of biofuels into their products annually. These mandates increase yearly, and collectively, require the use of 36 billion gallons of renewable fuels in 2022. Each year the annual total renewable fuel volume mandate is calculated as a percentage of the nation's total projected fuel consumption for the upcoming year. The renewable fuel volume obligation (RVO) for each obligated party is calculated by applying that percentage to the total annual volume of gasoline and diesel produced or imported by each obligated party during that year. Compliance with the RFS2 each year is demonstrated through "Renewable Identification Numbers" (RINs) which are unique identifiers attached to every gallon of renewable fuel produced or imported. Obligated parties submit RINs as evidence of meeting the annual RVO.

Table 1 lists the four primary mechanisms that obligated parties can use for compliance with the RFS2. In the early years of the RFS2 program, these mechanisms offered a workable means for compliance. However, as the RFS2 volume requirements increase, combined with higher vehicle fuel efficiencies, these mechanisms become less effective until the RFS2 reaches the point of infeasibility.

Table 1: Fuel Production and Blending Options for Meeting RFS2 Compliance

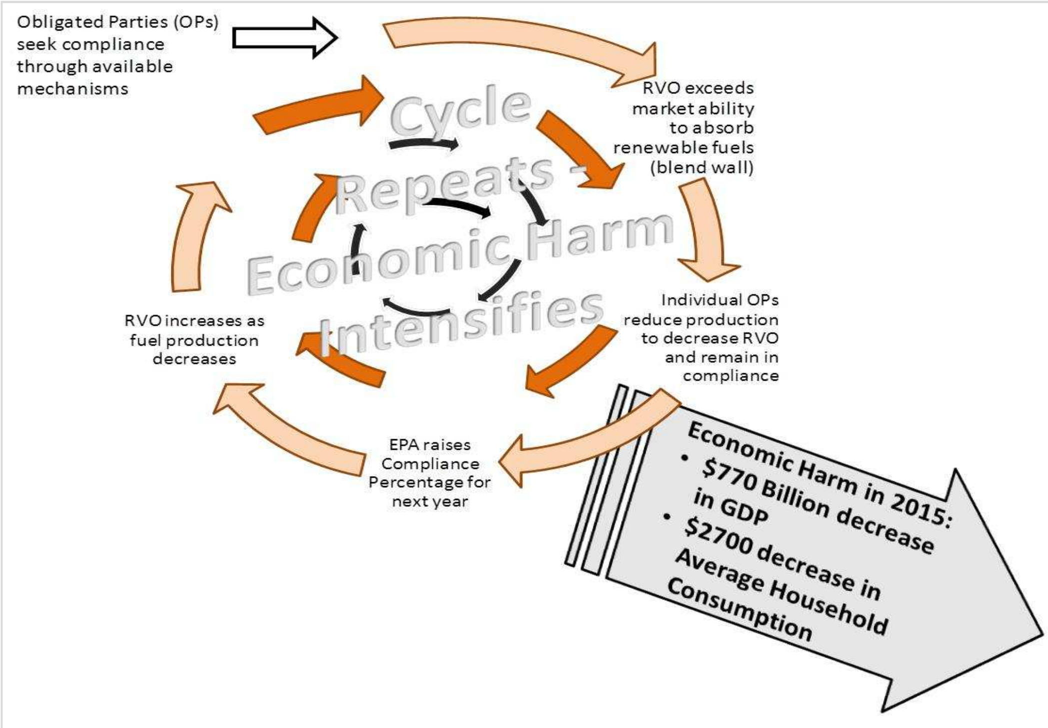
Compliance Mechanism	Limitation
Minimize production of E0	Demand for E0 will not completely disappear due to customer demand and limits on ethanol distribution
Increase production of E85	Demand for E85 will remain low due to limited E85 infrastructure, E85's low fuel economy, and consumer preference for conventional fuels
Increase use of biodiesel	The available volume of biodiesel is relatively small compared to the overall RFS2 requirement
Produce and market E15	Market penetration of E15 will be limited by vehicle warranty, retail infrastructure, misfueling, and general liability issues

As these mechanisms approach their limit, obligated parties will reach the point when biofuels cannot be incorporated into fuel products at the volumes necessary to meet the RIN obligation because of technological, infrastructure or market constraints.

This study finds that the RFS2 volume requirements will exceed the transportation fuel market's ability to absorb the biofuel volumes mandated within three to four years. At that point in time obligated parties will not be able to meet market demand for transportation fuel and still remain in compliance with the RFS2. Therefore, after exhausting all other available options for compliance, individual obligated parties, each acting independently, could be forced to reduce their RIN obligation by decreasing the volume of transportation fuel supplied to the domestic market – either by reducing production or exporting.

As domestic fuel supplies decrease, large increases in transportation fuel costs would ripple through the economy imposing significant costs on society. More specifically, as the RFS2 mandate is ratcheted up every year, the fuels market will be pushed into a death spiral shown in Figure 1. The death spiral depicts the economic harm that occurs as individual obligated parties act to remain in compliance with the program. Once the blend wall has been reached, the annual increase in the RVO results in decreased fuel availability and increased fuel costs to society. These increased fuel costs have a broad impact across the economy.

Figure 1: Economic Impact of Hitting the RFS2 Blend Wall: The Death Spiral



This process repeats itself yearly. As domestic supply continues to decline, the blending percentage obligation becomes increasingly untenable. Obligated parties rely on RINs acquired and carried forward from earlier years to meet compliance obligations. However, the findings and analysis of this report indicate that by 2015-2016 compliance with the RFS2 in its current form will likely be infeasible, which would result in significant damage to the economy.

The death spiral impact is seen most acutely in the diesel fuel market. The tightening of the diesel supply (up to 15% decline in 2015) causes large fuel cost increases to ripple through the economy, adversely affecting employment, income, consumption, and GDP. By 2015, the adverse macroeconomic impacts include a $770 billion decline in GDP and a corresponding reduction in consumption per household of $2,700.

I. Introduction

The American Petroleum Institute (API) commissioned a two-phase study of the economics and compliance issues resulting from the implementation of the Renewable Fuel Standard (RFS2) per the Energy Independence and Security Act of 2007. The RFS2 requires transportation fuel produces and importers (obligated parties) to incorporate specified volumes and categories of biofuels into their products annually. These mandates increase each year, and collectively, require the use of 36 billion gallons of renewable fuels in 2022. Each year the annual total renewable fuel volume mandate is calculated as a percentage of the nation's total projected fuel consumption for the upcoming year. The renewable fuel volume obligation (RVO) for each obligated party is calculated by applying that percentage to the total annual volume of gasoline and diesel produced or imported by each obligated party during that year. Compliance with the RFS2 each year is demonstrated through "Renewable Identification Numbers" (RINs) which are unique identifiers attached to every gallon of renewable fuel produced or imported. Obligated parties submit RINs as evidence of their compliance with the RVO.

A. Phase 1

API retained Charles River Associates (CRA) to conduct Phase I of the study.[1] The work concluded that the increasing volumes mandated by the RFS2 will eventually exceed the market's ability to absorb ethanol into petroleum fuel. That is, the RVO will eventually exceed the maximum feasible level of renewable fuel that can be contained on average in a gallon of petroleum transportation fuel given technological, behavioral, and infrastructure constraints. Using EIA's Annual Energy Outlook AEO 2011, the study estimated that the so-called blend wall (maximum concentration of ethanol of 10% that can be blended in gasoline and used by conventional gasoline-powered motor vehicles) will be reached by 2013.

To comply with the RFS2 mandates, obligated parties have increased production of E10 and E85 while minimizing production of E0 (pure gasoline). To the extent that biodiesel is available, obligated parties have blended biodiesel to produce B5. As the RFS2 mandated volumes for renewable fuels increase, however, these mechanisms reach their limit.

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1 Phase I study report: "Impact of the Blend Wall Constraint in Complying with the Renewable Fuel Standard," Charles River Associates, November 2, 2011.

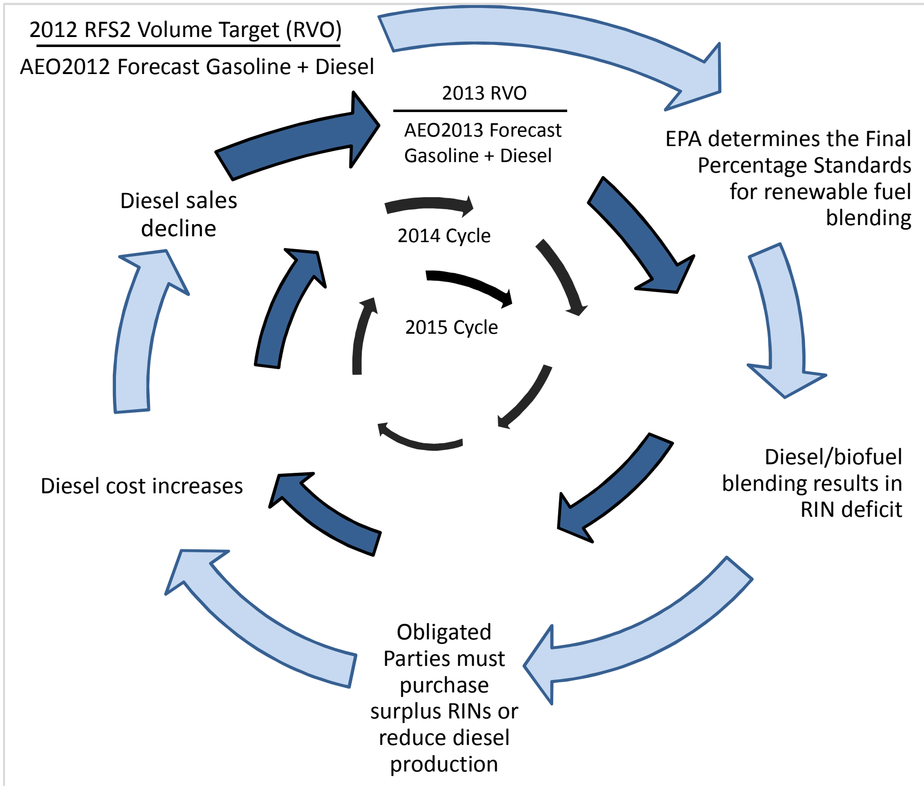
Table 2: Fuel Production and Blending Options for Meeting RFS2 Compliance

Compliance Mechanism	Limitation
Minimize production of E0	Demand for E0 will not completely disappear due to customer demand and limits on ethanol distribution
Increase production of E85	Demand for E85 will remain low due to limited E85 infrastructure, E85's low fuel economy, and consumer preference for conventional fuels
Increase use of biodiesel	The available volume of biodiesel is relatively small compared to the overall RFS2 requirement
Produce and market E15	Market penetration of E15 will be limited by vehicle warranty, retail infrastructure, misfueling, and general liability issues

The Phase 1 study concluded that as obligated parties exhaust these methods of compliance, they will eventually be forced to either decrease the production volumes or export product in order to reduce their individual biofuel obligation and meet RFS2 volume percentage requirements. These market shifts will initially result in a tightening of the diesel fuel supply followed by subsequent years of reductions in both the gasoline and diesel fuel supply. The shrinking domestic petroleum fuel supply coupled with expanding RFS2 requirements would result in making compliance increasingly more difficult and lead to significant economic impacts.

In Figure 2 this effect is depicted as a death spiral of the diesel fuel market. Each year obligated parties must absorb increasing volumes of biofuels into declining volumes of petroleum fuel without exceeding the approved percent blending limits. In each of the years under review in this study, the previous year's reduced forecast for diesel fuel demand exacerbates compliance hurdles for the following year, resulting in economic harm to trucking and commerce first and eventually impacting the U.S. economy as a whole.

Figure 2: Death Spiral Effect on the Diesel Fuel Market from the RFS2



This process repeats itself yearly. As domestic supply continues to decline, the blending percentage obligation becomes increasingly unattainable. Obligated parties rely on RINs acquired and carried forward from earlier years to meet compliance obligations. However, the findings and analysis of this report indicate that by 2015-16 compliance with the RFS2 would become infeasible and result in significant damage to the economy.

Phase II of the study builds on the findings of Phase I and quantifies the economic impacts of complying with the RFS2 requirements.

B. Phase II

For Phase II of the study, API retained NERA Economic Consulting (NERA) to analyze the potential impacts on the transportation fuels market and the U.S. economy resulting from complying with the RFS2. NERA relied upon publically available information and NERA's proprietary economic modeling to develop the analysis.

NERA used two proprietary models: NERA's transportation fuel model and the N_{ew}ERA macroeconomic model. These models were run[2] to quantify the economic impacts from implementation of the RFS2. Specifically, the transportation fuel model estimates the amount of fuel produced for and consumed by the transportation sector, and explicitly estimates the demand for E0, E10, E85, B0, and B5. The N_{ew}ERA macroeconomic model[3] simulates all economic interactions in the U.S. economy, including those among industry, households, and the government.

The macroeconomic impacts of the RFS2 mandate on the U.S. economy were estimated through the year 2015. These results show large increases in transportation fuel costs and disruptions to the transportation fuel supply that will ripple adversely through the economy. From 2012 to 2014, the higher transportation diesel fuel costs will have the biggest and most immediate impact on the economy. The cost to move raw materials and finished goods about the country will increase. This increased cost will be passed through to consumers in the form of higher costs on finished goods and services and, as a result, consumption per household will drop. Although labor earnings initially rise, such an increase is modest compared to the loss in consumption, as labor earnings are unable to offset the higher costs for goods. In the near term, investment and production is temporarily accelerated in anticipation of rising prices and GDP increases, but this shift is unsustainable and by 2014, GDP declines by more than $250 billion.

In 2015, the economic impacts worsen. In addition to the negative impact of higher costs for finished goods and services caused by rising diesel fuel costs, gasoline costs increase as a result of RSF2. Consumers are left with fewer dollars to spend on other goods and services, resulting in lower consumption. Lower levels of consumption lead to declining production of goods and services that consumers would have otherwise purchased. In 2015, the consumption per household declines by about $2,700 per year from baseline levels, with total U.S. consumption declining by about $340 billion. Since there is lower demand for finished goods

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[2] The macroeconomic model was connected to the transportation fuel model through a one-way link in which the macroeconomic model incorporated the fuel cost increases of the transportation model.

[3] The N_{ew}ERA macroeconomic model uses the resulting scenario fuel prices from the transportation fuel model. Then the N_{ew}ERA macroeconomic model is run to assess the economy wide impacts of the changes in fuel prices. Since the transportation model becomes infeasible in 2015 under Scenario 1, we could not run the N_{ew}ERA macroeconomic model over the 2012 to 2015 time horizon. Therefore, the following impacts are reflective of Scenario 2, but these should be considered as a lower bound of what might occur.

and services, the need for workers to provide those goods and services drops. As a result of the smaller size of the economy, workers would earn $580 billion less (Table 3). These negative impacts are also reflected by the loss in GDP of $770 billion dollars.

Table 3: Changes in Consumption, Labor Income, and GDP Relative to Baseline (2010$)

	2012	2013	2014	2015
Change in Average Consumption per Household	-$1,200	-$1,200	-$1,300	-$2,700
Change in Consumption (Billions)	-$150	-$140	-$160	-$340
Change in Labor Income (Billions)	$24	$42	$27	-$580
Change in GDP (Billions)	$43	$50	-$270	-$770

Source: NERA N_{ew}ERA model results.

The remainder of this report provides details on the models used, the reference cases, and the detailed results of the modeling analysis. The appendices provide descriptions of the RFS2 program and model details.

II. Background

A. RFS2

Congress first established a Renewable Fuel Standard (RFS) in 2005 with the enactment of the Energy Policy Act of 2005 (EPACT). Two years later, Congress passed the Energy Independence and Security Act of 2007 (EISA '07) which superseded and greatly expanded the biofuels blending mandate. This expanded RFS is referred to as RFS2, which applies to all transportation fuel used in the United States—including diesel fuel intended for use in highway motor vehicles, non-road, locomotive, and marine diesel.[4] RFS2 introduces four new major distinctions from RFS:

1. RFS2 increases the mandated usage volumes and extends the time frame over which the volumes ramp up to 2022;
2. RFS2 subdivides the total renewable fuel requirement into four separate but nested categories—total renewable fuels, advanced biofuels, biomass-based diesel, and cellulosic biofuel—each with its own volume requirement or standard;
3. Biofuels qualifying under each nested category must achieve certain minimum thresholds of lifecycle greenhouse gas (GHG) emission performance, with certain exceptions applicable to existing facilities; and
4. All renewable fuel must be made from feedstocks that meet the new definition of renewable biomass, including certain land use restrictions.

1. Nested Mandates

Because of the nested nature of the biofuel categories, any renewable fuel that meets the requirement for cellulosic biofuels or biomass-based diesel is also valid for meeting the overall advanced biofuels requirement. Thus, any combination of cellulosic biofuels or biomass-based biodiesel would count toward the advanced biofuels mandate, thereby reducing the potential need for imported sugarcane ethanol to meet the "other" advanced biofuels mandate. Similarly, any renewable fuel that meets the requirement for advanced biofuels is also valid for meeting the total renewable fuels requirement. As a result, any combination of cellulosic biofuels, biomass-

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[4] Heating oil, jet fuel, and fuels for ocean-going vessels are excluded from RFS2's national transportation fuel supply; however, renewable fuels used for these purposes may count towards the RFS2 mandates.

based biodiesel, or imported sugarcane ethanol that exceeds the advanced biofuel mandate would reduce the potential need for corn-starch ethanol to meet the overall mandate.

2. Waivers

The EPA Administrator has the authority to waive the RFS requirements, in whole or in part, if, in his/her determination, there is inadequate domestic supply to meet the mandate, or if "implementation of the requirement would severely harm the economy or environment of a State, a region, or the United States."[5] Further, under certain conditions, the EPA Administrator may waive (in whole or in part) the specific carve-outs for cellulosic biofuel and biomass-based diesel fuel.[6] Furthermore, EISA '07 requires that EPA evaluate and make an appropriate market determination for setting the cellulosic standard each year.

3. Implementation

Under EISA '07, the U.S. Environmental Protection Agency (EPA) is responsible for implementing regulations to ensure that transportation fuels sold in the United States contain a minimum volume of renewable fuels in accordance with the four nested volume mandates of the RFS2. Compliance with the RFS2 is demonstrated by the use of RINs.[7]

A RIN is generated by a biofuel producer or importer at the point of biofuel production or the port of importation. Each gallon of ethanol generates one RIN. Biodiesel generates 1.5 RINs per gallon. RIN generators must register with the EPA. After a RIN is created by a biofuel producer or importer, it must be reported to the EPA. RINs are transferable.

Congress determines the total renewable fuel volume that must be incorporated into the nation's fuel supply each year—referred to as a RVO. The EPA translates the RVO into blending percentage standards that are used by obligated parties to determine their individual

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5 Clean Air Act section 211(o)(7)(A)(i).

6 For example, in February 2010 EPA waived most of the 2010 cellulosic biofuel carve-out—EISA '07 had set the mandate at 100 million gallons but EPA lowered the requirement to 6.5 million gallons, more than 90% less than scheduled by EISA '07. Then, in July 2010, EPA lowered the 2011 RFS for cellulosic biofuels to a range of 5 to 17.1 million gallons. EPA cited a lack of current and expected production capacity, driven largely by a lack of investment in commercial-scale refineries. In 2011, EPA waived more than 98% of the cellulosic biofuel volume EISA "07 required for 2012.

7 For tracking purposes, each RIN has a unique 38-character number that is issued (in accordance with EPA guidelines). Each RIN identifies which of the four RFS categories—total, advanced, cellulosic, or biodiesel—the biofuel satisfies. In addition, a biodiesel RIN has an equivalence value of 1.5 when being used as an advanced biofuel.

RVO.[8] This percentage standard represents the ratio of renewable fuel volumes required by RFS2 to the projected total gallons of gasoline and diesel fuel that will be sold in the upcoming year. The EPA relies on projections from the Department of Energy's Energy Information Administration (EIA) for the information to estimate the expected total gallons sold.

Companies that refine or import gasoline or diesel transportation fuel for the retail market are obligated to include a quantity of biofuels equal to the percentage of their total annual fuel sales. At the end of the year, each obligated party must have enough RINs to show that it has met its share of each of the four mandated standards.

If an obligated party has met its mandated share and has acquired surplus RINs, it can sell the extra RINs to another party or it can hold onto the RINs for future use (to be used the following year, but the previous year's RINs can comprise only up to 20% of the current year's obligation).[9]

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8 The blending percentage standard is computed as the total amount of renewable fuels mandated under RFS2 to be used in a given year expressed as a percentage of expected total U.S. transportation fuel use. This ratio is adjusted to account for the small refinery exemptions. A separate ratio is calculated for each of the four biofuel categories.

9 A RIN would not be viable for any year's RVO beyond the immediately successive year; thus giving it essentially a two-year lifespan. For any individual company, up to 20% of the current year's RVO may be met by RINs from the previous calendar year.

III. Description of the Models

This study used NERA's proprietary transportation fuel model and its $N_{ew}ERA$ macroeconomic model. These models were run interactively[10] to quantify the economic impacts from RFS2 that are reported in this study. This section describes both models. A more detailed description of the models, including a model formulation is provided in Appendix B.

A. Transportation Fuel Model

The transportation fuel model is a partial-equilibrium model designed to estimate the amount of fuel produced for and consumed by the transportation sector. The model maximizes the discounted present value of household consumption (a measure of household value) subject to meeting the RFS2 program fuel requirements and satisfying the transportation sector's demand for fuel while not violating any transportation sector infrastructure constraints.

The model is calibrated in the near term to the EIA's Short-Term Energy Outlook (STEO) for September 2011 and in the long term to the AEO 2011 forecast, with a few minor adjustments to ensure that the E10 blend wall is not violated.

1. The Transportation Fuel Model is designed to Model RFS2 Program Characteristics

The transportation fuel model was customized to simulate the impacts resulting from the RFS2 program. The model solves in one-year time steps, and has a flexible time horizon. For purposes of this analysis, the first endogenous year is 2012 and the last year is 2015. The model solves for the demand of the following finished fuels: E0 (100% petroleum gasoline), E10 (gasoline containing at most 10% ethanol by volume), E85 (assumed to contain 74% ethanol by volume), and diesel fuel may contain up to 5% biomass based diesel or B5. The model also solves for the following fuel components used in the production of the above finished fuels: petroleum gasoline, corn ethanol, sugar ethanol, cellulosic ethanol, petroleum diesel, and biodiesel.

The model combines the six fuel components into the four finished fuels, which can be consumed by motor vehicles subject to the following constraints:

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[10] The macroeconomic model was connected to the transportation fuel model through a one-way link.

- Minimum E0 use held to 5% of total transportation fuel consumption to represent incomplete market conversion to E10 and preference of some consumers for E0;
- Conventional vehicles can consume either E0 or E10;
- Flexible fuel vehicles (FFVs) can use E0, E10 or E85; and
- Commercial trucks/buses, ships, and trains are allowed to use up to a 5% blend of biodiesel.

2. RFS/RIN Constraints:

The model accounts for the minimum annual volume of biofuel sales required under the RFS2 program by including constraints on three types of biofuels:

- Biomass-based diesel;
- Advanced biofuel (includes cellulosic biofuels, biomass-based diesel, and sugar ethanol); and
- Renewable fuel (includes advanced biofuel and corn ethanol).

For this analysis, we assume that cellulosic biomass will continue to be commercially available only in very limited quantities, and as a result, EPA would continue to grant a waiver. This assumption avoids the debate about the economic and technical feasibility of producing cellulosic fuel[11] because this analysis assumes ample supplies of corn and sugar ethanol to meet the RFS2 mandates. As a result, there is no need for cellulosic ethanol to meet the non-cellulosic RFS2 targets.

As discussed in detail in Appendix B, the fuel supply curves capture all pertinent technological issues (penetration rate, availability, and cost) for the different fuels. Similarly, the fuel demand curves capture the loss in utility from having to reduce travel and also the loss in welfare from fuel scarcity. Different scenarios were modeled, as discussed in section E. The change in economic activity between the scenarios and the baseline provides the economic impacts of the RFS2 policy.

[11] There is a secondary effect of assuming no measurable supplies of cellulosic biomass. Assuming no significant amount of cellulosic biomass production necessitates the production of additional amounts of biodiesel and sugar-based ethanol to meet the advanced biofuel requirement, and this affects costs.

The model also incorporates constraints on the availability of various finished fuels to account for both consumer acceptance and infrastructure issues. The sales of E85 are limited based on these issues. Biodiesel sales are limited by supply of biodiesel feedstocks.

B. N_{ew}ERA Macroeconomic Model

The N_{ew}ERA macroeconomic model is a forward-looking dynamic computable general equilibrium model of the United States. The model simulates all economic interactions in the U.S. economy, including those among industry, households, and the government. The macroeconomic and energy forecasts that are used to project the benchmark year going forward are calibrated to AEO 2011 produced by the EIA. Because the model is calibrated to an internally-consistent energy forecast, the use of the model is particularly well suited to analyze economic and energy policies and environmental regulations.

For this study, the N_{ew}ERA model runs from 2012 to 2015 in one-year increments. The model includes five energy and seven non-energy sectors: energy sectors include crude oil, oil refining, natural gas extraction and distribution, coal, and electricity; the non-energy sectors include agriculture, commercial transportation (excluding trucking), energy intensive sectors, manufacturing, motor vehicle production, services, and trucking.

The macroeconomic model incorporates all production sectors and final demands of the economy and is linked through terms of trade. The effects of policies are transmitted throughout the economy as all sectors and agents in the economy respond until the economy reaches equilibrium. The ability of the model to track these effects and substitution possibilities across sectors makes it a unique tool for analyzing policies such as those involving energy and environmental regulations. These general equilibrium substitution effects, however, are not fully captured in a partial-equilibrium framework or within an input-output modeling framework. The smooth production and consumption functions employed in this general-equilibrium model enable gradual substitution of inputs in response to relative price changes thus avoiding "all-or-nothing" solutions.

Business investment decisions are informed by future policies and outlook. The forward-looking characteristic of the model enables businesses and consumers to determine the optimal savings and investment while anticipating future policies with perfect foresight. The alternative approach on savings and investment decisions is to assume agents in the model are myopic, and thus have no expectations for the future. Though both approaches have their limitations, the latter approach can lead the model to produce inconsistent or incorrect impacts from an announced future policy.

C. Model Integration

The economic impacts of the RFS2 program were determined using the following methodology:

1. Using the transportation fuel model, the baseline and scenarios were run to determine the effect on fuel prices resulting from the RFS2 requirements for increased use of biofuels. The imposition of the RFS2 program leads to changes in fuel prices from the EIA baseline.
2. Using the N_{ew}ERA macroeconomic model, the resulting changes in fuel prices were translated into taxes (or subsidies) on gasoline and diesel that yield the same fuel price changes as seen in the transportation fuel model.

D. Analytical Methodology

All cases were run using NERA's transportation fuel model, which allowed us to simulate the dynamics of RFS2 compliance and the use of surplus RIN carryovers, and the methodology that EPA uses each year to determine the minimum percentages of the different categories of biofuels delineated in the RFS2 standard that fuel suppliers must use.

The transportation fuel model determined the impact of the RFS2 mandate on the quantities of finished gasoline (E0, E10, and E85) and diesel consumed in the transportation sector. In addition, the model calculated volumes of individual biofuels blended in the finished gasoline (corn ethanol, sugar ethanol, and cellulosic ethanol) and diesel. The N_{ew}ERA macroeconomic model then determined the impact on the U.S. economy of meeting the RFS2 mandate. The results were expressed in terms of well-known economic parameters: changes in consumer purchasing power, GDP, and labor earnings.

Implementation of the RFS2 may create a dynamic that can be characterized as a "death spiral," in which higher costs in the current year lead to lower demand, which in turn lead to higher costs in the next year and so on. NERA's transportation fuel model represents this process by solving in a recursive dynamic fashion. That is, the model minimizes the cost of compliance for the current year, through the use and value of surplus RINs that were carried forward. Therefore, the years are linked through the RINs. For example, the available surplus RINs at the beginning of 2012 represents 1.69 billion gallons of renewable fuel, which is the estimated amount of surplus RINs at the end of 2011 based on AEO 2011 fuel consumption data. After defining the RINs available at the beginning of 2012 and calibrating the model's supply and demand curves to the AEO's forecasted 2012 values, the model was solved with the RFS2 constraints and other infrastructure constraints for the year 2012.

The RINs available at the end of 2012, or the number of RINs carried forward to 2013, equals the RINs available at the beginning of 2012 (1.69 billion gallons) plus the difference between the number of RINs generated and the number of RINs submitted for compliance during 2012. The model will store RINs or use RINs in 2012 until either the value of a surplus RIN equals the marginal cost of complying with the RFS2 mandate or surplus RINs are depleted. This process is repeated for each successive year.

If any of the RFS2 or infrastructure constraints bind, then the average fuel price may rise to cause a switch in fuel consumption patterns which results in an increase of the percentage of renewable fuel sales to the level required by the RFS2 constraint. An increase in average fuel prices would cause a drop in the equilibrium level of fuel consumption from the EIA's forecast. The value of the elasticity of demand has a significant effect on the relationship between the increase in fuel price and decline in fuel demand. The more elastic the demand curve, the less prices need to move to induce consumers to reduce their demand and thus the easier and less costly it is to meet the RFS2 targets. As the absolute value of the elasticity of demand declines, demand becomes more inelastic and the cost of compliance increases.

Once finished with 2012, the model then solves for 2013. However, instead of using the EIA's forecast for 2013 energy consumption, the values to which the model calibrates its energy consumption are adjusted based on the model's 2012 solution values for energy consumption. Assuming that the RFS2 constraint binds for 2012, the forecasted fuel sales volumes will differ in 2012 from that of the EIA's forecast.

To be conservative regarding the costs of the RFS2 mandate, we allow surplus RINs to be exhausted over the model horizon. Retaining RINs for later years would raise program costs in the near term. This is because the transportation sector would need to consume higher percentage levels of biofuels in the near term instead of relying on the RINs generated in prior years to assist the sector in complying with RFS2. Allowing the RINs to be consumed in the near term (*e.g.*, 2014-2015 timeframe) rather than retaining RINs after 2015 allows obligated parties to meet the mandates with lower volumes of renewable fuels and hence reduces the burden of the policy.

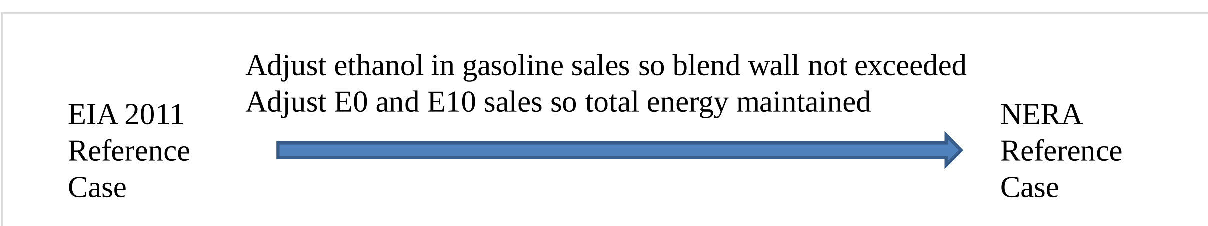
E. Description of Reference Case and Two Modeling Scenarios

To analyze the economic impacts of the RFS2 mandate, it was necessary to develop a Reference Case in which the RFS2 was not in force and a set of scenarios in which RFS2 was assumed to be fully implemented. Then by comparing the scenarios to the Reference Case it is possible to isolate the effects of the RFS2 mandate. This section first discusses the construction of the Reference Case and then describes the assumptions underlying each of the two scenarios.

1. Reference Case

The Reference Case is based upon AEO 2011 projections of transportation fuel supply, demand and prices, but with some modifications (Figure 3). Unlike EIA, our Reference Case limits the amount of ethanol in the gasoline pool to not violate the blend wall, and reduces the level of E0 sales. Our Reference Case includes the AEO 2011forecast for both biodiesel (which is less than that required under RFS2) and E85 consumption. Although the mix of fuel in our Reference Case differs from that in the EIA's AEO 2011 Reference Case, we maintain consistency with EIA's forecast of total energy (or vehicle-miles traveled, VMT) consumed in the transportation sector.

Figure 3: Development of the NERA Reference Case

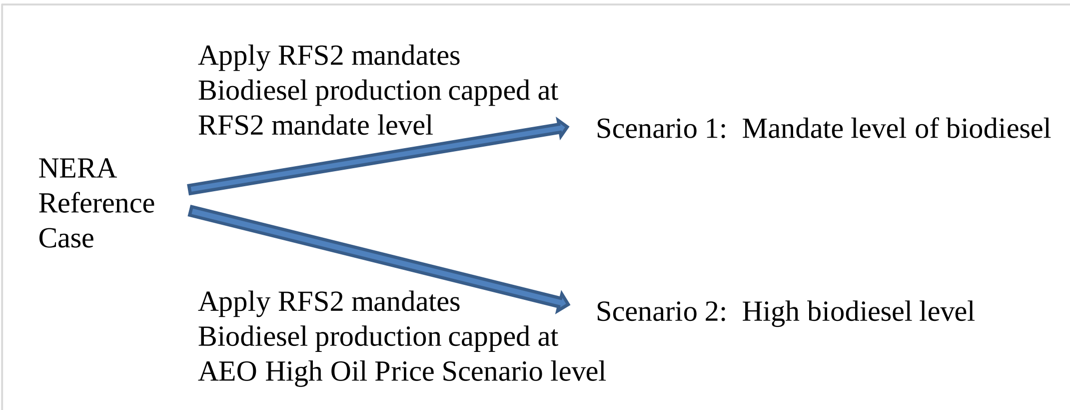


2. Modeling Scenarios

Our scenarios (Figure 4) used the same assumptions as the Reference Case with the added constraint that in each year obligated parties must comply with the RFS2 program requirements while still not violating the blend wall. A gallon of biodiesel is worth 1.5 RINs.

Also, the volume of biodiesel sales forecast in the EIA's Reference Case can only make up a percentage of biodiesel in diesel that is far below the B5 blending limit. Therefore, one way for obligated parties to increase the percentage of biofuels in their total fuel sales is to increase the amount of biodiesel they blend with conventional diesel. However, biodiesel production levels are quite uncertain.

Figure 4: Characterization of Scenarios 1 and 2



NERA developed two scenarios that differed only in their estimate of the availability of biodiesel supplies in the next four years (2012 through 2015). Scenario 1 limited use to no more than that proposed by EPA in their 2012 RFS2 NPRM. Scenario 2 limited biomass based diesel use to that forecast in the EIA AEO 2011 High Oil Price Scenario. These estimates are intended to bracket the likely range of biomass based diesel availability. The range of biomass based diesel availability is shown in Table 4.

- Scenario 1 – Biomass based diesel production is capped at the limit proposed by EPA in their 2012 RFS2 NPRM. This level reflects the levels used in the Phase I analysis.
- Scenario 2 - Biomass based diesel production capped at level in AEO 2011 High Oil Price Case.

Table 4: Range of Biomass Based Diesel Availability (Billions of Gallons per Year)

	2012	2013	2014	2015
Reference Case	0.92	1.07	1.07	1.23
Scenario 1	1.00	1.28	1.28	1.28
Scenario 2	1.35	1.74	1.66	1.90

Source: NERA analysis and EIA's Annual Energy Outlook 2011.

F. Model Parameters

1. Fuel Prices

All fuel prices are national, annual averages over multiple grades of fuel. Our Reference Case prices for finished products (gasoline and diesel) are the same as those forecast in the AEO 2011 Reference Case. The NERA Reference Case prices for individual types of biofuels were developed using a variety of sources and are expressed relative to petroleum gasoline or diesel prices. These relative prices are shown in Table 5, and the logic and sources upon which these relative prices are based are described below.[12]

Table 5: Reference Case Fuel Price Ratios for Blended Gasoline and Diesels (Ratio on a GGE[13] Basis of Biofuel to Conventional Fuel)[14]

	2010	2011	2012	2013	2014	2015
Gasoline	1.00	1.00	1.00	1.00	1.00	1.00
Corn Ethanol	1.86	1.78	1.72	1.61	1.58	1.49
Sugarcane Ethanol	2.08	2.00	1.92	1.81	1.77	1.67
Cellulosic Ethanol	2.62	2.48	2.41	2.23	2.13	2.01
Diesel	1.00	1.00	1.00	1.00	1.00	1.00
Soy-Based Biodiesel	1.74	1.66	1.7	1.66	1.65	1.64

Source: EIA's AEO 2011, EIA, California Energy Commission, IHS Glocal Insight, American Trucking Association, and NERA analysis.

12 The gasoline and diesel prices are taken from the AEO 2011 forecast.

13 Gasoline gallon equivalent basis; fuels GGE are adjusted by relative heating value to petroleum gasoline.

14 All price ratios are national, annual averages over multiple grades of fuel. For gasoline, the grades include regular unleaded, 89 octane unleaded, and premium unleaded.

Corn Ethanol:

- Ratio of corn ethanol to gasoline is from the AEO 2011 Reference Case, Table A12. We assumed a corn price equal to the average $/bushel price from January 1, 2008 through September 1, 2011 (or $5.00/bushel). We took the capital, operations, and maintenance costs from the EIA.[15] Summing up all of these costs yielded the forecasted price for corn ethanol.
- Sugar Ethanol: Ratio of sugar ethanol prices to gasoline prices taken from California Energy Commission statistics.[16]
- Cellulosic Ethanol: Ratio of cellulosic ethanol prices to gasoline prices based on EIA's cost build up.[17] To estimate this cost, we averaged two EIA forecasts – one based on the capital cost for cellulosic ethanol and the other based on the capital cost for biodiesel gasification. However, the future cost of cellulosic ethanol is uncertain.[18]
- Soy-Based Biodiesel: Ratio of soy-based biodiesel to petroleum diesel prices taken as average of historical spot prices. We calculated the averages based upon three sources: IHS Global Insight, the American Trucking Association's August 2011 comments on the EPA's proposed RFS2 rule, and the average ratio of spot SME B100 to spot ultra-low sulfur petroleum diesel from 2009 through 2011.[19]

2. Supply Elasticities

In addition, supply elasticities were derived by using fuel price and fuel supply information from EIA's AEO 2011 Reference and High Oil Price Cases. These two cases provided time series for the prices and quantities of the different fuels. The price elasticity of

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15 Statton, Mac, "Development of Production Costs as a Driver for the National Energy Modeling System," Energy Information Administration, Presentation at International Fuel Ethanol Workshop, June 29, 2011.

16 California Energy Commission, "2011 Integrated Energy Policy Report," February 2012.

17 Statton, Mac, "Development of Production Costs as a Driver for the National Energy Modeling System," Energy Information Administration, Presentation at International Fuel Ethanol Workshop, June 29, 2011.

18 Because we assume the RFS mandate for cellulosic ethanol will be waived, cellulosic ethanol is likely to be irrelevant in our analysis as long as its price is sufficiently greater than that of sugar ethanol, for sugar ethanol will be the ethanol of choice to meet the advanced biofuels mandate, and corn and sugar ethanol will be used in the production of E10 and E85 to help meet the overall biofuel requirement.

19 Kruse, John, "Biodiesel Production Prospects for the Next Decade," IHS Global Insight's Agriculture Group, March 2011; Moskowitz, Richard, "American Trucking Associations' comment on the EPA's proposed Regulation of Fuels and Fuel Additives: 2012 Renewable Fuel Standards," August 2011; and Chicago spot prices for ultra-low sulfur diesel and B100.

supply for each fuel is derived by dividing the percentage change in quantity of fuel demanded by the percentage change in fuel price. The percentage change in quantity and price are computed by comparing the difference between the fuel consumed and the price of fuel, respectively, in the AEO High Oil Price and Reference Cases. The elasticity of supply varies slightly from year to year, but on average, the elasticity of supply is about 0.4 for corn ethanol and 1.2 for sugar ethanol and soy-based biodiesel. The elasticity for petroleum fuels is 0.8.[20]

3. Demand Elasticities

The model has a demand curve for each finished fuel – E0, E10, E85, and diesel. The functional form of these curves is identical to that of the fuel supply curves. For the demand curves, the elasticity is the fuel's own-price elasticity of demand. Because this analysis concerns itself only with the next few years, the demand curves' elasticity equaled that of Dahl's estimate for short-term elasticity of -0.1.[21]

4. E85

Our characterization of the potential for E85 sales in the Phase II research is built upon the initial research on E85 performed as part of the Phase I study. The Phase I study evaluated the different factors affecting E85 demand. The Phase I research concluded that future demand for E85 is not limited by the number of FFVs, but instead factors such as consumer reluctance to purchase a new fuel and lack of infrastructure. Consumer reluctance stems from the lower fuel economy and limited range of E85. Economic theory suggests and the EPA acknowledges, E85 would have to be priced at a discount to gasoline to induce cost conscious FFV owners to buy E85 instead of gasoline. Progress in overcoming the lack of retail infrastructure is likely to be slowed by the relatively high investment costs and uncertain returns facing the parties that will be required to install the necessary infrastructure, particularly in the case of the numerous small and independent business people that own individual retail fuel stations.

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[20] Paltsev, Sergey, John M. Reilly, Henry D. Jacoby, Rishard S. Eckaus, James McFarland, Marcus Sarofim, Malcolm Asadoorian, and Mustafa Babiker, "The MIT Emissions and Prediction and Policy Analysis (EPPA). Model Version 4," August 2005.

[21] Dahl, C.A., "A survey of energy demand elasticities for the developing world," *Journal of Energy and Development* 18(I), 1—48, 1994.

For the Phase II analysis, our estimate of potential E85 availability is constructed based upon an optimistic set of assumptions about the issues affecting E85 sales. We assumed that there were no consumer acceptance issues. We assumed that new E85 retail stations would be strategically located in areas proximate to where FFV vehicles operated so that there was no distance penalty for FFVs to travel to an E85 station.

We based our estimates of potentially available E85 solely upon how quickly new E85 retail stations could be built. The Phase I research identified historical data on the level of new station construction. Table 6 shows the number of new stations built by year for the period from 2005 through 2011. During this period on average, there were about 340 stations built annually and the growth rate for new stations declined. For the period from 2012 through 2015 we optimistically assumed that new E85 station construction would grow at a rate of 25% per year. We also assumed that the volume of E85 sales per station would grow about 2.5 times during the period from 2012 to 2015. Table 7 presents our projection for maximum E85 sales as compared with the EIA's forecast of expected E85 sales.

Table 6: Number of E85 Stations Built Annually (2005 through 2011)

	# of E85 Stations	
	Total	Annual Change
2005	436	
2006	762	326
2007	1,208	446
2008	1,644	436
2009	1,928	284
2010	2,142	214
2011	2,442	300

Source: United States Department of Energy, Alternative Fuels Data Center, http://www.afdc.energy.gov/afdc/data/docs/alt_fueling_stations_fuel.xls.

Table 7: Sales of E85 (Billions of Gallons)

	2012	2013	2014	2015
AEO 2011 Forecast	0.06	0.07	0.08	0.09
Maximum Potential E85 Sales	0.54	0.99	1.7	2.6

Source: EIA's AEO 2011, NERA N_{ew}ERA model results.

5. RIN Banking

RIN banking in this report represents how surplus RINs can be carried from one compliance period to the next by an obligated party. Based upon EIA's AEO 2011 Table 11, we estimated that as of the beginning of January 2012, there were collectively 1.69 billion surplus RINs available. We refer to these RINs as the initial inventory of RINs available for compliance.

To arrive at this estimate, we first analyzed how many RINs were available at the end of 2010, which was the first year the policy was in effect and then assessed how many RINs were carried forward from 2010 to 2011 and then from 2011 to 2012.

The AEO 2011 shows that for 2010 13.64 billion RINs were generated in the U.S.[22] The mandate requires 12.95 billion RINs for 2010; hence there was a surplus of 0.69 billion RINs. Since 0.69 billion RINs represents less than 20% of the target renewable fuel volume, all surplus RINs could be banked or carried forward for use in the following year. Therefore, we assume that at the beginning of 2011, there were 0.69 billion RINs available to be used. In 2011, the EIA estimates that 14.95 billion RINs were generated in the U.S., while only 13.95 billion RINs were needed to comply with the regulation. Therefore, there would have been a surplus of 1billion RINs for 2013 (again this is less than 20% of the target so the full quantity could be banked). Adding this to the beginning of the year bank yields a 2011 end-of-year bank of 1.69 billion RINs. This figure becomes the number of RINs in the bank at the beginning of 2012 (Table 8).

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[22] AEO 2011, Table 11. Ethanol production is equivalent to 13.18 billion physical gallons (13.18 billion RIN gallons) and biodiesel production is equivalent to 0.31 billion physical gallons (0.465 billion RIN gallons).

Table 8: Computation of Available RINs at the Beginning of 2012 (Billions)

	2010	2011	2012
RINs Available at the Beginning of the Year	0.00	0.69	1.69
RFS2 Total Renewable Fuel required	12.95	13.95	15.20
RINs Generated	13.64	14.95	
Surplus RINs at End of Year	0.69	1.00	
20% Max RIN Carryover Allowed into Next Year	2.79	3.04	
RINs Available at the End of the Year	0.69	1.69	

Source: EIA's AEO 2011 and NERA analysis.

6. Cellulosic Biofuel

As discussed earlier, EPA can waive the RFS2 requirement, in whole or in part, if there is an inadequate supply to meet the mandate. With respect to the cellulosic biofuels mandate, there is an established track record by EPA of substantially reducing the cellulosic biofuel requirement because of the lack of commercially-available production. In 2010 and 2011, there were no cellulosic biofuel RINs generated. For 2012, EPA has reduced the requirement for cellulosic biofuels to less than 10 million gallons from the 500 million gallons required under RFS2.

As a result of the lack of progress in developing commercially-available supplies of cellulosic biomass and the technical and economic hurdles that remain with the production of cellulosic ethanol, and the time required to build and put into service biomass-to-liquids facilities,[23] we concluded that it was unlikely that cellulosic biofuels will be used in any appreciable quantities during our forecast horizon.

7. Other Fuel Constraints and Assumptions

The Reference Case imposed both the gasoline blend wall (no more than 10% ethanol) as well as the biodiesel blend limit (no more than 5% biodiesel). We allowed petroleum gasoline either to be blended with ethanol to make E10 or E85, or to be sold as neat gasoline (E0). A review of EIA data from May 2008 through April 2012 showed that E0 reached a low of about 5% in April 2012. The more gasoline that is used to produce E0 means that there is less to be

[23] Phase I report, p. 16.

blended with ethanol, and hence the more difficult it would be to comply with RFS2. To be conservative in our assessment of the compliance costs of RFS2, we assume that in the Reference Case, the share of gasoline used to produce E0 can drop to as little as 5%. This is consistent with April 2012 data generated by EIA.[24]

G. Analytical Methodology

The two scenarios were analyzed using NERA's transportation fuel model, which allowed us to simulate the dynamics of the RIN banking and the methodology that EPA uses each year to determine the minimum percentage of the different categories of biofuels delineated in the RFS2 standard that fuel suppliers must use. The transportation fuel model determined the impact of the RFS2 mandate on the transportation sector using the quantities of finished gasoline (E0, E10, and E85) and diesel consumed. In addition, the model calculated volumes of individual biofuels blended in the finished gasoline (corn ethanol, sugar ethanol, and cellulosic ethanol) and diesel (biodiesel). The $N_{ew}ERA$ macroeconomic model then determined the impact on the U.S. economy of meeting the RFS2 mandate. The results are expressed in terms of common economic parameters: changes in GDP, labor earnings, and consumer purchasing power.

[24] EIA Weekly Refiner and Blender Net Production data available at: http://www.eia.gov/dnav/pet/pet_pnp_wprodrb_dcu_nus_w.htm. Access date: May 31, 2012.

IV. Results

A. The Dilemma with RFS2

There is a fundamental problem with the RFS2 mandate: the blending percentage standard for total renewable fuel will eventually exceed the maximum feasible level of renewable fuel that can be contained on average in a gallon of transportation fuel given the technological, market, and infrastructure constraints in the economy.

In 2015, the total renewable fuels volume mandate requires that renewable fuels make up 11% of the total gallons of transportation fuel sold (see Table 9). This exceeds the volume that can be blended in E10 and diesel, which comprise more than 95% of the fuel market.[25] The only transportation fuel with a renewable fuel blending percentage above 11% is E85, but as was discussed earlier, it is unlikely that more than 2.6 billion gallons could be sold in 2015 when the total transportation fuel demand is estimated to be approximately 180 billion gallons.

Table 9: RFS2 Mandated Total Biofuels Percentage and the Maximum Percentage of Renewable Fuel in Finished Fuel in Diesel, E85, and E10

	2012	2013	2014	2015
RVO as Percentage of Total Finished Fuel Sales	8.4%	9.0%	9.8%	11.0%
Max Diesel Biofuel % (Blending biodiesel at 5% is accounted as 7.5% for compliance with total renewable fuel volume standard)	5.0%	5.0%	5.0%	5.0%
Max E85 Biofuel %	74.0%	74.0%	74.0%	74.0%
Max E10 Biofuel %	10.0%	10.0%	10.0%	10.0%

Source: NERA assumptions and analysis.

In order to meet the RFS2 target in 2015, RINs that were banked in prior years must be used. However, as the banked RINs become exhausted, the value of RINs will increase as will the cost

25 E10 can contain no more than 10% ethanol. E85 is assumed to contain 74% ethanol on an annual average basis. Diesel can contain no more than 5% biodiesel. Biodiesel, however, earns 1.5 RIN credits for each gallon, so a 5% volumetric blend equates to 7.5% biodiesel on a RIN basis.

of gasoline and diesel. This will result in the drastic cut in sales of diesel, E10, and E0 so that E85 becomes a much larger share of the transportation fuel market.[26]

B. RFS2 Implementation

RFS2 requires that at the end of each year, obligated parties have enough RINs to meet their RVO. An obligated party can increase its number of RINs by increasing the amount of biofuels blended into its current fuel volumes. Additionally, an obligated party can acquire RINs by purchasing either biofuel from a biofuel producer or RINs from another obligated party. The lack of surplus RIN supply results in high RIN value and reduced total fuel demand so that the ratio of RINs to physical gallons increases. Conversely, if additional RINs are not available for purchase, an obligated party may have no option other than to reduce its total volume of fuel produced so that its current stock of RINs is sufficient to meet its RVO. It is likely that over time an obligated party would be forced to do some combination of both acquiring surplus RINs and reducing the volume of fuel produced to meet its RVO.

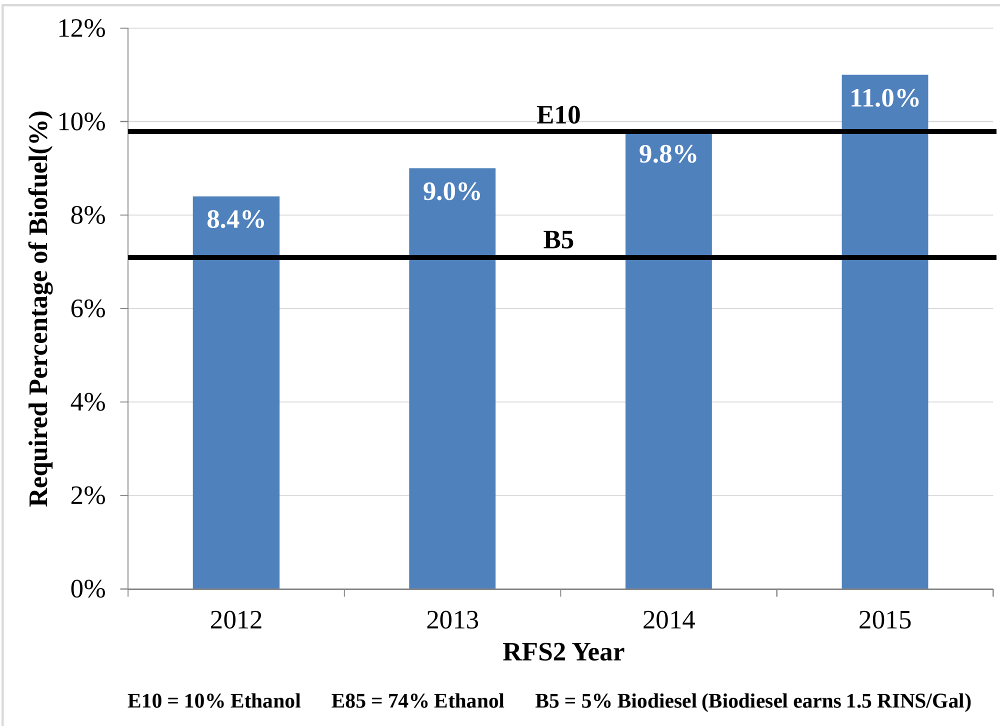
Each obligated party will choose its optimal compliance path based upon the cost of RINs, the market response to changes in fuel cost, technology limitations on blending biofuels with petroleum, and infrastructure and consumer acceptance issues surrounding increasing E85 sales. An obligated party may first try to blend more biofuels into its transportation fuels in order to acquire RINs. For the motor gasoline fuels, this increase is accomplished by increasing the share of ethanol in motor gasoline by blending more ethanol into conventional gasoline (limited by the blend wall), increasing production of E10 in the early years, or increasing production of E85. For diesel, increasing the content of biofuels means adding more biodiesel into the finished diesel fuel (limited by a 5% blending maximum). The ability of obligated parties to increase the blending percentage of biofuels is limited by the availability of biodiesel, blending and infrastructure constraints, and the size of the E85 market.

Producing E85 gives obligated parties the greatest surplus RINs per gallon of fuel sold. E10 gallons generate a small amount of surplus RINs through 2014. On the other hand, diesel

[26] In our analysis the ethanol blend wall is reached in 2012-2013. However, the severe economic impacts do not occur until 2015-2016. The reason is that in 2012 – 2014 obligated parties acquire as many RINs as is feasible in anticipation of being unable to meet the RFS2 requirements in later years. The result is that the excess RINs postpone the severe economic impacts that result when obligated parties can no longer acquire the number of RINS required to comply with RFS2 mandated volumes and thus are forced to limit supplies of gasoline and diesel.

always generates a deficit in RINs. Obligated parties that sell diesel in the U.S. must always acquire additional RINs beyond those generated through biodiesel blending because the percentage of biodiesel in diesel is below the total renewable fuels blending percentage obligation. Increasing the biodiesel content in finished diesel reduces the number of RINs that need to be purchased to offset the deficit. Hence all available biodiesel supplies are purchased by obligated parties, but biodiesel supplies are limited.

Figure 5: RIN Obligations



Source: NERA analysis.

As a result, diesel can be thought of as incurring a RIN deficit and gasoline, for the first few years at least, as creating a surplus of RINs. The value of RINs that must be purchased separately is reflected in the cost of the finished gasoline or diesel.[27] If a fuel requires the purchase of RINs, such as with diesel, the cost of the finished product will increase. If the

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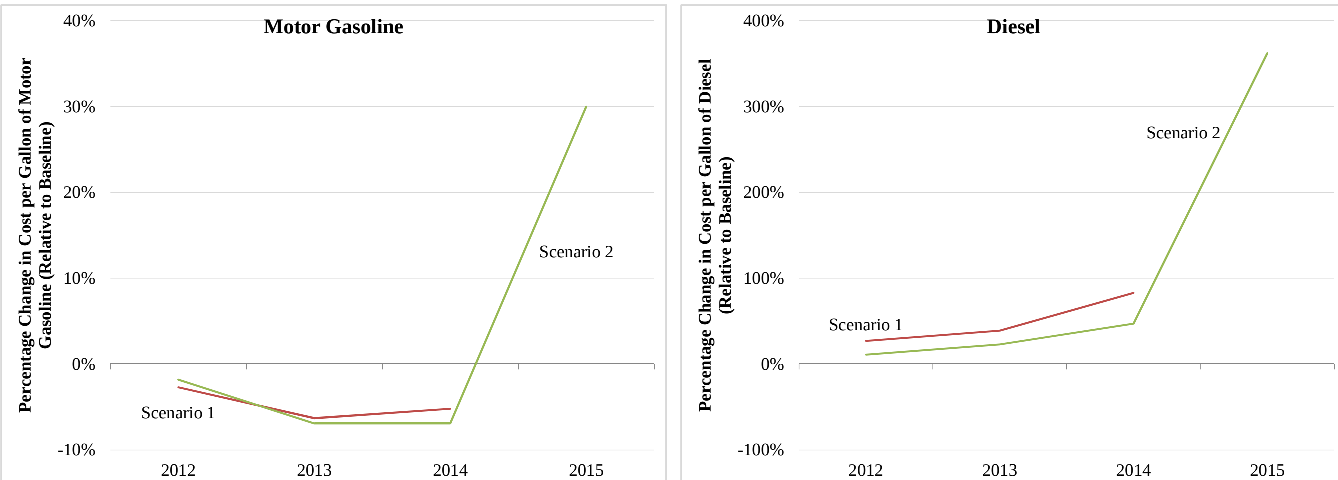
[27] The value of a gallon of diesel equals the cost to produce diesel plus the price of additional RINs that must be purchased to meet the blending percentage standard. The value of gasoline (E10 or E85) equals the cost to produce E10 or E85 less the price of excess RINs that the fuel generates and can be sold. The RIN market equilibrates at the point where the marginal value of selling one more gallon of diesel equals the value of selling one more gallon of E10 or E85.

production of a fuel generates surplus RINs that can be sold, such as with E85 and E10 early on, then the cost of the finished product will decrease.

By 2015, however, E10 is no longer generating surplus RINs. In fact, it cannot generate enough RINs to meet its own blending percentage obligation. As a result, the gasoline cost increases significantly reflecting the shortage of RINs available (see Figure 6).

Figure 6: Percentage Change in Cost per Gallon of Motor Gasoline and Diesel



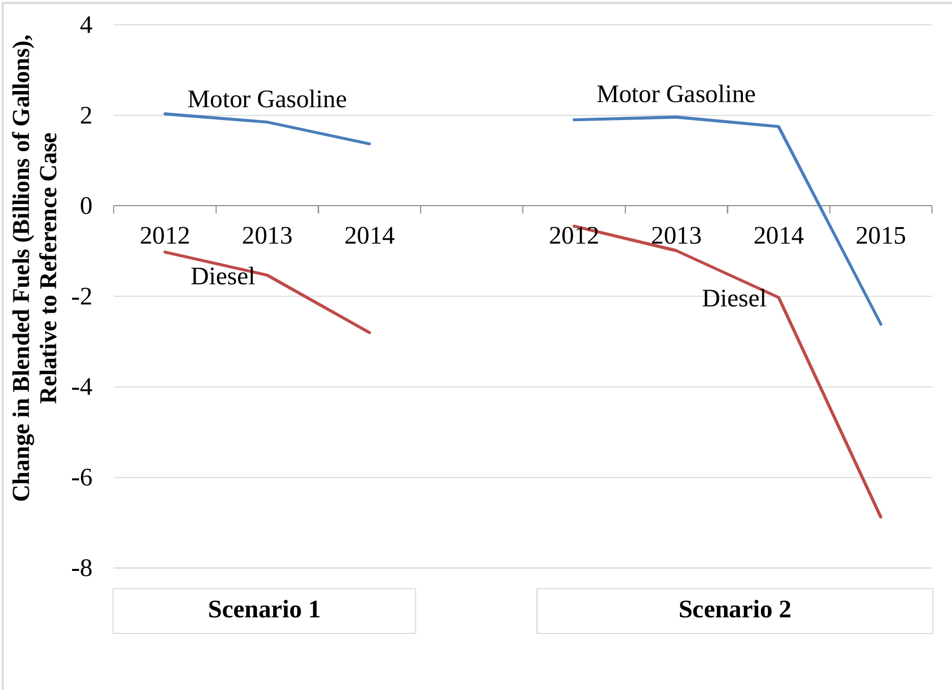
Source: NERA N_{ew}ERA model results.

As RINs become scarcer, fewer gallons of fuels that require additional RINs can be produced. Since the economy still demands these transportation fuels, the value of the RIN will increase to the point that the cost of the fuel, which includes the cost of the necessary RINs, results in the demand equilibrating with the supply of fuel. Consequently the cost to produce fuels that require the purchase of additional RINs increases (*e.g.*, diesel), and the cost to produce fuels that generate surplus RINs declines (*e.g.*, E85).

Diesel costs increase by 45% to 80% in 2014 for Scenarios 2 and 1, respectively; and the cost of diesel increases by over 300% in 2015 in Scenario 2. These cost increases match up with a drop in sales of 2 to 3 billion gallons in 2014 for Scenarios 2 and 1, respectively; and a decline of 7 billion gallons in 2015 for Scenario 2, which represents a decline of over 15% from the Reference Case.

On the other side, blended fuels that generate surplus RINs experience a decline in fuel costs, which induces greater sales. Motor gasoline sales increase by roughly 2 billion gallons from the Reference Case for all years between 2012 and 2014. In 2015, motor gasoline sales decline by at least 3 billion gallons from Reference Case levels (see Figure 7).

Figure 7: Change in Blended Fuels Sales (Motor Gasoline and Diesel)



Source: NERA N_{ew}ERA model results.

However with time this approach of increasing E10 sales and reducing diesel sales to comply is not sustainable. As illustrated in Figure 5, the originally targeted blending percentage standard for total renewable fuel[28] increases with time. From 2012 through 2014 the blending percentage standard is less than 10%, which is lower than the gasoline blend wall limit. But as the blending percentage standard increases, this contribution of E10 to producing surplus RINs shrinks. This shrinkage occurs at the same time that the gap increases between the total RVO and the total RINs collected from blending biodiesel. In other words, as fewer excess RINs are being generated more RINs are demanded. Thus to comply with the total biofuels mandate the reduction in diesel sales would become so large that it would lead to such severe rationing of diesel so as to cause extreme disruption in the commercial transportation sector. It is this growing gap between RIN supply and RIN demand that causes the approach to be unsustainable by 2015-16.

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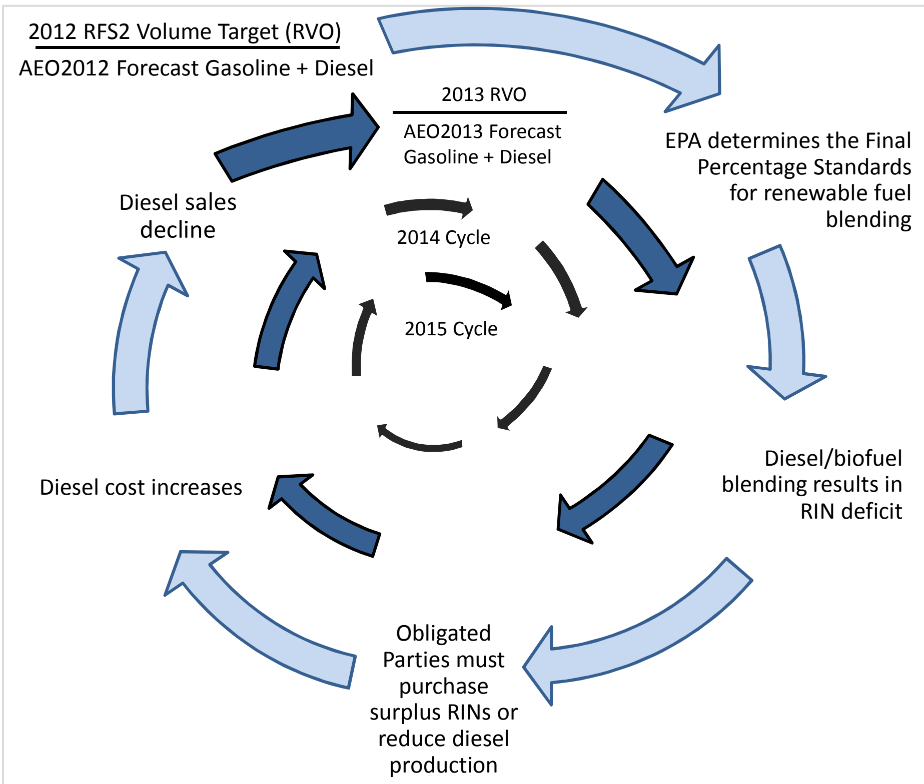
[28] Originally targeted blending percentage standard equals the total renewable fuel volume as required by EISA '07 divided by EIA's 2011 forecast for transportation fuel demand.

C. Diesel Death Spiral

An unintended consequence of the regulatory procedures for determining compliance is the potentially self-destructive way in which the annual blending percentage standards are determined. Figure 8 schematically presents the series of steps which result from EPA setting greater blending percentage obligations that cause an increasingly steep decline in diesel sales and lead to unattainable compliance obligations and supply disruptions.

Figure 8: Progression of the Diesel Death Spiral



As specified in EISA ’07, each year EPA calculates the next year’s blending percentage standards as the ratio of the targeted biofuel volumes to the EIA’s forecast for total transportation fuel sales in the next year. To comply with the blending percentage obligations, obligated parties have several options:

- Sell more E85;
- Increase the ethanol content in gasoline;
- Sell less E0; and
- Increase the biomass-based diesel content in diesel.

Each of these options has limitations. As the Phase I study concluded, there is limited consumer acceptance of E85 and limited infrastructure from which to dispense E85. The blending of ethanol into gasoline is restricted by the blend wall. Higher ethanol blends such as E15 are unlikely to be widely sold in the near future. E0 sales are unlikely to fall below 5% of total gasoline sales in the next several years, and there is a limited amount of biodiesel that can be cost-effectively produced.

In order to meet the blending percentage obligation, obligated parties would be forced to change the mix of fuels they sell to the extent that is possible in order to acquire enough RINs to meet the RFS2 mandates. All obligated parties would sell as much E85 and blend as much biodiesel into diesel as possible because of the relatively high RINs per gallon these actions generate: 0.74 RINs per gallon of E85 (typical), which compares to only 0.1 RINs for E10 and zero for E0. Biomass based diesel earns 1.5 RINs/gallon, or 0.075 RINs, when blended to make a gallon of B5.

The difference between the renewable fuel volumes mandated by the RFS2 program and the RINs generated through blending of biofuels into finished products represents the surplus or shortfall in RINs. If obligated parties continued to supply the same volumes of gasoline and diesel fuel, they would not be able to blend enough biofuel, or purchase enough surplus RINs, to remain in compliance with RSF2. This shortage in RINs puts upward pressure on RIN values (Table 10). For Scenario 1, in 2015 the program becomes infeasible, so there is no RIN value listed in the table.

Table 10: RFS2 Mandated Total Biofuels Percentage and Associated RIN Values

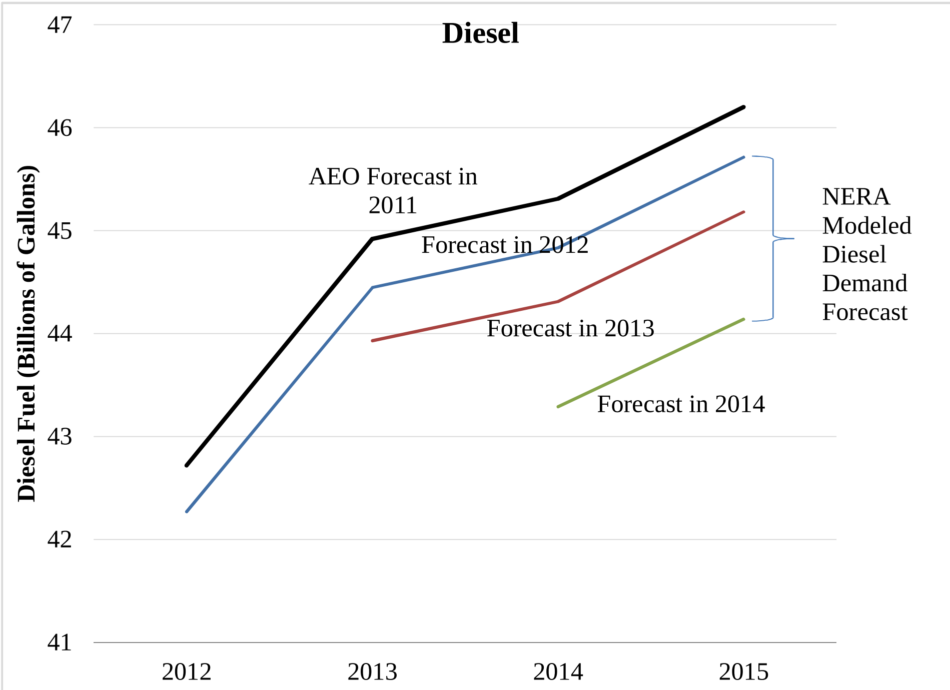
	2012	2013	2014	2015
Renewable Volume Obligation as Blending Percentage	8.4%	9.0%	9.8%	11.0%
RIN value Scenario 1 (2010$/RIN)	$10	$14	$27	Note 1
RIN value Scenario 2 (2010$/ RIN)	$5	$10	$17	$100

Note 1: Model solution for Scenario 1 in the year 2015 was infeasible.

Source: NERA analysis and N_{ew}ERA model results.

The cost of the RINs is borne by the obligated party and leads to higher costs and lower sales (effectively rationing) for fuels that require additional RINs. The cost of RINs also depends on the supply of RINs, which depends greatly on the supply of excess RINs from gasoline sales. During the first few years, the result is that the cost of diesel increases because this fuel requires RINs and the cost of E10 and E85 declines since these fuels produce excess RINs. The higher cost dampens demand for diesel, which results in the EIA lowering its forecast for diesel sales. The lower forecast for demand, means that the next year's blending percentage obligation becomes higher than it would have been, resulting in additional pressure on obligated parties who blend diesel to acquire even more RINs. This process repeats each year. The reduced diesel demand forecasting is depicted in Figure 9. The top black line represents the AEO diesel demand for 2011. As the cost of diesel rises, demand declines in subsequent years. The declining demand forecasted through NERA modeling is shown in order for 2012, 2013, 2014 years by the blue, red, and green lines, respectively.

Figure 9. Declining Diesel Demand Forecasting (2012 – 2015)



Source: NERA N_{ew}ERA model results.

Eventually the RFS2 total renewable fuel target increases to the point that it is no longer possible to satisfy the mandate through the available compliance mechanisms. As a result, the blending percentage obligation becomes infeasible.

D. The Role of Banked RINs

Table 11 displays the shortfall or surplus of RINs from selling a gallon of diesel, E10, or E85. The shortfall for diesel depends on the scenario studied, because the amount of biodiesel differs by scenario. Under Scenario 2, more biodiesel is available and consequently blended with petroleum diesel to yield more RINs per gallon of finished diesel than in Scenario 1. Since the E10 blend wall is reached in both scenarios for all years, the RIN shortfall and surplus are the same across scenarios as is the E85 RIN surplus. The level of E10's RIN deficit or surplus suggests how great demand for previously banked RINs will be.

Table 11: RIN Deficit or Surplus per Gallon of Fuel Sold (RIN/Gallon of Fuel)

		2012	2013	2014	2015
Diesel	Scenario 1	-0.048	-0.045	-0.053	
	Scenario 2	-0.036	-0.030	-0.040	-0.038
E10	Both Scenarios	0.016	0.010	0.002	-0.010
E85	Both Scenarios	0.66	0.65	0.64	0.63

Source: NERA N_{ew}ERA model results.

One way obligated parties may lessen the problems created by the gap between maximum RINs generated by blending B5 diesel and the total renewable fuel blending percentage obligation is to purchase or use RINs that have been banked from previous years. Depending upon the circumstances in a given year, obligated parties may choose to either acquire additional RINs or use RINs that they acquired in the previous year. The availability of RINs reserved for later use depends critically on the surplus RINs generated through the production of E10.

Table 11 shows that the surplus RINs decline dramatically to almost zero in 2014 and becomes negative in 2015. Therefore, in the first two years, it may be possible to increase the number of banked RINs, but by 2014 only sales of E85 would contribute anything meaningful to the surplus RIN supply. From 2014 surplus RIN inventories would be drawn down in an effort to make up for the shortfall in RINs created by diesel sales.

Table 12 shows the decline of surplus RINs over time. The table illustrates that in the early years obligated parties will acquire more RINs than they need for compliance (*i.e.*, they will add RINs to their RIN bank) and use these banked RINs in the later years: from 2013 onward in Scenario 1 and from 2014 onward in Scenario 2. This market behavior is reflective of the value of RINs early on being relatively inexpensive compared to the value of RINs later when the RFS2 mandates become more stringent. The total of cumulative banked RINs increases until 2013 in Scenario 1. In Scenario 2 the total increases until 2014 because there are more RINs available from the blending of biodiesel into finished diesel in Scenario 2. The subsequent exhaustion of the RIN surplus portends an impending collapse in terms of the RFS mandate leading to an infeasible outcome in the fuels market.

Table 12: Cumulative Total of Surplus Banked RINs in Billions

		Scenario 1	Scenario 2
2012	Starting RIN Surplus	1.69	1.69
	Surplus RINs Produced	0.16	0.67
	RINS Used	0.00	0.00
	End of Year RIN Surplus	1.85	2.36
2013	Starting RIN Surplus	1.85	2.36
	Surplus RINs Produced	0.00	0.29
	RINS Used	0.40	0.00
	End of Year RIN Surplus	1.45	2.65
2014	Starting RIN Surplus	1.45	2.65
	Excess RINs Produced	0.00	0.00
	RINS Used	1.45	0.92
	End of Year RIN Surplus	0.00	1.73
2015	Starting RIN Surplus	NA	1.73
	Surplus RINs Produced	NA	0.00
	RINS Used	NA	1.73
	End of Year RIN Surplus	NA	0.00

Source: NERA N_{ew}ERA model results.

E. RFS2 Program Will Eventually Fail

With time the RFS2 requirements become more stringent and options for complying become more limited: the blend wall is encountered, E85 is sold at maximum levels, and biodiesel production is fully exhausted. The result is that the demand for RINs exceeds the supply, which causes RIN values to increase and obligated parties to draw down their bank of RINs. Eventually the surplus of RINs is depleted (Table 12).

With surplus RINs depleted at the end of 2014 for Scenario 1, obligated parties must meet the total biofuels obligation percentage of close to 11% in 2015 through the blending and sale of E0, E10, E85, and B5 diesel. There are no surplus RINs from previous years that can be used. The 11% RVO target exceeds the ethanol content in E10, which means that E85 sales must greatly increase to make up for the shortfall. But the market infrastructure and consumer acceptance limits E85 sales causing surplus RINs from E85 sales to be scarce. To remain in compliance, obligated parties would have to drastically curtail their sales of diesel and E10. Table 13 shows that if the supply of gasoline and diesel were reduced by over 50% from the EIA's Reference Case, then obligated parties could comply with RFS2. Clearly, this is an infeasible result. In addition, this result leads to far fewer biofuel gallons (9.4 billion gallons) being sold compared with the 2015 RFS total renewable fuel volume mandate of 20.5 billion gallons. As reported in Table 10, the model solution was infeasible for 2015 for scenario 1. Table 13 illustrates the unrealistic changes in fuel consumption that would have to take place for the RFS2 policy to be achievable.

Table 13: RFS2 Collapse for Scenario 1

	Renewable Fuel per Gallon (%)	Fuel Sales (Billion Gallons)	RINs (Billions)	EIA Reference Scenario 2015 Levels (Billion Gallons)	% Reduction in Fuel Scenario 1 vs. EIA
Obligation %	11.0%				
E85	74%	2.6	1.9		
Diesel	7.5%	20	1.5		
E10	10%	60	6.0		
E0	0%	3.0			
Motor Gasoline				140	53%
Diesel				46.2	57%
Total		85.6	9.4	186.2	

Source: NERA N_{ew}ERA model results.

In scenario 2, this infeasibility is delayed until 2016 because the additional biodiesel supplies allow about 1.7 billion RINs to be carried forward from 2014 and to be used in 2015.

Exhausting the bank of RINs in 2015 fails to prevent the escalation of diesel costs, and they increase by over 300% from the Reference Case.

F. Economic Impact of RFS2

The macroeconomic impacts of the RFS2 mandate on the U.S. economy were estimated through the year 2015. The estimates show that the increasing demand for and escalating cost of RINs causes dramatic increases in the cost of diesel and ultimately, the cost of gasoline by 2015. These higher costs ripple through the economy, collectively harming economic growth.

From 2012 through 2014, the higher diesel fuel costs increase the cost to move raw materials and finished goods about the country. This increased cost will be passed through to consumers of finished goods and services. As a result, consumption of goods and services declines. The lower gasoline prices in this time period slightly offset the negative impacts on consumption from the higher diesel prices.[29]

In the 2012 to 2014 time frame, labor earnings increase, but their increase is modest compared to the loss in consumption, as labor earnings are unable to offset the higher costs for goods.[30] In the near term, investment and production is temporarily accelerated in anticipation of rising costs, and GDP increases, but this shift is unsustainable. By 2014 GDP declines by more than $250 billion.

In 2015, the economic impacts worsen. In addition to the negative impact of higher costs for finished goods and services caused by rising diesel fuel costs, gasoline costs increase relative to the baseline as a result of RSF2. Consumers are left with fewer dollars to spend on other goods and services resulting in lower consumption. Lower consumption translates into less need for the production of other goods and services that consumers would have otherwise purchased.

The combined effect of less money consumers have available to spend with the higher cost for finished goods and services means that consumption declines even further. By 2015, consumption per household declines by about $2,700 per year and total consumption declines by about $340 billion. Since there is lower demand for finished goods and services, there is less need for workers to provide those goods and services. As a result, workers would earn $584

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[29] Consumers are affected by higher diesel prices which are reflected through increases in the costs of goods and services.

[30] Increases in biofuel production lead to increases in labor demand.

billion less as a result of the smaller size of the economy resulting from the implementation of RFS2 (Table 14). These negative impacts are also expressed by the loss in GDP of $770 billion.

Table 14: Changes in Consumption per Household, Consumption, Labor Income and GDP Relative to Baseline (2010$s)

	2012	2013	2014	2015
Change in Average Consumption per Household ($/Household)	-$1,200	-$1,200	-$1,300	-$2,700
Change in Consumption (Billions of $s)	-$150	-$140	-$160	-$340
Change in Labor Income (Billions of $s)	$24	$42	$27	-$580
Change in GDP (Billions of $s)	$43	$50	-$270	-$770

Source: NERA N_{ew}ERA model results.

V. Conclusions

The RFS2 mandate as currently written is likely infeasible given the current technological, infrastructure and market constraints of the transportation sector. The fuel capability of the existing fleet, the infrastructure of the fuel distribution system and limited compliance mechanisms are some of the factors that undermine the viability of the RFS2. As obligated parties seek to comply with the RFS2, the mandates lead to unintended consequences that have dramatic and potentially long-term negative impacts on the motor fuel industry's ability to meet market demand and on the economy as a whole. As it becomes increasingly difficult for obligated parties to generate sufficient RINs to comply with the blending percentage obligation targets from RFS2, very large increases in transportation fuel costs ripple through the economy causing negative macroeconomic impacts. Depending on biodiesel availability, this collapse occurs in 2015 to 2016 timeframe. By 2015, the adverse macroeconomic impacts include a $770 billion decline in GDP and a corresponding reduction in consumption per household of $2,700.

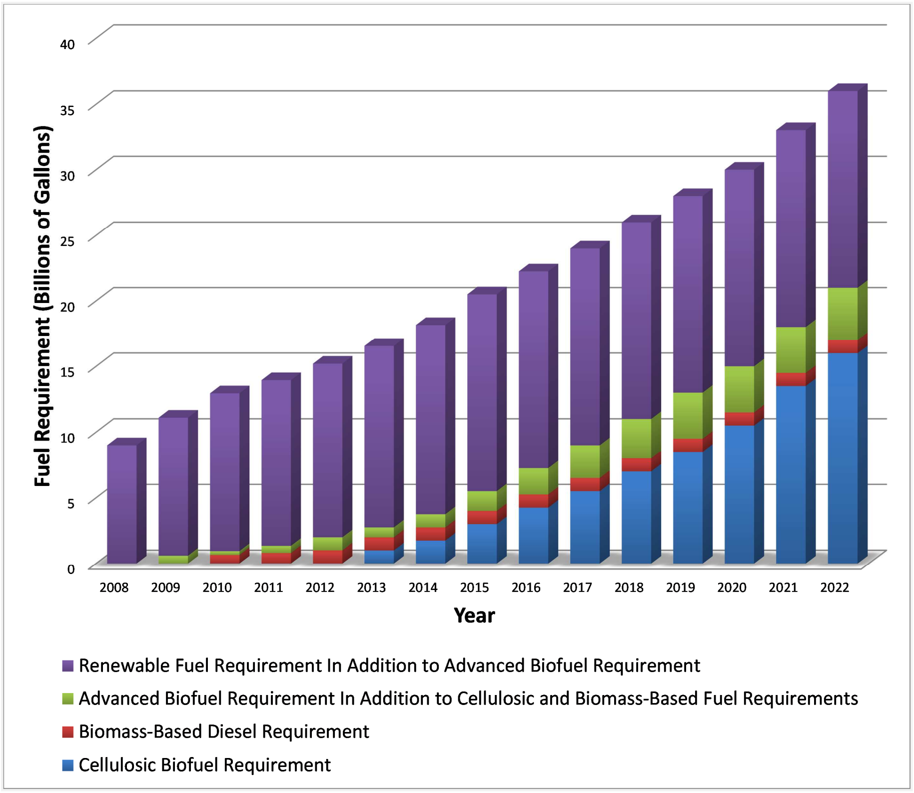
Appendix A: Renewable Fuels Standard Description

A. Renewable Fuel Standard (RFS2)

Congress first established a Renewable Fuel Standard (RFS1) in 2005 with the enactment of EPACT. Two years later, Congress passed EISA '07 which included RFS2 that increased the volume mandates of renewable fuels and expanded the transportation fuel mix beyond gasoline.

RFS2 became effective in 2010 and applies to all transportation fuel used in the United States—including diesel fuel intended for use in highway motor vehicles, non-road, locomotive, and marine diesel. As shown in Figure 10, RFS2 consists of four nested mandates for the minimum volume of renewable fuels contained in the transportation fuels sold in the United States. These mandates increase each year, and collectively, require the use of 36 billion gallons of renewable fuels in 2022.

Figure 10: EISA '07 Renewable Fuel Standard 2008-2022



Notes:
Cellulosic biofuel requirments were reduced per waiver approval by EPA for 2010-2012:
2010: 100 million gallons reduced to 6.5 million gallons
2011: 250 million gallons reduced to 6.6 million gallons
2012: 500 million gallons reduced to 8.65 million gallons

Biomass-based Diesel requirement for 2013-2022 has yet to be determined by the EPA but shall be no less than 1 billion gallons. This graph assumes 1 billion gallons per year in 2012-2022.

Each of the four nested mandates (biofuel categories) has its own lifecycle GHG minimum emission reduction requirements and annual volume mandate.

- Total renewable fuel is produced from renewable biomass and must reduce GHG emissions by at least 20% from the baseline value.
- Advanced biofuel is a subcategory of renewable fuel having a lifecycle GHG emission at least 50% less than the baseline value.
- Biomass-based diesel is a subcategory of advanced biofuel, and includes biodiesel or renewable diesel fuel having a lifecycle GHG emission at least 50% less than the baseline value.
- Cellulosic biofuel – a subcategory of advanced biofuel, and includes fuel produced from cellulose, hemicelluloses or lignin and having a lifecycle GHG emission at least 60% less than the baseline value.

Because of the nested nature of the biofuel categories, any renewable fuel that meets the requirement for cellulosic biofuels or biomass-based diesel is also valid for meeting the overall advanced biofuels requirement. Similarly, any renewable fuel that meets the advanced biofuel requirement is also valid for meeting the total renewable fuel mandate.

By November 30 of each year, EPA sets for the following year the blending percentage standard for total renewable fuel, advanced biofuel, biomass-based diesel, and cellulosic biofuel by dividing the volumetric mandates for each biofuel category by the projected annual transportation fuel demand forecasted by EIA.

Renewable fuel producers and importers generate credits in proportion to the amount and type of renewable fuel produced/imported – these credits are called RINs.

Transportation fuel producers and importers ("obligated parties") must acquire sufficient RINs to demonstrate compliance. Their compliance requirement is based on the amount of gasoline and diesel they refine or import. The number of required RINs, for each renewable fuel category, is calculated by multiplying the blending percentage standard for that year as set by EPA with the volume of gasoline or diesel obligated parties produce or import in that year.

Fuels sold that contain less than the blending percentage standard incur a RIN deficit, and fuels that contain more than the blending percentage standard accrue surplus RINs. The overall annual blending percentage standard is met if the surplus RINs generated from fuels containing greater than the required percentage are sufficient to offset the RIN deficits from fuels containing less than the required percentage. An obligated party is in compliance with RFS2 if its supply of RINs for each of the four renewable fuel categories equals or exceeds its fuel sales times the EPA's stated blending percentage standard for each renewable fuel category.

Fuels currently sold into the U.S. market include E0 and E10 gasoline, B0 and B5 diesel and E85, an alternative fuel containing greater than 50% ethanol by volume. E10 is the predominant fuel in the market, when the ethanol volume requirement is greater than what can be achieved by blending E10, the E10 blend wall has been reached, and the blend wall will restrict the greater use of renewable fuels.

Most biodiesel fuel is consumed in blended diesel fuels in which petroleum-based diesel fuel constitutes 95 percent or more of the blend by volume. The most common of such blends is B5 (five percent biodiesel by volume). Most diesel engine manufacturers and automakers continue to recommend the use of blends not greater than five percent. These requirements effectively create a B5 blend limit that is analogous to the E10 blend wall.

Original equipment manufacturers design and warranty engines and vehicles consistent with the E10 specification. Vehicle manufacturers have stated that use of fuels with higher ethanol content would void their warranty on existing vehicles with the exception of FFVs, which can accommodate ethanol gasoline blends with as much as 85% by volume ethanol.

EPA has approved two partial waivers, that together, allow E15 in vintage 2001 on-road vehicles and newer. For reasons described in the report, however, volumes of E15 are not considered to be materially significant. For example, the EIA in its recent Short-Term Energy Outlook assumed zero E15 demand in 2012 and 2013.[31]

[31] "This forecast assumes that E15 (gasoline blended with 15 percent ethanol by volume) does not yet reach the market. Consequently, U.S. ethanol production is projected to exceed the volume that can easily be used in the U.S. liquid fuels pool, so the Nation will continue to be a net exporter of ethanol over the next two years." Energy Information Administration, Short Term Energy Outlook, p. 10, May, 2012.

Appendix B: Detailed Model Description

This analysis used the linked system of NERA's proprietary bottom-up transportation fuel model and its $N_{ew}ERA$ macroeconomic model. This section describes these two models.

A. Transportation Fuel Model

The transportation fuel model is a partial equilibrium model designed to estimate the amount of fuel produced for and consumed by the transportation sector with and without the RFS2 mandate in place. The model maximizes the sum of consumers' and producers' surplus subject to meeting the RFS2 program fuel requirements and satisfying the transportation sector's demand for fuel while not violating any transportation sector infrastructure constraints.

1. Input Data Assumptions for the Model Baseline

The fuel sales forecast for the gasoline market is based upon the AEO 2011 Reference scenario. Table 15 reports the EIA's forecast for petroleum gasoline and ethanol sales as well as E85. To be optimistic about the ability of obligated parties to meet the RFS2 mandate, we assume that the level of E0 sales is only five percent of the total petroleum gasoline sales. Until recently, this percentage has been above 10% (see Phase I report). Applying this assumption to the AEO's forecast yields the following forecast for E0, E85, and petroleum and ethanol in the remaining motor gasoline fuel (Table 15).

Table 15: September 2011 STEO and AEO 2011 Reference Scenario – Sales of Gasoline Fuels (Billions of Gallons, Unless Otherwise Noted)

Fuel (Billions of Gallons or %)	2012	2013	2014	2015
E0	6.28	6.29	6.28	6.27
Petroleum in E10	119.24	119.54	119.40	119.22
Ethanol in E10	15.01	15.25	15.48	15.72
% Ethanol in E10	**11.2%**	**11.3%**	**11.5%**	**11.7%**
E85	0.06	0.07	0.08	0.09

Source: EIA's AEO 2011 and EIA's STEO September 2011.

The fundamental problem with the EIA's forecast is that the percentage of ethanol in E10 exceeds the blend wall of 10%. In 2012, the share of ethanol in E10 is forecasted to be 11.2%. To eliminate this infeasibility, we adjusted the sales of ethanol and petroleum in E10 so that the modified E10 would comply with the E10 blend wall while the overall total energy content in motor gasoline remained the same. That is, the forecast used in the model maintains the total energy demanded on an MMBtu basis for travel (Table 16).

Table 16: NERA Reference Case Sales of Gasoline Fuels (Billions of Gallons Unless Noted Otherwise)

Fuel (Billions of Gallons or %)	2012	2013	2014	2015
E0	6.28	6.29	6.28	6.27
Petroleum in E10	120.35	120.77	120.79	120.78
Ethanol in E10	13.37	13.42	13.42	13.42
% Ethanol in E10	**10.0%**	**10.0%**	**10.0%**	**10.0%**
E85	0.06	0.07	0.08	0.09

Source: NERA Analysis.

The AEO's 2011 forecast without modifications is used for the petroleum diesel and biomass based diesel sales forecast (Table 17).

Table 17: NERA Reference Case Sales of Diesel Fuels (Billions of Gallons)

	2012	2013	2014	2015
Petroleum Diesel	41.8	43.9	44.2	45.0
Biomass based diesel	0.92	1.07	1.07	1.23
Effective Biodiesel %	2.2%	2.4%	2.4%	2.7%

Source: EIA's AEO 2011 and NERA analysis.

For the forecasts for the volume of biofuel components in motor gasoline, we disaggregate the ethanol production into corn, cellulosic, and sugar ethanol (see Table 18). Sugar ethanol consumption is based on the Food and Agricultural Policy Research Institute's (FAPRI's) 2011 Outlook. We use the EIA's forecast for cellulosic ethanol. Corn-based ethanol equals the sum of ethanol used in E10 and E85 less cellulosic and sugar ethanol consumption.

This assumption is optimistic because it gives higher volumes for sugar ethanol. Ethanol use in E10 and E85 is inferred from Table 18.

Table 18: NERA Reference Case Sales of Biofuels in Motor Gasoline (Billions of Gallons)

	2012	2013	2014	2015
Corn Ethanol	12.60	12.22	11.16	10.49
Sugar Ethanol	0.81	1.25	2.33	3.00
Cellulosic Ethanol	0.01	0.01	0.01	0.01

Sources: Food and Agricultural Policy Research Institute for sugar ethanol imports.

Note: Corn ethanol = Ethanol in E10 + Ethanol in E85 – Sugar Ethanol – Cellulosic Ethanol

The forecasts for fuel price ratios are based upon a number of data sources. The gasoline and diesel prices come from AEO's 2011 Reference forecast. For corn ethanol we built up the prices from the EIA's work. We assumed a corn price equal to the average $/bushel price from January 1, 2008 to September 1, 2011 (or $5.00/bushel). We took the capital, operations, and maintenance costs from the EIA.[32] Summing up all these costs yielded the forecasted price for corn based ethanol. The price of sugar ethanol is assumed to be $1.00 to $1.50 per gallon higher than neat gasoline based on recent actual price differentials between the two fuels.[33] The cost of cellulosic ethanol is uncertain.[34] To estimate this cost, we averaged two EIA forecasts – one based on the capital cost for cellulosic ethanol and the other based on the capital cost for biodiesel gasification.[35] For biodiesel, we made use of three sources: Global Insights, the American Trucking Association's comment on the EPA's proposed rule entitled: *Regulation of Fuels and Fuel Additives: 2012 Renewable Fuel Standards*, and the average ratio of spot SME B100 to spot ultra-low sulfur petroleum diesel from 2009 through 2011.

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32 Statton, Mac, "Development of Production Costs as a Driver for the National Energy Modeling System," Energy Information Administration, Presentation at International Fuel Ethanol Workshop, June 29, 2011.

33 California Energy Commission, "2011 Integrated Energy Policy Report," February 2012.

34 Because we assume the RFS mandate for cellulosic ethanol will be waived, cellulosic ethanol is likely to be irrelevant in our analysis as long as its price is sufficiently greater than that of sugar ethanol, for sugar ethanol will be the ethanol of choice to meet the advanced biofuels mandate, and corn and sugar ethanol will be used in the production of E10 and E85 to help meet the overall biofuel requirement.

35 Statton, Mac, "Development of Production Costs as a Driver for the National Energy Modeling System," Energy Information Administration, Presentation at International Fuel Ethanol Workshop, June 29, 2011.

All price ratios are national, annual averages over multiple grades of fuel. For gasoline, the grades include regular unleaded, 89 octane unleaded, and premium unleaded (Table 19).

Table 19: Baseline Fuel Price Ratios for Blended Gasoline and Diesels (Ratio on a GGE Basis of Biofuel to Conventional Fuel)

	2010	2011	2012	2013	2014	2015
Gasoline	1.00	1.00	1.00	1.00	1.00	1.00
Corn Ethanol	1.86	1.78	1.72	1.61	1.58	1.49
Sugarcane Ethanol	2.08	2.00	1.92	1.81	1.77	1.67
Cellulosic Ethanol	2.62	2.48	2.41	2.23	2.13	2.01
Diesel	1.00	1.00	1.00	1.00	1.00	1.00
Soy-Based Biodiesel	1.74	1.66	1.7	1.66	1.65	1.64

Source: NERA assumptions.

2. Fuel Supply Curves

To address the changes in fuel production from the baseline, we use separate supply curves for each fuel. The elasticity of the supply dictates how the prices of fuels change with changes in production. In particular, they help determine how costly it is to expand biofuel production above the Reference Case levels.

Each supply curve is benchmarked to the NERA Reference Case, which is a slight modification of the EIA's Reference Case. The Reference Case price and quantity are denoted by $(Q_0(t),P_0(t))$. Each supply curve is also defined by an elasticity that is estimated from several data points from the EIA's Reference and High Oil Price scenarios. Each supply curve has the following functional form:

$$Q(t)/Q_0(t) = (P(t)/P_0(t))^{elasticity}$$

Formulation of the supply curves is such that the model replicates the Reference Case if no RFS2 mandate is imposed. For each year, the benchmark datum point for the biodiesel supply curve is derived from the EIA's reference scenario projections for fuel quantities and prices. The benchmark datum point for the corn ethanol supply curve comes from our adjusted EIA reference scenario (NERA Reference Case) for quantities and the EIA's cost analysis. For sugar ethanol, we used the EIA's demand forecast and the ARB's cost ratio of sugar ethanol to corn ethanol. Table 17, Table 18, and Table 19 report the prices and quantities to which the supply curves were calibrated.[36]

The own price elasticity for each fuel is derived by dividing the percentage change in quantity of fuel demanded by the percentage change in fuel price. The percentage change in quantity and price are computed by comparing the difference between the fuel consumed and price of fuel, respectively, in the AEO high oil price and reference scenarios. The elasticity of supply varies a bit from year to year, but on average, the elasticity of supply is about 0.4 for corn ethanol, 1.2 for sugar ethanol and biodiesel. The elasticity for petroleum fuels was is 0.8.[37]

3. Demand Curves

The model has a demand curve for each final fuel – E0, E10, E85, and diesel. The functional form of these curves is identical to that of the fuel supply curves. For the demand curves, the elasticity is the fuel's own price elasticity of demand. Because this analysis concerns itself only with the next few years, the demand curves' elasticity equaled that of Dahl's estimate for short-term elasticity of -0.1.[38]

These curves are calibrated to the demand data in Table 16 and Table 17. The EIA's AEO 2011 Reference Case provides the gasoline and diesel prices to which the demand curves' initial prices are calibrated (Table 20). As with the supply curves, the demand curves are structured so that the model replicates the NERA Reference Case level of demand for each fuel in the absence of the RFS2 mandate.

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[36] The previous section provides more detail on how the forecast prices were derived.

[37] Paltsev, Sergey, John M. Reilly, Henry D. Jacoby, Rishard S. Eckaus, James McFarland, Marcus Sarofim, Malcolm Asadoorian, and Mustafa Babiker, "The MIT Emissions and Prediction and Policy Analysis (EPPA). Model Version 4," August 2005.

[38] Dahl, C.A., "A survey of energy demand elasticities for the developing world," *Journal of Energy and Development* 18(I), 1—48, 1994.

Table 20: AEO 2011 Reference Case Fuel Prices ($/Gallon)

Fuel	2012	2013	2014	2015
Gasoline	2.82	2.97	3.05	3.13
Diesel	2.92	2.97	3.02	3.08

Source: EIA's AEO 2011.

4. Transportation Fuel Model is Designed to Model RFS2 Program Characteristics

The transportation fuel model was customized to simulate the impacts resulting from the RFS2 program. The model solves in one-year time steps and has a flexible time horizon. The first endogenous year is 2012. The model tracks the sale of the following fuels: E0 (100% petroleum gasoline), E10 (gasoline containing at most 10% by volume ethanol), E85 (assumed to contain 74% ethanol by volume), and diesel (containing at most 5% biodiesel). The model also tracks the use of the following fuel components in the production of the above finished fuels: petroleum gasoline, corn ethanol, sugar ethanol, cellulosic ethanol, petroleum diesel, and biodiesel.

The model combines the six fuel components into the four end-use fuels, which can be consumed by specific vehicle types:

- Minimum E0 use held to 5% to represent incomplete market conversion to E10 and preference of some consumers for E0;
- Conventional vehicles can consume either E0 or E10;
- FFVs can use E0, E10, or E85; and
- Commercial trucks/buses, ships, and trains are allowed to use diesel, which has up to a five percent mix of biodiesel (B5).

5. RFS/RIN Constraints

The model includes three biofuel constraints to account for the minimum annual volume of biofuel sales required under the RFS2 program:

- Biomass based diesel;
- Advanced biofuel (includes cellulosic biofuels, biomass-based diesel, and sugar ethanol); and
- Renewable fuel (includes advanced biofuel and corn ethanol).

For this analysis, we omit the RFS2 constraint for cellulosic ethanol under the assumption that the EPA would continue to grant a waiver because cellulosic biofuels will be commercially available only in very limited quantities. This assumption avoids the debate about the economic and technical feasibility of producing cellulosic biofuel[39] and is likely optimistic given the current difficulty procuring cellulosic biofuel supplies. Since this analysis assumes ample supplies of corn and sugar ethanol to meet the RFS2 mandates, there is no need for cellulosic ethanol to meet the non-cellulosic RFS2 targets.

Therefore, we model the following three RFS2 constraints, which are defined in the EPA's Final Rule for the Regulation of Fuels and Fuel Additives.

Figure 11: EPA's Formulas for the RFS2 Percentage Mandates[40]

$$\mathrm{Std}_{\mathrm{BBD},\,i} = 100\% \times \frac{\mathrm{RFV}_{\mathrm{BBD},\,i} \times 1.5}{(G_i - RG_i) + (GS_i - RGS_i) - GE_i + (D_i - RD_i) + (DS_i - RDS_i) - DE_i}$$

$$\mathrm{Std}_{\mathrm{AB},\,i} = 100\% \times \frac{\mathrm{RFV}_{\mathrm{AB},\,i}}{(G_i - RG_i) + (GS_i - RGS_i) - GE_i + (D_i - RD_i) + (DS_i - RDS_i) - DE_i}$$

$$\mathrm{Std}_{\mathrm{RF},\,i} = 100\% \times \frac{\mathrm{RFV}_{\mathrm{RF},\,i}}{(G_i - RG_i) + (GS_i - RGS_i) - GE_i + (D_i - RD_i) + (DS_i - RDS_i) - DE_i}$$

39 We note that there is a second- or third-order effect of assuming no measurable cellulosic supplies. Assuming no significant amount of cellulosic ethanol production necessitates additional amounts of biodiesel and sugar based ethanol to meet the advanced biofuel requirement, and this affects costs and compliance.

40 http://www.gpo.gov/fdsys/pkg/FR-2012-01-09/pdf/2011-33451.pdf, at p. 19.

The final standards for 2012 are provided below in Table 21.

Table 21: EPA's Final Rule for RFS standards for 2012[41]

Fuel	Percentage
Cellulosic biofuel	0.002% to 0.01%
Biomass-based diesel	0.91%
Advanced biofuel	1.21%
Renewable fuel	9.21%

Source: EPA.

6. Model Formulation

The following text describes the transportation fuel model – its objective function and constraints - at a high-level.

Maximize: Consumer Surplus + Producer Surplus + Value of RIN Bank

Subject to: RFS2 advanced biofuel constraint (% requirement)

RFS2 biodiesel constraint (% requirement)

RFS2 total biofuel constraint (% requirement)

Blend wall constraint for E10 not to exceed 10% ethanol

Blend wall constraint for diesel not to exceed 5% biodiesel

Limit on E85 sales based on Phase I findings for penetration of E85 stations

Lower bound on E0 sales as a fraction of total sales (calibrated to baseline levels)

Upper bound on biodiesel production

RIN bank(t) = RIN bank(t-1) + RIN Deposit(t) – RIN withdrawal(t)   t = 2012, …, 2015

RIN bank cannot exceed 20% of biofuel sales…

Consumer Surplus = the area under the demand curve for each delivered fuel (*e.g.*, E0, E10, *etc.*)

[41] EPA's Section I on pg. 1323 of the EPA's Final Rule for the Regulation of Fuels and Fuel Additives: 2012 Renewable Fuel Standards. Table I.A. 3-2.

Producer Surplus = the area under the supply curve for each fuel component (*e.g.*, corn ethanol, biodiesel, *etc*.)

RIN bank in 2012 equals the carryover of RINs from 2011.

The supply curves capture the technological issues (penetration rate, availability, and cost) for the different fuels. The demand curves for fuel capture the loss in utility from having to reduce travel and also the loss in welfare from having to switch fuels. The RFS constraint is applied only in the RFS2 scenarios. The change in economic activity between the scenario and the baseline provides the economic impacts of the RFS policy.

The models for the reference and high biofuel scenarios differ only in the upper bound for the amount of biodiesel production. Table 22 reports these levels.

Table 22: Maximum Amount of Biomass Based Diesel That Can be Produced (Billions of Gallons)

Scenario	2012	2013	2014	2015
Reference Scenario	1.00	1.28	1.28	1.28
High Biodiesel Scenario	1.35	1.74	1.66	1.90

Source: EIA's AEO 2011 and NERA analysis.

The sales of E85 are limited by how quickly the E85 fueling infrastructure can be expanded. At the end of 2011, there were only about 2,400 stations that sold E85. This small volume resulted in E85 making up only about 1% of all potential FFV fuel purchases. By allowing the addition of E85 pumps in retail stations to increase at a rate far faster than that in recent history (1,000 stations per year versus about 400 stations per year from 2006 through 2010), yields about 6,400 stations by 2015. Given people's propensity to seek out E85 stations if they have a FFV, we assume that this level of stations translates into the following bound on E85 sales (see Phase I report for more details). Table 23 shows that this upper limit on E85 sales is quite optimistic relative to the EIA's forecasted E85 sales.

Table 23: Sales of E85 (Billions of Gallons)

	2012	2013	2014	2015
AEO 2011	0.06	0.07	0.08	0.09
Maximum	0.54	0.99	1.7	2.6

Source: EIA's AEO 2011 and NERA N_{ew}ERA model results.

B. Macroeconomic Model in N_{ew}ERA Modeling System

The N_{ew}ERA macroeconomic model is a forward-looking dynamic computable general equilibrium model of the United States. The model simulates all economic interactions in the U.S. economy, including those among industry, households, and the government. The economic interactions are based on the IMPLAN 2008 database for a benchmark year, which includes regional detail on economic interactions among 440 different economic sectors. The macroeconomic and energy forecasts that are used to project the benchmark year going forward are calibrated to the most recent AEO produced by the EIA. Because the model is calibrated to an internally-consistent energy forecast, the use of the model is particularly well suited to analyze economic and energy policies and environmental regulations.

For this study, the N_{ew}ERA macroeconomic model was set to run from 2012 to 2015 in one year time steps. We aggregated all the states into one U.S. region since the RFS2 program is a nationwide policy. We then aggregated the 440 sectors into five energy and seven non-energy sectors: energy sectors include crude oil, oil refining, natural gas extraction and distribution, coal, and electricity; the non-energy sectors include agriculture, commercial transportation (excluding trucking), energy intensive sectors, manufacturing, motor vehicle production, services, and trucking.

The N_{ew}ERA model incorporates EIA energy quantities and energy prices into the IMPLAN Social Accounting Matrices. This in-house developed approach results in a balanced energy-economy dataset that has an internally consistent energy benchmark data as well as IMPLAN consistent economic values.

The macroeconomic model incorporates all production sectors and final demands of the economy and is linked through terms of trade. The effects of policies are transmitted throughout the economy as all sectors and agents in the economy respond until the economy reaches equilibrium. The ability of the model to track these effects and substitution possibilities across sectors and regions makes it a unique tool for analyzing policies such as those involving energy and environmental regulations. These general equilibrium substitution effects, however, are not fully captured in a partial equilibrium framework or within an input-output modeling framework. The smooth production and consumption functions employed in this general equilibrium model enable gradual substitution of inputs in response to relative price changes thus avoiding all or nothing solutions.

Business investment decisions are informed by future policies and outlook. The forward-looking characteristic of the model enables businesses and consumers to determine the optimal savings and investment while anticipating future policies with perfect foresight. The alternative approach on savings and investment decisions is to assume agents in the model are myopic, thus have no expectations for the future. Though both approaches are equally unrealistic to a certain extent, the latter approach can lead the model to produce inconsistent or incorrect impacts from an announced future policy.

The CGE computable general equilibrium modeling tool such as the N_{ew}ERA macroeconomic model can analyze scenarios or policies that call for large shocks outside historical observation. Econometric models are unsuitable for policies that impose large impacts because these models' production and consumption functions remain invariant under the policy. In addition, econometric models assume that the future path depends on the past experience therefore fail to capture how the economy might respond under a different and new environment. For example, an econometric model cannot represent changes in fuel efficiency in response to increases in energy prices. However, N_{ew}ERA macroeconomic model can consistently capture future policy changes that envisage having large effects.

The N_{ew}ERA macroeconomic model is also a unique tool that can iterate over sequential policies to generate consistent equilibrium solutions starting from an internally consistent equilibrium baseline forecast (such as the AEO Reference Case). This ability of the model is particularly helpful to decompose macroeconomic effects of individual policies. For example, if one desires to perform economic analysis of a policy that includes multiple regulations, the N_{ew}ERA modeling framework can be used as a tool to layer in one regulation at a time to determine the incremental effects of each policy.

C. Integration of Models

To estimate the economic impacts of the RFS2 program on the overall economy, we established a one way linkage between the bottom-up transportation model and the top-down macroeconomic model. We first ran the reference and high biofuel scenarios through the transportation fuel model. The imposition of the RFS2 program leads to fuel price increases from the baseline without this program. For the top-down macroeconomic model, we translated the resulting higher fuel prices by applying a tax on gasoline and diesel that yields the same fuel price increase as seen in the bottom-up transportation fuel model.

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Attachment 2

FINAL REPORT

RENEWABLE FUEL STANDARDS

AND THE ETHANOL BLENDWALL

Prepared for

AMERICAN PETROLEUM INSTITUTE

By

MathPro Inc.

August 8, 2013

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GLOSSARY

- **AEO**: *Annual Energy Outlook*, published by the Energy Information Administration, Department of Energy.

- **Co-processed renewable diesel (CDR)**: Biodiesel produced by hydrotreating virgin vegetable oils or animal fats in conjunction with conventional hydrocarbons. CDR qualifies as an “advanced biofuel” under EISA (but not as a “biomass-based diesel”).

- **E0, E10, and E10+**: Gasoline containing no ethanol, gasoline containing 10 vol% ethanol, and gasoline containing more than 10 vol% ethanol (e.g., E15), respectively.

- **E85**: A vehicle fuel that is mixture of hydrocarbon blendstocks and 51% to 85 vol% ethanol (generally about 74 vol%).

- **EIA**: Energy Information Administration.

- **EISA**: Energy Independence and Security Act of 2007.

- **Ethanol Equivalency Factors**: Factors used to convert biodiesel (and bio-butanol) volumes to equivalent volumes of ethanol (based on relative energy content) for the purpose of calculating total renewable and advanced biofuel volumes required under EISA.

- **Ethanol Blendwall**: A constraint on the volume of ethanol that can be blended into the U.S. gasoline pool that is reached when essentially all U.S. gasoline is ethanol-blended at 10 vol%.

- **EPA**: Environmental Protection Agency.

- **FAME**: Fatty acid methyl ester, a biodiesel produced by processing raw vegetable oil (typically soybean, rapeseed, or canola oil) or animal fats through a chemical process called trans-esterification.

- **FFV**: Flex-fuel vehicle, a vehicle capable of using gasoline, E10+, or E85.

- **MOVES**: Motor Vehicle Emission Simulator, a complex, mobile source emission modeling system developed by EPA’s Office of Transportation and Air Quality.

- **NEMS**: National Energy Modeling System, an energy modeling system used by the Department of Energy to develop energy projections reported in each year’s AEO.

- **Non-co-processed renewable diesel (NCRD)**: biodiesel produced by hydrotreating virgin vegetable oils or animal fats. NCRD qualifies as a “biomass-based diesel.”

- **Vehicle Survival Rate**: The percentage of vehicles of a given model year remaining in service in a subsequent year. For example, the estimated ten-year survival rate of cars is about 83% in MOVES and 75% in NEMS.

INTRODUCTION

The American Petroleum Institute (API) retained MathPro Inc. to assess, in light of the E10 blendwall, annual renewable fuel volume standards that EPA might establish to implement the Renewable Fuels Standard (RFS). The study comprised two parts.

Part 1 involved the development of a spreadsheet-based model ("Software Tool") to assess specified compliance approaches for various schedules of annual renewable fuel volumes that EPA might establish. The spreadsheet incorporates the projections of energy demand in the transportation sector in EIA's *Annual Energy Outlook 2013* (*AEO 2013*) Reference and High Price cases.

Part 2 involved application of the Software Tool to assess three hypothetical scenarios involving assumed schedules of annual renewable fuel volumes and various compliance approaches.

This report is the final work product of the project.

The report is in four sections.

1. Background
2. Elements of the Software Tool
3. RFS Scenarios Analyzed and Results
4. Conclusions

1. Background

The Energy Independence and Security Act of 2007 (EISA) established a schedule of renewable fuel volume requirements, shown in **Table 1** below. EPA implements this schedule through annual rulemakings (as required by Section 211(o) of the amended Clean Air Act). The annual volume schedule set forth in EISA reflected the assumption that there would be substantial increases in production of cellulosic biofuels and lesser increases in the production of other advanced biofuels (imported sugarcane ethanol and biomass-based diesel). The EISA volume schedule also implicitly limited the use of corn ethanol to 15 billion gallons per year (B gal/y).

Table 1: EISA Schedule of Renewable Fuel Volumes (Billion gallons/year)

	Renewable Fuel			
		Advanced Biofuel		
Year	All Renewable Fuel	All Advanced Biofuel	Cellulosic Biofuel	Biomass-based Diesel
2006	4.00			
2007	4.70			
2008	9.00			
2009	11.10	0.60		0.50
2010	12.95	0.95	0.10	0.65
2011	13.95	1.35	0.25	0.80
2012	15.20	2.00	0.50	1.00
2013	16.55	2.75	1.00	>= 1
2014	18.12	3.75	1.75	>= 1
2015	20.50	5.50	3.00	>= 1
2016	22.25	7.25	4.25	>= 1
2017	24.00	9.00	5.50	>= 1
2018	26.00	11.00	7.00	>= 1
2019	28.00	13.00	8.50	>= 1
2020	30.00	15.00	10.50	>= 1
2021	33.00	18.00	13.50	>= 1
2022	36.00	21.00	16.00	>= 1
2023	(1)	(1)	(1)	(1)

(1) To be determined by EPA in a future rulemaking

EISA requires EPA, each year, to:

- set renewable fuel standards for the following year;
- set cellulosic biofuel volume standards based on evaluations of cellulosic biofuel production capacity (if less than EISA volumes); and
- establish volume standards for biomass-based diesel for 2013 and later years considering various factors, including production and infrastructure capabilities.

As **Table 2** indicates, thus far EPA has promulgated annual volume standards for: (i) total renewable and advanced biofuel equal to those specified in EISA; (ii) biomass-based diesel equal to those specified in EISA for 2010 to 2012, with an increase for 2013; and (iii) cellulosic biofuel substantially lower than those specified in EISA, because production capability is minimal. (Note that the asterisks in Table 2 denote volumes in EPA's proposed RFS standards rule for 2013.)

Table 2 : EPA Schedule of Renewable Fuel Volumes
(Billion gallons/year)

Year	Renewable Fuel			
		Advanced Biofuel		
	All Renewable Fuel	All Advanced Biofuel	Cellulosic Biofuel	Biomass-based Diesel
2010	12.95	0.95	0.065	1.15[1]
2011	13.95 *	1.35*	0.060*	0.80
2012	15.20	2.00	0.010	1.00
2013[2]	16.55	2.75	0.014	1.28

1 Carries over the 2009 EISA volume requirement into 2010.
2 Proposed volume standards.
Note: Volumes are in ethanol-equivalent gallons, except for Biomass-based Diesel, which is in physical gallons.

EPA's policy has been that, if sugarcane ethanol and biomass-based diesel (primarily FAME) are likely to be available in sufficient quantities to support EISA's schedule of total renewable and advanced biofuel volumes, those volumes should be met, for consistency with the GHG reduction goals of the Act.[1] That is, EPA has elected not to reflect in its total renewable and advanced biofuel volume standards the lack of available cellulosic biofuel.

EPA implements its volume standards by setting annual percentage standards for each of the four renewable biofuel categories. EPA calculates the annual percentage standard for each category as the ratio of that category's volume standard to the total volume of U.S. gasoline and diesel use projected for that year by EIA.[2] In turn, obligated parties (primarily domestic refineries and

[1] Regulation of Fuels and Fuel Additives: 2013 Renewable Fuel Standards; Proposed Rule, *Federal Register*, Vol 78, No. 26, 02/07/13, p. 9295.

[2] Gasoline and diesel use in Alaska are excluded from the calculations, as are projected volumes of gasoline and diesel production by exempted small refiners (such exemptions end by 2013). Each of the Percentage Standards,

transportation fuel importers) must use the percentage standards to calculate their Renewable Volume Obligations (RVOs) for each category of biofuel.

Compliance by obligated parties with their RVOs (individually calculated as the percentage standards times their combined sales of petroleum-based gasoline and diesel fuel) is accomplished through the accumulation of sufficient Renewable Identification Numbers (RINs). RINs, of which there are five types, are generated with each gallon of biofuels used domestically.

Table 3, below, shows the five types of RINs, the RINs generated per gallon of biofuel (the "ethanol equivalency" factor), and the biofuel categories to which various RIN types may be applied for compliance.

Table 3: RINs Generated per Physical Gallon of Biofuel -- Ethanol Equivalency Factors

Type of Renewable Fuel	Type of RIN	Number of RINS Generated per Gallon of Biofuel	Biofuel Category for which RINs May Be Used for Compliance			
			Renewable Biofuel	Advanced Biofuel	Cellulosic Biofuel	Biomass-Based Diesel
Corn ethanol	D6	1	●			
Sugarcane Ethanol	D5	1	●	●		
Cellulosic Ethanol	D3	1	●	●	●	
Cellulosic Diesel	D7	1.7	●	●	●	
Co-processed Renewable Diesel	D5	1.7	●	●		
Non Co-processed Renewable Diesel	D4	1.7	●	●		●
FAME Biodiesel	D4	1.5	●	●		●
Cellulosic Biofuel Waiver Credit		1			●	

For example, one gallon of FAME generates 1.5 D4 RINs, and D4 RINs may be used to comply with an obligated party's RVOs for biomass-based diesel, advanced biofuel, and/or total renewable fuel. Table 3 also shows that cellulosic biofuel waiver credits may be used to comply only with RVOs for cellulosic biofuel.[3]

RINs may be bought and sold and held in inventory as "carry-over RINs." In fact, due to "over-compliance," mostly during 2010 and 2011, the combined inventory of RINs at the end of 2012

including that for Biomass-based diesel, is calculated in terms of "ethanol-equivalency" to be compatible with the RIN system described in the next few paragraphs.

[3] If the cellulosic biofuel volume standard set by EPA is less than that specified in EISA, EPA must make cellulosic biofuel waiver credits available for purchase at a price equal to the greater of 25¢/gal or the average wholesale price of gasoline less $3 per gal. Such waiver credits have been used by obligated parties to meet most of their cellulosic biofuel RVOs from 2010 to 2012.

stood at almost 2.6 billion RIN-gallons, as shown in **Table 4**, below. These carry-over RINs are available for use in complying with RVOs for 2013 and later years.

Table 4: Estimated Carry-over RINs as of 2012
(million gallons)

	RIN Type	Carry-Over RINs
Total		**2,587**
Renewable	D6	2,097
Advanced Biofuel	D5	175
Biomass-based Diesel	D4	315
Cellulosic Ethanol	D3	0.0201
Cellulosic Diesel	D7	0.0017

Source: Derived from EPA's Website, as of April 12, 2013.
(http://www.epa.gov/otaq/fuels/rfsdata/2012emts.htm)

"Over-compliance" with renewable fuel RVOs in 2010 and 2011 was possible because the volumes of ethanol called for by the volume standards for those years were less than the volumes of ethanol needed to saturate the gasoline pool with 10% ethanol. Thus, with the bulk of the gasoline pool being E10 in 2010 and 2011, U.S. gasoline production generated excess (carry-over) D6 RINs. However, that is no longer the case. In fact, physical compliance with EPA's proposed volume standards for 2013 would require ethanol use in excess of 10% of the gasoline pool. Once the E10 blendwall is reached, any additional ethanol use mandated by EPA would exceed the U.S. gasoline pool's capacity to absorb ethanol without resort to E15 or E85 blending.

E15 and E85 have achieved only limited market acceptance, due in part to vehicle warranty issues with E15 and infrastructure limitations for both E15 and E85. In addition, when higher blends of ethanol are sold alongside E10, ethanol's fuel economy deficit becomes apparent to consumers. Significant expansion in the use of higher ethanol blends would require the price of D6 RINs to increase sufficiently to reduce the *effective* rack price of ethanol to a level that would make these higher blends economically attractive to consumers.

Increasing FAME production (beyond volumes required to meet the biomass-based diesel volume standards) may be an avenue to delay reaching the E10 blendwall, as excess D4 RINs may be used as D6 RINs for complying with renewable fuel RVOs. Biodiesel production remains well below current capacity (about 50% of capacity in 2012), even after application of the recently-extended $1.00/gal subsidy for bio-diesel production. Congress' willingness to continue that subsidy is uncertain, which in turn creates uncertainty regarding the economic feasibility of FAME production in the future.

The burden of near-term compliance with renewable fuel RVOs seems to rest primarily on carryover RINs (coupled, possibly, with expanded FAME production). Much of the inventory of carryover RINs at the start of 2013 (≈ 2.6 B gal/y) is likely to be used in 2013. This means that the introduction of additional volumes of FAME or E85 is likely to be required in 2014 and beyond.

2. Elements of the Software Tool

The Software Tool is designed to assess alternative schedules of volume standards that EPA might set. It consists of a number of sections, including:

- *User inputs*. In this section, the user can specify an annual volume scenario, along with other parameters such as the compliance method, the extent of FAME expansion, the use of E85 or E10+ to absorb excess ethanol, etc.

- *Carry-over RINs*. This section includes data on the inventory of RINs as of the end of 2012 as reported by EPA.

- *AEO forecasts*. This section contains selected forecasts from *AEO 2013* Reference and High Oil Price cases.

- *Vehicle fleet composition*. This section estimates the year-by-year distribution of vehicles and fuel use, by vehicle type and vintage, using reported data on vehicle sales, forecasts of vehicle sales from *AEO 2013*, and assumptions regarding vehicle survivability rates and VMT from MOVES and NEMS.

- *Outputs*. This section presents results of interest.

The Software Tool incorporates three alternative methods for compliance with the designated annual Volume Standards.

- *Use of carry-over RINs*. In this option, obligated parties use excess RINs accumulated in 2010 to 2012 to aid in complying with the RFS volume standards for 2013 and thereafter. (Accumulated D4 RINs are used solely to reduce the physical use of corn or sugarcane ethanol and are not used to reduce current FAME production.)

  The user may place upper limits on the percentage of the available RIN inventory used for compliance in a given year. This simulates obligated parties (that accumulated more RINs than needed for compliance) holding back RINs for their own subsequent use, rather than selling them on the open market.

- *Expansion of FAME production*. In this option, obligated parties, in addition to using carry-over RINs for compliance purposes, cause production of FAME to expand beyond the annual volumes needed to meet the biomass-based diesel volume standards. This generates "excess" D4 RINs that are used to reduce the physical use of imported sugarcane ethanol (which generates D5 RINs) or corn ethanol (which generates D6 RINs) in combined volume equal to the volume of excess D4 RINs.

  The annual volume of FAME expands to the lesser of (i) the volume needed to generate sufficient excess D4 RINs to prevent reaching the ethanol blendwall, or (ii) the volume consistent with limits on the percentage of FAME that can be blended in the distillate pool due to product specifications or marketing constraints that limit higher FAME/diesel blends.

Unlike the use of carry-over RINs, which can be implemented directly by obligated parties, expansion of FAME production would come about indirectly from price signals generated in the RIN market. The Software Tool does not simulate this latter process, nor does it assess the implications of expanded production on the production cost or market price of FAME. It simply assumes that expansion of FAME occurs and estimates the extent of the required expansion.

- *Expansion of E85 production.* In this option, in addition to the use of carry-over RINs for compliance purposes, E85 production is allowed to expand to meet the annual renewable fuel volume standards. The additional E85 generates additional D6 RINs to aid in meeting the annual renewable fuel volumes.

  The Software Tool also calculates the percentage of FFVs that must use E85. The Software Tool calculates the number of FFVs each year based on EIA and EPA data and methodologies, with the assumption that any FFV using E85 uses only E85 for the entire year.

The Software Tool allows the pairing of any combination of volume scenarios and compliance method.

The compliance method in which FAME production expands reflects the assumption that EPA does not adjust annual volume standards upwards in subsequent years in response to FAME production in excess of that necessary to meet the current year's biomass-based diesel volume standard. The effects of such reactive behavior by EPA can be assessed by using the Software Tool's "user-specified RFS schedule" to iteratively expand the volume standards for total renewable, advanced biofuel, and biomass-based diesel in response to the previous year's FAME use.

The Software Tool computes the combined volume of corn, sugarcane, and cellulosic ethanol needed to comply with the annual volume standards. If that combined volume exceeds the volume of ethanol that can be absorbed in the gasoline pool through E10 (i.e., the E10 blendwall is reached), the "excess" ethanol is absorbed through expansion of higher ethanol blends – E85 or E10+, as specified by the user. The calculated volumes of E10 and E85 (or E10+) must satisfy two constraints: (i) the volume of ethanol in the gasoline pool (defined here as including E0, E10, and higher ethanol blends such as E85) equals the volume of ethanol required to meet the annual volume standards; and (ii) the combined energy content of the gasoline pool equals the combined energy content of the gasoline pool (E10 and E85) forecast in *AEO 2013* for either the Reference or High Oil Price cases, as specified by the user.

3. RFS Scenarios Analyzed and Results

The analysis assessed three potential annual volume scenarios and, within each scenario, various means of compliance with the specified annual volume standards. The scenarios span the range of future annual volume standards that EPA plausibly might set. All three scenarios use EIA's *AEO 2013* projections for cellulosic biofuel volumes, rather than the statutory volumes.

The first scenario adopts the EISA volume standards for total renewable fuel and advanced biofuel, notwithstanding that future production of cellulosic biofuel likely will fall well short of EISA volumes.

The second scenario reduces the EISA volume standards for total renewable fuel and total advanced biofuel for each year by an amount equivalent to the difference between the *AEO 2013* projection of cellulosic biofuel volumes and the EISA volume standard for cellulosic biofuel.

The third scenario represents total renewable fuel volumes for each year consistent with the projected gasoline pool volume being E10. (That is, ethanol volumes are limited to 10% of the projected gasoline demand, so that the gasoline pool reaches but does not exceed the E10 blendwall).

In terms of the year in which the E10 blendwall is reached (and exceeded), the first scenario accelerates it, the second delays it, and the third avoids it. Thus far, EPA has issued standards consistent with the first scenario.

The various scenarios (and the alternative compliance approaches for each scenario) that were analyzed and the results of the analysis are discussed below. Detailed quantitative results of the analysis are shown in the exhibits following the last section of this report.

Expansion of E15 was not assessed as a compliance approach for absorbing volumes of ethanol in excess of those required to reach the E10 blendwall.

3.1 Scenario 1: EISA volume schedule for total Renewable Fuel and Advanced Biofuel

In this scenario, the annual renewable fuel and advanced biofuel volume standards are set equal to the corresponding EISA volume standards. The annual biomass-based diesel volumes are set at 1.28 B gal (as proposed by EPA for 2013) and the annual cellulosic biofuel volumes (and the split between ethanol and biodiesel) are set at the volumes forecast in the *AEO 2013* Reference case.

This scenario represents the most aggressive case, where EPA would leave the total renewable and advanced biofuel standards unchanged from the EISA volume schedule, notwithstanding that cellulosic biofuel is and is projected to remain available in only small volumes.

Scenario 1A: EISA volume standards, unrestricted expansion of FAME, no expansion of E85, AEO 2013 cellulosic biofuel volumes

The results for Scenario 1A are shown in **Exhibit 1A**. The analysis assumes unrestricted expansion of FAME production and calculates the volumes required to avoid exceeding the E10 blendwall.

In this compliance approach, FAME blending begins a rapid expansion in 2014, by which time the gasoline pool has been saturated with ethanol (2012) and carry-over RINs have been exhausted (2014). To achieve compliance, about 2 B gal/y of FAME would be required in 2014; 4.7 B gal/y in 2015; and 11.1 B gal/y in 2020. These volumes are substantially larger than current production levels.

By 2015, the FAME volume would exceed (i) the current 5 vol% limit on FAME blending in diesel fuel, and (ii) the biodiesel industry's current nameplate capacity of about 2.2 B gal/y.[4] By 2020, FAME blending would have to account for about 16 vol% of the distillate pool to enable compliance with the volume standards.

In summary, the analysis of this scenario indicates that compliance with the EISA standards through unrestricted expansion of FAME production would require a rapid and large expansion in the production and use of biomass-based diesel and would exceed existing constraints on biofuel content in diesel fuel.

Scenario 1B: EISA volume standards, expansion of E85, no expansion of FAME, AEO cellulosic biofuel volumes

The results for Scenario 1B are shown in **Exhibit 1B**. The analysis represents E85 expansion as the compliance method and calculates E85 volumes required to meet the EISA volume standards.

The analysis places no restrictions on E85 expansion and holds biomass-based diesel volume constant at the 2013 RFS standard of 1.28 billion gallons. Annual cellulosic biofuel volume standards (and the split between ethanol and diesel) are set at the volumes forecast in the *AEO 2013* Reference case.

In this compliance scenario, as in Scenario1A, carry-over RINs would be consumed in 2013 and 2014 to assist in compliance. The E10 blendwall would be reached in 2014, and ethanol's share of the gasoline pool would increase from about 11 vol% in 2014 to almost 20 vol% by 2020. E85 consumption would have to grow from 0.02 B gal/y in 2013 to ~ 1.9 B gal/y in 2014, ~ 7.9 B gal/y in 2015, and 22.4 B gal/y in 2020.

Furthermore, as Exhibit 1B indicates, most of the increase in ethanol volume would have to come from imported sugarcane ethanol. Sugarcane ethanol volumes would have to grow to 1.2

[4] Biodiesel production capacity as reported on the Energy Information Administration website; http://www.eia.gov/biofuels/biodiesel/production/table1.pdf

B gal/y in 2014, 3.1 B gal/y in 2015, and 12.3 B gal/y in 2020. By contrast, Brazil's maximum annual production capacity for sugarcane ethanol is ~ 6 B gal/y, and exports to the U.S. have not exceeded 0.7 B gal/y.

The results also indicate that the required volumes of E85 would be too large to be supported by the prospective fleet of FFVs[5]. The ability of the prospective FFV fleet's to absorb E85 volumes would be exceeded by 2017 (even under the optimistic assumptions that FFV owners using E85 would use it exclusively). Exhibit 1B shows that by 2017, the percentage of FFVs using E85 fuel would have to exceed 100%. This result implies that FFV sales would have to expand considerably beyond those projected in *AEO* 2013.

Overall, the analysis indicates that compliance with the EISA through expansion of E85 consumption would require a rapid and substantial expansion in the production and use of E85, a corresponding expansion in the supply of imported sugarcane ethanol, and an infeasibly high degree of E85 use by the projected FFV fleet.

Scenario 1C: EISA volume standards, expansion of E85, expansion of FAME to 5 vol%, AEO cellulosic biofuel volumes

The results for Scenario 1C are shown in **Exhibit 1C**. The analysis represents compliance through a combination of E85 fuel expansion and FAME expansion up to B5, with cellulosic biofuels held at levels projected in *AEO 2013*.

As in Scenarios 1A and 1B, carry-over RINs would be consumed in 2013 and 2014 to assist in compliance. The E10 blendwall would be reached in 2015, and ethanol's share of the gasoline pool would increase from about 11.5 vol% in 2015 to 18.5 vol% by 2020.

Relative to Scenario 1B, the expansion in FAME use to 5 vol% of the diesel pool would delay reaching the E10 blendwall and reduce the call for E85. However, the results shown in Exhibit 1C indicate that meeting the EISA volume standards with this approach would still require large volumes of E85, sugarcane ethanol imports, and FAME use. Furthermore, as in Scenario 1B, the required volumes of E85 could not be supported by the prospective fleet of FFVs; by 2019 the projected FFV fleet would not be able to use the required E85 volumes.

3.2 Scenario 2: EISA volume schedule of total Renewable Fuel and Advanced Biofuel adjusted for reductions in Cellulosic Biofuel.

In this scenario, EPA would modify the annual total renewable fuel and advanced biofuel volume standards to account for cellulosic biofuel being available only in volumes significantly

[5] FFVs' prospective annual share of gasoline use (in BTUs) was calculated using estimated vehicle stocks as of 2009, reported vehicle (and FFV) sales for 2010 to 2012, *AEO* forecast vehicle (and FFV) sales for 2013 and after, vehicle survival rates, estimates of VMT by vehicle vintage, and reported and forecast vehicle fuel economy.

lower than those contemplated in EISA. Annual cellulosic biofuel volume standards (and the split between ethanol and diesel) are set at the volumes forecast in the *AEO 2013* Reference case.

For example, EISA sets the cellulosic biofuel volume standard in 2016 at 4.25 billion ethanol-equivalent gallons, whereas *AEO 2013* projects cellulosic biofuel production for 2016 of about 0.38 billion ethanol-equivalent gallons, yielding a delta cellulosic biofuel volume of about 3.87 billion ethanol-equivalent gallons. Subtracting the delta cellulosic biofuel volume from the 2016 EISA renewable fuel volume standard of 22.25 B gal/y and the advanced biofuel volume standard of 7.25 B gal/y yields adjusted volume standards of 18.38 B gal/y and 3.38 B gal/y, respectively.

For 2014, this procedure yields total renewable fuel and advanced biofuel volume standards lower than those already proposed by EPA for 2013. Consequently, the volume standards proposed by EPA for 2013 are assumed to be imposed for 2014 (and in 2015 for advanced biofuel). The volume standards in later years reflect the EISA schedule with cellulosic biofuel backed out.

Scenario 2A. Adjusted EISA volume standards, unrestricted expansion of FAME, no expansion of E85, AEO cellulosic biofuel volumes

The results for Scenario 2A are shown in **Exhibit 2A** As in Scenario1A, the analysis represents unrestricted expansion of FAME production as required to avoid exceeding the E10 blendwall.

Under this approach, FAME use would begin to expand in 2015, by which time the gasoline pool is saturated with ethanol (2012) and carry-over RINs have been exhausted (2014). By 2017, FAME blending would exceed the current 5% blending limit in diesel fuel, and FAME production would have to reach 3.6 B gal/y, over 50% higher than the reported current FAME nameplate capacity of about 2.2 B gal/y. By 2020, FAME would have to account for about 6.5 vol% of the distillate pool to enable compliance with the RFS volume standards, which exceeds the current blending limit of 5 vol%.

Scenario 2B: Adjusted EISA volume standards, expansion of E85, no expansion of FAME, AEO cellulosic biofuel volumes

The results for Scenario 2B are shown in **Exhibit 2B**. As in Scenario 1B, the analysis represents expansion of E85 use as required to avoid exceeding the E10 blendwall, with FAME use held constant at 1.28 B gal/y and carry-over RINs consumed by 2015.

Under this approach, the E10 blendwall would be reached in 2015, even with the EISA volume standards reduced to reflect the shortfall in cellulosic biofuel supply. E85 fuel demand would have to grow from 0.02 B gal/y in 2013 to ~ 3.5 B gal/y in 2015 and ~ 7.3 B gal/y in 2020.

As indicated in Exhibit 2B, over half of the fuel used by the projected FFV fleet would have to be E85 by 2019. Reaching this level of E85 use would call for a significant change in consumer behavior. Similarly, sugar cane ethanol imports would have to double by 2016 vs. 2012 and grow to 2.25 B gal/y in 2019. These levels far exceed historical imports of sugar cane ethanol from Brazil.

Scenario 2C: Adjusted EISA volume standards, expansion of E85, expansion of FAME to 5 vol %, AEO cellulosic biofuel volumes

The results for Scenario 2C are shown in **Exhibit 2C**. In this scenario, carry-over RINs would be consumed by 2014 to assist in compliance. Expanded FAME blending – to 2.9 B gal/y in 2015 and 3.4 B gal/y in 2017 – would delay reaching the E10 blendwall until 2017. The current 5 vol% blending limit for FAME would be reached by 2017. Ethanol's share of the gasoline pool would increase from slightly over 10 vol% in 2017 to about 11 vol% by 2020.

The analysis of Scenarios 2A, 2B, 2C indicates that compliance with the EISA standards, even if they were to be adjusted to reflect the shortfall in cellulosic biofuel supply, would require rapid expansion in the production and use of either FAME or E85. The required expansion in FAME production and use would require going beyond the 5 vol% limit on FAME blending in diesel fuel. The required expansion in E85 use would require corresponding expansion in the supply of imported sugarcane ethanol, and an infeasibly high degree of E85 use by the projected FFV fleet.

3.3 Scenario 3: Derived RFS schedule that maximizes ethanol use without exceeding the E10 blendwall.

In this scenario, the gasoline pool is entirely E10 (with *de minimis* volumes of E85), and the annual RFS volume standards are calculated to be consistent with this level of ethanol use, given the *AEO 2013* Reference case projections of gasoline use. For this calculation, the biomass-based diesel volume standard are held at 1.28 billion physical gallons (the 2013 standard); all available carry-over RINs are used in 2013 and 2014 (and are incorporated in the computed renewable fuel volume standards for those years). In Scenario 3A, cellulosic biofuel volume standards are set at zero; in Scenario 3B, cellulosic volume standards are consistent with *AEO 2013* Reference case projections of cellulosic biofuel use.

Scenario 3A: Maximum ethanol use without exceeding the E10 blendwall, no FAME expansion, no cellulosic biofuel volumes

In this scenario, the annual cellulosic biofuel volume standards are set at zero.

Scenario 3B: Maximum ethanol use without exceeding the E10 blendwall, no FAME expansion, and AEO 2013 cellulosic biofuel volumes

In this scenario, the annual cellulosic biofuel volume standards (and the split between cellulosic ethanol and diesel) are set at the volumes forecast in the *AEO 2013* Reference case.

The results for Scenarios 3A and 3B are shown in **Exhibits 3A and 3B**. As the exhibits indicate, the results of the two scenarios are similar. The projected total annual volumes of ethanol are the same in the two scenarios. The relative shares of corn, sugarcane, and cellulosic ethanol in the two scenarios differ only slightly (reflecting the availability of small projected volumes of cellulosic ethanol in Scenario 3B). Similarly, the calculated volume standards differ slightly between the two scenarios, reflecting the availability of small volumes of cellulosic biofuel (ethanol and diesel) in Scenario 3B.

The estimated combined volume of corn, sugarcane, and cellulosic ethanol would be about 13.4 billion gallons in 2013 and would decline thereafter to about 12.7 billion gallons in 2020 (in response to forecast declines in gasoline use). The calculated annual total renewable volume standards are higher in 2013 and 2014 than in other years because carry-over RINs are assumed to be used in 2013 and 2014: 60% of the inventory in 2013 and the balance in 2014.

* * * * * * * * * *

Exhibits 4 and 5 (at the very end of the report) show, in graphical form, the estimated annual volumes of FAME and E85 required for compliance with the RFS standards in the various scenarios analyzed.

Exhibit 4 shows (i) the annual profiles of FAME volumes in Scenarios 1A, 1C, 2A, and 2C and (ii) the current total U.S. nameplate capacity for FAME production, as reported by EIA.

Exhibit 5 shows (i) the annual profiles of E85 volumes in Scenarios 1B, 1C, 2B, and 2C.

4. Conclusions

The primary conclusions from this analysis are:

- Use of carry-over RINs alone can delay some of the consequences of the ethanol blendwall to 2014, but not beyond.

- Subsequently, steep and likely unattainable increases in either E85 use or biomass-based diesel (FAME) use would be required to meet the RFS volume standards.

- Expanded use of FAME, to generate excess D4 RINs, could delay reaching the ethanol blendwall after carry-over RINs are exhausted. But the likelihood and extent of the delay depends on the annual volume standards established by EPA and the extent to which FAME production and use can be increased.

- If EPA were to increase the annual volume standards in response to expanded FAME production, such increases would negate some or all of the compliance benefits associated with increased use of FAME, thereby limiting the extent to which increased use of FAME could avoid or delay reaching the E10 blendwall.

- With FAME use is limited to 5 vol% of the distillate pool, EPA's continued use of the EISA volume schedule for renewable fuel and advanced biofuel likely would result in reaching the ethanol blendwall in 2015.

- When the ethanol blendwall is reached (with limited FAME expansion), the volume of E85 necessary to generate sufficient RINs for compliance with the renewable fuel volume standards would require rapid, large expansion in the availability of E85 and in the number of FFVs using E85. In most of the cases studied, the necessary expansions would be beyond what might be considered feasible.

- Annual volume standards can be set that maximize ethanol use subject to the practical constraints imposed by the E10 blendwall. Such volume standards would facilitate compliance with RFS requirements.

Exhibit 1A: EISA Volume Standards, Unrestricted Expansion of FAME, No Expansion of E85, *AEO* Cellulosic Biofuel Volumes

Category	2012	2013	2014	2015	2016	2017	2018	2019	2020
E10 Blendwall Reached									
RFS Volume Schedule (B EOH equiv gal)[1]									
Renewable	15.20	16.55	18.12	20.50	22.25	24.00	26.00	28.00	30.00
Advanced Biofuel	2.00	2.75	3.75	5.50	7.25	9.00	11.00	13.00	15.00
Biomass-Based Diesel (B physical gal)	1.00	1.28	1.28	1.28	1.28	1.28	1.28	1.28	1.28
Cellulosic	0.010	0.014	0.281	0.313	0.381	0.401	0.426	0.457	0.494
Use of Carry-over RINs (MM EOH equiv gal)		**1,036**	**1,550**	**0**	**0**	**0**	**0**	**0**	**0**
Renewable (D6)		1036	1061	0	0	0	0	0	0
Advanced Biofuel (D5)		0	175	0	0	0	0	0	0
Biomass-Based Diesel (D4)		0	315	0	0	0	0	0	0
Cellulosic (D3 & D7)		0.000	0.022	0.000	0.000	0.000	0.000	0.000	0.000
Carry-over RIN Inventory (MM EOH equiv gal)	**2,587**	**1,550**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Renewable (D6)	2,097	1061	0	0	0	0	0	0	0
Advanced Biofuel (D5)	175	175	0	0	0	0	0	0	0
Biomass-Based Diesel (D4)	315	315	0	0	0	0	0	0	0
Cellulosic (D3 & D7)	0.022	0.022	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Physical Volumes of Biofuels (B gal)									
Ethanol									
Corn	12.6	12.8	12.5	12.2	12.2	12.1	12.0	11.9	11.8
Sugar Cane	0.46	0.64	0.46	0.64	0.64	0.64	0.64	0.64	0.64
Cellulosic	0.000	0.006	0.234	0.234	0.234	0.234	0.234	0.234	0.234
Diesel									
FAME	0.0	1.2	2.0	4.7	5.8	7.0	8.3	9.7	11.1
Non-co-processed	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Co-processed	0.0	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2
Cellulosic	0.00	0.00	0.03	0.05	0.09	0.10	0.11	0.13	0.15
Volumes of Finished Fuels (MM b/d)									
Gasoline									
E0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
E10		8.7	8.6	8.5	8.5	8.5	8.4	8.3	8.3
E85		0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Ethanol Share of Pool (Vol %)		10.0%	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%
Distillate, including biodiesel (MM b/d)		4.0	4.1	4.2	4.3	4.3	4.3	4.4	4.4
FAME Share (Vol %)		2.0%	3.2%	7.0%	8.6%	10.2%	12.1%	14.0%	15.9%
FAME Share > 5% (X)				X	X	X	X	X	X
FFV Detail									
Share of Light Duty Vehicle Sales	7.5%	8.4%	8.7%	8.5%	8.6%	8.5%	8.3%	8.1%	8.0%
Share of Light Duty Vehicle Stock	5.0%	5.4%	5.9%	6.3%	6.6%	7.0%	7.3%	7.5%	7.8%
Required Percentage of FFVs Using E85	-	-	-	-	-	-	-	-	-
Insufficient FFVs to Absorb E85 (X)									
E85 Volume (B gal/y)		0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02

1 Annual biofuel volume standards set by EPA: 2012-2013 -- actual; 2014 & after -- projected.

Exhibit 1B: EISA Volume Standards, Expansion of E85, No Expansion of FAME, *AEO* Cellulosic Biofuel Volumes

Category	2012	2013	2014	2015	2016	2017	2018	2019	2020
E10 Blendwall Reached			X	X	X	X	X	X	X
RFS Volume Schedule (B EOH equiv gal)[1]									
Renewable	15.20	16.55	18.12	20.50	22.25	24.00	26.00	28.00	30.00
Advanced Biofuel	2.00	2.75	3.75	5.50	7.25	9.00	11.00	13.00	15.00
Biomass-Based Diesel (B physical gal)	1.00	1.28	1.28	1.28	1.28	1.28	1.28	1.28	1.28
Cellulosic	0.010	0.014	0.281	0.313	0.381	0.401	0.426	0.457	0.494
Use of Carry-over RINs (MM EOH equiv gal)		**1,036**	**1,550**	**0**	**0**	**0**	**0**	**0**	**0**
Renewable (D6)		1036	1061	0	0	0	0	0	0
Advanced Biofuel (D5)		0	175	0	0	0	0	0	0
Biomass-Based Diesel (D4)		0	315	0	0	0	0	0	0
Cellulosic (D3 & D7)		0.000	0.022	0.000	0.000	0.000	0.000	0.000	0.000
Carry-over RIN Inventory (MM EOH equiv gal)	**2,587**	**1,550**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Renewable (D6)	2,097	1061	0	0	0	0	0	0	0
Advanced Biofuel (D5)	175	175	0	0	0	0	0	0	0
Biomass-Based Diesel (D4)	315	315	0	0	0	0	0	0	0
Cellulosic (D3 & D7)	0.022	0.022	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Physical Volumes of Biofuels (B gal)									
Ethanol									
Corn	12.6	12.8	13.0	15.0	15.0	15.0	15.0	15.0	15.0
Sugar Cane	0.46	0.64	1.20	3.09	4.70	6.40	8.33	10.30	12.26
Cellulosic	0.000	0.006	0.234	0.234	0.234	0.234	0.234	0.234	0.234
Diesel									
FAME	0.9	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
Non-co-processed	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Co-processed	0.0	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2
Cellulosic	0.00	0.00	0.03	0.05	0.09	0.10	0.11	0.13	0.15
Volumes of Finished Fuels (MM b/d)									
Gasoline									
E0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
E10		8.7	8.5	8.1	8.0	7.8	7.6	7.4	7.1
E85		0.001	0.123	0.514	0.678	0.853	1.052	1.256	1.461
Ethanol Share of Pool (Vol %)		10.0%	10.9%	13.8%	15.0%	16.3%	17.8%	19.3%	20.9%
Distillate, including biodiesel (MM b/d)		4.0	4.2	4.3	4.4	4.4	4.4	4.5	4.5
FAME Share (Vol %)		2.0%	1.9%	1.8%	1.8%	1.8%	1.7%	1.7%	1.7%
FAME Share > 5% (X)									
FFV Detail									
Share of Light Duty Vehicle Sales	7.5%	8.4%	8.7%	8.5%	8.6%	8.5%	8.3%	8.1%	8.0%
Share of Light Duty Vehicle Stock	5.0%	5.4%	5.9%	6.3%	6.6%	7.0%	7.3%	7.5%	7.8%
Required Percentage of FFVs Using E85	-	-	17.2%	68.2%	85.7%	103.7%	124.1%	144.8%	166.1%
Insufficient FFVs to Absorb E85 (X)						X	X	X	X
E85 Volume (B gal/y)		0.02	1.89	7.89	10.40	13.08	16.13	19.25	22.40

1 Annual biofuel volume standards set by EPA: 2012-2013 -- actual; 2014 & after -- projected.

Exhibit 1C: EISA Volume Standards, Expansion of E85, Expansion of FAME to 5 vol%, *AEO* Cellulosic Biofuel Volumes

Category	2012	2013	2014	2015	2016	2017	2018	2019	2020
E10 Blendwall Reached				X	X	X	X	X	X
RFS Volume Schedule (B EOH equiv gal)[1]									
Renewable	15.20	16.55	18.12	20.50	22.25	24.00	26.00	28.00	30.00
Advanced Biofuel	2.00	2.75	3.75	5.50	7.25	9.00	11.00	13.00	15.00
Biomass-Based Diesel (B physical gal)	1.00	1.28	1.28	1.28	1.28	1.28	1.28	1.28	1.28
Cellulosic	0.010	0.014	0.281	0.313	0.381	0.401	0.426	0.457	0.494
Use of Carry-over RINs (MM EOH equiv gal)		**1,036**	**1,550**	**0**	**0**	**0**	**0**	**0**	**0**
Renewable (D6)		1036	1061	0	0	0	0	0	0
Advanced Biofuel (D5)		0	175	0	0	0	0	0	0
Biomass-Based Diesel (D4)		0	315	0	0	0	0	0	0
Cellulosic (D3 & D7)		0.000	0.022	0.000	0.000	0.000	0.000	0.000	0.000
Carry-over RIN Inventory (MM EOH equiv gal)	**2,587**	**1,550**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Renewable (D6)	2,097	1061	0	0	0	0	0	0	0
Advanced Biofuel (D5)	175	175	0	0	0	0	0	0	0
Biomass-Based Diesel (D4)	315	315	0	0	0	0	0	0	0
Cellulosic (D3 & D7)	0.022	0.022	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Physical Volumes of Biofuels (B gal)									
Ethanol									
Corn	12.6	12.8	12.5	14.3	15.0	15.0	15.0	15.0	15.0
Sugar Cane	0.46	0.64	0.46	0.64	1.47	3.13	5.01	6.94	8.88
Cellulosic	0.000	0.006	0.234	0.234	0.234	0.234	0.234	0.234	0.234
Diesel									
FAME	0.0	1.2	2.0	3.3	3.3	3.4	3.4	3.4	3.4
Non-co-processed	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Co-processed	0.0	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2
Cellulosic	0.00	0.00	0.03	0.05	0.09	0.10	0.11	0.13	0.15
Volumes of Finished Fuels (MM b/d)									
Gasoline									
E0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
E10		8.7	8.6	8.4	8.2	8.1	7.8	7.6	7.4
E85		0.001	0.001	0.203	0.360	0.531	0.725	0.925	1.128
Ethanol Share of Pool (Vol %)		10.0%	10.0%	11.5%	12.7%	14.0%	15.4%	16.9%	18.5%
Distillate, including biodiesel (MM b/d)		4.0	4.1	4.3	4.4	4.4	4.5	4.5	4.5
FAME Share (Vol %)		2.0%	3.2%	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%
FAME Share > 5% (X)									
FFV Detail									
Share of Light Duty Vehicle Sales	7.5%	8.4%	8.7%	8.5%	8.6%	8.5%	8.3%	8.1%	8.0%
Share of Light Duty Vehicle Stock	5.0%	5.4%	5.9%	6.3%	6.6%	7.0%	7.3%	7.5%	7.8%
Required Percentage of FFVs Using E85	-	-	-	26.9%	45.6%	64.5%	85.5%	106.6%	128.2%
Insufficient FFVs to Absorb E85 (X)								X	X
E85 Volume (B gal/y)		0.02	0.02	3.11	5.52	8.14	11.11	14.17	17.28

1 Annual biofuel volume standards set by EPA: 2012-2013 -- actual; 2014 & after -- projected.

Exhibit 2A: Adjusted EISA Volume Standards, Unrestricted Expansion of FAME, No Expansion of E85, *AEO* Cellulosic Biofuel Volumes

Category	2012	2013	2014	2015	2016	2017	2018	2019	2020
E10 Blendwall Reached									
RFS Volume Schedule (B EOH equiv gal)[1]									
Renewable	15.20	16.55	16.65	17.81	18.38	18.90	19.43	19.96	19.99
Advanced Biofuel	2.00	2.75	2.75	2.81	3.38	3.90	4.43	4.96	4.99
Biomass-Based Diesel (B physical gal)	1.00	1.28	1.28	1.28	1.28	1.28	1.28	1.28	1.28
Cellulosic	0.010	0.014	0.281	0.313	0.381	0.401	0.426	0.457	0.494
Use of Carry-over RINs (MM EOH equiv gal)		**1,036**	**1,550**	**0**	**0**	**0**	**0**	**0**	**0**
Renewable (D6)		1036	1061	0	0	0	0	0	0
Advanced Biofuel (D5)		0	175	0	0	0	0	0	0
Biomass-Based Diesel (D4)		0	315	0	0	0	0	0	0
Cellulosic (D3 & D7)		0.000	0.022	0.000	0.000	0.000	0.000	0.000	0.000
Carry-over RIN Inventory (MM EOH equiv gal)	**2,587**	**1,550**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Renewable (D6)	2,097	1061	0	0	0	0	0	0	0
Advanced Biofuel (D5)	175	175	0	0	0	0	0	0	0
Biomass-Based Diesel (D4)	315	315	0	0	0	0	0	0	0
Cellulosic (D3 & D7)	0.022	0.022	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Physical Volumes of Biofuels (B gal)									
Ethanol									
Corn	12.6	12.8	12.5	12.2	12.2	12.1	12.0	11.9	11.8
Sugar Cane	0.46	0.64	0.46	0.64	0.64	0.64	0.64	0.64	0.64
Cellulosic	0.000	0.006	0.234	0.234	0.234	0.234	0.234	0.234	0.234
Diesel									
FAME	0.0	1.2	1.0	2.9	3.2	3.6	3.9	4.3	4.4
Non-co-processed	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Co-processed	0.0	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2
Cellulosic	0.00	0.00	0.03	0.05	0.09	0.10	0.11	0.13	0.15
Volumes of Finished Fuels (MM b/d)									
Gasoline									
E0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
E10		8.7	8.6	8.5	8.5	8.5	8.4	8.3	8.3
E85		0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Ethanol Share of Pool (Vol %)		10.0%	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%
Distillate, including biodiesel (MM b/d)		4.0	4.2	4.2	4.2	4.3	4.3	4.4	4.4
FAME Share (Vol %)		2.0%	1.6%	4.3%	4.8%	5.3%	5.7%	6.3%	6.4%
FAME Share > 5% (X)						X	X	X	X
FFV Detail									
Share of Light Duty Vehicle Sales	7.5%	8.4%	8.7%	8.5%	8.6%	8.5%	8.3%	8.1%	8.0%
Share of Light Duty Vehicle Stock	5.0%	5.4%	5.9%	6.3%	6.6%	7.0%	7.3%	7.5%	7.8%
Required Percentage of FFVs Using E85	-	-	-	-	-	-	-	-	-
Insufficient FFVs to Absorb E85 (X)									
E85 Volume (B gal/y)		0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02

1 Annual biofuel volume standards set by EPA: 2012-2013 -- actual; 2014 & after -- projected.

Exhibit 2B: Adjusted EISA Volume Standards, Expansion of E85, No Expansion of FAME, *AEO* Cellulosic Biofuel Volumes

Category	2012	2013	2014	2015	2016	2017	2018	2019	2020
E10 Blendwall Reached				X	X	X	X	X	X
RFS Volume Schedule (B EOH equiv gal)[1]									
Renewable	15.20	16.55	16.65	17.81	18.38	18.90	19.43	19.96	19.99
Advanced Biofuel	2.00	2.75	2.75	2.81	3.38	3.90	4.43	4.96	4.99
Biomass-Based Diesel (B physical gal)	1.00	1.28	1.28	1.28	1.28	1.28	1.28	1.28	1.28
Cellulosic	0.010	0.014	0.281	0.313	0.381	0.401	0.426	0.457	0.494
Use of Carry-over RINs (MM EOH equiv gal)		**1,036**	**1,317**	**233**	**0**	**0**	**0**	**0**	**0**
Renewable (D6)		1036	1061	0	0	0	0	0	0
Advanced Biofuel (D5)		0	175	0	0	0	0	0	0
Biomass-Based Diesel (D4)		0	82	233	0	0	0	0	0
Cellulosic (D3 & D7)		0.000	0.022	0.000	0.000	0.000	0.000	0.000	0.000
Carry-over RIN Inventory (MM EOH equiv gal)	**2,587**	**1,550**	**233**	**0**	**0**	**0**	**0**	**0**	**0**
Renewable (D6)	2,097	1061	0	0	0	0	0	0	0
Advanced Biofuel (D5)	175	175	0	0	0	0	0	0	0
Biomass-Based Diesel (D4)	315	315	233	0	0	0	0	0	0
Cellulosic (D3 & D7)	0.022	0.022	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Physical Volumes of Biofuels (B gal)									
Ethanol									
Corn	12.6	12.8	12.8	14.8	15.0	15.0	15.0	15.0	15.0
Sugar Cane	0.46	0.64	0.20	0.40	0.83	1.30	1.76	2.26	2.25
Cellulosic	0.000	0.006	0.234	0.234	0.234	0.234	0.234	0.234	0.234
Diesel									
FAME	0.9	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
Non-co-processed	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Co-processed	0.0	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2
Cellulosic	0.00	0.00	0.03	0.05	0.09	0.10	0.11	0.13	0.15
Volumes of Finished Fuels (MM b/d)									
Gasoline									
E0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
E10		8.7	8.6	8.4	8.3	8.2	8.1	8.0	7.9
E85		0.001	0.001	0.226	0.297	0.351	0.404	0.463	0.474
Ethanol Share of Pool (Vol %)		10.0%	10.0%	11.7%	12.2%	12.6%	13.0%	13.5%	13.6%
Distillate, including biodiesel (MM b/d)		4.0	4.2	4.3	4.4	4.4	4.4	4.5	4.5
FAME Share (Vol %)		2.0%	1.9%	1.8%	1.8%	1.8%	1.7%	1.7%	1.7%
FAME Share > 5% (X)									
FFV Detail									
Share of Light Duty Vehicle Sales	7.5%	8.4%	8.7%	8.5%	8.6%	8.5%	8.3%	8.1%	8.0%
Share of Light Duty Vehicle Stock	5.0%	5.4%	5.9%	6.3%	6.6%	7.0%	7.3%	7.5%	7.8%
Required Percentage of FFVs Using E85	-	-	-	30.0%	37.5%	42.6%	47.6%	53.4%	53.9%
Insufficient FFVs to Absorb E85 (X)									
E85 Volume (B gal/y)		0.02	0.02	3.47	4.55	5.37	6.19	7.09	7.27

1 Annual biofuel volume standards set by EPA: 2012-2013 -- actual; 2014 & after -- projected.

Exhibit 2C: Adjusted EISA Volume Standards, Expansion of E85, Expansion of FAME to 5 vol%, *AEO* Cellulosic Biofuel Volumes

Category	2012	2013	2014	2015	2016	2017	2018	2019	2020
E10 Blendwall Reached						X	X	X	X
RFS Volume Schedule (B EOH equiv gal)[1]									
Renewable	15.20	16.55	16.65	17.81	18.38	18.90	19.43	19.96	19.99
Advanced Biofuel	2.00	2.75	2.75	2.81	3.38	3.90	4.43	4.96	4.99
Biomass-Based Diesel (B physical gal)	1.00	1.28	1.28	1.28	1.28	1.28	1.28	1.28	1.28
Cellulosic	0.010	0.014	0.281	0.313	0.381	0.401	0.426	0.457	0.494
Use of Carry-over RINs (MM EOH equiv gal)		**1,036**	**1,550**	**0**	**0**	**0**	**0**	**0**	**0**
Renewable (D6)		1036	1061	0	0	0	0	0	0
Advanced Biofuel (D5)		0	175	0	0	0	0	0	0
Biomass-Based Diesel (D4)		0	315	0	0	0	0	0	0
Cellulosic (D3 & D7)		0.000	0.022	0.000	0.000	0.000	0.000	0.000	0.000
Carry-over RIN Inventory (MM EOH equiv gal)	**2,587**	**1,550**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Renewable (D6)	2,097	1061	0	0	0	0	0	0	0
Advanced Biofuel (D5)	175	175	0	0	0	0	0	0	0
Biomass-Based Diesel (D4)	315	315	0	0	0	0	0	0	0
Cellulosic (D3 & D7)	0.022	0.022	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Physical Volumes of Biofuels (B gal)									
Ethanol									
Corn	12.6	12.8	12.5	12.2	12.2	12.4	12.8	13.3	13.2
Sugar Cane	0.46	0.64	0.46	0.64	0.64	0.64	0.64	0.64	0.64
Cellulosic	0.000	0.006	0.234	0.234	0.234	0.234	0.234	0.234	0.234
Diesel									
FAME	0.0	1.2	1.0	2.9	3.2	3.4	3.4	3.4	3.4
Non-co-processed	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Co-processed	0.0	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2
Cellulosic	0.00	0.00	0.03	0.05	0.09	0.10	0.11	0.13	0.15
Volumes of Finished Fuels (MM b/d)									
Gasoline									
E0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
E10		8.7	8.6	8.5	8.5	8.4	8.4	8.2	8.2
E85		0.001	0.001	0.001	0.001	0.028	0.077	0.131	0.141
Ethanol Share of Pool (Vol %)		10.0%	10.0%	10.0%	10.0%	10.2%	10.6%	11.0%	11.1%
Distillate, including biodiesel (MM b/d)		4.0	4.2	4.2	4.2	4.3	4.4	4.4	4.4
FAME Share (Vol %)		2.0%	1.6%	4.3%	4.8%	5.0%	5.0%	5.0%	5.0%
FAME Share > 5% (X)									
FFV Detail									
Share of Light Duty Vehicle Sales	7.5%	8.4%	8.7%	8.5%	8.6%	8.5%	8.3%	8.1%	8.0%
Share of Light Duty Vehicle Stock	5.0%	5.4%	5.9%	6.3%	6.6%	7.0%	7.3%	7.5%	7.8%
Required Percentage of FFVs Using E85	-	-	-	-	-	3.4%	9.0%	15.2%	16.0%
Insufficient FFVs to Absorb E85 (X)									
E85 Volume (B gal/y)		0.02	0.02	0.02	0.02	0.43	1.17	2.02	2.16

1 Annual biofuel volume standards set by EPA: 2012-2013 -- actual; 2014 & after -- projected.

Exhibit 3A: Maximum Ethanol Use without Exceeding the E10 Blendwall, No FAME Expansion, No Cellulosic Biofuel Volumes

Category	2012	2013	2014	2015	2016	2017	2018	2019	2020
E10 Blendwall Reached									
RFS Volume Schedule (B EOH equiv gal)[1]									
Renewable	15.20	17.06	16.32	15.22	15.24	15.19	15.15	15.05	14.93
Advanced Biofuel	2.00	2.75	2.75	2.75	2.83	2.85	2.89	2.89	2.90
Biomass-Based Diesel (B physical gal)	1.00	1.28	1.28	1.28	1.28	1.28	1.28	1.28	1.28
Cellulosic	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Carry-over RINs (MM EOH equiv gal)									
Use		1.6	1.0	0.0	0.0	0.0	0.0	0.0	0.0
Inventory	2.6	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Physical Volume of Biofuels (B gal)									
Ethanol									
Corn		12.8	12.5	12.5	12.4	12.3	12.3	12.2	12.0
Sugar Cane		0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65
Cellulosic		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Diesel									
FAME		1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
Non-co-processed		0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Co-processed		0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2
Cellulosic		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fuel Volumes (MM b/d)									
Gasoline									
E0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
E10		8.7	8.6	8.5	8.5	8.5	8.4	8.3	8.3
E10+									
E85		0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Distillate, including biodiesel (MM b/d)		4.0	4.2	4.3	4.4	4.4	4.4	4.5	4.5
FAME Share (%)		2.0%	1.9%	1.8%	1.8%	1.8%	1.7%	1.7%	1.7%

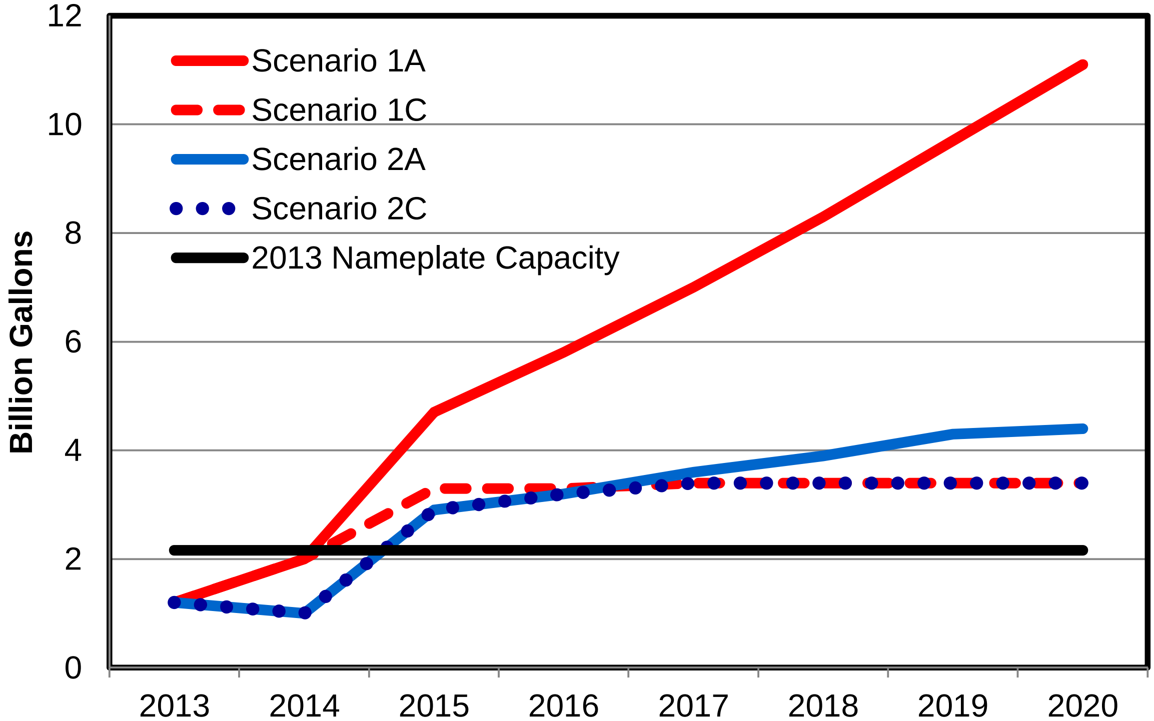
1 Annual biofuel volume standards set by EPA: 2012 -- actual; 2013 & after -- projected

Exhibit 3B: Maximum Ethanol Use without Exceeding the E10 Blendwall, No FAME Expansion, *AEO* Cellulosic Biofuel Volumes

Category	2012	2013	2014	2015	2016	2017	2018	2019	2020
E10 Blendwall Reached									
RFS Volume Schedule (B EOH equiv gal)[1]									
Renewable	15.20	17.07	16.36	15.30	15.38	15.36	15.34	15.28	15.20
Advanced Biofuel	2.00	2.75	3.02	3.05	3.19	3.24	3.31	3.34	3.38
Biomass-Based Diesel (B physical gal)	1.00	1.28	1.28	1.28	1.28	1.28	1.28	1.28	1.28
Cellulosic	0.01	0.01	0.28	0.31	0.38	0.40	0.43	0.46	0.49
Carry-over RINs (MM EOH equiv gal)									
Use		1.6	1.0	0.0	0.0	0.0	0.0	0.0	0.0
Inventory	2.6	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Physical Volume of Biofuels (B gal)									
Ethanol									
Corn		12.8	12.3	12.2	12.2	12.1	12.0	11.9	11.8
Sugar Cane		0.64	0.64	0.64	0.64	0.64	0.64	0.64	0.64
Cellulosic		0.01	0.23	0.23	0.23	0.23	0.23	0.23	0.23
Diesel									
FAME		1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
Non-co-processed		0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Co-processed		0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2
Cellulosic		0.00	0.03	0.05	0.09	0.10	0.11	0.13	0.15
Fuel Volumes (MM b/d)									
Gasoline									
E0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
E10		8.7	8.6	8.5	8.5	8.5	8.4	8.3	8.3
E10+									
E85		0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Distillate, including biodiesel (MM b/d)		4.0	4.2	4.3	4.4	4.4	4.4	4.5	4.5
FAME Share (%)		2.0%	1.9%	1.8%	1.8%	1.8%	1.7%	1.7%	1.7%

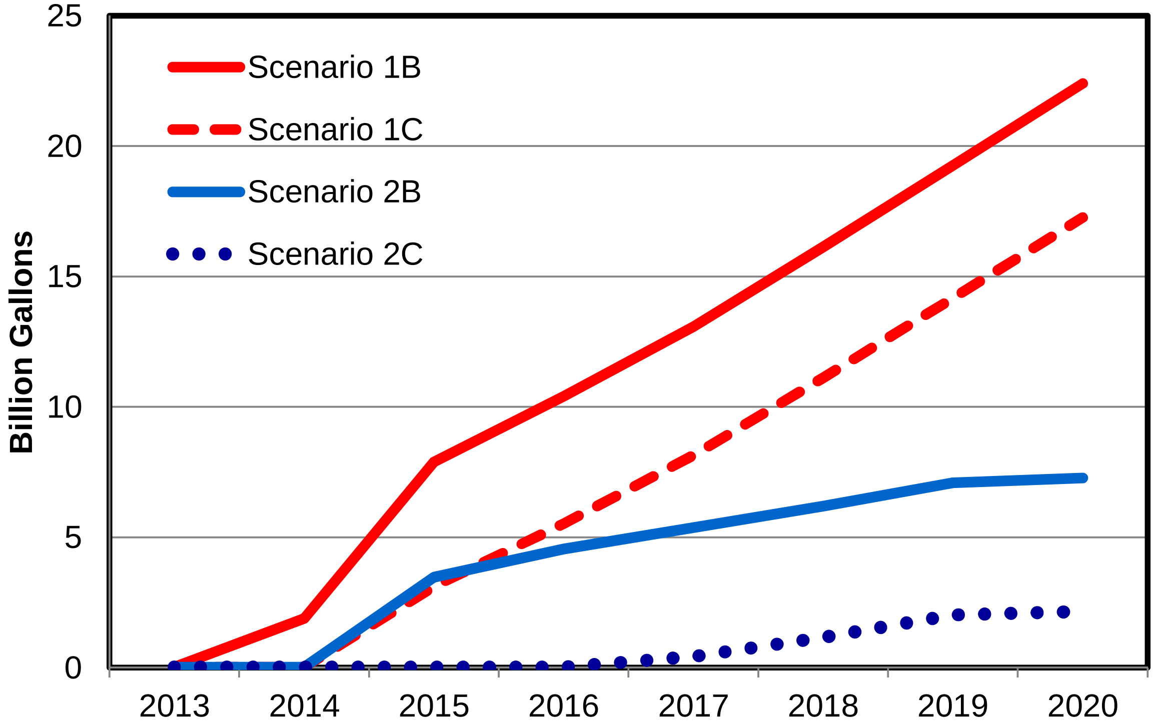
1 Annual biofuel volume standards set by EPA: 2012 -- actual; 2013 & after -- projected

Exhibit 4: FAME Volume, by Scenario



Note: 2013 nameplate capacity from EIA website.

Exhibit 5: E85 Volume, by Scenario



Note: E85 use in 2012 was on the order of 0.1 B gallons (*AEO 2013*).

Appendix B

AFPM letter to EIA letter (November 2013)

Richard Moskowitz
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November 22, 2013

The Honorable Adam Sieminski
U.S. Energy Information Administration, E1-1
1000 Independence Avenue, S.W.
Washington, DC 20585

Re: Volumetric Estimates for 2014 Renewable Fuel Standard

Dear Administrator Sieminski:

The American Fuel & Petrochemical Manufacturers (AFPM)[1] is writing to inform you that the Energy Information Administration (EIA) has failed to comply with section 211(o)(3)(A) of the federal Clean Air Act (CAA). That section requires EIA to provide the Environmental Protection Agency (EPA) with information needed to implement the federal renewable fuel standard (RFS).

> Not later than October 31 of each of calendar years 2005 through 2021, the Administrator of the Energy Information Administration shall provide to the Administrator of the Environmental Protection Agency an estimate, with respect to the following calendar year, of the volumes of transportation fuel, biomass-based diesel, and cellulosic biofuel projected to be sold or introduced into commerce in the United States.[2]

In prior years EIA has complied with this requirement; however, as of the date of this letter, EIA has not provided EPA with these volumetric estimates for the 2014 compliance period.

In the November 20, 2013 edition of *This Week In Petroleum,* EIA acknowledged its statutory obligation to provide EPA with fuel consumption and production estimates for 2014, but indicated that it would do so “in the month before issuance of EPA’s final RFS rulemaking

[1] The American Fuel & Petrochemical Manufacturers is a national trade association of more than 400 companies. Its members are obligated parties under the Renewable Fuel Standard (“RFS”) and include virtually all U.S. refiners and petrochemical manufacturers. AFPM members supply consumers with a wide variety of products and services used daily in their homes and businesses. These products include gasoline, diesel fuel, home heating oil, jet fuel, lubricants and the chemicals that serve as “building blocks” in making diverse products, such as plastics, clothing, medicine and computers.

[2] 42 U.S.C. § 7545(o)(3)(A).

for each program year."[3] This is a significant and impermissible rewrite of EIA's statutory obligation. The law is unambiguous and requires EIA to provide this estimate "not later than October 31."

The timely generation of this information is needed for EPA's promulgation of annual requirements for obligated parties under the RFS. CAA section 211(o)(3(B)(i) requires the Administrator of EPA to determine the annual renewable fuel obligation "based on" this estimate. Thus, the failure to provide this information to EPA in accordance with the statutory deadline has resulted in errors in the recently signed notice of proposed rulemaking.[4] For example, EPA has not utilized correct or even consistent estimates for diesel consumption. Nor has EPA explained how its estimates for cellulosic production differ from those derived by EIA's experts.

We ask that you look into this matter and correct this legal deficiency. We also ask that you provide us with a copy of the letter you will send to EPA, as the data it contains is necessary for us to provide informed comments at the RFS public hearing on December 5.

If you have any questions concerning this matter, please contact me at (202) 552-8474.

Respectfully submitted,

Richard Moskowitz
General Counsel
American Fuel & Petrochemical Manufacturers

[3] *See* U.S. Energy Information Administration, "EPA proposes 2014 Renewable Fuel Standard, with EIA to provide input to the final rule," *This Week In Petroleum*, (November 20, 2013), http://www.eia.gov/oog/info/twip/twip.asp

[4] A prepublication copy of EPA's proposed rule "2014 Standards for the Renewable Fuel Standard Program" is available at: http://www.epa.gov/otaq/fuels/renewablefuels/documents/rfs-2014-standards-nprm-11-15-13.pdf

Appendix C

“Analysis and critical review of Monte Carlo simulation and decision analysis in EPA’s 2014 RFS proposed rule”

Prepared for the American Petroleum Institute
by Professor Robert T. Clemen
January 16, 2014

Analysis and critical review of Monte Carlo simulation and decision analysis in EPA's 2014 RFS proposed rule

Prepared for the American Petroleum Institute

by

Professor Robert T. Clemen
January 16, 2014

Executive Summary

A critical review of EPA's 2014 RFS proposed rule revealed the following:

1. In its Proposed Rule for the 2014 Standards for the Renewable Fuel Standards (RFS) Program, EPA describes a methodology for developing the proposed standards. The methodology involves developing ranges and probability distributions for renewable fuel production and using the probability distributions as inputs to a Monte Carlo simulation (MCS) model that aggregates the information into a single output distribution of the possible outcomes. In general, the modeling process was performed in a manner that was technically correct. The results of the analysis have been replicated for cellulosic biofuel, total renewable fuel, and advanced biofuel, using information in the proposed rule, along with information from the memorandum by D. Korotney in the EPA docket..
2. The only general issue with the modeling relates to the way probability distributions were assigned to the various companies/facilities expected to produce cellulosic biofuel in 2014. There are two major problems. First, is that the probability that a particular facility would produce no fuel was not directly specified. The approach of assigning a lower bound (5th percentile) of zero implies that the probability of producing no fuel is the same (5%) across all facilities with the zero lower bound. This is an important modeling mistake. Especially for new facilities that were not yet producing, the probability of producing no fuel in 2014 should have been separately assessed.

   Second, the probability distributions assigned appear to ignore recent experience with cellulosic producers. In particular, the smooth six-month ramp-up period from start-up to a stable volume appears to be inconsistent with information from the two facilities that began producing in 2013, both of which appear to have experienced wide variation in production levels from month to month. Moreover, neither appears to have exceeded 10% of its capacity utilization in its first year.

   The MCS output distribution for total cellulosic fuel produced can be sensitive to the input probability distributions assigned. The proposed rule indicates 5th and 95th percentiles of 8 and 30 million gallons, respectively. However, applying more realistic probability distributions for Abengoa, DuPont, and Poet – probability of producing no fuel set to 20% for Abengoa and 40% for both DuPont and Poet; and if fuel is produced, a distribution with the 95th percentile set at 20% of the plant's nameplate capacity, prorated over months the plant is expected to be open – results in 5^{th} and 95^{th} percentiles of 4.6 and 15.4 million gallons, respectively.

In order to improve the input probability distributions for new cellulosic facilities, EPA would benefit greatly by engaging the services of professional business analysts and experts that specialize in new-technology start-ups, especially in the renewable fuel industry. In addition, for these experts the EPA may benefit by using a more formal probability elicitation procedure.

3. A specific issue in the total renewable fuel model is that the amount of ethanol used in E10 is taken to be a fixed value, based on EIA's forecast. Incorporating uncertainty into this forecast could have an impact on the output distribution.
4. The analysis appears to have been done in a straightforward, "no frills" manner. The proposed rule says nothing about whether or what kind of sensitivity analysis might have been performed. Sensitivity analysis is typically a key part of any analysis and can reveal important insights about the model. In this case, sensitivity analysis identifies Abengoa as the key driver in the cellulosic biofuel model, and biomass-based diesel as the key driver in both total renewable fuels and advanced biofuel. The extent of the potential impact of small changes in the distributions for these variables is demonstrated.
5. Given an output distribution from the MCS process, EPA requested comment on what value to choose as the standard (mean, median, mode, or another percentile.) The choice of a particular value to use as a standard should be recognized as a decision, and a "neutral methodology" would require proper cost-benefit analysis for all affected parties. Whether to use the mean, median, mode, or some other value boils down to this: EPA should do the economic analysis that would lead to a specific optimum value that can, in turn, be justified by the analysis. The agency appears to have the ability, and should be provided with adequate budgetary support, to perform such analysis as part of the proposed rule. The selected value would then be more than an arbitrary point chosen from the distribution but would be defensible on economic grounds.

Disclaimer

The American Petroleum Institute (API) engaged Professor Robert Clemen to perform an independent analysis of EPA's proposed rule for the 2014 Renewable Fuel Standards. Professor

Clemen conducted this analysis and prepared this report with reasonable care and skill, utilizing methods consistent with best industry practice. No other representations or warranties, expressed or implied, are made by Professor Clemen. All results and observations are based on information available at the time of this report. To the extent that additional information becomes available or the factors upon which the analysis is based change, the analytical results and opinions expressed could be substantially affected.

1. Introduction

In its Proposed Rule for the 2014 Standards for the Renewable Fuel Standards (RFS) Program, EPA describes a methodology for developing the proposed standards. The methodology involves identifying input variables relating to the supply and demand of renewable fuels and developing ranges and probability distributions for those variables. The individual probability distributions are used as inputs to a Monte Carlo simulation (MCS) model that aggregates the information into a single output distribution of the possible outcomes.

For example, in developing the standard for cellulosic biofuel, EPA identifies a number of potential producers of cellulosic biofuels. Because the technology for cellulosic biofuel is still developing, the quantity of fuel from each producer's facility is highly uncertain. Taking each facility one at a time, EPA uses information about that producer and facility to develop a range of possible quantities of fuel generated. The range is used to specify the 5^{th} and 95^{th} percentiles of a probability distribution with a shape that matches the producer and facility's circumstances.

Ultimately, the question is how much total cellulosic biofuel will be produced in aggregate. If we knew exactly how much fuel would come from each producer, we would simply add up the quantities. MCS provides a way to do this in a probabilistic setting, and the basic concept is straightforward: Step 1, generate a random amount of fuel from each on the input distributions. Step 2, add those amounts to get the total amount. Now repeat steps 1 and 2 many times (typically thousands). Each iteration is called a "trial," and each trial gives a different total amount. Keep track of the total amount from each of the trials, and at the end they can be assembled into an output probability distribution for the total amount of cellulosic fuel produced. EPA can then consider aspects of that distribution, such as the mean, median, and percentiles, to understand what totals may reasonably be expected to occur, and use that information in choosing a standard, in this case a required volume of cellulosic biofuel.

MCS is typically used as part of a risk or decision analysis. The example above highlights the three key steps in the MCS process:

1. First is the modeling stage. The calculation model is created, with both input and output variables identified. As deemed appropriate, probability distributions are assigned to the input variables.
2. Second is the analysis phase, in which the MCS procedure is run. In practice, though, because the inputs and the calculation model include many judgments on the part of the modeler, the analysis involves multiple runs, trying different distributions, parameters, and scenarios in order to understand how sensitive the results are to the various inputs. If the results are highly sensitive to a particular input or some aspect of the model, then that part of the model would be revisited and, if necessary, refined to ensure the model's fidelity.
3. Third is the interpretation stage, in which results of the analysis are considered and incorporated as needed into the larger risk or decision analysis. In the case of the proposed rule, the decision is what specific number to use as the standard.

In this report, I will begin with an overall assessment of the MCS methodology as used to support the proposed rule, focusing on how each of the three steps above was executed. That will be followed by comments on the three specific applications of the methodology (cellulosic biofuel, total renewable fuel, and advanced biofuel).

2. Overall Assessment

First, the MCS modeling and analysis reported in the proposed rule is "technically correct" in my opinion. That is, using information in the proposed rule, along with some details from the memorandum by David Korotney (see footnote 81 in the proposed rule), I was able to replicate the results. That is good news; it means that the methodology described in the proposed rule accurately reflects the work that was done. However, we still need to evaluate the steps in the overall process.

2.1. Modeling

Modeling is the essence of analytical work. Many judgments are used to develop a calculation model that accurately reflects the system in question and, in this case, to specify ranges and probability distributions for the input variables. Modeling is sometimes said to involve as much art as science, and to a large extent, this is true; two analysts may create very different models of a system, depending on what each one deems to be the essential aspects of the system, and experts may have different information that can lead them to specify very different probability distributions for the same variable. Ultimately, though, the question is whether the model is appropriate for the purpose at hand. A very elaborate and complex hydrological model may be necessary to understand a specific hydrologic system in detail. However, if the problem is to manage an entire watershed, then a less elaborate model that provides an overview of the watershed and focuses attention on the management issue at hand may be more useful.

In the case of the proposed rule, the calculation model is straightforward; it is a matter of adding up quantities of fuel from different sources. Only addition is used. Everyone would agree on that, and so there is no question about the appropriateness of the calculation model.

More problematic is the selection of variables (sources of fuel) and the specification of probability distributions for them. The selection of variables appears to be reasonable. In each section of the report, EPA carefully enumerates possible sources and explains why each one should or should not be incorporated into the model. For example, in the cellulosic biofuel section, certain potential producers are excluded because EPA judges it highly unlikely that they will be able to start production during 2014.

After identifying variables, EPA examines the available information about each source of fuel in the model and specifies upper and lower bounds, thereby establishing a range for the amount of fuel from each source. The range is interpreted as a 90% confidence interval. That is, EPA judges a 5% chance (1 in 20) that the amount will fall below the lower bound and similarly a 5% chance that the amount will fall above the upper bound. The upper and lower bounds are thus used to specify the 5^{th} and 95^{th} percentiles of a probability distribution for the corresponding variable.

It is fairly common practice to identify upper and lower bounds as the EPA has done. The general reasoning behind the bounds are given in detail in the proposed rule. Understanding and documenting the reasoning used is an important aspect of the process, and EPA has done so.

There are a number of possible biases in probability judgment that have been well documented by psychologists. The two that are the most problematic in this case are overconfidence and optimism. Overconfidence in assessed ranges, like those that EPA proposes, means that the ranges would be too narrow relative to the probabilities specified. Upper bounds tend to be too low, and lower bounds tend to be too high. For example, when examining all of the times an individual has assessed a 90% confidence interval, one would expect 90% of the actual values to fall inside the corresponding assessed interval. In both experiments and realistic settings, psychologists have shown that the rate is on the order of 40%-60% falling inside the so-called 90% interval. When eliciting probability ranges from an expert, an analyst will work to counteract overconfidence by getting the expert to envision extreme possibilities, thereby extending the interval range.

Is overconfidence an issue in this case? Considering the upper bounds, it appears that EPA, in examining the information available, especially for new biofuel production facilities, has considered some "extreme" possibilities on the positive side. The lower bound is a different story. EPA has specified lower bounds of 0 for several of the cellulosic biofuel producers, but has not changed the percentile. With zero as the 5th percentile, they are essentially saying that there is a 5% chance that the facility will not open. Based on my reading of their reasoning in these cases, it would be very easy to argue that the probability of not opening could vary considerably across the facilities considered. For example, the DuPont plant in Nevada, Iowa, is projected by the company to begin production in the second half of 2014, and EPA has taken as a best-case scenario that production will begin in October. However, considering the experience of other facilities (notably INEOS Bio and KiOR, both of which began producing in 2013), delays are very likely. If the best case is that production begins in October, it would seem reasonable to assign a probability much greater than 5% that the plant will not begin production in 2014.

The second bias is optimism, a natural effect when considering new technology. It is easy to get caught up in the enthusiasm and possibilities associated with future developments, and it is arguable that optimism may, to some extent, account for the overambitious standards set in the original and subsequent RFS rules. Reading only what is included in the proposed rule, it might appear that EPA has managed to avoid being overoptimistic. If anything, the bounds specified appear to be on the conservative side; arguments could have been made for higher numbers. For example, in considering cellulosic ethanol producer Poet, EPA projects an upper bound of 6 million gallons, in contrast to Poet's own projection of 7-12 million gallons. Similarly, EPA gives a lower bound of 0, reasoning that delays are common in completing and commissioning a commercial-scale cellulosic facility.

However, I will argue that EPA has indeed been overoptimistic in the ranges (and subsequent probability distributions) that it has assigned in the proposed rule. In particular, the assumption of a smooth six-month ramp-up period from zero to full production is unrealistic. Consider the experience of KiOR. In a December 23, 2013 press release, KiOR estimated that the total first-year (2013) production from its Columbus facility would be approximately 920,000 gallons, or just over 8% of the plant's nameplate capacity. Although we do not have up-to-date information from INEOS Bio regarding its Vero Beach plant, judging from RIN data taken from EPA's EMTS system, INEOS Bio cannot have produced at a higher rate than KiOR, and probably substantially less. Moreover, the RIN data, coupled with information in the proposed rule, seem to indicate that both companies experienced wide variation in production levels from month to month, circumstances not surprising given the fact that both companies are developing entirely new technologies. Taking a 10% utilization rate during the first year as a base case, then 20% would seem like a suitable "best-case" first-year utilization rate for Abengoa, DuPont, and Poet, pro-rated by the number of months out of the year that they are likely to be open. Such an approach should result in more realistic ranges and hence more appropriate probability distributions.

Having specified upper and lower bounds, the next modeling step is to assign probability distributions. As shown in Figure II.C-1 in the proposed rule, EPA chose to use only three types of distributions, normal (the classic bell-shaped curve), half-normal (the upper half of the bell-shaped curve), and skewed (a specific member from the so-called Weibull family). There are many different distribution types to choose from, and there is also the possibility of creating custom probability distributions – my MCS add-in for Excel permits me to do so quite easily. Is the choice of a particular distribution type crucial? Generally, no, especially in a case like this one, where the focus is on values that fall in the middle of the output distribution. (In some cases, for example when extreme events can lead to disastrous results, careful modeling of the tails of the input distributions can be important.) The three distributions used in the proposed rule are appropriate for the models and provide adequate flexibility.

As indicated above, the main caveats regarding the probability model relate to the cellulosic producers that have not yet begun production. First, basing the upper range on a smooth, six-month ramp-up process leads to unrealistic upper bounds and hence probability distributions with 95th percentiles that are too high. Second, in these cases zero is always the 5th percentile. In the calculation model, what this implies is that, if the random draw from an input distribution turns out to be less than zero, then it is set to zero. Thus, the probability of the facility producing no fuel, P(Vol=0), is always 5%, regardless of the situation. Thus, the fact that all facilities with a lower bound of zero have P(Vol=0) = 5% appears to be an artifact of the way ranges and probability distributions were assigned, rather than arising from careful judgment based on relevant information for each facility. In my opinion, this is an important modeling mistake. Especially for new facilities that were not yet producing, the probability of producing no fuel in 2014 should have been separately assessed. Including this probability in the MCS model is not complicated or difficult. For example, information in the proposed rule indicates that the DuPont and Poet plants are not expected to begin production until sometime in the second half of 2014. In both cases, technical difficulties could easily result in production being delayed until 2015. With this in mind, setting P(Vol=0) in the range of 30% - 50% seems plausible. As we will see below in considering the proposed cellulosic standard, the results can be quite sensitive to such changes.

One last point about the probability model is that there is no mention of the possibility that the input variables might have been correlated. Ignoring correlations is all too common in MCS analyses, and doing so can in some cases lead to substantial misrepresentation of the output uncertainty. Consider the cellulosic biofuel analysis. Although all of the businesses considered face considerable idiosyncratic risks, they all would be subject to general economic or policy conditions. For example, weak economic conditions could make investment dollars scarce for all companies. Not extending the renewable fuels tax credit could have a similar effect. How strong would the correlation be? Not particularly strong, given the large individual risks the companies face. However, a modest correlation coefficient of 0.2 is not out of the question. (While it is surprising that correlation was not mentioned, the good news, as we shall see below, is that none of the results are highly sensitive to correlation.)

It is worth mentioning here that there are established protocols for performing formal probability elicitations, and such protocols have been used many times in both public and private settings. EPA itself has used such formal procedures, notably in 2006 when eliciting expert opinion regarding the effects of PM 2.5. A National Research Council report (NRC 2002) provided guidelines for how EPA can incorporate uncertainty into its assessments. A complete, formal expert elicitation involves careful identification and selection of multiple experts; training the experts in the probability assessment process, including familiarizing them with psychological biases in probability judgment; structured 1-on-1 interviews to elicit probabilities and documenting the reasoning behind the probability judgments; and feedback to the experts to be sure they understand and confirm their responses. Such a process can be both expensive and timeconsuming and is not always feasible, nor is it always necessary. Many projects involve less formal procedures.

For the proposed rule, EPA has chosen to use a more informal process. In my opinion, this is appropriate. EPA staff should be knowledgeable about renewable fuels and have thorough access to relevant information. The proposed rule does an excellent job of reviewing the information and the reasoning behind the judgments made. Because the concern is primarily with the central portion of the output probability distribution, there is less need for careful specification of the input probability distributions. Given these circumstances, the time and expense associated with a full, formal expert elicitation was not called for. It may be beneficial to have an analyst review the probability judgments and work with those making the judgments to ensure that biases were minimized. In addition, EPA would benefit greatly by engaging the services of professional business analysts that specialize in new-technology start-ups. Doing so may have led to more careful assessments of P(Vol=0) when the lower bound was set to zero.

2.2. Analysis

As mentioned at the beginning, analysis involves more than just running the MCS procedure. In the same way that a good statistician will look at data from multiple perspectives to determine all that it has to say, a good risk or decision analyst will analyze the model in a variety of ways to develop as much insight as possible. In this case, we cannot say exactly what was or was not done; we can only see what is reported in the proposed rule. However, there are a few important insights that analysis can provide that are not mentioned. Most of these relate to sensitivity analysis of one sort or another. It is surprising, for example, that the proposed rule does not mention that the uncertainty in biomass-based diesel is the key driver in the models used for total renewable fuel and advanced biofuel. Similarly, Abengoa accounts for most of the uncertainty in cellulosic biofuel. Here is a non-exhaustive list of questions that might be answered by sensitivity analysis in this case:

- What are the key drivers of the uncertainty in each model?
- Which input distributions can be changed without affecting the outputs in any material way?
- How sensitive are the results to correlation in the variables?
- How sensitive are the results to P(Vol=0)?

- Do the specific shapes of the distributions matter?
- How do the results change if the 95th percentile is decreased? Increased?
- What if the upper and lower bounds are used to represent the 10th and 90th percentiles (a relatively common practice), instead of the 5th and 95th?

We will look at some of these possibilities when we consider each specific model below.

2.3. Interpretation and Decision Making

The decision that the EPA must make is to choose specific standards (values) for cellulosic biofuel, total renewable fuel, and advanced biofuel. The use of MCS is meant to support that in a way that allows them to incorporate their uncertainty about the various fuel sources. This is a laudable approach. The question, though, is how to use the output distribution. EPA itself seems somewhat at a loss in this respect. For each standard, the proposed rule reports the mean, median (50th percentile), mode (most "likely" value, or highest point on the curve), and the 25th and 75th percentiles. EPA proposes using the mean as the standard but requests comment on the merits of using other values.

In an interesting twist, if EPA does decide to use the mean of the output distribution, then the Monte Carlo procedure itself is not necessary. Because the calculation model involves only adding up several uncertain values, all that is required to obtain the aggregate mean is to calculate the mean of each input variable and then add up those means. The mean of the normal distribution is simply the midpoint between the assessed 5th and 95th percentiles. Calculating the mean of the skewed distribution is only slightly more difficult; the formula involves the distribution's shape and scale parameters. Calculating the mean of the half-normal distribution is similarly straightforward. The only complication would be to account for setting any negative values to zero. Doing so results in a probability mass at zero and will require modifying the standard formula for the mean of the half-normal.

Before addressing the deeper economic issues, we can consider the relative merits of the mean, median, and mode as candidate values to use as the RFS standard. The mean is a probability-weighted average of all possible values, and thus can be thought of as the most "representative" value. The median is the value that splits the range evenly in a probabilistic sense; the random value is just as likely to fall above the median as below. The mode is the most likely value; in this case, it is the high point on the output distribution. Arguments can be made in favor of all three, and each one is a reasonable choice. Personally, I prefer to use the median; I find the "just as likely to be above as below" characteristic to be compelling. In addition, the median is not affected by outliers, as is the mean. Also, the median does account for the probability distribution in a straightforward way, whereas the mode could turn out to be anywhere in the range. For the half-normal, for example, the mode is at one extreme of the range, making it questionable as a choice for a forecast. The median also represents something of a compromise; unless it coincides with the mean or mode (or both), it falls between the other two.

The language in the proposed rule suggests that the EPA is indeed looking at the standard-setting problem as a forecasting problem. As discussed in section II.D of the proposed rule, EPA is required to use a "neutral methodology" to generate a prediction of "what will actually happen." Taking that language at face value, it does sound as if the problem is to choose a single value to use as the forecast of the quantity of renewable fuel under consideration. If taken as a forecast, then the mean, median, and mode are all reasonable candidates. Although I prefer the median, the mean and the mode are just as reasonable. Moreover, for all three categories of renewable fuel, the mean, median, and mode are all relatively close.

However, I propose to re-frame the problem. The output distributions from the MCS process can be viewed as satisfactory probabilistic forecasts. When based on a carefully constructed model, expert probability assessments, and complete analysis, one could say that such probabilistic forecasts are indeed the results of a neutral methodology. These distributions represent the distillation of all available information into a reasonable probabilistic representation of the possible outcomes that may occur.

But if the output probability distribution represents the forecast, what does the selection of a particular value as a standard represent? I am sure that the EPA, as well as all of the obligated parties, understand clearly that choosing a standard is a policy decision with real economic consequences. And that begs the question, what is a "neutral methodology" for choosing a particular value? Decision analysts, management scientists, and operations researchers all would recognize this problem; it is similar to any organization's inventory problem. If the company orders too many of a particular item, it has leftovers that it may have to sell or discard at a loss. If it orders too few, it misses out on potential sales. The problem essentially boils down to balancing the costs and benefits on each side. In setting renewable fuel standards, there are likewise costs and benefits associated with each possible value that might be chosen. A careful economic analysis would quantify the costs and benefits for all affected parties, incorporating non-monetary costs and benefits as well, in order to find the value that optimizes the balance. This is no easy task. However, such cost-benefit analyses are done all the time by many governmental agencies. Even the EPA does these; when done in support of air pollution regulation, they are called Regulatory Impact Analyses. EPA's Technology Transfer Network has resources available online to support economic analyses of this nature.

Ultimately, my comment on whether to use the mean, median, mode, or some other value boils down to this: EPA should do the economic analysis that would lead to a specific optimum value that can, in turn, be justified by the analysis. The agency appears to have the ability, and should be provided with adequate budgetary support, to perform such analysis as part of the proposed rule. The selected value would then be more than an arbitrary point chosen from the distribution but would be defensible on economic grounds that would, in principle at least, make sense to everyone.

3. Detailed Comments on the Three Models

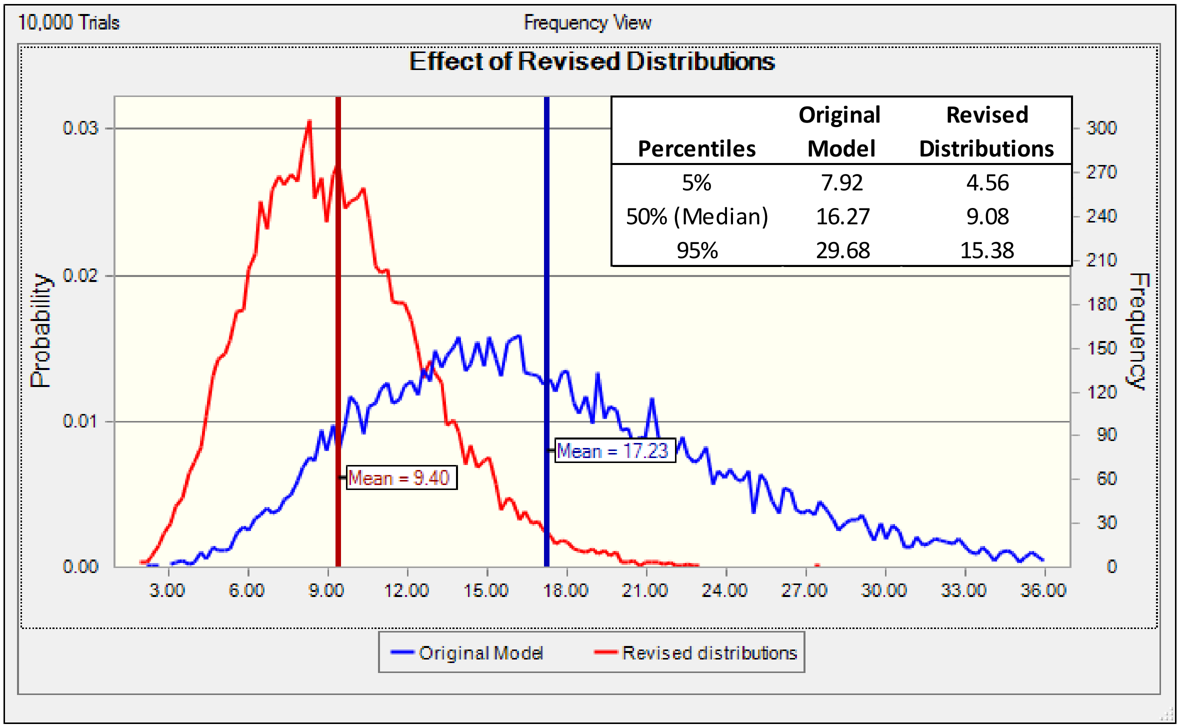
3.1. Cellulosic Biofuel

The cellulosic biofuel model suffers the most from the problem that P(Vol=0) was not carefully specified for the individual producers. As it stands, five producers with approved pathways were considered. Of these, Abengoa, DuPont, KiOR, and Poet all have 5th percentiles equal to zero, which, given the way the model was implemented, implies that P(Vol=0) = 5% for each of these producers. In contrast, CoolPlanet, Fiberight, LanzaTech, and Sweetwater were considered and excluded from the model on the grounds that none are considered in a position to produce any cellulosic biofuel in 2014. INEOS Bio was assigned a skewed distribution, and the minimum volume that distribution can generate is 1.71 million gallons, implying P(Vol=0) = 0%. So we have a situation where one producer is deemed certain to produce at least 1.71 million gallons, four are judged to have a 5% chance of producing nothing, and four are judged to have a 100% chance of producing nothing. In my opinion, this is not a satisfactory way to model the uncertainty associated with new technology and start-up firms. Surely there are aspects of the various enterprises that would indicate a finer distinction in terms of the likelihood of producing no cellulosic biofuel at all.

If the modeling suffers from the P(Vol=0) problem, it is to a large extent reprieved by the fact that Abengoa accounts for fully 72% of the variance in the aggregate total. In a distant second place is KiOR at 17%. What this implies is that Abengoa is the firm to focus on in terms of refining the probability judgment. However, relatively modest changes in Abengoa's distribution can result in meaningful changes in the aggregate distribution. For example, in the original model, the median aggregate output is 16.27 million gallons. Dropping Abengoa's 95th percentile from 18 million gallons to 16 million, an 11% decrease, results in the median aggregate output dropping to 15.71 million gallons. If in addition we increase Abengoa's P(Vol=0) from 5% to 20%, the median drops further to 14.62 million gallons. These two small changes in Abengoa's distribution have resulted in the median aggregate output dropping by over 1.6 million gallons, a 10% change. Noticing this effect that Abengoa can have on the results suggests that additional care be given to assigning Abengoa's probability distribution.

But what if we replace the three distributions for Abengoa, DuPont, and Poet with more realistic distributions as suggested above? In an experiment, I set P(Vol=0) 0.20 for Abengoa, and 0.40 for DuPont and Poet. For the 95th percentile, I assumed that Abengoa would be producing for nine months, Poet for six, and DuPont for three. (The numbers for DuPont and Poet are consistent with the timing assumptions in the proposed rule. According to a November, 2013, OPIS report, Abengoa anticipates beginning production in April, 2014.) Finally, I assumed that the best case for each of these three would be producing at 20% of capacity during those months. For INEOS Bio and KiOR, one could argue for more conservative distributions. For the purposes of the experiment, though, I chose to retain the original distributions for these two.

The results of these changes are striking, as shown by the graph below. Where my version of the original model gives 5th, 50th, and 95th percentiles of 7.92, 16.27, and 29.68 million gallons, respectively, the revised model gives 4.56, 9.08, and 15.38. (The small differences between my original model results and those in the proposed rule reflect inherent random variation in MCS.) If the mean of the output distribution were chosen as the cellulosic standard, then the changes made imply dropping the standard from 17.23 to 9.40 million gallons, a reduction by almost 45%.



The results are clearly sensitive to reasonable changes in the ranges and probabilities assigned to the producers' output. Given this sensitivity, along with the past overoptimism in EPA's forecasts of cellulosic, EPA should consider consulting business analysts that specialize in new-technology start-ups, especially for renewable fuel. In addition, it may be useful to use a more formal probability elicitation procedure with these experts.

I mentioned above that it would not be unreasonable to assign a modest correlation to the five producers, on the grounds that all are subject to common economic and policy drivers. Fortunately, the results are not highly sensitive to small correlations. Assigning a correlation of 0.2 to each pair of variables resulted in the median in the original model dropping from 16.27 to 16.09 million gallons. This change is only slightly greater than what might be expected due only to the random variation inherent in MCS. The aggregate distribution also is slightly more spread out than the original model.

3.2. Total Renewable Fuel

The model for total renewable fuel is generally good, with some quirks. In this case, the distribution for non-ethanol cellulosic amounts to the same distribution that was assigned to KiOR in the cellulosic biofuel model (because KiOR is the only firm producing non-ethanol cellulosic). And as before, there is the question of whether P(Vol=0) =0.05 is appropriate for KiOR.

The key driver of the uncertainty in total renewable fuel turns out to be biomass-based diesel. In the original model, it accounts for a whopping 88% of the uncertainty in total renewable fuel. With that much impact, we expect that even small changes will have a noticeable effect on the results. In fact, reducing biomass-based diesel's 95th percentile from 2400 to 2352 (10% of the range between the 5th and 95th percentiles) results in a slightly narrower distribution for total renewable fuel and drops the median from 15,181 to 15,166 million gallons, a change of 15 million gallons.

Given that biomass-based diesel can have this kind of impact on the aggregate distribution, it is worthwhile looking at the information that was used to develop its range and distribution, as described in Section IV.B.2.b. The lower end of the range was anchored by the 2013 standard of 1.28 billion gallons, reasoning that it would be very unlikely that less than that amount would be produced in 2014. To establish the upper end, several kinds of information were considered, including production capacity and utilization rates, whether the biodiesel tax credit would be extended through 2014, production data from EPA's Moderated Transaction System (EMTS), price and quantity forecasts for feedstocks, and an estimate of the amount of biodiesel that could be economically produced in 2014. The sources are summarized in Table IV.B.2.b-1.

Ultimately, EPA settled on a range of 1.28-1.6 billion gallons. This range is consistent with EMTS production forecasts. The arguments for these numbers appear reasonable. A half-normal distribution was used in the model, reflecting the belief that smaller volumes are more likely than larger volumes. (Note that the range and distribution were assigned under the assumption that the biodiesel tax credit would not be extended through 2014.) Nevertheless, given the potential impact of biomass-based diesel on the aggregate results, it may be appropriate to enlist additional expertise to confirm or refine this distribution.

The real surprise in the total renewable fuel model is how "Ethanol that can be consumed" is represented. The discussion on which this distribution is based focuses entirely on E85, and it comes to a reasonable conclusion that the range for E85 would be 100-300 million gallons, which corresponds to a range of 67-200 million gallons of ethanol. This range is tacked on to 12,887 million gallons of ethanol used in E10, a number that is derived from EIA's Annual Energy Outlook (AEO) forecast of total gasoline consumption in 2014 (see footnote 62). According to the proposed rule, Section IV.B.1.d, this amount of gasoline consumption is assumed to be fixed.

It is surprising that EIA's forecast would be assumed to be perfectly accurate, especially in light of its AEO forecasts over the past several years. Using past AEO reports available at EIA's website, I estimated that the AEO forecasts for gasoline consumption in 2011-2013 have erred on the high side by 3.5% - 5.5%. Given the amount of total renewable fuel involved, almost 13 billion gallons, even a modest amount of uncertainty can affect the results. I ran the model incorporating uncertainty in EIA's forecast using a normal distribution with a mean of 12,887 million gallons and standard deviation 128.87 million gallons (1% of the mean). In the original model, the median for total renewable fuel was 15,181 million gallons. With the added uncertainty, the median increased to 15,192 million gallons. Setting EIA's forecast standard deviation to 258 million gallons (2% of the mean), the median for total renewable fuel increased to 15,204 million gallons. This is a small difference in percentage terms (about 0.15%), but amounts to a change of 23 million gallons in total renewable fuel. The mean and mode show similar changes.

The real story, though, is not how the median changes, although the median is perhaps most relevant for standard setting. The dramatic change is in the spread of the distribution for total renewable fuel. In the original model, the 5th and 95th percentiles of total renewable fuel were 14,995 and 15,514 million gallons, respectively. In the revised model using 258 million gallons as EIA's standard deviation, the 5th and 95th percentiles become 14,707 and 15,715 million gallons, an increase in the spread by about 500 million gallons.

As with the cellulosic biofuel model, I re-ran the total renewable fuel model incorporating a correlation of 0.2 between each pair of variables. Again, the correlation results in a slight drop in the median (about 3.4 million gallons) and a slight increase in the distribution's spread. As above, these are very modest changes, suggesting that careful modeling of correlations is not necessary.

3.3. Advanced Biofuel

Given the ground covered in reviewing cellulosic biofuel and total renewable fuel above, the story about the advanced biofuel model can be told rather quickly. This model includes the five cellulosic biofuel producers that were included in the cellulosic model. The problem of specifying P(Vol=0) would seem to apply here as well. In addition, the model includes biomass-based diesel, using the same distribution found in the total renewable fuel model. Domestic non-ethanol advanced biofuel is also included and appears to have been used in the total renewable fuel model with the same distribution, just without the "domestic" label. Thus, all of the variables and distributions in this model have been seen before.

The story here is easily told, because biomass-based diesel again accounts for the lion's share, over 94% this time, of the variation in the aggregate distribution. In this case, dropping the biomass-based diesel's 95th percentile from 2400 to 2352 million gallons (same as before), the median of the output distribution drops from 2172 to 2157 million gallons, a change of 15 million gallons. The fact that biomass-based diesel controls so much of the variation in the distribution for advanced biofuel reinforces the need to ensure that it's input distribution reflects all available information.

Incorporating a correlation of 0.2 into the model makes almost no difference in the output distributions. The median is virtually the same as in the original model, and the distributions are only slightly more spread out. Increasing the correlation to 0.5 changes the median a bit more (less than 1 million gallons) and again spreads the distributions. Given that biomass-based diesel controls so much of the variation by itself, it is perhaps not surprising that incorporating correlations among the variables has little impact.

About the Author

Robert Clemen is Professor Emeritus of Decision Sciences at Duke University's Fuqua School of Business. He has broad interests in the use of decision analysis for organizational decision making, and special interests in the psychology of judgment, assessing expert probabilities, the effectiveness of decision-making techniques, and using decision analysis to help organizations become environmentally sustainable. The author of the widely used text Making Hard Decisions, Professor Clemen has over thirty years of teaching experience, including courses on decision analysis and analytical tools for sustainability. He has published over fifty scholarly articles that have appeared in such journals as *Management Science*, *Operations Research*, *International Journal of Forecasting*, *Decision Analysis*, and others. Professor Clemen's consulting and executive teaching include work for corporations, utilities, and government agencies, and have covered such diverse areas as salmon farming, offshore oil leasing, avalanche prediction, nuclear waste storage, electric power demand forecasting, and environmental policy. He was a member of the National Research Council committee that produced Models in Environmental Regulatory Decision Making (Washington, DC: National Academies Press, 2007) and served on the Advisory Committee for the National Biodiesel Board Sustainability Task Force, 2008-2009. His CV is attached.

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- Ramsey Medal, 2012. Lifetime achievement award by the Decision Analysis Society (INFORMS).
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- Forecasting Publication Award, International Institute of Forecasting:
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TEACHING AWARDS

- Page Prize for Sustainability Curriculum, Honorable Mention, 2010
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Editorial Board Member, *Decision Analysis,* 2007-present.

National Academy of Sciences Committee on Model Use for Regulatory Decision Making, 2004-2007.

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Member, Harvard Center for Risk Analysis Advisory Committee, Harvard University 1999-2001.

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SELECTED CONSULTING ENGAGEMENTS

2011-2012. Omaha Foreign Exchange Corporation. Decision and risk management.

2010. BC Hydro. Probability forecasting for customer response to demand-side management programs.

2009. Environmental Protection Agency. Multiattribute decision making for research proposal funding.

2007. Army Corps of Engineers. Reviewer for Louisiana Coastal Protection and Restoration project.

1999. Cadmus Group. Decision analysis support for USEPA procedures.

1998. EC/R Inc. Advisory role in EPA risk assessment project.

1997. Alceon Corporation. Mathematical statistics consultant for risk analysis project.

1995. Eli Lilly & Co. Provided a 2-day workshop on structuring decision models.

1992-1994. Southwest Research Institute, San Antonio, TX. Risk assessment regarding future climate change at Yucca Mountain, Nevada.

Appendix D

ANALYSIS AND CRITICAL REVIEW OF THE MONTE CARLO SIMULATION AND DECISION ANALYSIS USED TO DEVELOP THE EPA'S 2014 RENEWABLE FUEL STANDARDS PROPOSED RULE

ANALYSIS AND CRITICAL REVIEW OF THE MONTE CARLO SIMULATION AND DECISION ANALYSIS USED TO DEVELOP THE EPA'S 2014 RENEWABLE FUEL STANDARDS PROPOSED RULE

Decision Strategies, Inc.

January 27, 2014

http://www.decisionstrategies.com

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The American Petroleum Institute (API) engaged Decision Strategies, Inc. (Decision Strategies) to perform an independent analysis of the data, assumptions, and methods used in the EPA's proposed rule for the 2014 Renewable Fuel Standards.

Decision Strategies conducted this analysis and prepared this report with reasonable care and skill, utilizing methods we believe to be consistent with normal industry practice. No other representations or warranties, expressed or implied, are made by Decision Strategies. All results and observations are based on information available at the time of this report. To the extent that additional information becomes available or the factors upon which our analysis is based change, our opinions could be subsequently affected.

Decision Strategies is not expert in Biofuels production. In this analysis and in any and all commentary, Decision Strategies is solely addressing the applied mathematical techniques and decision analysis practices. Decision Strategies is not addressing the validity of the input ranges provided by company representatives or the results. Within this document are Decision Strategies' comments on the techniques used by the EPA in the assessment and handling of the input data, the methodology used in the Monte Carlo simulation, and the results.

1. Executive Summary

1.1 Overview

As required by the Renewable Fuel Standard (RFS), each year the Environmental Protection Agency (EPA) determines volumes for cellulosic, biomass-based diesel, advanced biofuel, and total renewable fuels and sets annual standards that apply to all motor vehicle gasoline and diesel consumed in the United States. In November 2013, the EPA published in the Federal Register the proposed rule for the 2014 RFS standards.

For the first time, the EPA is proposing the use of probabilistic modeling using Monte Carlo simulation to establish the standards. Probabilistic modeling involves assessing ranges and frequency distributions for input data and using random sampling techniques (Monte Carlo simulation) to develop a range of possible outcomes. In performing this review, two EPA personnel were interviewed: David Korotney and Dallas Burkholder. Mr. Korotney designed and built the EPA's model. Mr. Burkholder captured the cellulosic biofuel data for use in the analysis. Both gentlemen were very helpful in providing data and answering questions.

Decision Strategies has reviewed the work done by the Environmental Protection Agency (EPA) to set the Renewable Fuel Standard (RFS) as outlined in the Federal Register. This report includes the details of the analysis done by Decision Strategies covering:

- Overview of EPA Process
- Technical assessment of the probabilistic modeling done by the EPA
- Critique of the EPA methods and assumptions
- Sensitivity analysis of Cellulosic Biofuel Volumes
- Recommendations for improvements

1.2 Technical Assessment and Critique of the EPA Methods and Assumptions

From the information provided by the EPA and in the Federal Register, Decision Strategies was able to reproduce the results of the proposed RFS. The Monte Carlo simulation and basic algorithms used in the EPA model appear to have been correctly applied.

Decision Strategies believes that probabilistic modeling using Monte Carlo simulation is an industry best practice and could be an appropriate method for modeling uncertainties and evaluating the Renewable Fuel Standard (RFS) volume estimates. However, the utility of the model is highly dependent on the assumptions used and the assessment of the ranged data.

The EPA did not use best practice Subject Matter Expert interviewing techniques with the individual companies or with the other sources of data. Specifically with cellulosic biofuel producers, they discussed possible ranges of production and likely start-up dates, but they did not make probabilistic assessments with the experts or try to deal with their biases. Much of the data manipulation was done post-interview based on the expertise and experience within the EPA.

The EPA could improve their assessments through the use of de-biasing techniques with the Subject Matter Experts.

While the use of a 90 percent confidence range (P5 – P95) is fine, the EPA did not use best practice when creating ranges. They combined all of the variables associated with a volume into a single range plus distribution. A more appropriate modeling technique would have been to disaggregate uncertainties into two distinct groups for each company or category: one uncertainty would cover the risks related to plant completion and the second would determine the amount of production given a successful plant completion. This would improve the process without adding too much additional burden.

The EPA's method used a P5 of zero combined with the Half-Normal distribution to account for a plant that did not have commercial production in 2013. This applies the same probability of zero 2014 production to all plants. The probability of not achieving production is understated in the 5% to 8% range.

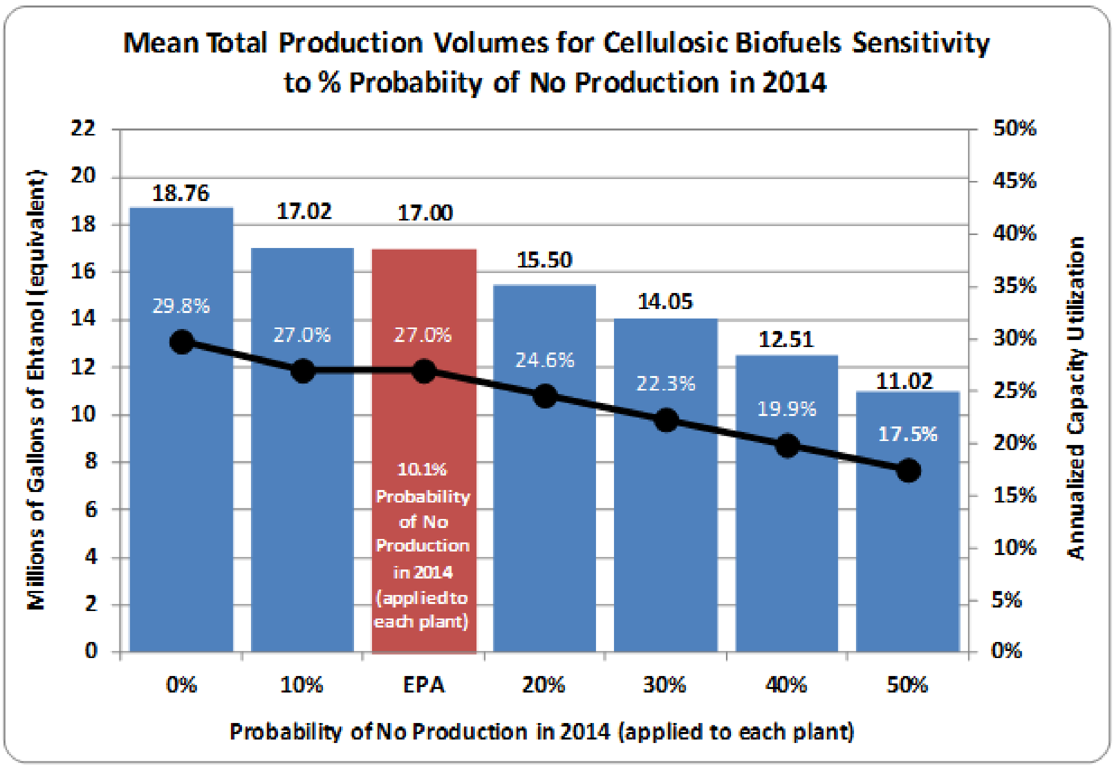
The assumption to combine a six-month ramp-up (best case) with a plant capacity to develop the P95 is overly optimistic. The plant capacity is typically the volume a plant could produce if operated at nameplate capacity indefinitely. The availability factor influenced by maintenance, unplanned shut downs, etc. reduces this value. Therefore, the EPA set the P95 values at best case for the ramp-up and absolute best case for ultimate volume. Even if both the ramp up and the plant capacity were considered to be P95 values individually, to have both occur simultaneously would create a P99.75 value.

Using the EPA data of the cellulosic biofuel volume shows that Abengoa has the largest impact (47.5%) on the variance of the total proposed volume and the combination of the two largest impacts (Abengoa and KiOR) is 71%. This would indicate that if there are any significant delays during completion of construction (for Abengoa) or ramp up problems with either of these producers the 2014 produced volume of cellulosic biofuels could be significantly impacted. The issues mentioned earlier in this section, combined with the dominating influence of these two plants, likely produces estimates for cellulosic biofuels that are overly optimistic.

1.3 Sensitivity Analysis of Cellulosic Biofuel Volumes

A sensitivity analysis should be performed to test assumptions and ranges. Decision Strategies has conducted a sensitivity analysis on the cellulosic biofuel assumptions. For the purpose of the sensitivity analysis, the variables were recast into two uncertainties as mentioned in section 4.1.5. The sensitivity of the volumes to the probability that each plant would not achieve start-up in 2014 was completed. The assumptions used to set the ranges were based on the work done by the EPA with some modifications. This is fully described in section 5.

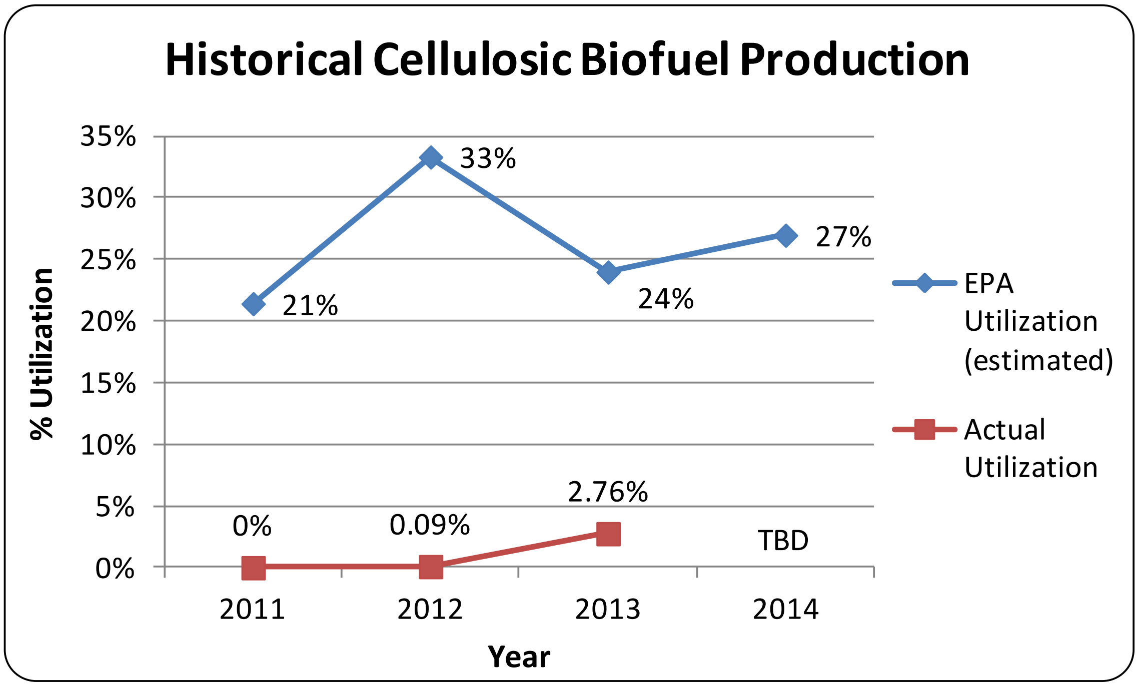
The results of the sensitivity analysis are shown in the graph below. As expected, the higher the probability of each plant not achieving startup in 2014, the lower the total cellulosic biofuel volume.



The results above apply the same probability of no production to all of the plants in each test

The red bar is the EPA RFS result and, compared to the sensitivity runs, equates to a 10.1% probability of each plant not achieving production in 2014. As shown the 17 million gallons of cellulosic biofuel requires a 27% mean utilization of the predicted plant capacity for 2014, which takes into account the start-up dates for the five plants included in the analysis.

This 27% mean utilization is higher than the EPA predicted mean utilization for 2013 (24%) and significantly higher than the 2.8% actually achieved by cellulosic biofuel producers in 2013. The 17 million gallons of cellulosic biofuel is a 400%+ increase over the 2013 predicted volumes and a 1700% increase over the actual volumes achieved by the cellulosic biofuel producers in 2013.



2011-2013 data provided by API

The majority of this increase is dependent upon 3 new plants (that have not yet completed construction) and an existing plant (KiOR) that has just announced a planned shutdown for the entire first quarter of 2014 (the shutdown was not included in the calculations above). Based on this analysis and compared to historical performance, the EPA numbers for cellulosic blofuels appear to be overly optimistic.

It is Decision Strategies opinion that the EPA should work with the companies and use its experience and engineering judgment to assess each of these facilities and develop range and probability inputs specific to each.

<u>Based on the results of this sensitivity analysis and the historical achievement of the industry it is possible that several of the plants could have a probability of not producing in 2014 even greater than 50%.</u>

1.4 Overall Recommendations

The list below summarizes Decision Strategies' recommendations.

1. The EPA should use best practice Subject Matter Expert interviewing techniques to assess probabilistic data and ensure de-biasing the experts. See section 6.2 for more guidance of best practice interviewing techniques.
2. For cellulosic biofuel the EPA should disaggregate uncertainties into two distinct groups for each company or category. See section 4.1.5. The first group would include variables such as construction delays. The second group would include start-up uncertainties, ramp-up variables, production variables, utility reliability, date of start-up, etc.
3. The EPA should run a separate Monte Carlo simulation to aggregate the CNG/LNG volumes instead of summing these capacities. See section 4.1.2.
4. The EPA should range the total energy assumption (provided by the EIA) for the energy needed for gasoline in 2014, which they used to calculate the total consumable ethanol volume for 2014. See section 4.1.4.
5. The EPA should perform a sensitivity analysis to test assumptions and ranges. See section 5.
6. The EPA should avoid use of the Half-Normal distribution. See sections 4.1.5, 4.2.1, and 6.3.
7. The EPA should develop familiarity with and use of the Influence Diagram to capture the interconnected nature of the uncertainties. See section 6.2.
8. The EPA should develop familiarity with and use of the Tornado Diagram to capture valuable insight into the impact of the uncertainties on the final values. See section 6.5.
9. The EPA should evaluate "off the shelf" probabilistic software options available for future assessments. See section 6.4.

2. Overview of EPA Process

2.1 Proposed 2014 Renewable Fuel Standards

The EPA is required to set the renewable fuel percentage standards each November for the following year. The table below details the proposed standards for cellulosic biofuel, biomass-based diesel, advanced biofuel, and renewable fuels that would apply to all motor vehicle gasoline and diesel produced or imported in the year 2014. Also included are the results from the Monte Carlo simulation and the original requirements from the Clean Air Act (CAA).

Proposed 2104 Volume Requirements and Ranges				
Top Level Fuel Type	Sub-level Fuel Categories	Proposed Volume	Results from Monte Carlo Simulation	Required Applicable Volumes for 2014 (CAA)
Cellulosic Biofuel	• EtOH Cellulosic Biofuel • Non-EtOH Cellulosic Biofuel	17 million gallons	8 to 30 million gallons	1.75 billion gallons
Biomass-based Diesel	Biomass-based Diesel (Ethanol Equivalent volume)	1.28 billion gallons (1.92)	1.28 to 1.6 billion gallons (1.92 to 2.4)	>= 1.0 billion gallons (1.5)
Advanced Biofuel	• Cellulosic Biofuel • Biomass-based Diesel • EtOH Advanced Biofuel • Non-EtOH Advanced Biofuel • EtOH – Sugarcane (imported)	2.20 billion gallons	2.00 to 2.51 billion gallons	3.75 billion gallons
Renewable Fuel	• Advanced Biofuel • EtOH - Corn	15.21 billion gallons	15.00 to 15.52 billion gallons	18.15 billion gallons

2.2 Data Needed for Monte Carlo Simulation

In order to run the Monte Carlo simulation, the EPA required ranged input data for each category of renewable fuel for each source. The EPA applied a set of overarching assumptions to the data to establish the lower and upper ends of the ranges.

2.2.1 Data Sources

The EPA gathered information from a number of sources to develop the range estimates and distributions used in their Monte Carlo simulation.

The sources included:

- Interviews with potential and current producers to determine:
    - Current status of the construction projects
    - Project funding
    - Projected timeline
    - Estimated start-up dates
    - Ramp-up schedules
    - Feedstock supply and customer contracts
- EPA's experience and engineering judgment
- Information from the Energy Information Administration (EIA)
- Department of Agriculture (USDA)
- Department of Energy (DOE)

2.2.2 Low End of Ranges

For facilities that have not produced commercial volumes, a low end of zero gallons was used. Based on the EPA's experience that no commercial scale biofuel facility has been able to meet its target start-up date, using a zero as the low end of the range acknowledged the uncertainties that construction, funding, permitting, and other delays can have upon the projected timelines and start-up dates.

For facilities which have achieved commercial production of biofuel, the primary uncertainty with regard to the low end of the range is the reliability of the company. The EPA used production history to set the lower end of these ranges. As a guideline, the EPA established these values where they felt it was "highly unlikely" that the production would be lower in 2014. While not a P0 value (since the ultimate worst case would be zero production), the EPA considered these to be P5 values with a 5% probability of the actual values being lower than these numbers.

2.2.3 High End of Ranges

In developing the upper end of the production ranges, the EPA combined the impacts of many variables including start-up date, ramp-up, nameplate capacity, production history, and process used.

As in the determination of the lower ends of the ranges, the EPA considered facilities that have already produced commercial volumes separately from facilities that were under construction and projected to start-up in 2014. For facilities that have not produced commercial volumes, the EPA used the estimated start-up date and a six month straight line ramp-up period from zero to the nameplate capacity of the plant to determine a “best case” production for 2014. If the volume estimates provided by the company were lower than the number calculated through this method they were used, otherwise the EPA “best case” value was used. Any volume estimates provided by the companies that were above the EPA calculated number were not considered to be “credible”.

The EPA also used their engineering judgment, the history of the company, the progress of the construction, etc. to further discount the volumes or delay the start-up in their calculations if they felt it was warranted.

For facilities that completed construction in 2013 and begun producing commercial volumes of biofuel, the upper end of the volume range is impacted by many factors including the plant’s capabilities, operational skill and experience. Other factors include: security and quality of feedstock supply, plant engineering issues, utilities, operational issues, weather, customer events, etc. The longer a plant has been producing biofuels, the closer the upper end of the range approaches to the nameplate capacity of the plant.

While the upper end of the range does not represent a P100 (absolute maximum), the EPA tried to set these values at a level where production above these numbers was “highly unlikely.” In their analysis, they considered these to be P95 values, with a 5% probability of the actual values being higher than these numbers.

2.2.4 Cellulosic Biofuel Volume for 2014

The EPA identified and tracked the progress of several dozen companies with the potential to produce cellulosic biofuel in 2014. The EPA included five companies thought to be the highest potential of commercial production of cellulosic biofuel in 2014, based on discussions with the DOE, USDA, EIA, and the biofuel producers. Other companies were excluded as they were considered highly unlikely to produce biofuel in 2014.

The five companies considered likely to produce commercial volumes of cellulosic biofuel in 2014 included: Abengoa, DuPont, INEOS Bio, KiOR, and Poet. These companies are in different stages of planning and construction and the range of projected volumes for each was handled accordingly.

> *“Information such as the funding status of these facilities, current status of the production technologies, announced construction and production ramp-up periods, and annual fuel production targets were all considered when we spoke with representatives of each company to discuss cellulosic biofuel target production levels for 2014.”*

"40 CFR Part 80 - 2014 Standards for the Renewable Fuel Standard Program; Proposed Rule." *Federal Register* 78 (29 November 2013): 71739.

In addition to the five companies slated to produce cellulosic biofuel in 2014, two other companies - Ensyn and Edeniq – and a group of LNG/CNG producers were assessed as potential contributors to the cellulosic biofuel total volumes. The end products of these three sets of businesses are not currently approved for cellulosic biofuel. Their volumes were assessed and a separate total produced that would only be included should their pathways be approved for use in this category.

Data Summary – Federal Register – Cellulosic Biofuel Plant Volumes					
Company	Location	Product	Annual Plant Capacity, Million Gallons EtOH Equivalent	Estimated First Production	Volume used in Monte Carlo simulation, P5 – P95, Million Gallons EtOH Equivalent
Companies with Approved Pathways					
Abengoa	Hugoton, KS	Ethanol	24	1 Qtr 2014	0 – 18
DuPont	Nevada, IA	Ethanol	30	2nd Half 2014	0 – 2
INEOS Bio	Vero Beach, FL	Ethanol	8	3 Qtr 2013	2 – 5
KiOR	Columbus, MS	Gasoline & Diesel	11	March 2013	0 – 9
Poet	Emmetsburg, IA	Ethanol	25	1st Half 2014	0 – 6
Companies without Approved Pathways					
CNG/LNG Producers	Various	CNG/LNG	Various	Existing	35 – 54
Edeniq	Various	Cellulosic Ethanol	Various	Existing	0 – 7
Ensyn	Wisconsin and Ontario, Canada	Heating Oil	5	Existing	0 – 5

For information about the specific plants/groups see appendix A1-1 thru A1-8.

2.2.5 Advanced Biofuel Volume for 2014

The advanced biofuel category includes the cellulosic biofuel detailed in 2.1.4 as well as biomass-based diesel, domestic ethanol advanced biofuel, domestic non-ethanol advanced biofuel, and imported ethanol from sugarcane.

Data Summary – Federal Register – Advanced Biofuel Volumes for 2014		
Category	Product	Volume used in Monte Carlo simulation, P5 – P95, Million Gallons EtOH Equivalent
Cellulosic Biofuel	Varied	See Previous Section
Biomass-based Diesel	Diesel Fuel	1.2 – 1.6 billion gallons diesel
Domestic Ethanol Advanced Biofuel	Ethanol	28 – 142 million gallons Ethanol
Domestic Non-ethanol Advanced Biofuel	Heating Oil Biogas Renewable Diesel Naphtha	24 – 132 million gallons Ethanol Equivalent
Imported Ethanol from Sugarcane	Ethanol	300 – 800 million gallons Ethanol

For information about the specific categories see appendix A1-9 thru A1-12.

2.2.6 Total Renewable Fuels Volumes 2014

The total renewable fuels volume includes non-ethanol portion of the advanced biofuels detailed in 2.2.5 (which already includes cellulosic biofuels from 2.1.4), non-ethanol non-advanced biofuel and total consumable ethanol.

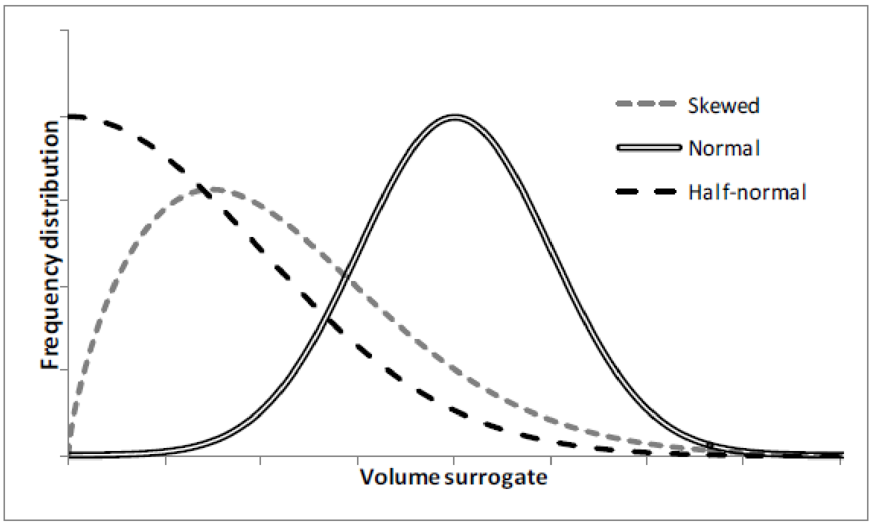
Data Summary – Federal Register – Advanced Biofuel Volumes for 2014		
Category	Product	Volume used in Monte Carlo simulation, P5 – P95, Million Gallons EtOH Equivalent
Advanced Biofuels	Varied	See Previous Section
Non-ethanol Non-Advanced Biofuels	Biodiesel	1 – 25 million gallons ethanol equivalent
Total Consumable Ethanol	Ethanol	12,954 – 13,087 million gallons

For information about the specific categories see appendix A1-13 thru A1-14.

2.3 Distributions

With the lower and upper ends of the range established, the EPA still needed to determine the shape of the distributions for each of the plants or categories included in the simulation. For this purpose, three standardized distributions were used:

1. Normal
2. Half-Normal
3. Skewed (Weibull)



From Memo to Docket: David Korotney - Application of Monte Carlo process to the determination of proposed volume requirements for 2014 standards NPRM

The Normal or Gaussian distribution is sometimes referred to as a "Bell-Shaped Curve" is a symmetric continuous distribution around a center. The mean, median, and mode align at the same value at the center of the distribution. Neither end of the distribution is bounded. For the standardized distribution used in the analysis, the mean is set to 0.8 and the standard deviation is 0.2. The Normal distribution is an appropriate choice to represent an aggregation of several values added together. The more variables that are summed, the more the resulting distribution will take on the shape of a Normal distribution. The EPA selected this distribution when the assumed clustering of values was near the middle of the range. Since the Normal distribution is asymptotic to the X-axis, it is necessary in the model to limit the lower end to zero.

The Half-Normal distribution is a construct for this analysis. It is the positive half of a Normal distribution with a mean of zero and a standard deviation of 0.4. Cutting off the lower end of the curve moves the mean of the resulting curve to the right (0.39 using a P95 of 1.00). The lower bound is zero. The EPA selected this distribution when the most likely total volume was assumed to be near the lower end of the range or zero.

The Skewed distribution is a Weibull distribution. A Weibull distribution is actually a family of continuous distributions. They can be assume the shape of an exponential decline curve, a right skewed distribution, a symmetric distribution or even a left skewed distribution depending on the values of the parameters. They are defined by a location, shape factor, and scale factor, or by specifying the P5, P50, P95 values. The values listed in Table A-1 from the *Memorandum to Docket: David Korotney - Application of Monte Carlo process to the determination of proposed volume requirements for 2014 standards NPRM* for the Skewed Distribution were shape factor of 0.5 and scale factor of 1.7.

Working backwards from the mean, mode and percentiles for the Aligned Standard Distributions in Table A-2 from the same source, the values for the Aligned Standard Skewed Distribution are: location = 0.147, shape factor = 0.442, and scale factor = 1.704. The Weibull distribution is an excellent choice for the skewed distribution as it is extremely flexible in application. The EPA selected this distribution when the most likely volume outcome was closer to the lower end of the range. Since the Weibull distribution is bounded on the left, less management of the simulation is required to keep the numbers in the positive range.

In selecting the appropriate distribution for each set of data, the EPA reviewed the shape of the distribution and the frequency of occurrences within the ranges and used the distribution that fit their assumptions concerning where the most likely production value would occur within the range based on individual companies/categories and the factors impacting each.

- Half-Normal – This distribution is used for facilities where no commercial production has occurred. These facilities have the highest degree of uncertainty surrounding the start-up dates, ramp-up time, initial production volumes, delays in construction, etc. In the biomass-based diesel and the total consumable ethanol cases, the lower end is set to the P5 instead of zero. The Half-Normal distribution has a large frequency of occurrence at the very low end of the range.
- Skewed – The facilities that have had some success in commercial production are described using the Skewed distribution. This distribution has a large portion of the values closer to the lower end of the range.
- Normal – The facilities that have the longest history of commercial production or aggregates of multiple producers (such as the LNG/CNG producers) are described using the Normal distribution. This distribution places the highest likelihood of production in the middle of the range.

Data Summary – Federal Register – Distributions and 2014 Volume Ranges		
Company/Product	Distribution	2014 Volume Range P5 – P95 Million Gallons EtOH Equivalent
Abengoa	Half-normal	0 – 18
DuPont	Half-normal	0 – 2
INEOS Bio	Skewed	2 – 5
KiOR	Skewed	0 – 9
Poet	Half-normal	0 – 6
CNG/LNG Producers	Normal	35 – 54
Edeniq	Half-normal	0 – 7
Ensyn	Normal	0 – 5
E85 Consumption	Half-normal	100 – 300
Biomass-based Diesel	Half-normal	1920 – 2400
Domestic Non-ethanol Advanced Biofuel	Normal	24 – 132
Non-ethanol Non-Advanced Renewable Fuel	Normal	1 – 25
Domestic Ethanol Advanced Biofuel	Normal	28 – 142
Imported Sugarcane Ethanol	Normal	300 – 800

2.4 Monte Carlo Analysis

The EPA has proposed the use of Monte Carlo simulation (or Method) which is a computational technique that uses repeated random sampling of input data to calculate a distribution of outcomes. In their simulation the EPA performed 3000 trials using the data and distributions identified in the previous sections. They used this method to set the proposed volumes for cellulosic biofuels, advanced biofuels, biomass-based diesel, and total renewable fuels as required by section 211(o) of the CAA.

For each one of the 3000 trials in the Monte Carlo simulation, the model sampled from each input distribution and calculated a total volume. At the end of the simulation, the totals for all the trials created the range and distribution of the results.

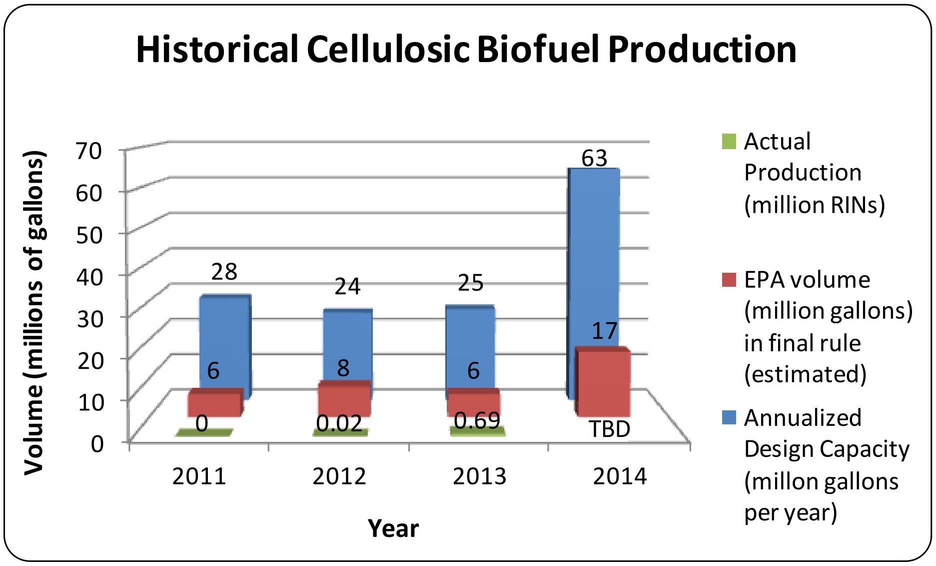
Being unable to obtain a copy of the EPA model, Decision Strategies developed a Monte Carlo simulation model designed to mirror the functionality of the EPA model. The results of our model were very close to those of the EPA, and we believe it to be within reasonable statistical tolerance to show the EPA numbers to be valid.

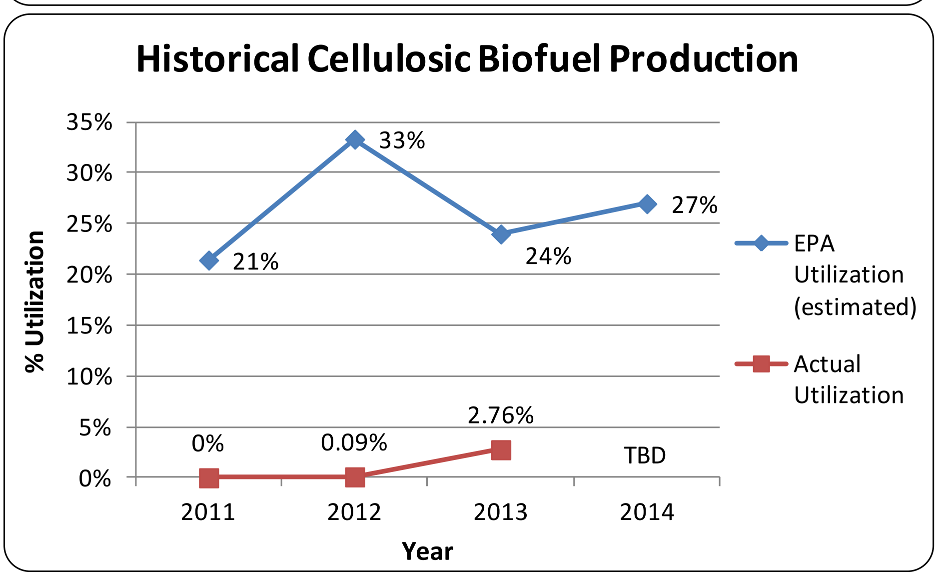
For the results of the comparison of the EPA Analysis and the Decision Strategies Mirror Analysis results see Appendix 2.

2.5 Historic Cellulosic Biofuel Production

Historically the cellulosic biofuel industry production has fallen significantly short of both the EIA estimates and Renewable Fuel Standards set by the EPA. For 2014, the expected utilization of 27% (based on the mean value of approved pathway sources) is significantly higher than any of the utilization percent achieved in the past.

This 27% mean utilization is higher than the EPA predicted mean utilization for 2013 (24%) and significantly higher than the 2.8% actually achieved by cellulosic biofuel producers in 2013. The 17 million gallons of cellulosic biofuel is a 400%+ increase over the 2013 predicted volumes and a 1700% increase over the actual volumes achieved by the cellulosic biofuel producers in 2013.





2011-2013 data provided by API

3. Technical Assessment of the Probabilistic Modeling Done by the EPA

Monte Carlo simulation (or Method) is a computational technique that uses repeated random sampling of input data to calculate a distribution of outcomes. In their simulation the EPA performed 3000 trials. This would have provided enough trials for the results to converge and to be statistically significant given the input data. This is an appropriate and best practice method for aggregating the ranged volumes.

While Decision Strategies did not have access to the model used by the EPA, the results were recreated in a probabilistic model from the data set outlined in the source documentation.

Based on our understanding of the EPA model and how it functions through review of the available documentation and discussions with relevant EPA personnel, the Monte Carlo simulation modeling done by the EPA (under the assumption that the input ranges and distributions used were proper) properly calculates the output value ranges.

4. Critique of the EPA Methods and Assumptions

4.1 Data

4.1.1 Data Gathering

The EPA gathered information from a number of sources to develop the range estimates and distributions used in their Monte Carlo simulation. It would appear that the data sources used were adequate.

The EPA did not use best practice Subject Matter Expert interviewing techniques with the individual companies or with the other sources of data. With individual companies, they discussed possible ranges of production and likely start-up dates, but they did not make probabilistic assessments with the experts. Much of the data manipulation was done post-interview. The incorporation of a better Subject Matter Expert interviewing process is highly recommended as an improvement in the process.

For data developed from an aggregate of multiple existing supply sources or where historical data existed, the EPA used a measure of “highly unlikely” to determine the extent of the ranges. They considered these ranges to be a 90 percent confidence band (P5 to P95). With the exception of the Ethanol (discussed further below), these ranges appear to be appropriately wide.

4.1.2 Data Bias

In estimating the 2014 volumes for Renewable Fuels, the EPA was faced with several unique challenges. The companies that provided data for this analysis are publicly held. It is the impression of the EPA (and a reasonable assumption) that these companies are hesitant to provide information which might cast them in an unfavorable light or adversely impact funding, e.g. announcing the delay of a start-up. This makes obtaining data more complicated. It is Decision Strategies' experience that working with probabilistic estimates and ranges actually encourages reticent Subject Matter Experts to be more forthcoming. Once they understand the intent of the probabilistic analysis, they are more comfortable and confident in providing ranged estimates versus deterministic values.

Since the EPA has been criticized in past analyses for assuming data were too optimistic or pessimistic (sometimes in the same analysis by different parties), they try to respect the data provided by the Subject Matter Experts in each company and then fairly and consistently apply engineering judgment from their own staff as well as other sources to de-bias the data.

In an effort to remove the bias from the data, the EPA applied several assumptions based on their engineering judgment and experience:

1. At least a six month ramp-up period from zero to the nameplate capacity
2. Since no company to date has been able to meet its projected start-up date, the EPA calculations delayed most of the projected start-ups
3. If the company had no commercial production in 2013, the lower end of the range was set to zero to acknowledge the possibility that delays could push production into 2015

While the EPA's knowledge and experience with these types of products are likely broader than the individual companies, their information concerning the specific issues faced by each company is obviously more limited than the company representatives. Using a different range from that provided by company Subject Matter Experts can be problematic, but the explanations provided by the EPA in their report are well done and appear both to respect the data where feasible and to apply sound engineering judgment when the data is outside the bounds of what the EPA would have expected based on their experience with similar products or technology.

In Decision Strategies' opinion, the use of best practice Subject Matter Expert interviewing techniques is the optimum way to assess probabilistic data and ensure de-biasing the experts. The EPA did not use these methods in this analysis. See section 6.2 Data Assessment Interviews for more guidance of best practice interviewing techniques.

The CNG/LNG Producer volume range uses the sum of a group of companies producing CNG and LNG to establish the P5 to P95 values. The P5 is a sum of the production rates in 2013 and P95 is the sum of the peak capacities. It would have been better to run a separate Monte Carlo simulation to aggregate these volumes instead of summing these capacities. If this product stream is approved for addition to the cellulosic biofuel, these numbers should be revisited. As an example, the sum of the peak capacities is likely to be closer to a P99 or P100 value while the sum of the 2013 production is likely a P50 value because actual production could be much lower.

4.1.3 Use of P5-P95 Range

In developing the ranges for the 2014 volumes, the EPA set limits where occurrences outside of the range were considered to be “highly unlikely”. They attributed a 90 percent confidence to this range. The lower end was considered to be a P5 (only a 5% chance of an outcome below this number) and the upper limit was considered to be a P95 (only a 5% chance of an outcome above this number). It is difficult to distinguish between a P100 and a P95. The highly unlikely test is not much assistance as either would fall into that designation. As mentioned in the section above, combining highly unlikely probabilities into one variable can result in the number tending toward the P100.

Decision Strategies has no issue with a P5-P95 range being used and considered. Decision analysis in the Oil & Gas Industry typically uses a P10-P50-P90 range (80% confidence band), but if the EPA would like to use the P5-P95 as their range, this is perfectly valid and can also be used by most of the software available today.

While the EPA used a verbal limit of “highly unlikely to exceed” to test the reasonableness of the P95, the assumption to combine a six-month ramp up (best case) with a plant capacity is likely overly optimistic. The plant capacity is typically the volume a plant could produce if operated at nameplate capacity indefinitely. The availability factor influenced by maintenance, unplanned shut downs, etc reduces this value. Therefore, the EPA set the P95 values at best case for the ramp up and absolute best case for ultimate volume. Even if both the ramp up and the plant capacity were considered to be P95 values individually, to have both occur simultaneously would have result in a P99.75 value.

A common mistake in probabilistic assessment is to become anchored on a number and to use arbitrary plus/minus percentages. This creates ranges that are too narrow to be considered either a 90 percent confidence band or to be representative of what might actually occur with the uncertainty. The main goal is to have ranges that appropriately represent the uncertainty. With the exception of the Total Consumable Ethanol and the CNG/LNG Producer ranges, the numbers used by the EPA appear to be sufficiently broad to be considered a 90 percent confidence band.

4.1.4 Total Consumable Ethanol

While the other ranges appear to be wide enough to represent a 90 percent confidence band for the data, the total consumable ethanol volume range is only 140 million gallons, or about 1 percent of the total. This is a very narrow range and highly unlikely to represent a 90 percent confidence band.

The total consumable ethanol volume is calculated from an assumption of the energy needed from gasoline in 2014. This number was provided by the EIA and was used as a constant. This energy assumption should be ranged to provide further insight into the range of total consumable ethanol volumes could be in 2014.

How wide is an appropriate range for this factor? This is a difficult question as several issues need to be balanced for a proper assessment. First, the estimate is provided for next year. Subject Matter Experts have more insight into what might happen next year versus multiple years out. This tends to narrow ranges in the early years and widen them in later years. Second, given the magnitude of the number and the large number of uncertainties impacting the consumption of gasoline, a broad range would be anticipated.

Even given that a range was not provided, this analysis uses Mean values for the final numbers. If a symmetric range around the energy consumption is used, the mean will not change and the final answer will be the same. Most assessments in a probabilistic analysis are skewed either positively or negatively. The range needs to be explored with the Subject Matter Experts to determine if there is more of a tendency for the values to continue to trend downward or upward (especially given the recent downward trend in gasoline consumption).

4.1.5 Combination of variables

The EPA coupled the P5-P95 ranges with one of three standard distributions based on where the highest frequency of volumes was likely to occur. A Normal distribution was used where the anticipated highest likelihood of occurrence was in the middle of the range. The Skewed distribution shifts the highest likelihood of occurrence toward zero and was used where the volumes were expected to be lower than the middle of the curve, but not zero. The Half-Normal distribution was used where the volumes were anticipated to be closer to either zero (no commercial volumes to date) or the P5 end of the range.

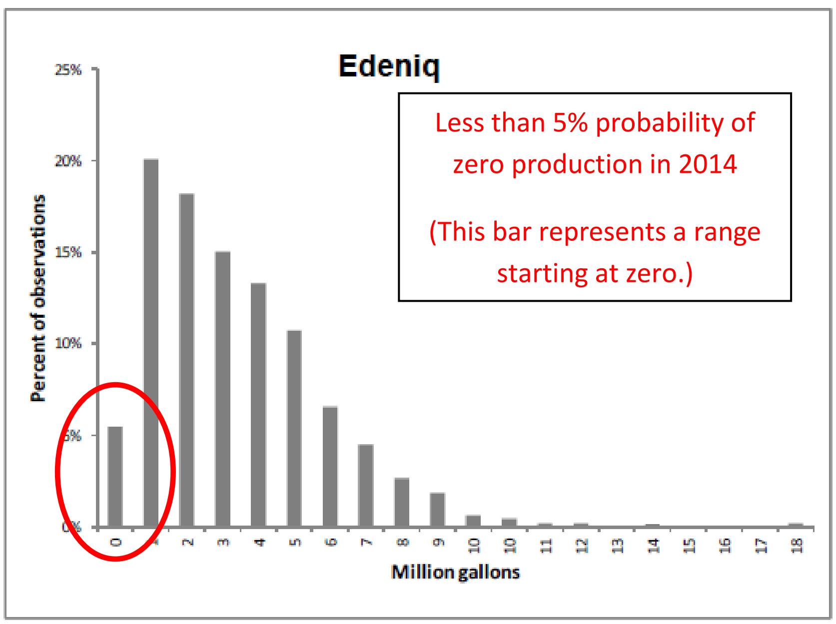
In this analysis, there are multiple variables including start-up dates, construction delays, permitting delays, ramp-up difficulties, production issues, equipment reliability, pricing, demand, etc. Instead of evaluating each uncertainty separately, the EPA combined the effects of many uncertainties into the assessment of the volume range and distribution used in the model. This is common in probabilistic analyses; it would take an inordinate amount of time to specifically assess each variable for each company and that effort would likely not add value in the final analysis.

The process could have been improved without too much additional burden by aggregating the uncertainties in two distinct groups for each company or category: one handling the risks related to plant completion and the second involving the amount of production given a successful plant completion.

- The first group would include variables such as construction delays, weather delays, funding, permitting, etc. All the variables in this set would need to have a positive outcome for any production to occur.

- The second group would include start-up uncertainties, ramp-up variables, production variables, utility reliability, date of start-up, etc. Poor outcomes in this second set would cause production at or near the lower end of the range, and conversely, good outcomes would cause higher production.

The EPA used the Half-Normal distribution to handle the zero production possibilities. This limits the “zero production” occurrences. For example, the distribution of results below for Edeniq uses the Half-Normal distribution with a 0 to 7 Million gallons per year range. The “zero production” is shown to be approximately 5 percent of the observations (Monte Carlo simulation trials). While it is true that a large portion of the observations are in the small categories, it does indicate only a 5 percent probability of the technology/plant not successfully producing in 2014.



The same is true wherever this distribution is used with the zero as the lower limit as shown in the table below. Given the notes in the Federal Register for these companies, it seems likely that the probability of them not producing any volume in 2014 is higher than 5 percent.

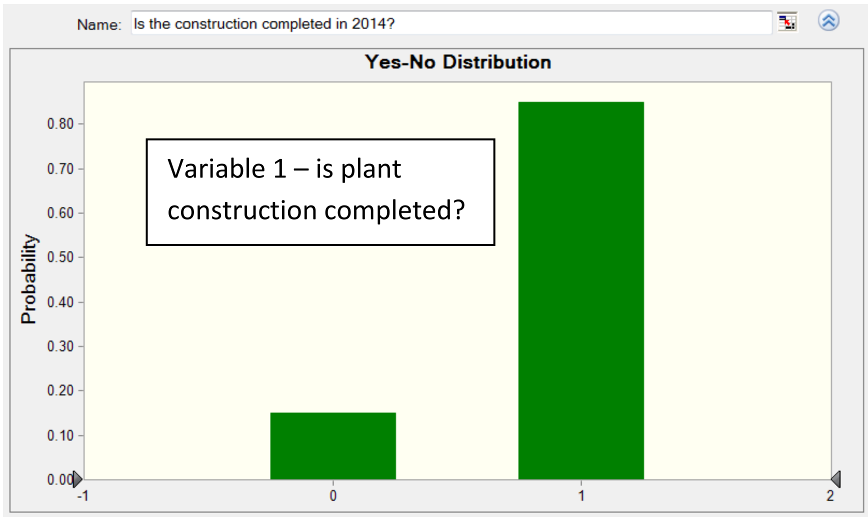
The distribution is continuous and mathematically dense as all values down to zero are possible. When dealing with plant start-ups, it seems reasonable that there would be some minimum feasible production given plant start-up (commercial level volumes).

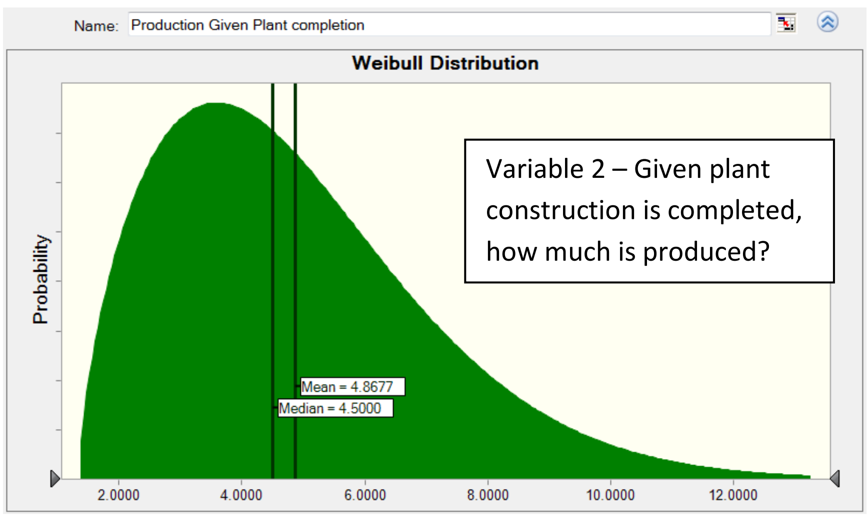
Data Summary – Federal Register Distributions and 2014 Volume Ranges			
Company	Distribution	2014 Volume Range P5 – P95 Million Gallons EtOH Equivalent	Probability of Zero Production in 2014
Abengoa	Half-normal	0 – 18	5%
DuPont	Half-normal	0 – 2	5%
Poet	Half-normal	0 – 6	5%
Edeniq	Half-normal	0 – 7	Approx. 5%

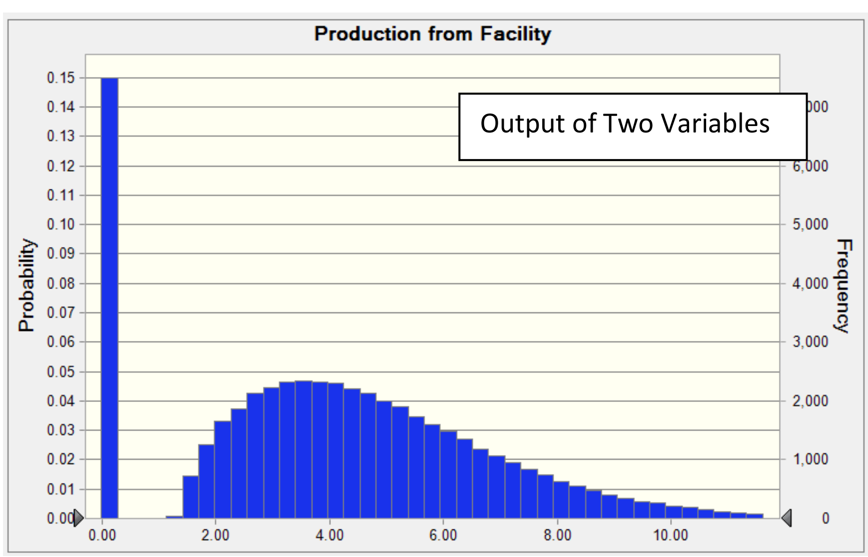
A better method would be to have two variables for each plant. The first variable would be: What is the probability of the plant construction being completed in 2014? The second variable would be: Given that the plant is complete, how much is produced? For each trial of the model, a random number would determine whether or not the plant was completed based on the assessed probability of completion. If the plant is not completed in that trial the production is set to zero. If it is completed, a second random number would determine how much was produced given the range of the production.

This methodology is illustrated below. The first two graphs are the variables. For example purposes a 15% probability that the plant does not successfully complete construction was selected. The second variable is a Weibull (skewed) distribution with a P5-P95 range of 2 to 9 million gallons (for example purposes only). The third chart is the combination of the two variables using a Monte Carlo simulation.

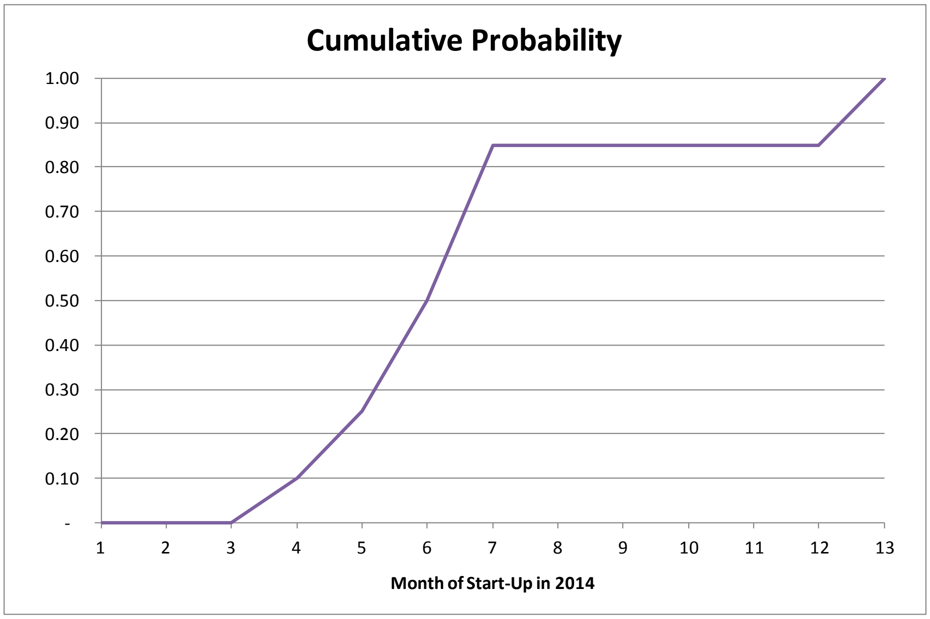
The simulation first checks to see if the plant has been completed. If not, the production is zero. This happens in 15% of the trials and causes the spike of observations at zero in the resulting distribution. If the result had been continuous, this would be called a “bi-modal” distribution as it has two high points. Since the Weibull distribution is bounded on the left (does not approach the x-axis asymptotically), there is a discontinuity between the zero spike and the rest of the values. This is perfectly acceptable and would allow the EPA to determine the probability of the plant construction being completed separately from the production.


Name: Is the construction completed in 2014?
Yes-No Distribution
Variable 1 – is plant construction completed?
Probability
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
-1
0
1
2


Name: Production Given Plant completion
Weibull Distribution
Variable 2 – Given plant construction is completed, how much is produced?
Probability
Mean = 4.8677
Median = 4.5000
2.0000
4.0000
6.0000
8.0000
10.0000
12.0000


Production from Facility
Output of Two Variables
Probability
Frequency
0.15
0.14
0.13
0.12
0.11
0.10
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0.00
6,000
5,000
4,000
3,000
2,000
1,000
0
0.00
2.00
4.00
6.00
8.00
10.00

As an alternative to the “YES-NO” construction completion variable 1 illustrated above, a probability distribution for the start-up date month can be used in the Monte Carlo simulation. A fictitious example is shown in the chart below as a cumulative probability of the construction being complete in a given month in 2014. The probability is zero prior to the second quarter (proposed start-up date) and then it increases throughout the year since this is a cumulative probability. It means the likelihood of construction being completed before December is higher than it is for being completed before June. In the chart below, there is a 15% probability of the start-up date being pushed into 2015, resulting in a zero production situation for 2014.



This method would require the EPA to develop more granular data for each of the companies and categories. This may or may not be feasible, but the question, “What is the probability of hitting your specific start-up target?” might be easier for a public company to answer than moving an announced target.

If this data is still not available, the EPA can again make some simplifying assumptions using their engineering judgment concerning proposed start-up dates, such as “Those companies with earlier proposed start-up dates are more likely to complete construction in the calendar year than those which have later start-up dates”.

4.2 Distributions

4.2.1 Half-Normal

The Half-Normal distribution was constructed for this analysis to accommodate instances where zero production was a significant possibility or where the likely occurrences were near the p5. It was created by shifting a Normal distribution to have a mean of zero and only using the positive half (with a mean of zero and a standard deviation of 0.4.). As mentioned above in the combining of variables discussion, this distribution attempts to combine two variables – the likelihood of the plant achieving completion and starting up and the production given completion has occurred.

This distribution does accomplish the goal of clustering the highest frequency of occurrences at the lower end of the range, but it does create a limit on the probability of the plant not being completed. The number of times in the distribution where the volume is zero (or in the near zero grouping) is between 5 to 8 percent (depending on the size of the first grouping). This gives nearly the same probability of not achieving completed construction in 2014 to every company. These should have been considered separately from the commercial production range. Allowing for a higher probability of not achieving plant completion would have provided much more flexibility to represent what is likely to happen at each plant.

Additionally, the distribution is continuous and mathematically dense; all values down to zero are possible. When dealing with real plant start-ups, it seems reasonable that there would be some minimum feasible production given plant start-up.

As mentioned in the previous section concerning combinations of variables, allowing for a higher probability of not achieving plant completion would have provided a model with much more flexibility to represent what is likely to happen at each plant.

4.2.2 Normal

While the Normal distribution is used in probabilistic analysis, not many uncertainties tend to be symmetric with the same variability on the lower side of the mean as on the upper. If the model is adding a number of uncertainties, the end result tends toward a normal distribution regardless of the skewness of the individual distributions. In the case of the CNG/LNG providers, the total would be a sum of the individual companies' production and a Normal distribution is appropriate.

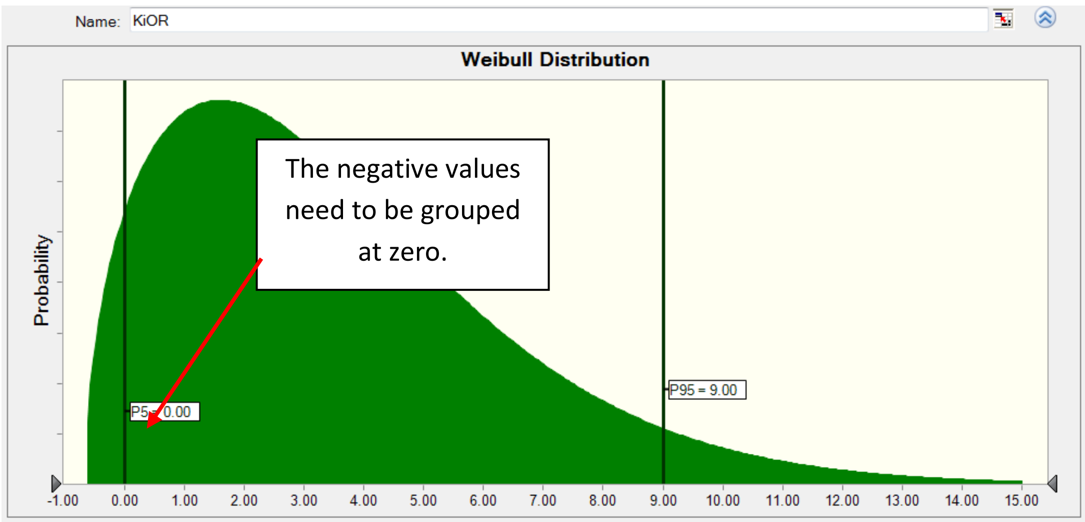
In the other instances the EPA selected the Normal distribution for those variables where it was felt that the clustering of likely outcomes was in the middle of the range. A best practice is to assess a P50 (median) with the Subject Matter Expert – a value where there is an equal likelihood of the actual result being above or below this number – to establish the skewness and to help fit the data to an appropriate distribution such as a Weibull or other non-normal distribution.

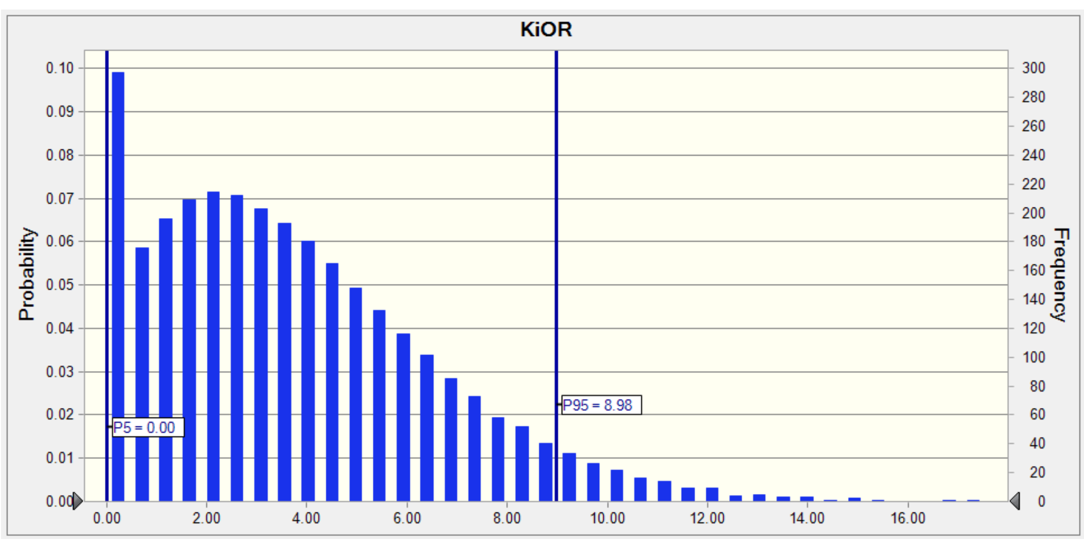
If the EPA used symmetric distributions and a better fit was a skewed distribution, the final answers might be slightly different but not enough for major concern.

4.2.3 Right Skewed

The Right Skewed distribution used by the EPA is in the Weibull family of distributions and is appropriate. This distribution set is very flexible. However, the EPA defined a single Weibull to use with all the ranges where it was chosen. As mentioned above, a P50 value for each of the data sets would have helped further defined the skewness of the distribution for each. If the analysis was slightly off (the wrong skewness was used), it would not have a profound impact on the final answers.

Many of the distributions set the lower limit to be zero. This was defined to be the P5. In order to have a true P5 at zero, the distribution as defined will slip below zero as shown below. This approach can still be used if a limit is set in Excel to pull the negative values back up to zero in the final distribution, which will result in a spike at zero as shown in the second chart below.





4.3 Use of Means

The use of the means as indicators of the central tendency for results calculated by the Monte Carlo simulation and as final numbers is appropriate and follows with industry practice. They should not be used to create input ranges, but are appropriate for outputs.

For the Biomass Based Diesel, the EPA selected the standard at the P5 value instead of the mean. Using the P5 provides a 95 percent probability that the actual volume in this category would be higher than this value. The EPA considered other market factors when selecting the P5 in this category.

Selecting the appropriate value to use as a standard is a question of risk tolerance, e.g. how confident do you need to be that the actual result will be at least that amount or higher.

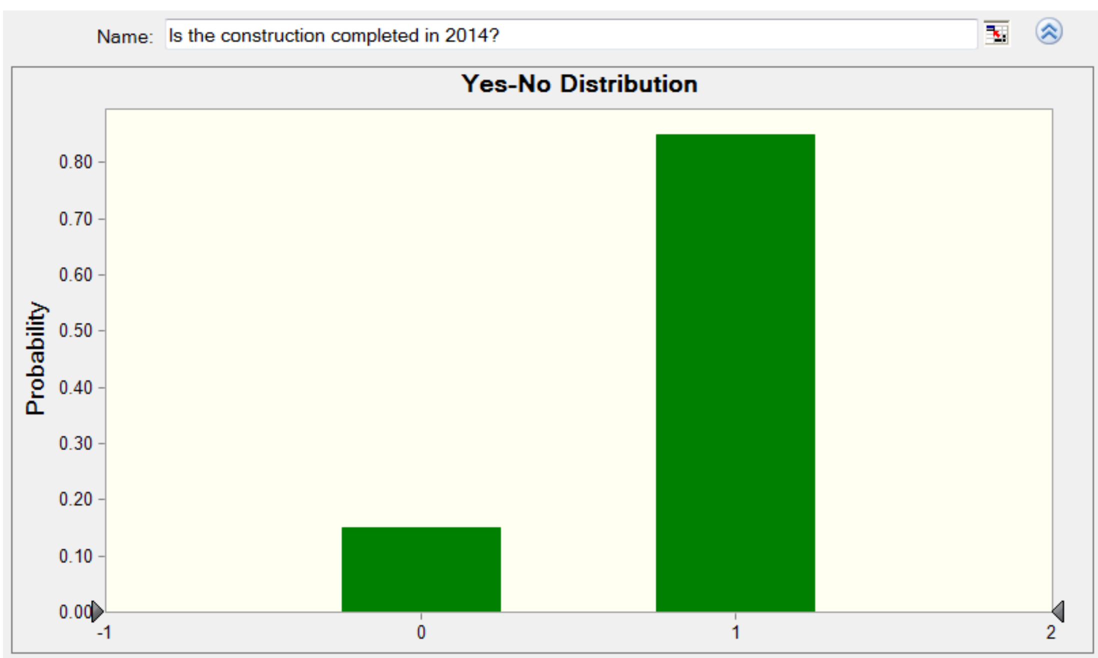
5. Sensitivity Analysis of Cellulosic Biofuel Volumes

Decision Strategies tested the sensitivity of the cellulosic biofuel volumes proposed standards for 2014 to a varied set of assumptions.

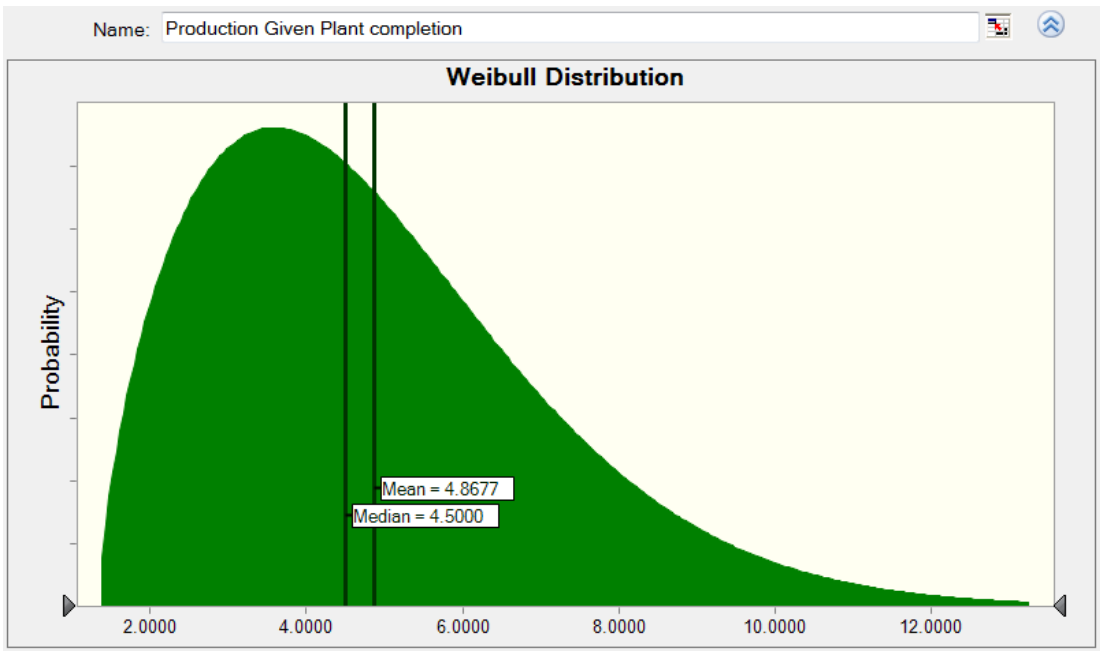
5.1 Method Used

In order to test the sensitivities, Decision Strategies used two separate variables to represent each plant. The first variable is binary – Yes/No – Does the plant have zero production in 2014? The model input is a probability of zero production in 2014 for all the plants that did not produce in 2013 (Abengoa, DuPont, Poet) and KiOR. When this variable is "No" there is zero production in 2014. A "Yes" value allows the model to sample from the second variable which is: How much is produced in 2014? A right skewed distribution (Weibull) was used for all the plants to model the production. See section 4.1.5, Combination of Variables.

1. The first variable would answer the question, "What is the probability of the plant not starting up in 2014?". This variable would group uncertainties such as construction delays, weather delays, funding, permitting, etc. This would make the probability of not producing any commercial volumes of biofuels in 2014 a distinct variable to be assessed for each plant. All the uncertainties in this set would need to have a positive outcome for any production to occur.



2. The second variable would answer the question "Given that the plant starts-up in 2014, how much is produced?" This variable groups uncertainties such as start-up issues, ramp-up issues, production issues, utility reliability, date of start-up, etc. This range assumes that the pre-start-up delays/impacts allow for the production of commercial volumes of biofuels in 2014, but allows for pre-startup delays/impacts that move the operations start date to a later period in time. It also includes the risks related to production ramp-up that determine the time period to full production. Poor outcomes in this second set would cause production at or near the lower end of the range, and conversely, good outcomes would cause higher production.



5.2 The Assumptions and Data Ranges Used

In order to separate the variables as described in section 4.1.5, it was necessary for Decision Strategies to modify the assumptions around the P5 and P95 values used by the EPA.

The P5 values used by Decision Strategies are based on start-up and ramp-up assumptions as opposed to fixed zero values. These new ranges represent the second variable discussed in section 4.1.5 (production given successful start-up in 2014) for each plant (except INEOS).

The P95 values used by Decision Strategies use the EPA P95 values as a P100 values to adjust for the combination of variables discussed in section 4.1.3 (except INEOS).

The assumptions applied by Decision Strategies are listed in the table below.

Assumption Summary – EPA vs Sensitivity Tests		
Assumption	EPA Assumptions	Adjusted Assumptions for Sensitivity Test
P95 (high end of range)	Identified start-up with 6 month straight-line ramp-up	• Use EPA P95 as P100 value • INEOS uses EPA P95 value
P5 or P0 (low end of range)	Value set to zero to show probability of no production	• 6 month delayed start-up with 12 month straight-line ramp-up • If the 6 month delay pushes start-up into 2015 the zero value was used as a P0 with a small positive value at the P5 • INEOS uses EPA P5 value
Distribution Used	Half-Normal distribution	Weibull (right-skewed) and yes/no probability distributions

Given the plant completes construction and starts up, the two major assumptions that determine the volumes of biofuel generated by a given plant in the coming year are:

1. When is the start-up date?
2. What is the ramp-up period?

The first manages pre-start-up delays and issues (while allowing possible commercial production in 2014), while the second manages a number of issues including ramp-up issues, production issues, utility reliability, etc.

Decision Strategies reviewed the data adjustment methods and assumptions used by the EPA and used a similar process of applying assumptions globally across all of the plants that did not begin operations in 2013 (Abengoa, Dupont, and Poet). The data was not available to treat the plants independently.

Each plant is facing different levels of risk related to the ramp-up, production issues, utility reliability, etc. Decision Strategies recommends doing an individual assessment of each plant considering the current ramp-up status, applicable historical ramp-up data, and general potential operations issues to determine the range of ramp-up periods and likely annual production for each plant.

Decision Strategies developed ranges for the plants that did not begin operations in 2013 (Abengoa, DuPont, Poet) for use in the sensitivity testing by applying adjustments that directly address the two major assumptions identified above.

1. The P95 values established by the EPA (using the identified plant start-up date with a 6 month straight-line ramp-up) were maintained, but used as a P99.
2. The P5 values were adjusted applying a 6 month start-up delay and extending the ramp-up period to a 12 month straight-line. If 6 month start-up delay pushes the start-up to 2015, then zero was used for the P0 which creates a small (but positive) P5 value. This is appropriate given that conditions causing zero production in 2014 are included in the yes-no probability variable.

For the plants that began production in 2013:

1. INEOS Bio – Decision Strategies used the established EPA P5 and P95 values. This plant was operating in 2013 and no longer has construction uncertainty or issues related to ramp-up. The range used in the table below includes the remaining operational uncertainties that the plant continues to face.
2. KiOR – Decision Strategies used the established EPA P95 value as a P99. The conditions that cause zero production in 2014 are presumed to be included in the yes-no probability variable and the P5 value needs to be greater than zero. Since the EPA value for the P5 is zero, Decision Strategies used zero as a P0 – the absolute minimum. This plant was operating in 2013 and no longer has construction uncertainty. The EPA noted in the discussion on KiOR in the November 2013, Federal Register that outlined the 2014 RFS standards that KiOR was not meeting the expected 2013 production and identified continuing ramp-up issues.

This ranges established for use in the sensitivity testing can be seen in the following table.

Data Assumption and Range Summary – EPA vs Sensitivity Tests – Cellulosic Biofuel Plant Volumes (millions of gallons of Ethanol)				
Company	EPA Assumptions	Volume used in EPA Monte Carlo simulation	Adjusted Assumptions for Sensitivity Test	Volume used in Sensitivity Test Monte Carlo simulation
Abengoa	• P95 – Jan. 1, 2014 start-up with 6 month straight-line ramp-up • P5 – value set to zero to show probability of no production • Used Half-Normal distribution	• P95 – 18 • P5 – 0	• P95 – same as EPA, but used as P99 • P5 – June 1, 2014 start-up with 12 month straight-line ramp-up • Used Weibull (right-skewed) distribution	• P99 – 18 • P5 – 3
DuPont	• P95 – Oct. 1, 2014 start-up with 6 month straight-line ramp-up • P5 – value set to zero to show probability of no production • Used Half-Normal distribution	• P95 – 2 • P5 – 0	• P95 – same as EPA, but used as P99 • P0 – April 1, 2015 start-up with 12 month straight-line ramp-up • Used Weibull (right-skewed) distribution	• P99 – 2 • P0 – 0
Poet	• P95 – July 1, 2014 start-up with 6 month straight-line ramp-up • P5 – value set to zero to show probability of no production • Used Half-Normal distribution	• P95 – 6 • P5 – 0	• P95 – same as EPA, but used as P99 • P0 – Jan. 1, 2015 start-up with 12 month straight-line ramp-up • Used Weibull (right-skewed) distribution	• P99 – 6 • P0 – 0
INEOS Bio	• All ready operating in 2013 • Used Weibull (right-skewed) distribution	• P95 – 5 • P5 – 2	• P95 – same as EPA • P5 – same as EPA • Used Weibull (right-skewed) distribution	• P95 – 5 • P5 – 2
KiOR	• P95 – March 2013 start-up with 9 month straight-line ramp-up • P5 – value set to zero to show probability of no production • Used Weibull (right-skewed) distribution	• P95 – 9 • P5 – 0	• P95 – same as EPA, but used as P99 • P0 – Since EPA P5 value was zero, set P0 to 0 creating small positive P5 • Used Weibull (right-skewed) distribution	• P99 – 9 • P0 – 0

See Appendix 4 for graphs of data range values.

5.3 The Sensitivity Analysis

Setting the production variable to the ranges and distributions identified in the table above, Decision Strategies ran a series of sensitivity tests to on the first variable "What is the probability on the plant not starting up in 2014?".

For the 3 plants that did not produce in 2013 and KiOR, the test values for this variable were set to 0%, 10%, 20%, 30%, 40%, and 50% in consecutive Monte Carlo Simulations. This variable was applied to the KiOR volumes because of the continued start-up issues the plant is facing make the probability of no production in 2014 greater than zero. The percent values were applied uniformly to each plant due to a lack of granularity in data.

In all sensitivity runs, INEOS was given a 0% probability of not producing in 2014 (or a 100% probability of having production in 2014) as they produced commercially in 2013. The assumption was made that some level of commercial production (defined by the ranged production variable) would occur in 2014. This plant was operating in 2013 and no longer has construction uncertainty or issues related to ramp-up.

The probability variable represents the likelihood that a given plant would not produce in 2014. This variable can be somewhat confusing since it is applied at the plant level and a "portfolio effect" is experienced when the numbers are combined. This means that the likelihood of achieving at least one successful startup is very high. The following table should help to clarify the implications of the probability math as it applies to the number of plants that achieve startup.

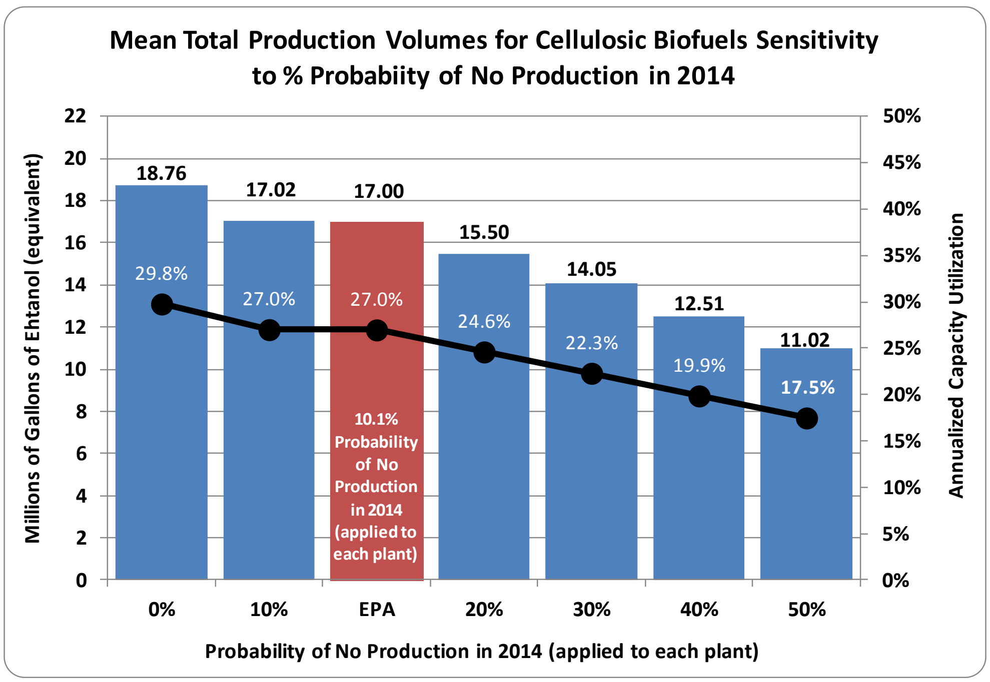
Probability of the Number of Plants Achieving Startup						
Number of Plants Starting Up in 2014 (Out of 4, INEOS excluded)	Individual Probability of Each Plant Not Starting Up					
	0%	10%	20%	30%	40%	50%
No Plants – 4 Failures	n/a	0%	0%	1%	3%	6%
1 Plant Only – 3 Failures	n/a	0%	3%	8%	15%	25%
2 Plants Only – 2 Failures	n/a	5%	15%	26%	35%	38%
3 Plants Only – 1 Failure	n/a	29%	41%	41%	35%	25%
All 4 Plants – 0 Failures	100%	66%	41%	24%	13%	6%
At Least 1 Plant (Any of the 4)	100%	~100%	99.8%	99.2%	97.4%	93.8%

For example, with a probability of no production in 2014 of 30% applied to all of the plants individually, there is a 26% probability that 2 out of the 4 plants will achieve startup (only 2 with 2 failures). In the same 30% probability case, there is a 99.2% probability of having at least one successful startup (Note – "at least one" includes 1 and 2 and 3 and 4 successful startup cases' probabilities). Additionally, given a 40% probability of no production in 2014, there is a 13% chance of all 4 plants will start-up or (1-40%)^4.

Each plant is facing different levels of risk related to the completion of construction and starting up. Decision Strategies recommends doing individual assessment of each plant considering the construction history and status and other issues that will impact start-up to determine the probability the plant will not produce in 2014 for each individual plant.

5.4 Results of Sensitivity Testing

The results of the sensitivity analysis are shown in the graph below. As expected, the higher the probability of each plant not achieving production in 2014, the lower the total cellulosic biofuel volume. The EPA results (indicated by the red bar), when compared to this test, equates to 10.1% probability of each plant not achieving production in 2014.



The results above apply the same probability of no production to all of the plants in each test.

As shown the 17 million gallons of cellulosic biofuel requires a 27% mean utilization of the predicted plant capacity for 2014. This is higher than the EPA predicted mean utilization for 2013 (24%) and significantly higher than the 2.8% actually achieved by cellulosic biofuel producers in 2013.

The 17 million gallons is a 400%+ increase over the 2013 predicted volumes and a 1700% increase over the actual volumes achieved by the cellulosic biofuel producers in 2013.

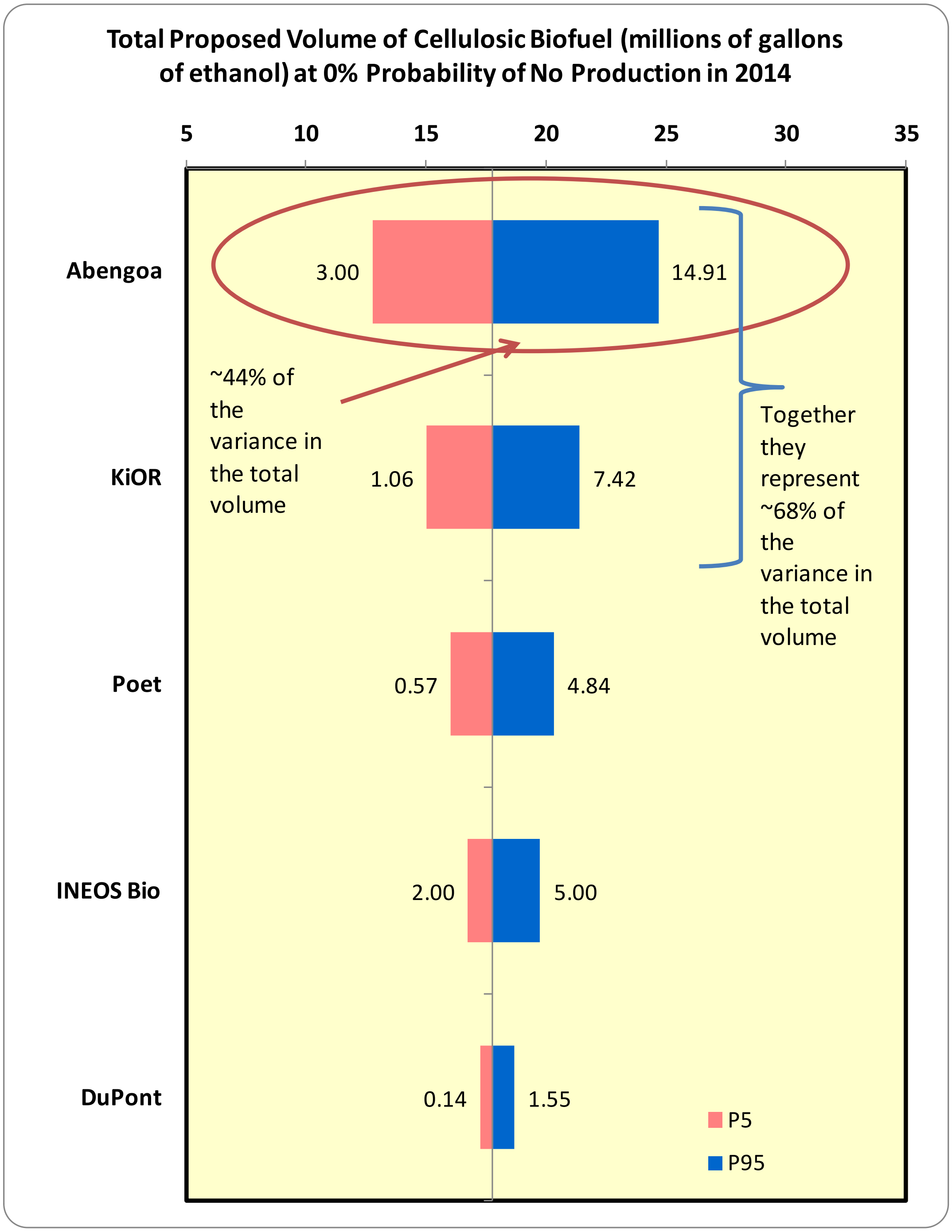
The majority of this increase is dependent upon 3 new plants (that have not yet completed construction) and an existing plant (KiOR) that has just announced a planned shutdown for the entire first quarter of 2014 (the shutdown was not included in the calculations above).

Decision Strategies routinely uses the Tornado charts to understand how the input values are influencing the output. The Tornado chart shows the impact of each of the variables independently on the output. The model records the output totals as it moves each variable from the low to the high end value (P5 to P95) while holding all other variables at their median values (P50). The width of each tornado bar is a measure of the impact of each variable.

With regard to the impact of the plant volumes (using the sensitivity case inputs) individually on the total volume the Tornado chart below show that Abengoa and KiOR together represent ~68% of the variance in the total volume. A better understanding of the status of these two plants and their production will provide significant insight into the actual production volume of cellulosic biofuel in 2014. Some questions to ask include:

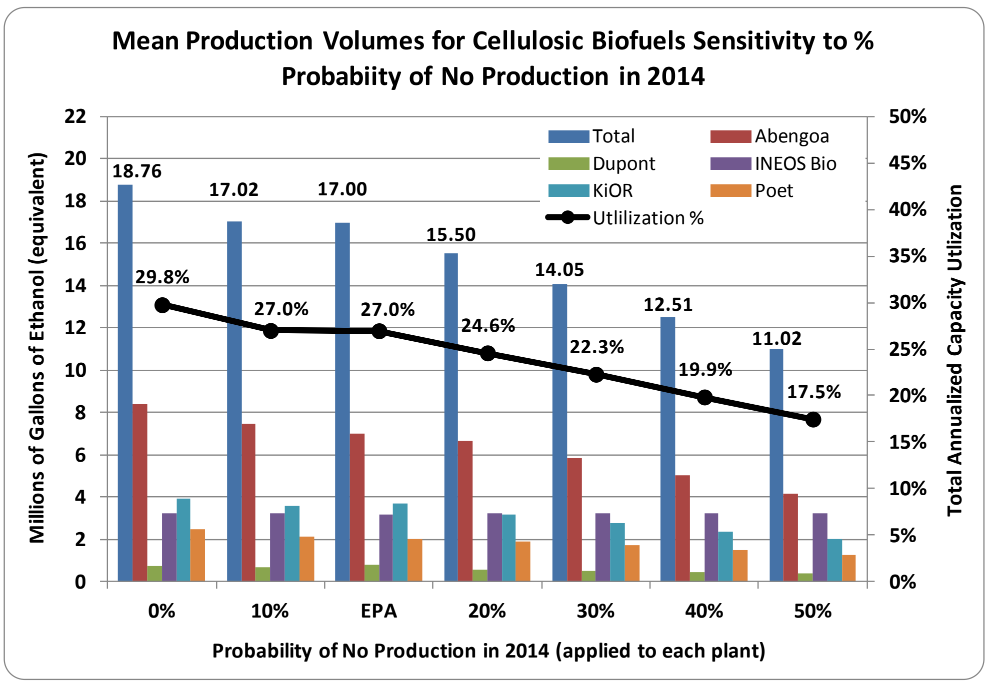
- Is Abengoa meeting the planned construction completion date for the plant? What other issues is the Abengoa plant facing that could impact the start-up date? Are there any early indications of issues that could extend the Abengoa plant ramp-up period?
- What is the current status of the KiOR plant? Has it completed its' ramp-up period? What production levels have been achieved in the past 3 or so months?

It is Decision Strategies opinion that the EPA should work with the companies and other data providers and use its experience and engineering judgment to assess each of these facilities (as well as the DuPont and Poet facilities) for the range and % inputs. Based on the results of this sensitivity analysis and the historical achievement of the industry it is possible that several of the plants could have even a greater than 50% probability of not producing in 2014.


Total Proposed Volume of Cellulosic Biofuel (millions of gallons of ethanol) at 0% Probability of No Production in 2014
5
10
15
20
25
30
35
Abengoa
3.00
14.91
KiOR
1.06
7.42
Poet
0.57
4.84
INEOS Bio
2.00
5.00
DuPont
0.14
1.55
~44% of the variance in the total volume
Together they represent ~68% of the variance in the total volume
P5
P95

The results by plant are show in the table and chart below.

Results Summary – Sensitivity Tests – Cellulosic Biofuel Plant Volumes							
Company/ Probability of No Production in 2014	0%	10%	EPA	20%	30%	40%	50%
Total	18.76	17.02	17.00	15.50	14.05	12.51	11.02
Abengoa	8.42	7.44	7.00	6.63	5.86	5.01	4.17
DuPont	0.72	0.65	0.78	0.58	0.50	0.43	0.36
INEOS Bio	3.21	3.21	3.20	3.21	3.21	3.21	3.21
KiOR	3.95	3.56	3.70	3.17	2.78	2.39	2.03
Poet	2.46	2.16	2.00	1.91	1.69	1.48	1.24
Annualized Total % Utilization	29.8%	27.0%	27.0%	24.6%	22.3%	19.9%	29.8%



6. Decision Strategies' Recommendations for Improvements to Future Assessments Using Probabilistic Analysis

6.1 Summary

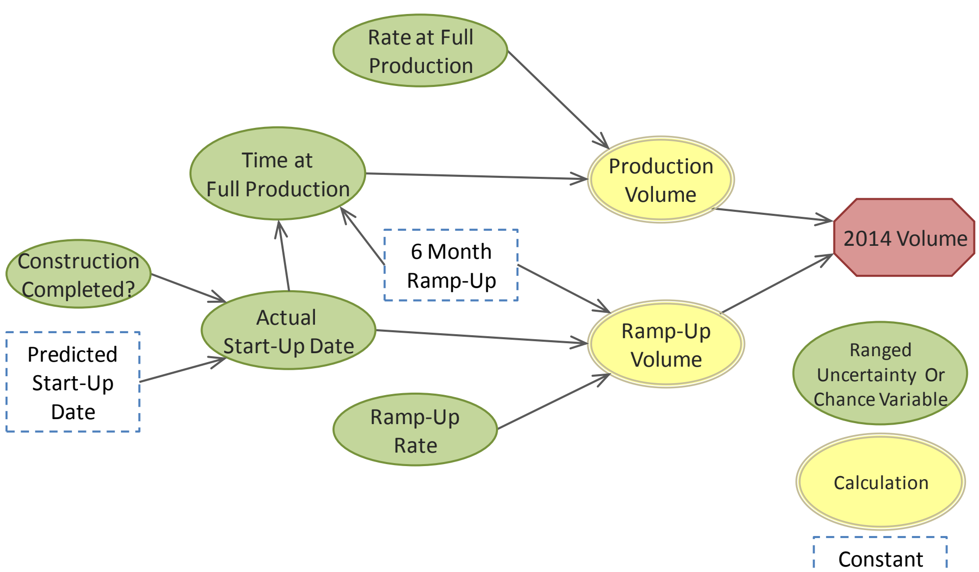
Overall, the EPA performed a good probabilistic analysis. Some of the issues regarding modifying the data are grounded in the basic EPA process of collecting outlook projections from publicly held companies for new plants and/or new technologies. This poses some unique difficulties, but the following recommendations might prove useful in future analyses. Several opportunities for improvement are included in the discussions in sections 4 and 5. Some additional opportunities are discussed below.

6.2 Data Assessment Interviews

Data Assessment interviews of Subject Matter Experts is fully described in Chapter 10 of:

> Parnell, Gregory S, et al. *Handbook of Decision Analysis*. Wiley: Hoboken, New Jersey, 2013. Print.

One of the first steps in assessing probabilistic data is to develop an Influence Diagram. This tool is a pictorial representation of the critical uncertainties linked together to illustrate how they influence each other and the final value being calculated. Shown below is an example simple Influence Diagram that describes many of the uncertainties that could have been used in this analysis. In this example the Predicted Start-Up Date and a 6 Month Ramp-Up are entered as constants. The total 2014 Volume is a sum of the volumes during production time (if any) and the volumes during Ramp-Up.



If possible, the EPA should identify the Subject Matter Experts for each company/category being assessed for each of the variables. Most likely, the same interviewee would provide all the information concerning all the variables for their company/category. Since much of the industry is not familiar with probabilistic analysis, the EPA should either send a pre-read prior to the interviews that describes the basics of what they are trying to accomplish and/or spend time in the interview to ground the participant. In order to properly assess an expert, de-biasing techniques are extremely useful and are described in the reference mentioned earlier.

A good “rule of thumb” is to allow the Subject Matter Expert to provide estimates in their own vernacular. Since you are asking for ranges, they need to be able to “think” and estimate in those ranges. Asking them to combine uncertainties is difficult and can be programmed into the model later.

There is no issue with a P5-P95 range being used and considered. Decision analysis in the Oil & Gas Industry typically uses a P10-P50-P90 range (80% confidence band), but if the EPA would like to use the P5-P95 as their range, this is perfectly valid and can also be used by most of the software available today. They do need to be wary of combining too many variables and pushing the limits either up or down as a result.

Adding a few variables to the model will greatly improve flexibility. Splitting the volume into a combination of variables – namely the probability of achieving construction completion/start-up and the range/distribution of production volumes given success – should provide additional clarity and improved predictive capability.

6.3 Distributions

The Normal distribution is a good choice for cases such as the CNG/LNG or the Ensyn technology. The greater the number of parts aggregated, the more the outcome or total will resemble a normal distribution. Normal distributions are typically defined with two parameters which allow the P5-P95 data to be adequate. However, where possible the EPA should evaluate the data sets to ensure the Normal is applicable through assessment of the P50 and possible skewness of the data set.

The Weibull distribution is very flexible and can handle a wide variety of input data. It is also bounded on the left making negative values impossible without the need for further data limits in the Monte Carlo simulation. The EPA defined one standard Weibull shape to be used when selected, and the different ranges were applied to that standard. A better method would have been to secure a P50 data point (median) in each range and define a separate Weibull distribution for each P5-P50-P95 range. Subject Matter Experts do not think in terms of Shape or Scale in defining distributions, but they can readily provide Medians. The EPA defaulted to these values to define the distributions in order to build them inside Excel. The software options mentioned in section 6.4 are capable of constructing any number of distributions from the P-Ranges.

The Half-Normal distribution conflates several variables – ramp-up schedule and volumes and construction completion uncertainty. It was designed to provide a distribution where the most likely outcomes were clustered at the lower end of the range. While the Half-Normal does have a large portion of the outcomes at the lower end of the range, it limits the "no production" event to the same probability for all uses and it has a large number of outcomes just above zero. This is not likely in reality as the plant starts up, it is either going to produce zero or some commercial volume. Producing 1 gallon or 4 gallons or 30 gallons is not an outcome that will be experienced. Using two variables – Likelihood of Completing Construction & Ramp-up Production given construction is complete – would be a more effective way to model this variable. We would recommend avoiding use of the Half-Normal distribution in the future.

6.4 Monte Carlo Simulation

According to our interviews, the EPA developed and built a Monte Carlo simulator in Excel to perform this analysis. To simplify their efforts, the EPA should consider using one of the Monte Carlo simulation software packages on the market. We recommend either Crystal Ball by Oracle Corporation or @Risk by Palisade Corporation. Both of these are Excel add-ons and easy to learn and use. Either program will add computation power and speed to the analysis.

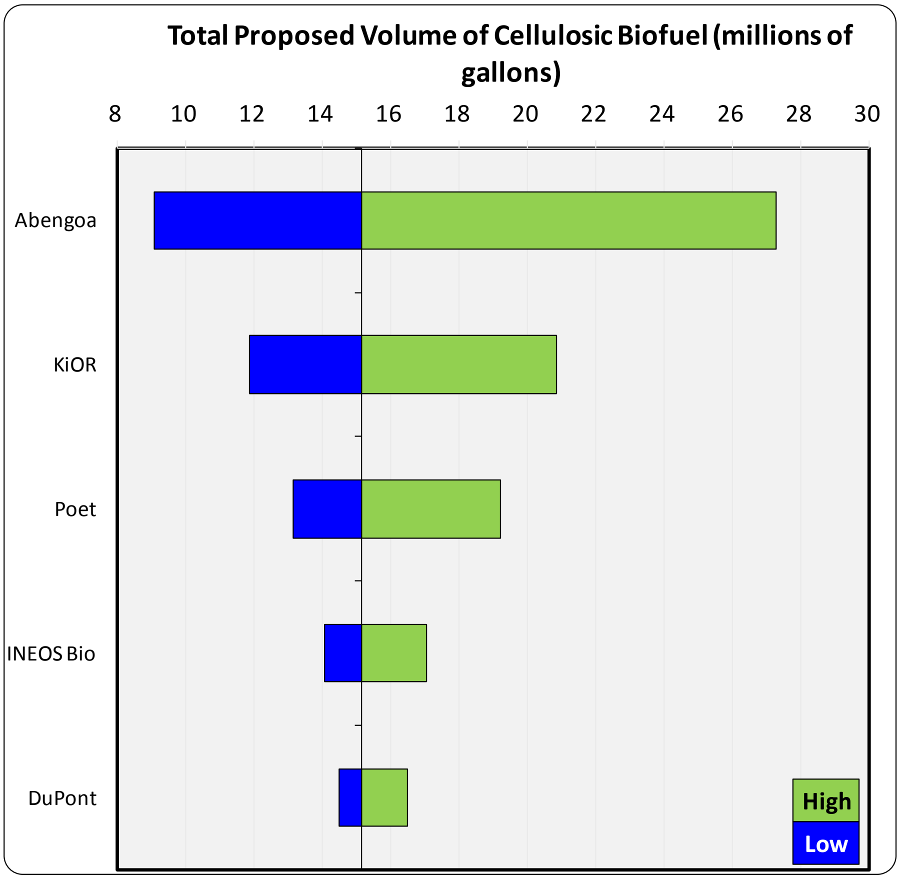
Using one of the "off the shelf" software packages would provide the EPA with some flexibility in the use of multiple variables as well as in the use of more distributions for the ranges.

Even though Decision Strategies feels that use of 3000 trials "would have provided enough trials for the results to converge and be statistically significant", these "off the shelf" software packages would allow the EPA to increase the number of trials significantly due to the speed at which they could run a model of this level of complexity.

6.5 Other recommendations

- Modes and Means are not easily estimated and should be avoided in the assessment of input data ranges.
- Tornado Diagrams can provide valuable insight into the impact of the uncertainties on the final values. We recommend becoming familiar with this tool and using it in the probabilistic analysis.

  Decision Strategies routinely uses the Tornado charts to understand how the input values are influencing the output. The Tornado chart shows the impact of each of the variables independently on the output. The model records the output totals as it moves each variable from the low to the high end value (P5 to P95) while holding all other variables at their median values (P50). The width of each tornado bar is a measure of the impact of each variable. The example below uses the EPA data of the proposed total cellulosic biofuel volume. It shows that the volume produced by Abengoa has the largest impact (47.5%) on the variance of the total proposed volume and the combination of the two largest impacts (Abengoa and KiOR) is 71%. This would indicate that if there are any significant delays during completion of construction (for Abengoa) or ramp up problems with either of these producers the 2014 produced volume of cellulosic biofuels could be significantly impacted.



See Appendix 3 for a number of example tornado diagrams.

Appendix 1 – Review of the Data Used by the EPA (Specific Companies/Groups/ Categories)

A1 – 1: Data Used for Abengoa – Company with Approved Pathway

"Abengoa, a large international biofuels company, has developed an enzymatic hydrolysis technology to convert corn stover and other agricultural waste feedstocks into ethanol. After successfully testing and refining their technology at a pilot scale facility in York, Nebraska as well as in a demonstration-scale facility in Salamanca, Spain, Abengoa is now working towards the completion of their first commercial scale cellulosic ethanol facility in Hugoton, Kansas."

"40 CFR Part 80 - 2014 Standards for the Renewable Fuel Standard Program; Proposed Rule." *Federal Register* 78 (29 November 2013): 71740.

The following table summarizes the data for Abengoa.

Data Summary – Federal Register – Abengoa 2014 Standards for the Renewable Fuel Standard Program; Proposed Rule					
Product	Construction Completion Estimate	Construction Status	Annual Plant Capacity	2014 Company Production Projection	Company Estimated Ramp-up to Plant Capacity
Cellulosic Ethanol	4th Quarter 2013; Startup January 2014	All major process equipment purchased; all permits approved	24 million gallons	17-20 million gallons ethanol	6 months

The data used by the EPA: 0 to 18 million gallons for 2014 production of cellulosic ethanol with a Half-Normal distribution.

This was based on a start up in January 2014 and a six month ramp up of production to plant capacity. As shown in the chart below, this generates an annual production of 18 million gallons for the upper limit (assumed to be a P95). The lower limit of zero was used as the plant has not begun producing commercial volumes of ethanol.

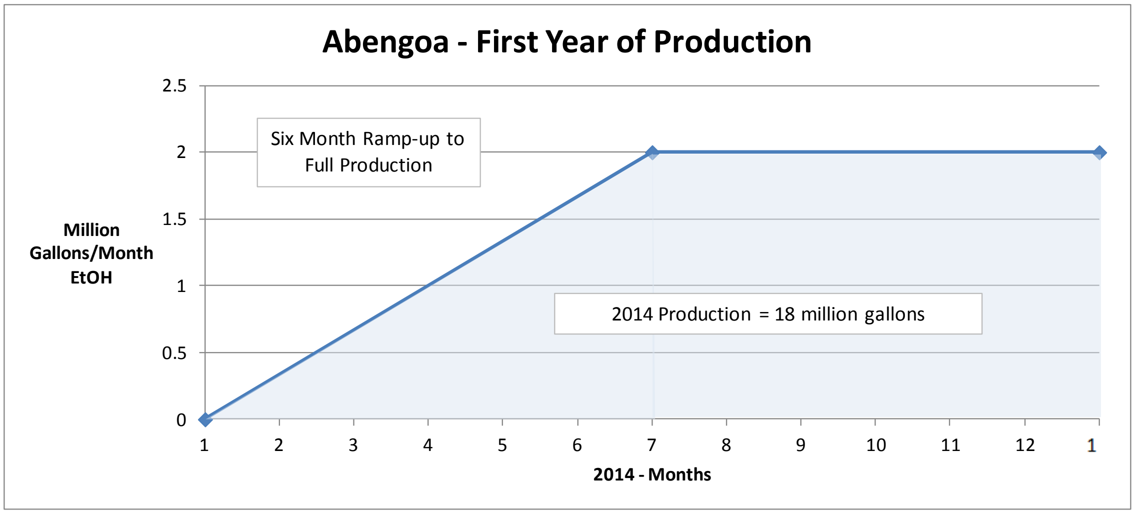
Further information considered:

- *"All of the major process equipment for this project has been purchased and all of the required permits for construction have been approved."*

- *"To date construction at the Abengoa facility has proceeded as expected and EPA has no reason to believe this facility is less likely to achieve their production targets than any other new first-of-a-kind cellulosic biofuel facility."*

  "40 CFR Part 80 - 2014 Standards for the Renewable Fuel Standard Program; Proposed Rule." *Federal Register* 78 (29 November 2013): 71740.

The following chart shows the P95 projected production for the Poet joint venture.



A1 – 2: Data Used for DuPont – Company with Approved Pathway

"DuPont has developed an enzymatic process to convert corn stover into cellulosic ethanol. On November 30, 2012 DuPont began the construction of their first commercial scale cellulosic ethanol facility in Nevada, Iowa."

"40 CFR Part 80 - 2014 Standards for the Renewable Fuel Standard Program; Proposed Rule." *Federal Register* 78 (29 November 2013): 71741.

The following table summarizes the data for DuPont.

Data Summary – Federal Register - DuPont 2014 Standards for the Renewable Fuel Standard Program; Proposed Rule					
Product	Construction Completion Estimate	Construction Status	Annual Plant Capacity	2014 Company Production Projection	Company Estimated Ramp-up to Plant Capacity
Cellulosic Ethanol	June 2014; Startup 2nd Half 2014	Minor delay could cause no production in 2014	30 million gallons	3 million gallons ethanol	None mentioned

The data used by the EPA: 0 to 2 million gallons for 2014 production of cellulosic ethanol with a Half-Normal distribution.

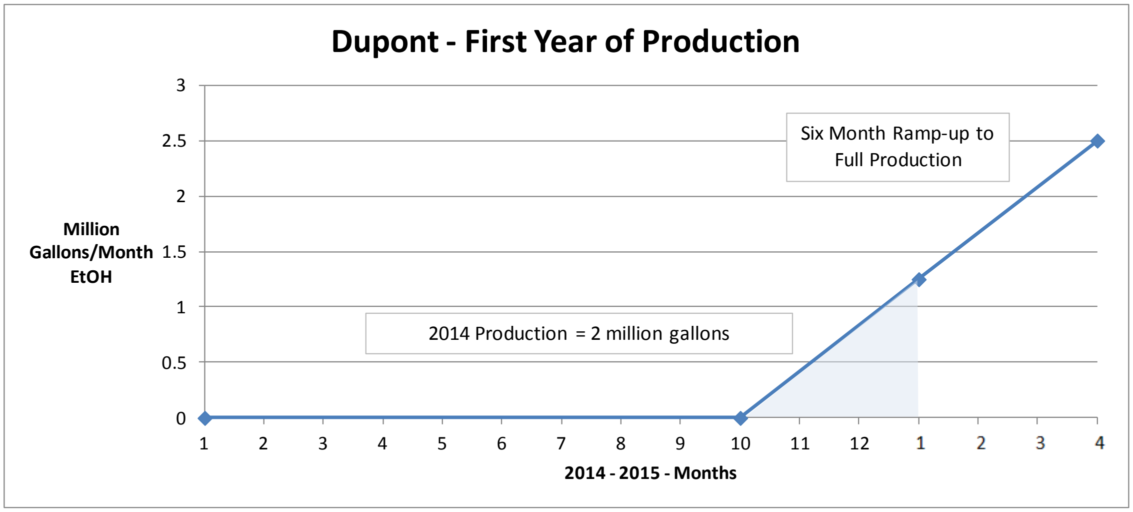
The range is based on a start up in October 2014 and a six month ramp up of production to plant capacity. As shown in the chart below, this generates an annual production of 2 million gallons for the upper limit (assumed to be a P95). The lower limit of zero was used as the plant has not begun producing commercial volumes of ethanol.

Further information considered:

- *"Due to the start-up date that is late in the year, however, even a relatively minor delay in the construction and commissioning timeline or unforeseen challenges in start-up would result in no production from this facility in 2014."*

  "40 CFR Part 80 - 2014 Standards for the Renewable Fuel Standard Program; Proposed Rule." *Federal Register* 78 (29 November 2013): 71741.

The following chart shows the P95 projected production for the Poet joint venture.



A1 – 3: Data Used for INEOS Bio – Company with Approved Pathway

"On July 31, 2013, INEOS Bio announced they had begun producing cellulosic ethanol at commercial scale from their Vero Beach facility. INEOS Bio currently projects cellulosic ethanol production at this facility to be 4–5 million gallons in 2013."

"40 CFR Part 80 - 2014 Standards for the Renewable Fuel Standard Program; Proposed Rule." *Federal Register* 78 (29 November 2013): 71741.

The following table summarizes the data for INEOS Bio.

Data Summary – Federal Register – INEOS Bio 2014 Standards for the Renewable Fuel Standard Program; Proposed Rule					
Product	Construction Completion Estimate	Construction Status	Annual Plant Capacity	2014 Company Production Projection	Company Estimated Ramp-up to Plant Capacity
Cellulosic Ethanol	Completed in 2013	Production began in 2013	8 million gallons	4-5 million gallons ethanol in 2013	N/A

The data used by the EPA: 2 to 5 million gallons for 2014 production of cellulosic ethanol with a Right Skewed distribution.

The upper end of the estimated 2013 production was used as the upper end of the range (P95) for the 2014 production due to problems experienced at INEOS Bio's facility in 2013 with ramp-up and power outages. The lower limit of 2 million gallons was above zero as the plant has produced commercial volumes of ethanol.

Further information considered:

- *"The facility has not yet reached production rates consistent with its projected production volume, and production ramp-up could take longer than expected."*
- *"INEOS Bio also experienced several setbacks to production related to weather-caused power losses at the facility."*

"40 CFR Part 80 - 2014 Standards for the Renewable Fuel Standard Program; Proposed Rule." *Federal Register* 78 (29 November 2013): 71741-42.

A1 – 4: Data Used for KiOR – Company with Approved Pathway

"KiOR's first commercial scale facility is located in Columbus, Mississippi and is capable of producing approximately 11 million gallons of gasoline, diesel, and jet fuel per year. Construction on this facility began in May 2011 and was completed in September 2012."

"40 CFR Part 80 - 2014 Standards for the Renewable Fuel Standard Program; Proposed Rule." *Federal Register* 78 (29 November 2013): 71741.

The following table summarizes the data for KiOR.

Data Summary – Federal Register – KiOR 2014 Standards for the Renewable Fuel Standard Program; Proposed Rule					
Product	Construction Completion Estimate	Construction Status	Annual Plant Capacity	2014 Company Production Projection	Company Estimated Ramp-up to Plant Capacity
Gasoline, Diesel, Jet Fuel	Completed in September 2012	March 17, 2013 KiOR generated their first cellulosic biofuel RINs from this facility	11 million gallons – Gasoline & Diesel	1-2 million gallons product in 2013 – Reduced from 3-5 million*	9-12 months

*No 2014 estimate provided.

The data used by the EPA: 0 to 9 million gallons ethanol equivalent for 2014 production with a Right Skewed distribution.

The upper end (P95) based on running at 50% of nameplate capacity for 2014. The low end of the range reflected uncertainty in the production based on the low volumes produced in 2013 and the reduction in their targets.

Further information considered:

- *"On August 8, 2013 KiOR reduced its production targets for 2013 from 3–5 million gallons to 1–2 million gallons."*
- *"We believe this reduced volume is appropriate given the low production volumes KiOR has achieved to date and KiOR's statements, in an August 8, 2013 conference call discussing their second quarter performance, that they had not yet begun focusing on increasing the efficiency and yields of the facility."*

"40 CFR Part 80 - 2014 Standards for the Renewable Fuel Standard Program; Proposed Rule." *Federal Register* 78 (29 November 2013): 71742.

A1 – 5: Data Used for Poet – Company with Approved Pathway

> *"In January 2012, Poet formed a joint venture with Royal DSM of the Netherlands, called Poet-DSM Advanced Biofuels, to commercialize and license their cellulosic ethanol technology. The joint venture's first commercial scale facility, called Project LIBERTY, will be located in Emmetsburg, Iowa."*
>
> "40 CFR Part 80 - 2014 Standards for the Renewable Fuel Standard Program; Proposed Rule." *Federal Register* 78 (29 November 2013): 71742.

The following table summarizes the data for the Poet joint venture.

Data Summary – Federal Register – Poet 2014 Standards for the Renewable Fuel Standard Program; Proposed Rule					
Product	Construction Completion Estimate	Construction Status	Annual Plant Capacity	2014 Company Production Projection	Company Estimated Ramp-up to Plant Capacity
Cellulosic Ethanol	Began Spring 2012; Completed 1st Half 2014	Delays could cause no production in 2014	25 million gallons	7 to 12 million gallons	None given

The data used by the EPA: 0 to 6 million gallons ethanol for 2014 production with a Half-Normal distribution.

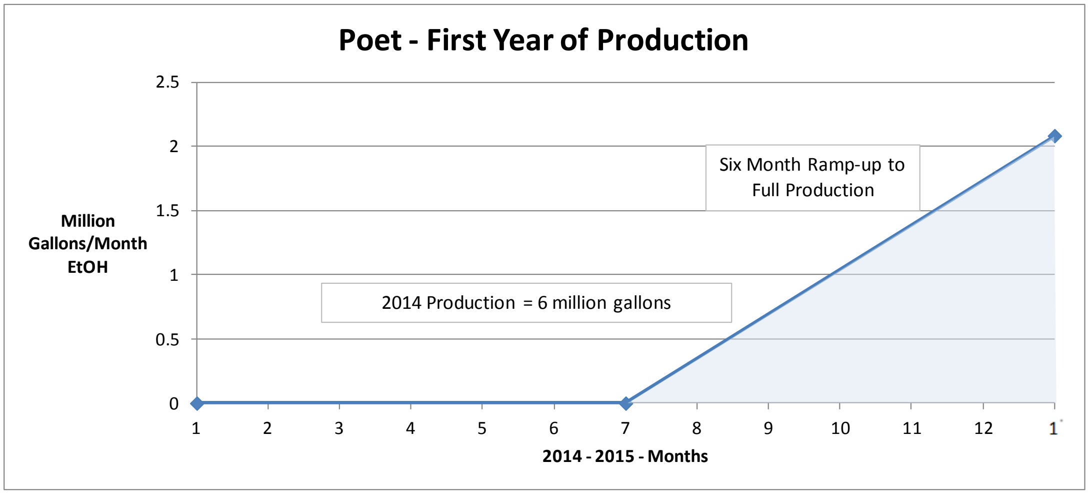
This data is based on a start up on July 1, 2014 with a six month ramp up of production to plant capacity. As shown in the chart below, this generates an annual production of approximately 6 million gallons for the upper limit (P95). The lower limit of zero was used as the plant has not begun producing commercial volumes of ethanol.

Further information considered:

- *"While EPA has no reason to believe this facility will be any more prone to these types of challenges than any other commercial scale cellulosic biofuel production facility, our experience suggests that these types of delays are common and should be considered when projecting the low end of the range for production volume in 2014."*

  "40 CFR Part 80 - 2014 Standards for the Renewable Fuel Standard Program; Proposed Rule." *Federal Register* 78 (29 November 2013): 71742-43.

The following chart shows the P95 projected production for the Poet joint venture.



A1 – 6: Data Used for Ensyn – Company Currently Without Approved Pathway

"Ensyn is currently using this technology in two commercial facilities located in Wisconsin and Ontario, Canada to produce renewable chemicals, food additives, and heating oil. They estimate that they have up to 3 million gallons of additional capacity at these two facilities that could be utilized if the fuel were eligible to generate RINs under the RFS program as home heating oil."

"40 CFR Part 80 - 2014 Standards for the Renewable Fuel Standard Program; Proposed Rule." *Federal Register* 78 (29 November 2013): 71743.

The following table summarizes the data for Ensyn.

Data Summary – Federal Register – Ensyn 2014 Standards for the Renewable Fuel Standard Program; Proposed Rule					
Product	Construction Completion Estimate	Construction Status	Annual Plant Capacity	2014 Company Production Projection	Company Estimated Ramp-up to Plant Capacity
Heating oil	Additional capacity in existing plants	Production delays or delays in qualifying product for use could push this into 2015; plant has history of consistent production	3 million gallons; 5 million ethanol equivalent	3 million gallons; 5 million gallons ethanol equivalent	None given

EPA has included this volume separate from the volumes already approved by the EPA. This volume can be included if it qualifies for RINs. The range used is 0 to 5 million gallons ethanol equivalent for 2014 production using a Normal distribution. The lower limit of zero reflects that the plant does not have all approvals needed for their product to qualify as a renewable fuel.

Further information considered:

- *"However, even if the fuel produced using the RTP process meets the new definition; Ensyn still faces several challenges to generating cellulosic biofuel RINs. Ensyn must still secure approved sources of renewable feedstock for their existing production facilities, increase production at these facilities, and find customers willing to make the modifications necessary to use Ensyn's RFO as home heating oil."*

  "40 CFR Part 80 - 2014 Standards for the Renewable Fuel Standard Program; Proposed Rule." *Federal Register* 78 (29 November 2013): 71743.

A1 – 7: Data Used for Compressed Natural Gas (CNG) and Liquefied Natural Gas (LNG) Producers – Companies Currently Without Approved Pathway

"One of the new pathways proposed by EPA for the production of cellulosic biofuel is for the production of CNG or LNG from landfill biogas if used as a transportation fuel."

"The only change at issue in the proposal to approve this pathway for the generation of cellulosic biofuel RINs is a change in the type of RIN that is generated, allowing for the generation of cellulosic biofuel instead of advanced biofuel RINs based on new information of the composition of the feedstock. The use of CNG and LNG as a transportation fuel in 2014 is expected to be approximately 700 million ethanol-equivalent gallons."

"40 CFR Part 80 - 2014 Standards for the Renewable Fuel Standard Program; Proposed Rule." *Federal Register* 78 (29 November 2013): 71744.

The following table summarizes the data for CNG/LNG Producers.

Data Summary – Federal Register – CNG & LNG Producers 2014 Standards for the Renewable Fuel Standard Program; Proposed Rule					
Product	Construction Completion Estimate	Construction Status	Annual Plant Capacity	2014 Production Projection	Company Estimated Ramp-up to Plant Capacity
Transportation Fuel (LNG & CNG)	Existing	Existing Facilities at landfill sites	Various	35 to 54 million gallons ethanol equivalent	N/A

EPA has included this volume separate from the sources with approved pathways. The range used is 35 to 54 million gallons ethanol equivalent for 2014 production using a Normal distribution. The lower limit represents the sum of production rates taken for a full year of all the locations producing advanced biofuel from landfill biogas in 2013. The upper limit is the sum of those same locations peak capacities.

Further information considered:

- *"The use of CNG and LNG as a transportation fuel in 2014 is expected to be approximately 700 million ethanol-equivalent gallons."*
- *"To generate RINs for landfill biogas, however, companies must be able to demonstrate that any fuel for which they generate RINs is used as transportation fuel."*

"40 CFR Part 80 - 2014 Standards for the Renewable Fuel Standard Program; Proposed Rule." *Federal Register* 78 (29 November 2013): 71743.

A1 – 8: Data Used for Edeniq – Company Currently Without Approved Pathway

"Edeniq has developed a proprietary process that would allow corn ethanol producers to generate cellulosic ethanol from corn kernel fiber at the producers' existing production facilities."

"40 CFR Part 80 - 2014 Standards for the Renewable Fuel Standard Program; Proposed Rule." *Federal Register* 78 (29 November 2013): 71744.

The following table summarizes the data for Edeniq technology.

Data Summary – Federal Register – Edeniq 2014 Standards for the Renewable Fuel Standard Program; Proposed Rule					
Product	Construction Completion Estimate	Construction Status	Annual Plant Capacity	2014 Production Projection	Company Estimated Ramp-up to Plant Capacity
Cellulosic Ethanol (from corn kernel)	Existing	Several existing ethanol facilities are considering the new process	Various	0 to 7 million gallons ethanol equivalent	N/A

EPA has included this volume separately from the sources with approved pathways. The range used is 0 to 7 million gallons ethanol equivalent for 2014 production using the Half-Normal distribution. The lower limit is set at zero since Edeniq's technology has not been used to produce commercial volumes of cellulosic ethanol. The upper limit is based on Edeniq's projections based on the contracts in place and their experience with installing their technology.

Further information considered:

- *"This volume is also dependent on the finalization of EPA's proposed rule clarifying that the definition of crop residue includes corn kernel fiber."*
- *"If the pathway for the production of cellulosic ethanol from corn kernel fiber is approved, these facilities would be in position to begin generating cellulosic RINs shortly after approval."*

"40 CFR Part 80 - 2014 Standards for the Renewable Fuel Standard Program; Proposed Rule." *Federal Register* 78 (29 November 2013): 71744.

A1 – 9: Biomass-based Diesel Volume for 2014

"The biodiesel industry has clearly demonstrated that it can produce the volumes of biomass-based diesel up to the minimum required by the statute, and that 1.28 bill gal of biodiesel is readily attainable."

"There is a large amount of excess production capacity for biomass-based diesel, including at facilities that were in operation in 2012."

"40 CFR Part 80 - 2014 Standards for the Renewable Fuel Standard Program; Proposed Rule." *Federal Register* 78 (29 November 2013): 71752 & 62.

The following table summarizes the data for the Biomass-based Diesel.

Data Summary – Federal Register – Biomass-based Diesel 2014 Standards for the Renewable Fuel Standard Program; Proposed Rule				
2012 Volume	2012 Industry Capacity Total – Registered and Unregistered	2013 Volume	2013 Industry Capacity Total – Registered and Unregistered	2014 Volume Estimate P5-P95 Range
1.14 Billion Gallons	2.4 Billion Gallons	1.1 Billion Gallons August 2013 Total 1.6 to 1.8 Billion Gallons Estimated End of Year	3.6 Billion Gallons	1.28 – 1.61 Billion Gallons (actual diesel)

Data from EPA-Moderated Transaction System (EMTS)

For use in the Monte Carlo simulation, the EPA used a range of 1.28 to 1.61 billion gallons of diesel for estimated 2014 production using a Half-Normal distribution. The lower limit is set at the required volume by statute and the upper limit is set at the number that is likely to be used in 2013. Even though the industry has excess capacity above the upper limit, a number of other factors (primarily economic) could reduce the production in 2014.

Further information considered:

- *"Federal tax credit for biodiesel that was most recently extended through the end of 2013 under the American Taxpayer Relief Act of 2012. Under this Act, parties that produce a mixture of biodiesel and diesel fuel can claim a $1.00-per-gallon credit against their tax liability.65 This tax credit has enabled biodiesel to be more competitive with other advanced biofuels. However, as of this writing it is unclear if this tax credit will apply in 2014."*
- *"These 2013 biodiesel production volumes are occurring in the context of a $1/gal tax credit. While they provide a clear indication of the production capabilities of the industry, they do not provide an accurate indicator of the volumes that would be produced in the absence of the tax credit."*

- *"In the past some stakeholders have expressed concern that there may be limitations in biodiesel consumption that could be imposed by manufacturer warranties and cold-weather operation, and that this could impact use of biodiesel above 1.28 bill gal. However, we do not believe that this is the case for 2014. For instance, most diesel engines are warranted by their manufacturer to B5."*
- *"Production of biodiesel in 2014 is likely to be impacted significantly by feedstock prices." [Steady decline in prices from a high in 2011.]*
- *"In their comments on the NPRM for the 2013 standards, the University of Illinois provided the results of an analysis of both production and consumption limitations for ethanol and biodiesel. They concluded that 1.7 bill gal of biodiesel could be available without overwhelming feedstock supplies, but provided little detail on the limits of feedstock supply."*

"40 CFR Part 80 - 2014 Standards for the Renewable Fuel Standard Program; Proposed Rule." *Federal Register* 78 (29 November 2013): 71763-65.

Projections of 2014 Biomass-based Diesel Ordered from Lowest to Highest Estimate	
Basis for Estimate	Biomass-based Diesel in 2014 Million Gallons
Biomass-based diesel volume requirement	1,280
IHS Global Insight report	1,540
Extrapolated 2013 production	1,570
All registered biodiesel facilities that operated at least 20% of capacity in 2012	1,600
Additional soy oil production and diversion of exported corn oil to biodiesel production	1,620
University of Illinois estimate in their comments	1,700
Darling International, Inc. estimate in their comments	1,900
Production capacity of all registered biodiesel facilities that produced some biodiesel in 2012	2,400

"40 CFR Part 80 - 2014 Standards for the Renewable Fuel Standard Program; Proposed Rule." *Federal Register* 78 (29 November 2013): 71765.

A1 – 10: Domestic Ethanol Advanced Biofuel

> *"In 2012, 28 mill gal of ethanol advanced biofuel (other than cellulosic ethanol) was produced in the U.S. Based on Production Outlook Reports, we project that domestic production of such biofuel using some combination of sugarcane, grain sorghum, and separated food wastes could be as high as 142 mill gal. Based on these sources, for this NPRM we have used a range of 28–142 mill gal to represent domestic production of ethanol advanced biofuel..."*
>
> "40 CFR Part 80 - 2014 Standards for the Renewable Fuel Standard Program; Proposed Rule." *Federal Register* 78 (29 November 2013): 71771.

The following table summarizes the data for the Domestic Ethanol Advanced Biofuel.

Data Summary – Federal Register – Domestic Ethanol Advanced Biofuel 2014 Standards for the Renewable Fuel Standard Program; Proposed Rule				
2012 Volume	2012 Industry Capacity Total – Registered and Unregistered	2013 Volume	2013 Industry Capacity Total – Registered and Unregistered	2014 Volume Estimate P5-P95 Range
28 Million Gallons	N/A	No Information	As much as 142 Million Gallons	28 – 142 Million Gallons

For use in the Monte Carlo simulation, the EPA used a range of 28 – 142 million gallons of ethanol for estimated 2014 production using a Normal distribution. The lower limit is set based on production in 2012 and the upper limit is set at the estimated total industry capacity.

A1 – 11: Domestic Non-Ethanol Advanced Biofuel Volume for 2014

"Non-ethanol advanced biofuel other than cellulosic biofuel and biomass based diesel has a D code of 5, and could include biodiesel and renewable diesel that is co-processed with petroleum ,76 heating oil, biogas, jet fuel, naphtha, and LPG."

"40 CFR Part 80 - 2014 Standards for the Renewable Fuel Standard Program; Proposed Rule." *Federal Register* 78 (29 November 2013): 71766.

The following table summarizes the data for Non-Ethanol Advanced Biofuel.

Data Summary – Federal Register – Non-Ethanol Advanced Biofuel 2014 Standards for the Renewable Fuel Standard Program; Proposed Rule		
Product	2012 Volumes Million Gallons Ethanol Equivalent	2014 Estimated Volumes Million Gallons Ethanol Equivalent
Heating Oil	0.2	-
Biogas	2.9	45.8
Renewable Diesel	20.5	79.1
Naphtha	-	6.6
Total	23.6	131.7

Taken from Production Outlook Reports submitted by all registered renewable fuel producers under § 80.1449

The EPA used a range of 24 to 132 million gallons ethanol equivalent for 2014 production of non-ethanol advanced biofuel using a Normal distribution. The lower limit is set at the actual volume produced in 2012 and the upper limit is based on industry estimates of the volumes available in 2014.

Further information considered:

- *"Since the 45.8 mill ethanol-equivalent gallons of biogas from the Production Outlook Reports … represents about 11% of the annual CNG vehicle consumption, it is reasonable to expect that this volume could be used in 2014 to fuel CNG vehicles and thus generate advanced biofuel RINs."*
- *"For the final rule we will update this range based on more recent data on actual production in 2013 and more recent versions of the Production Outlook Reports."*

"40 CFR Part 80 - 2014 Standards for the Renewable Fuel Standard Program; Proposed Rule." *Federal Register* 78 (29 November 2013): 71766.

A1 – 12: Ethanol from Sugarcane - Imported Volume for 2014

> *"Sugarcane ethanol qualifies as advanced biofuel, and historically the U.S. has imported substantial volumes of it."*
>
> *"While the generation of advanced biofuel RINs from sugarcane ethanol is not limited to ethanol imported from Brazil, historically Brazil has been the source of the majority of ethanol imported into the United States. As such, this section focuses on the availability of sugarcane ethanol imported from Brazil."*
>
> "40 CFR Part 80 - 2014 Standards for the Renewable Fuel Standard Program; Proposed Rule." *Federal Register* 78 (29 November 2013): 71771.

The EPA used a range of 300 to 800 million gallons of imported ethanol from Brazilian sugarcane in 2014 using a Normal distribution. The range is based on the table below of projections of 2014 import volumes of sugarcane based ethanol from Brazil from a variety of sources. The lower end of the range is not the lowest projection in the table, but based on 2013 volumes (estimated to be 500 million gallons), importing less than 300 million gallons is highly unlikely. Similarly, the upper end of the range is not the highest estimate, but it is set at a level where exceeding it is highly unlikely.

Projections of 2014 Imports of Ethanol Produced from Brazilian Sugarcane Ordered from Lowest to Highest Estimate

Basis for Estimate	Imports in 2014 Million Gallons
Average import volumes from 2003–2012	223
ISU Staff Report - Biodiesel tax credit in place	310
Ethanol exported from Brazil to the U.S. - historical max (2010)	490
FAPRI Biofuel Baseline	496
Production Outlook Reports	510
Historical max ethanol imported into the U.S. from Brazil (2006)	560
AEO2013	719
Projection from Brazilian Ministry of Mines and Energy	800
ISU Staff Report- Biodiesel tax credit not in place	820
FAPRI 2012 World Agricultural Outlook - Brazilian exports in 2014	1,259
Historical maximum ethanol exported from Brazil (2008)	1,350

"40 CFR Part 80 - 2014 Standards for the Renewable Fuel Standard Program; Proposed Rule." *Federal Register* 78 (29 November 2013): 71773.

A1 – 13: Non-Ethanol Non-Advanced Biofuel Volume for 2014

> *"To determine a range for the nonethanol non-advanced renewable fuel volume, we used the same approach as for the non-ethanol advanced biofuel volume. That is, we used actual 2012 production to represent the low end of the range and 2014 projections from Production Outlook Reports to represent the high end of the range."*
>
> "40 CFR Part 80 - 2014 Standards for the Renewable Fuel Standard Program; Proposed Rule." *Federal Register* 78 (29 November 2013): 71766.

The EPA used a range of 1 to 25 million gallons ethanol equivalent for 2014 production of non-ethanol non-advanced biofuel using a Normal distribution. The lower limit is set at the actual volume produced in 2012 and the upper limit is based on industry estimates of the volumes available in 2014.

Further information considered:

- *"[This range] mostly representing production of biodiesel at facilities that have been grandfathered under § 80.1403 and which may use feedstocks for which there is currently no valid RIN generating pathway, such as sunflower or cottonseed oil."*
- *"For the final rule we will update this range based on more recent data on actual production in 2013 and more recent versions of the Production Outlook Reports."*

"40 CFR Part 80 - 2014 Standards for the Renewable Fuel Standard Program; Proposed Rule." *Federal Register* 78 (29 November 2013): 71766.

A1 – 14: Total Consumable Ethanol Volume 2014

The calculation for total consumable ethanol volume uses an estimate of 14.33 Quadrillion Btu of energy being required in 2014 for all gasoline engines and vehicles (based on EIA Annual Energy Outlook 2013, Table 37). The EPA used a range of 100 to 300 million gallons of E85 consumption. The remaining energy comes from ethanol and gasoline in an E10 blend.

Assuming volumes of E0 and E15 would be zero and using a range of 100 to 300 million gallons of E85 consumption in 2014, the volume of Total Consumable Ethanol was back calculated from the required energy (energy contents of 77,000 Btu/gal for ethanol and 115,000 Btu/gal for gasoline) as follows:

Assumption: Gasoline Energy Needed in 2014 = 14.33 x 10^{15} Btu
Total Energy Required = Energy from E10 + Energy from E85
Total Ethanol = E10 Ethanol + E85 Ethanol

Two Cases:

1. P5 Case - 100 million gallons of E85
2. P95 Case - 300 million gallons of E85

<u>Case 1 - 100 million gallons of E85</u>

Energy from E85

100 million gallons of E85 provides = 8.27 x 10^{12} Btu (86,880 Btu/gal – 74% EtOH)

Energy from E10

14.33 x 10^{15} Btu - 8.69 x 10^{12} Btu = 14.321 x 10^{15} Btu

Volume of E10

14.321 x 10^{15} Btu / 111,200 Btu/gal = 128.79 million gallons

Volume of Ethanol

0.10 x 128.79 million gallons + 0.74 * 100.00 million gallons = 12.95 million gallons

<u>Case 2 - 300 million gallons of E85</u>

Energy from E85

300 million gallons of E85 provides = 26.06 x 1012 Btu (86,880 Btu/gal – 74% EtOH)

Energy from E10

14.33 x 1015 Btu – 26.06 x 1012 Btu = 14.304 x 1015 Btu

Volume of E10

14.304 x 1015 Btu / 111,200 Btu/gal = 128.63 million gallons

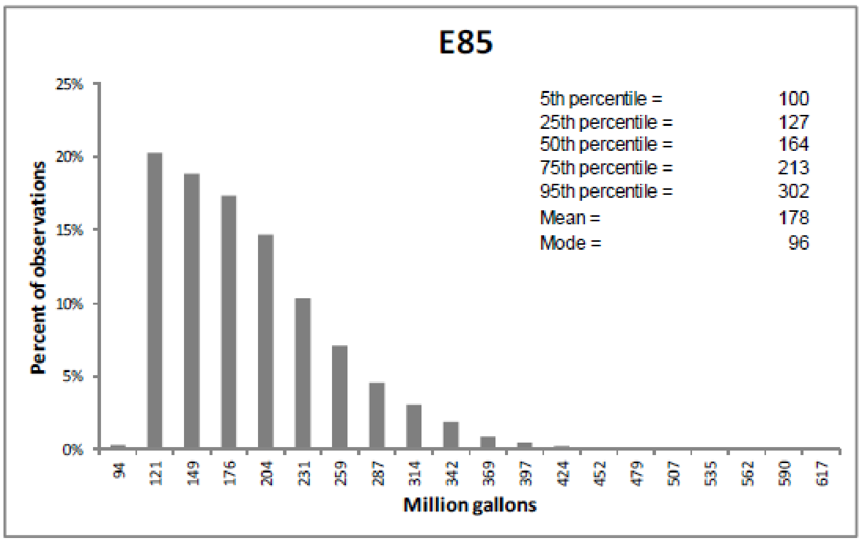
Volume of Ethanol

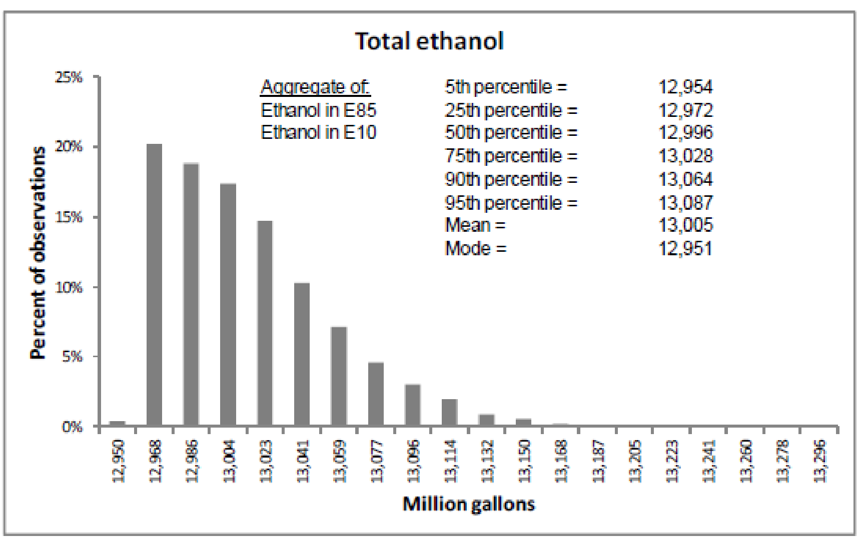
0.10 x 128.63 million gallons + 0.74 * 300.00 million gallons = 13.09 million gallons

The total ethanol consumption range for 2014 was 12.95 to 13.09 billion gallons. The Half-Normal distribution was used in the Monte Carlo simulation as illustrated in the two graphs below.

Further information considered: *"This ethanol volume would include non-advanced ethanol such as that made from corn as well as advanced biofuels such as sugarcane ethanol or other domestically-produced advanced ethanol."*

> "40 CFR Part 80 - 2014 Standards for the Renewable Fuel Standard Program; Proposed Rule." *Federal Register* 78 (29 November 2013): 71762.





Both charts above from Memo to Docket: David Korotney - Application of Monte Carlo process to the determination of proposed volume requirements for 2014 standards NPRM

Appendix 2 – Results of Comparison between the EPA Analysis and Decision Strategies Mirror Analysis

A2 – 1: Cellulosic Biofuel Results

A Monte Carlo simulation was done by the EPA to aggregate the volume ranges from the set of likely producers with approved pathways. The result of the simulation was a range of 8–30 million ethanol equivalent gallons of cellulosic biofuel (P5-P95) with a mean value of 17 million gallons.

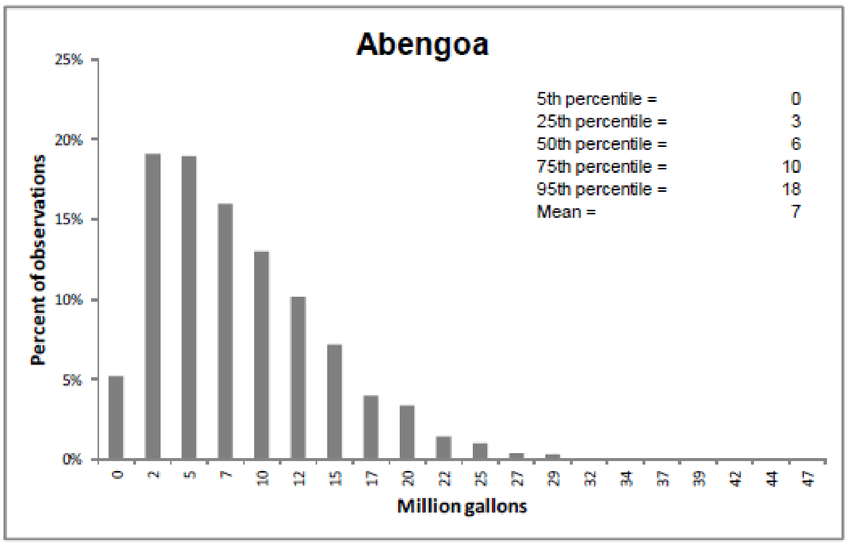
When potential producers who currently do not have approved pathways are included in the analysis the range (p5-p95) increases to 53-83 million gallons of ethanol equivalent in 2014 with a mean value of 67 million gallons.

Decision Strategies created a model to mirror the EPA Monte Carlo Simulation and produced results that are practically identical for both the individual company/group inputs and the aggregate volumes for the total (both available and proposed) cellulosic biofuel, the ethanol cellulosic biofuel, and the non-ethanol cellulosic biofuel.

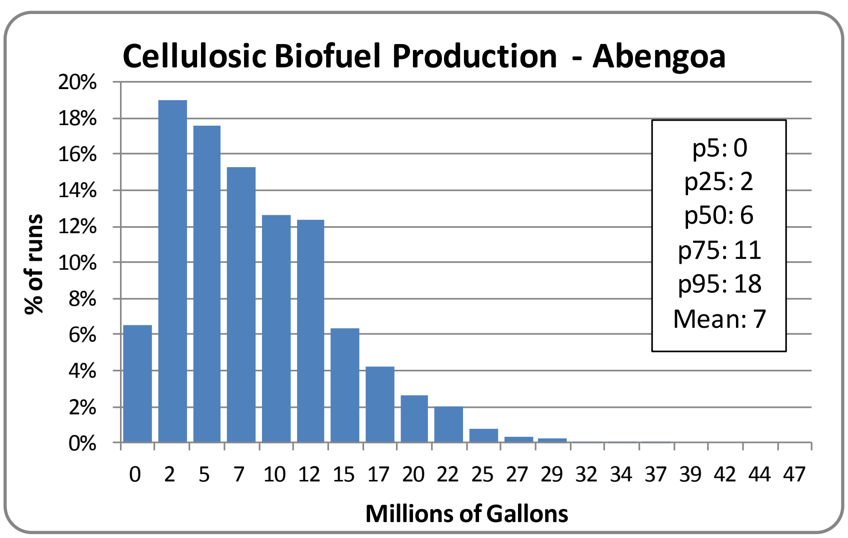
A2 – 1.1: Abengoa – Company with Approved Pathway

Abengoa - Model Results Comparison (millions of gallons)						
	p5	p25	p50	p75	p95	mean
EPA	0	3	6	10	18	7
Decision Strategies	0	2	6	11	18	7

The EPA results from Memo to Docket: David Korotney – "Application of Monte Carlo process to the determination of proposed volume requirements for 2014 standards NPRM".



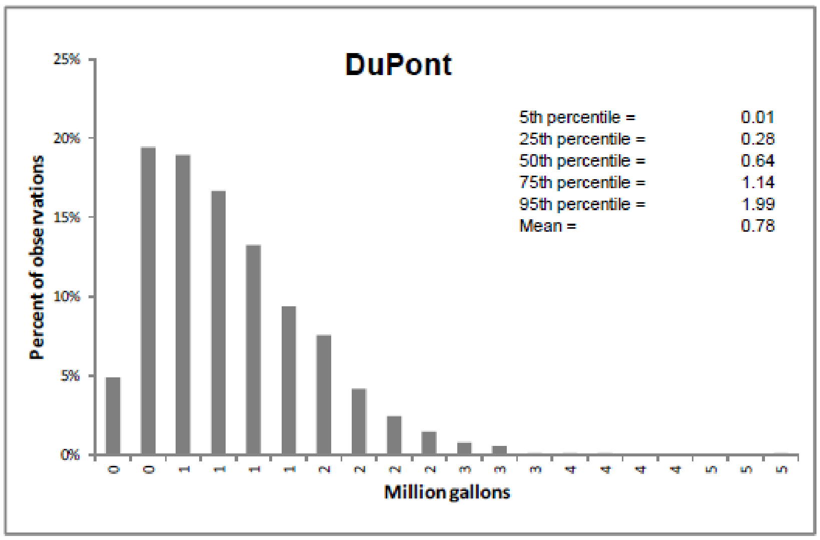
Decision Strategies results



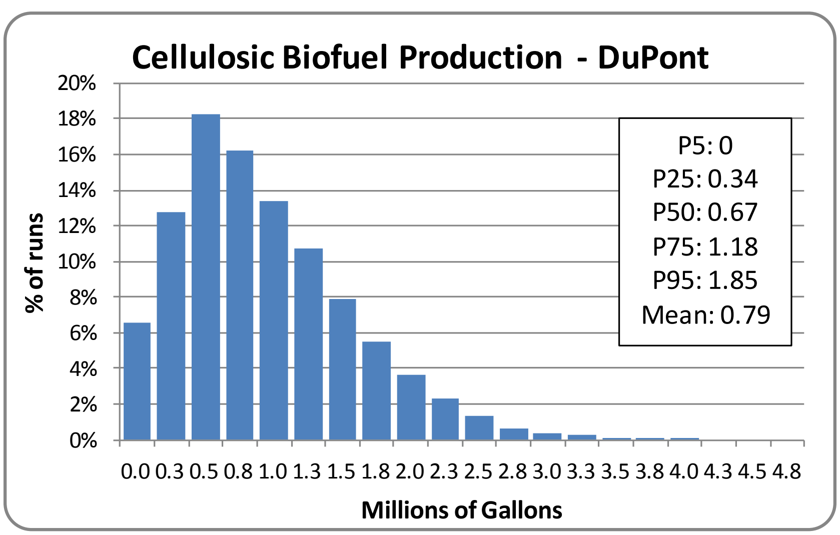
A2 – 1.2: Dupont – Company with Approved Pathway

Dupont – Model Results Comparison (millions of gallons)						
	p5	p25	p50	p75	p95	mean
EPA	0.01	0.28	0.64	1.14	1.99	0.78
Decision Strategies	0.00	0.34	0.67	1.18	1.85	0.79

The EPA results from Memo to Docket: David Korotney – "Application of Monte Carlo process to the determination of proposed volume requirements for 2014 standards NPRM".



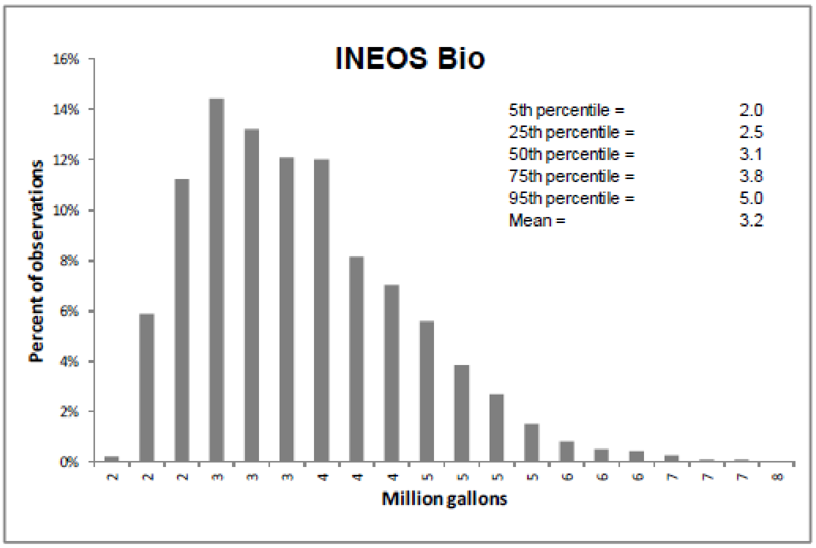
Decision Strategies results



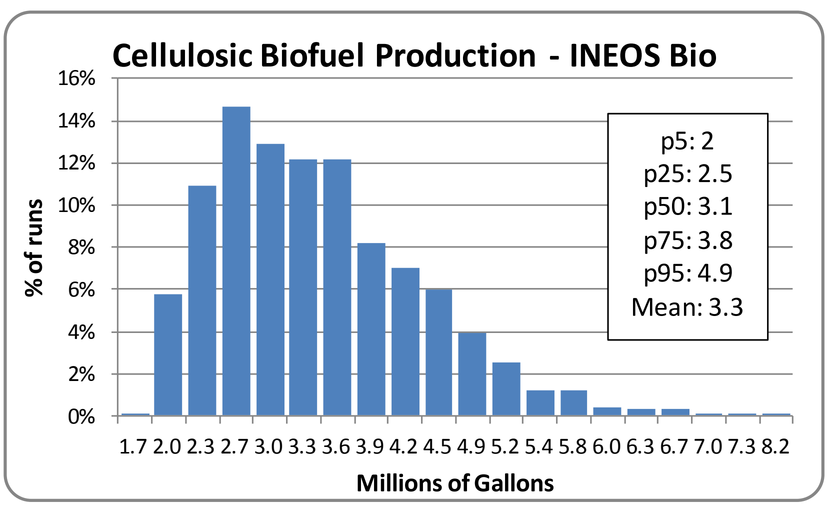
A2 – 1.3: INEOS Bio – Company with Approved Pathway

INEOS Bio – Model Results Comparison (millions of gallons)						
	p5	p25	p50	p75	p95	mean
EPA	2.0	2.5	3.1	3.8	5.0	3.2
Decision Strategies	2.0	2.5	3.1	3.8	4.9	3.3

The EPA results from Memo to Docket: David Korotney – "Application of Monte Carlo process to the determination of proposed volume requirements for 2014 standards NPRM".



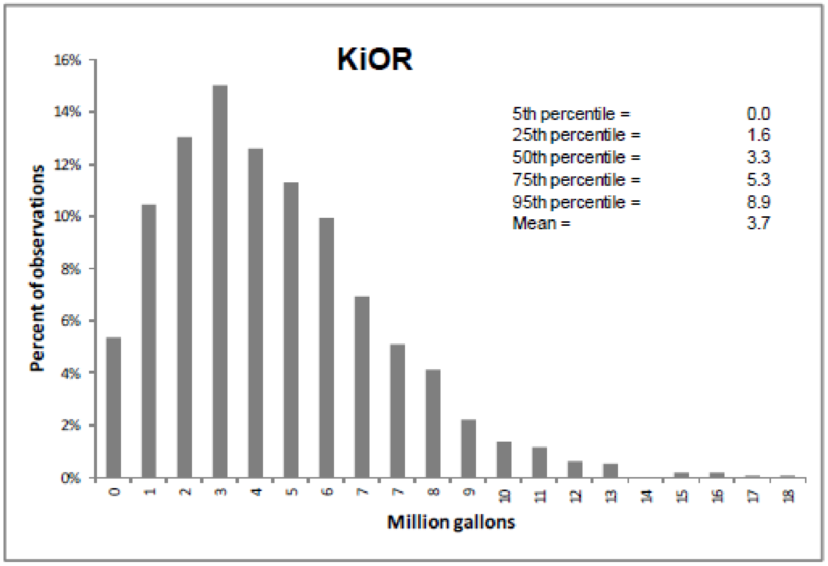
Decision Strategies results



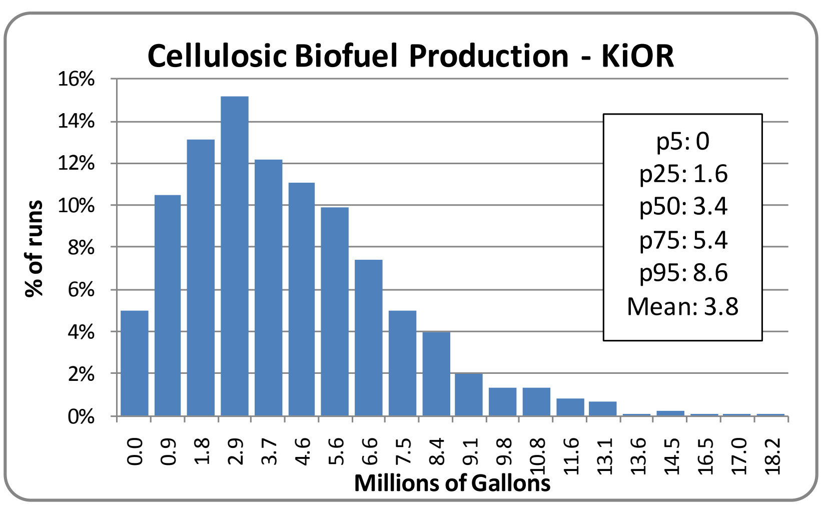
A2 – 1.4: KiOR – Company with Approved Pathway

KiOR – Model Results Comparison (millions of gallons)						
	p5	p25	p50	p75	p95	mean
EPA	0.0	1.6	3.4	5.3	8.9	3.7
Decision Strategies	0.0	1.6	3.4	5.4	8.6	3.8

The EPA results from Memo to Docket: David Korotney – "Application of Monte Carlo process to the determination of proposed volume requirements for 2014 standards NPRM".



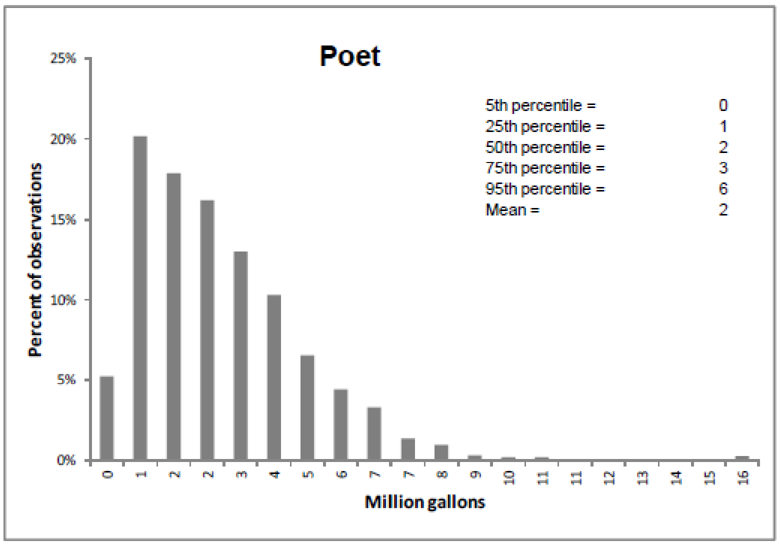
Decision Strategies results



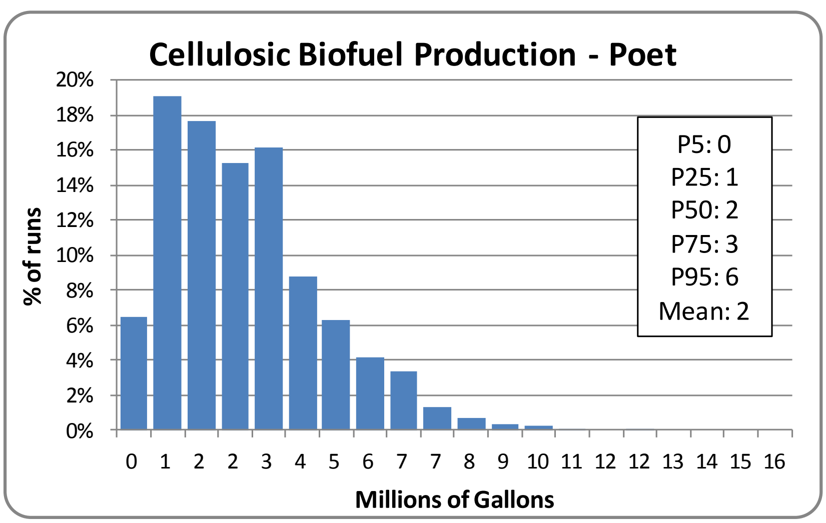
A2 – 1.5: Poet – Company with Approved Pathway

Poet – Model Results Comparison (millions of gallons)						
	p5	p25	p50	p75	p95	mean
EPA	0	1	2	3	6	2
Decision Strategies	0	1	2	3	6	2

The EPA results from Memo to Docket: David Korotney – "Application of Monte Carlo process to the determination of proposed volume requirements for 2014 standards NPRM".



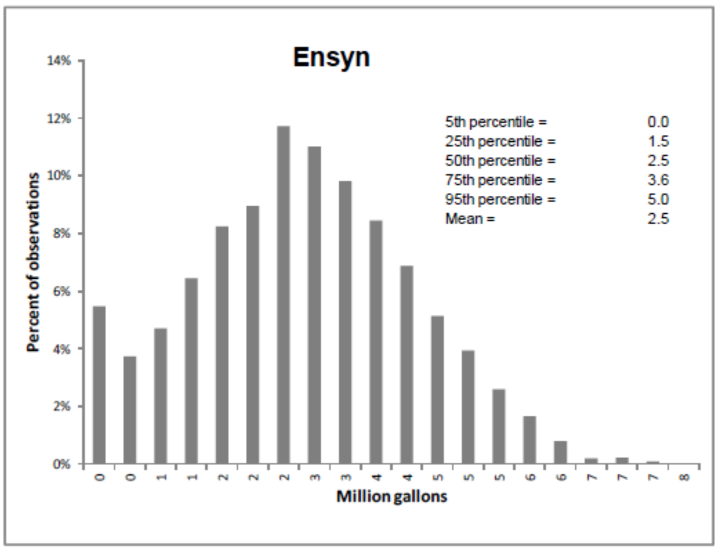
Decision Strategies results



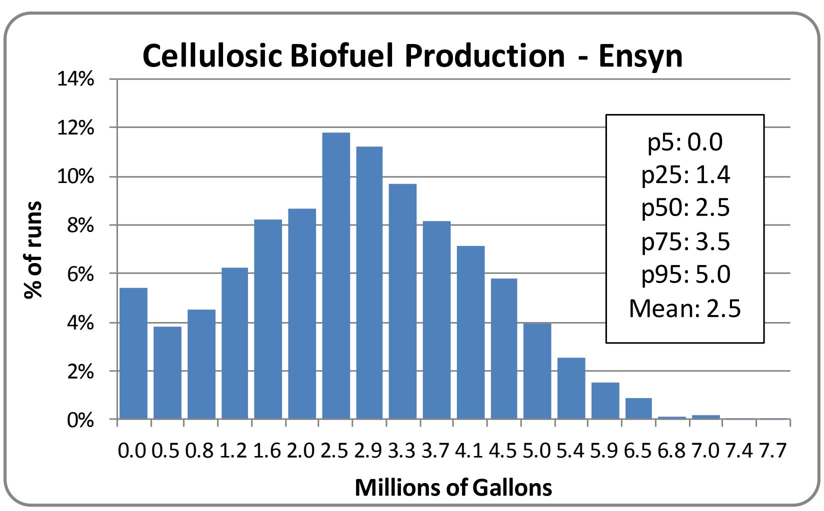
A2 – 1.6: Ensyn – Company Without Approved Pathway

Ensyn – Model Results Comparison (millions of gallons)						
	p5	p25	p50	p75	p95	mean
EPA	0.0	1.5	2.5	3.6	5.0	2.5
Decision Strategies	0.0	1.4	2.5	3.3	5.0	2.5

The EPA results from Memo to Docket: David Korotney – "Application of Monte Carlo process to the determination of proposed volume requirements for 2014 standards NPRM".



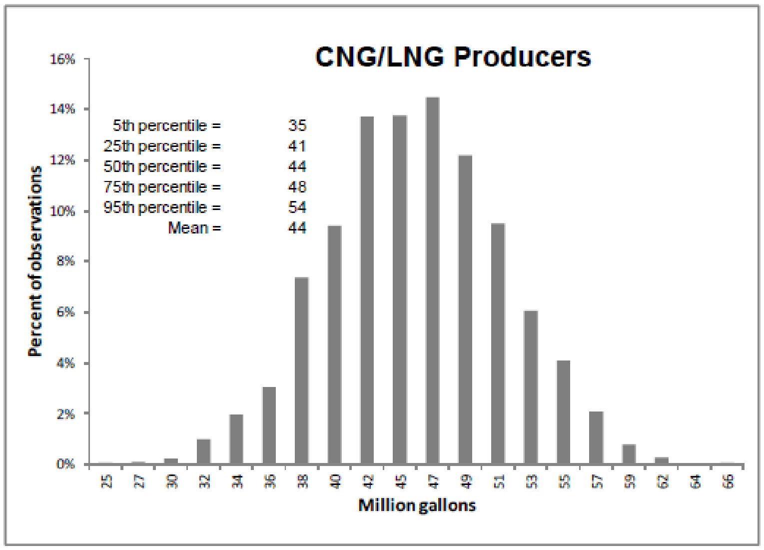
Decision Strategies results



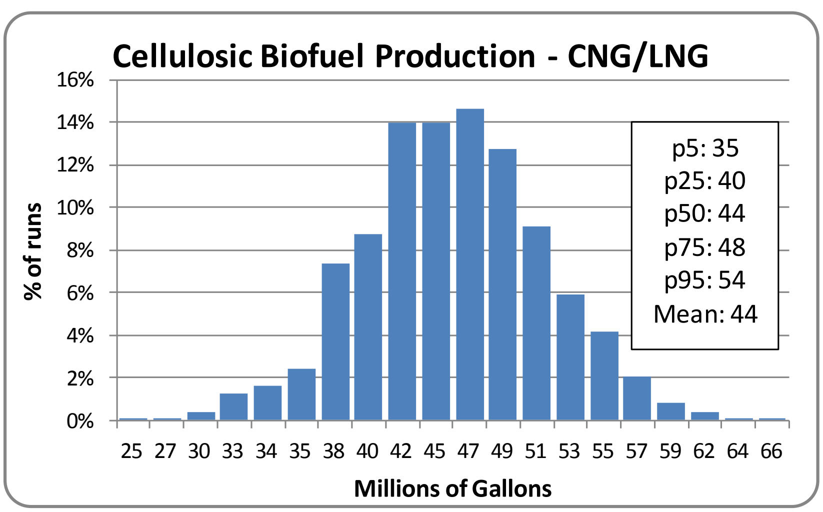
A2 – 1.7: CNG/LNG Producers – Companies Without Approved Pathway

CNG/LNG Producers – Model Results Comparison (millions of gallons)						
	p5	p25	p50	p75	p95	mean
EPA	35	41	44	48	54	44
Decision Strategies	35	40	44	48	54	44

The EPA results from Memo to Docket: David Korotney – "Application of Monte Carlo process to the determination of proposed volume requirements for 2014 standards NPRM".



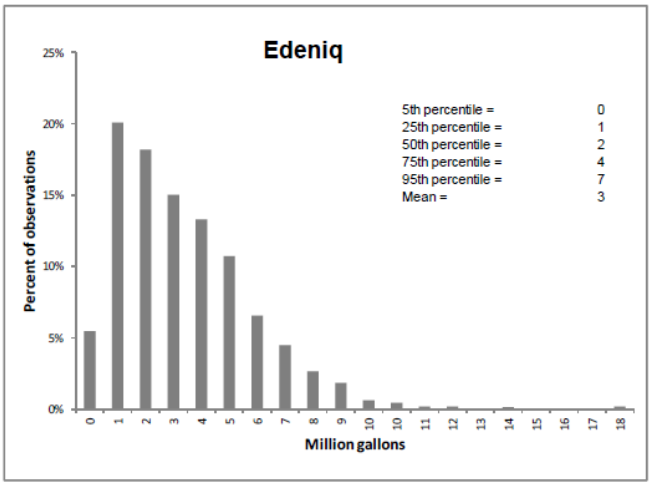
Decision Strategies results



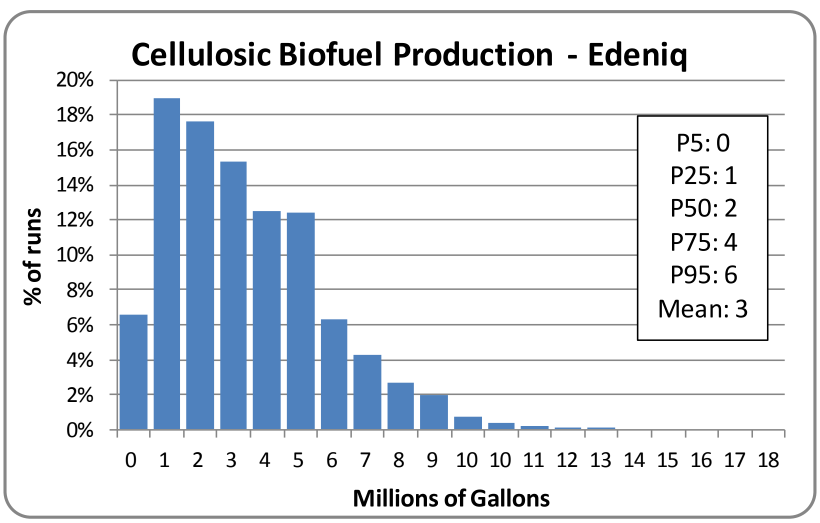
A2 – 1.8: Edeniq – Company Without Approved Pathway

Edeniq – Model Results Comparison (millions of gallons)						
	p5	p25	p50	p75	p95	mean
EPA	0	1	2	4	7	3
Decision Strategies	0	1	2	4	6	3

The EPA results from Memo to Docket: David Korotney – "Application of Monte Carlo process to the determination of proposed volume requirements for 2014 standards NPRM".



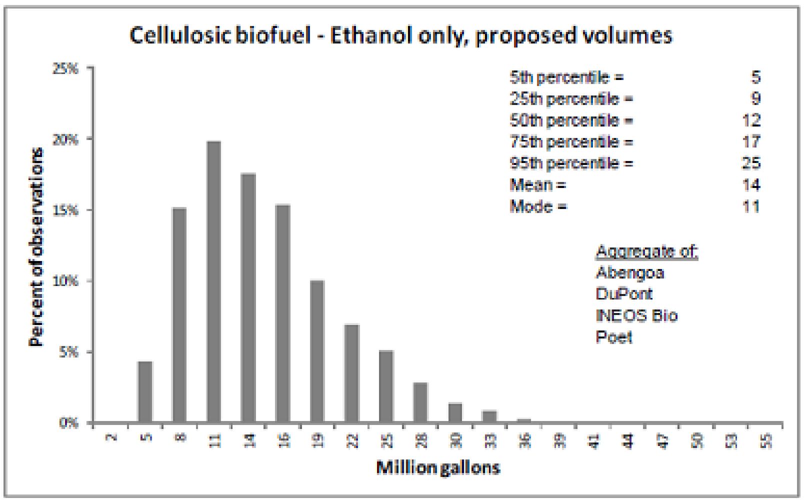
Decision Strategies results



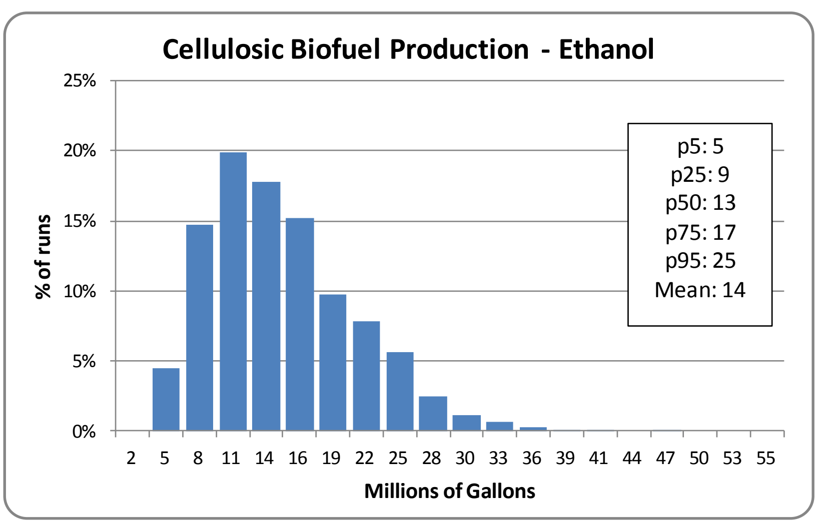
A2 – 1.9: Total Ethanol Cellulosic Biofuel (Approved Pathways)

Total Ethanol Cellulosic Biofuel – Model Results Comparison (millions of gallons)						
	p5	p25	p50	p75	p95	mean
EPA	5	9	12	17	25	14
Decision Strategies	5	9	13	17	25	14

The EPA results from Memo to Docket: David Korotney – "Application of Monte Carlo process to the determination of proposed volume requirements for 2014 standards NPRM".



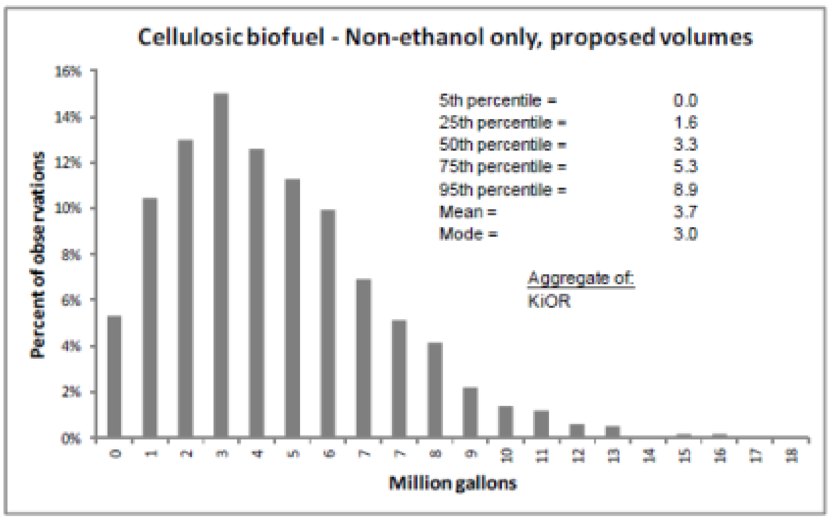
Decision Strategies results



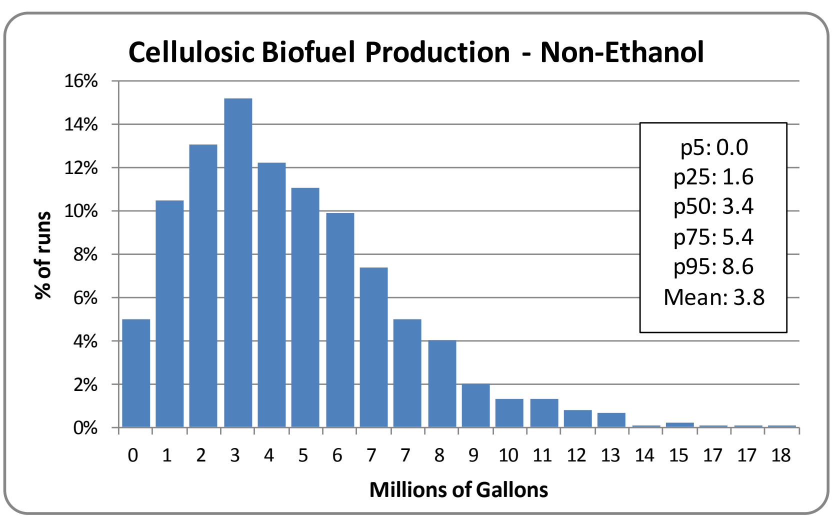
A2 – 1.10: Total Non-ethanol Cellulosic Biofuel (Approved Pathways)

Total Non-ethanol Cellulosic Biofuel – Model Results Comparison (millions of gallons)						
	p5	p25	p50	p75	p95	mean
EPA	0	1.6	3.3	5.3	8.9	3.7
Decision Strategies	0	1.6	3.4	5.4	8.6	3.8

The EPA results from Memo to Docket: David Korotney – "Application of Monte Carlo process to the determination of proposed volume requirements for 2014 standards NPRM".



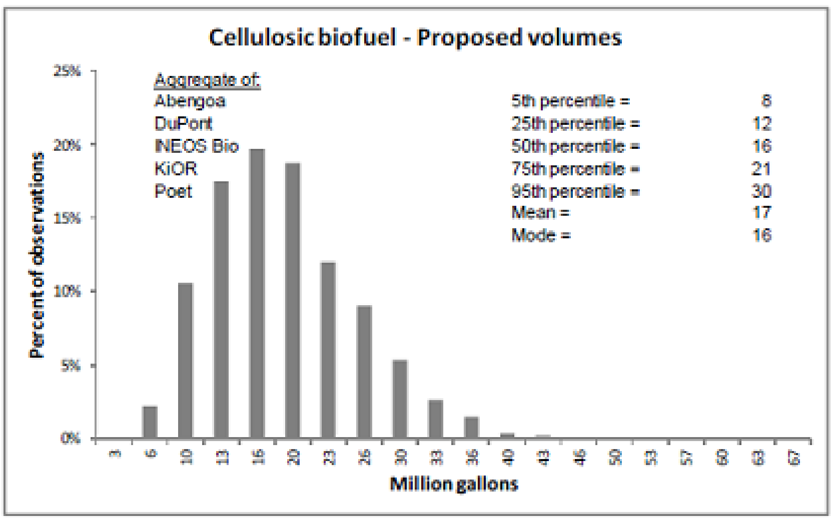
Decision Strategies results



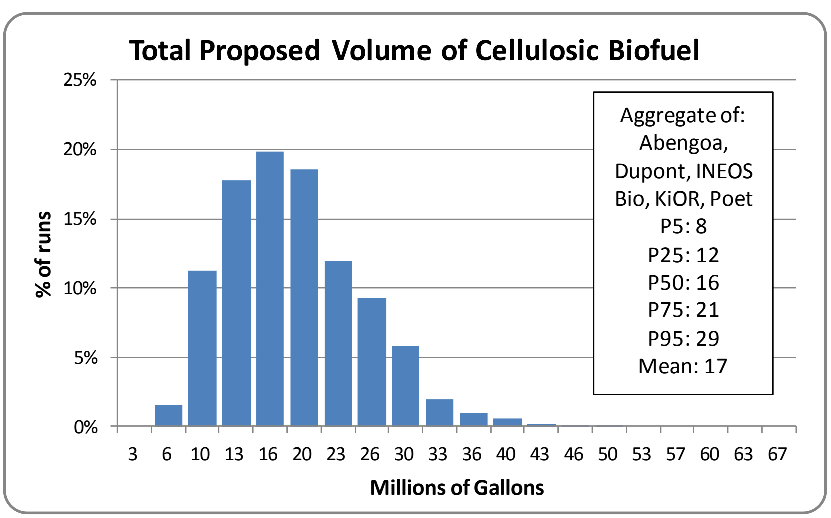
A2 – 1.11: Total Proposed Volume of Cellulosic Biofuel

Total Proposed Volume of Cellulosic Biofuel – Model Results Comparison (millions of gallons)						
	p5	p25	p50	p75	p95	mean
EPA	8	12	16	21	30	17
Decision Strategies	8	12	16	21	29	17

The EPA results from Memo to Docket: David Korotney – "Application of Monte Carlo process to the determination of proposed volume requirements for 2014 standards NPRM".



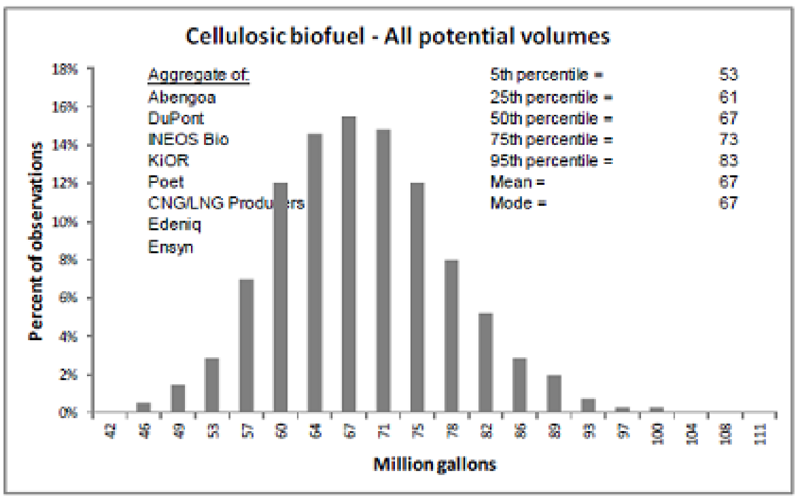
Decision Strategies results



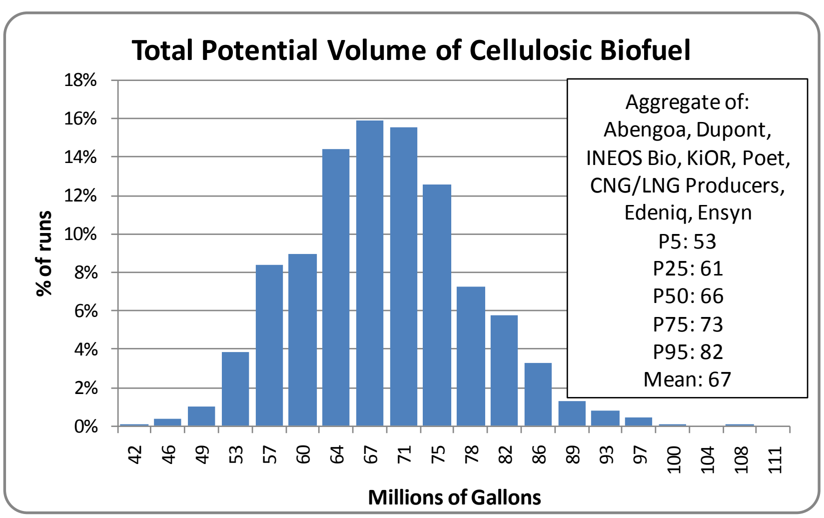
A2 – 1.12: Total Potential Cellulosic Biofuel (All Inclusive)

Total Potential Volume of Cellulosic Biofuel – Model Results Comparison (millions of gallons)						
	p5	p25	p50	p75	p95	mean
EPA	53	61	67	73	83	67
Decision Strategies	53	61	66	73	82	67

The EPA results from Memo to Docket: David Korotney – "Application of Monte Carlo process to the determination of proposed volume requirements for 2014 standards NPRM".



Decision Strategies results



A2 – 2: Advanced Biofuel Results

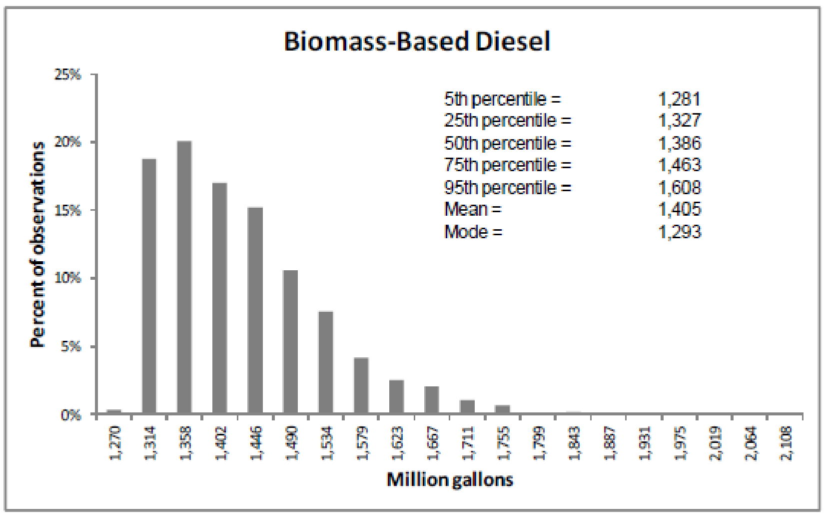
A Monte Carlo simulation was done to aggregate the volume ranges from the set of likely producers with approved pathways. The result of the simulation was a range of 2–2.5 billion ethanol equivalent gallons of advanced biofuel (P5-P95) with a mean value of 2.2 billion gallons.

Decision Strategies created a model to mirror the EPA Monte Carlo Simulation and produced results that are practically identical for both the individual company/group inputs and the aggregate volumes for the total advanced biofuels (both the proposed and available).

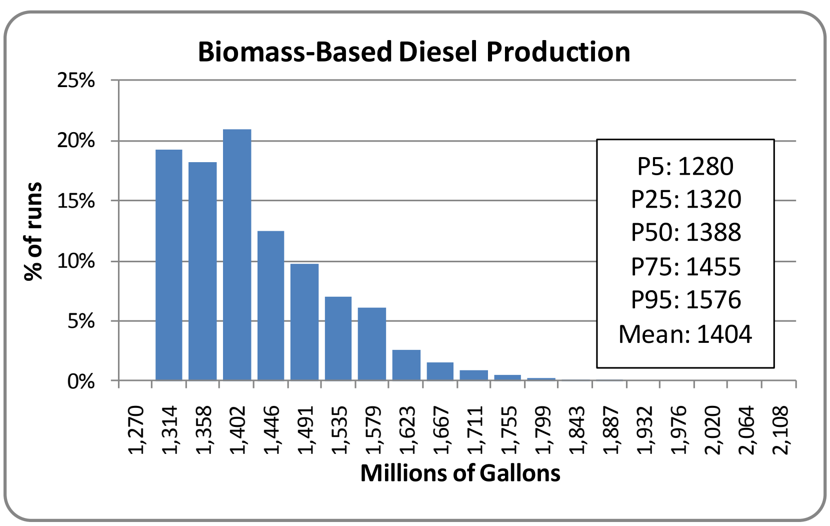
A2 – 2.1: Biomass Based Diesel

Biomass Based Diesel – Model Results Comparison (millions of gallons)						
	p5	p25	p50	p75	p95	mean
EPA	1,281	1,327	1,386	1,463	1,608	1,405
Decision Strategies	1,280	1,320	1,388	1,455	1,576	1,404

The EPA results from Memo to Docket: David Korotney – "Application of Monte Carlo process to the determination of proposed volume requirements for 2014 standards NPRM".



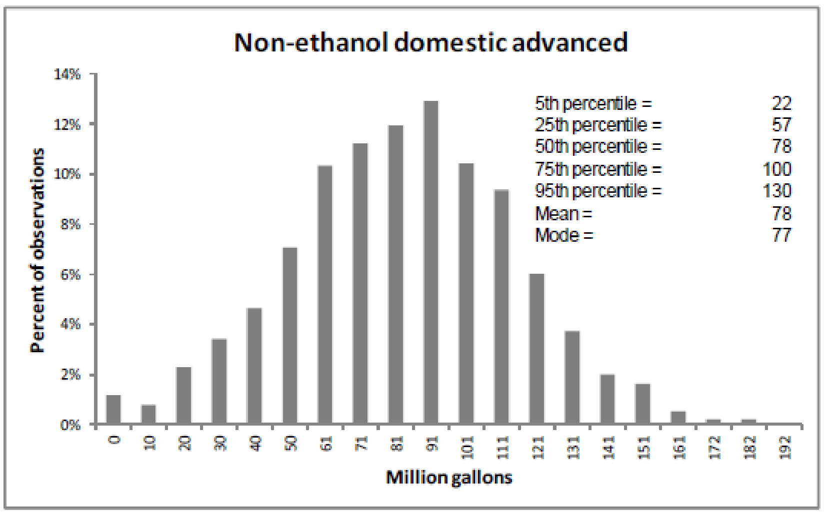
Decision Strategies results



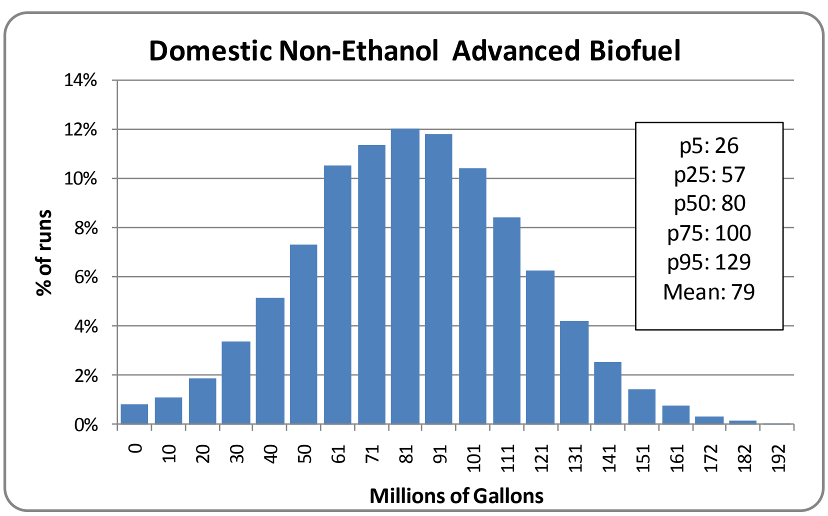
A2 – 2.2: Domestic Non-ethanol Advanced Biofuel

Domestic Non-ethanol Advanced Biofuel – Model Results Comparison (millions of gallons)						
	p5	p25	p50	p75	p95	mean
EPA	22	57	78	100	130	78
Decision Strategies	26	57	80	100	129	79

The EPA results from Memo to Docket: David Korotney – "Application of Monte Carlo process to the determination of proposed volume requirements for 2014 standards NPRM".



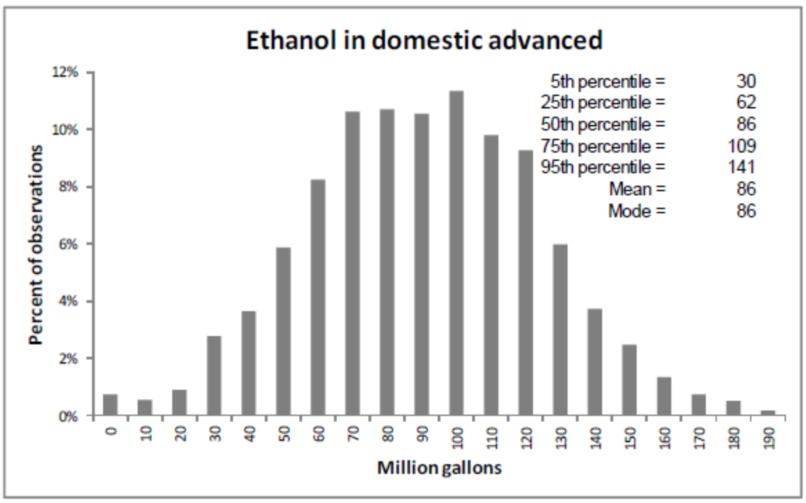
Decision Strategies results



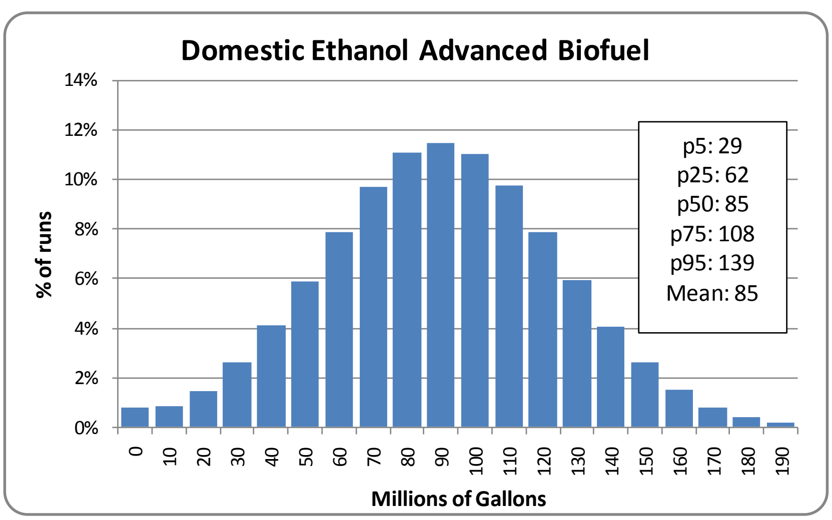
A2 – 2.3: Domestic Ethanol Advanced Biofuel

Domestic Ethanol Advanced Biofuel – Model Results Comparison (millions of gallons)						
	p5	p25	p50	p75	p95	mean
EPA	30	62	86	109	141	86
Decision Strategies	29	62	85	108	139	85

The EPA results from Memo to Docket: David Korotney – "Application of Monte Carlo process to the determination of proposed volume requirements for 2014 standards NPRM".



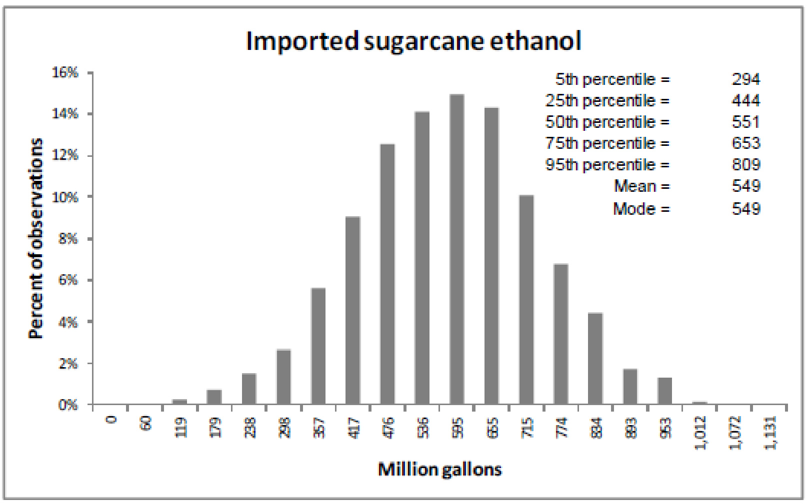
Decision Strategies results



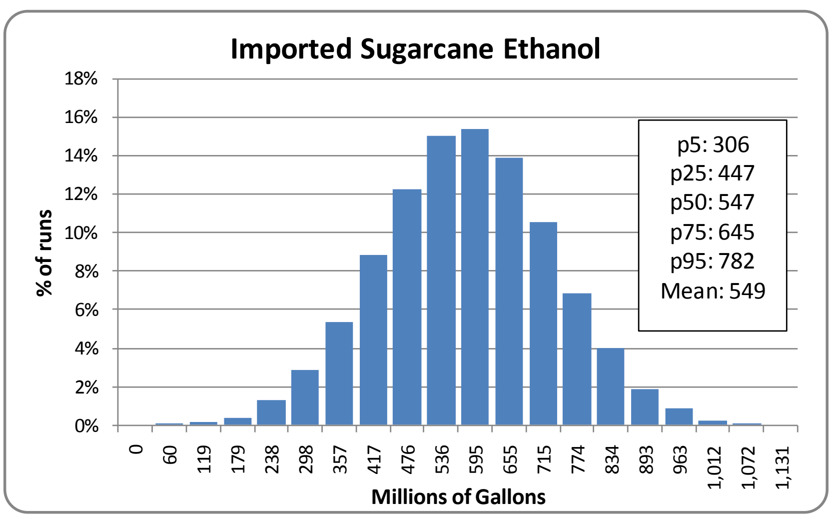
A2 – 2.4: Imported Sugarcane Ethanol

Imported Sugarcane Ethanol – Model Results Comparison (millions of gallons)						
	p5	p25	p50	p75	p95	mean
EPA	294	444	551	653	809	549
Decision Strategies	306	447	547	645	782	549

The EPA results from Memo to Docket: David Korotney – "Application of Monte Carlo process to the determination of proposed volume requirements for 2014 standards NPRM".



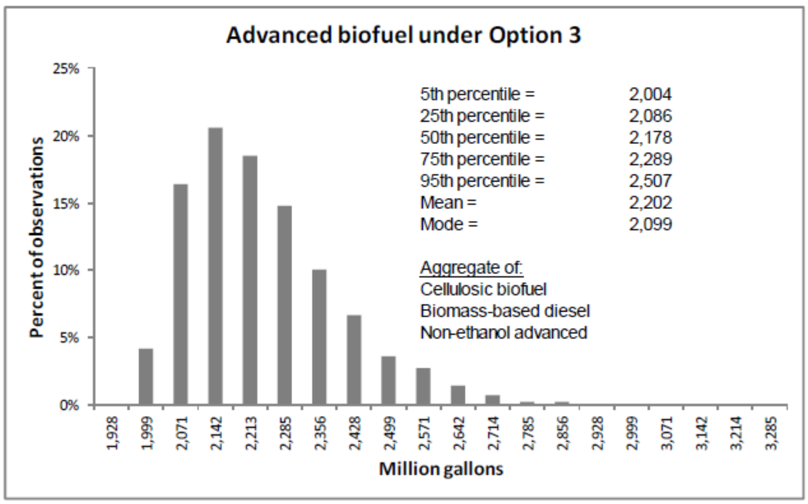
Decision Strategies results



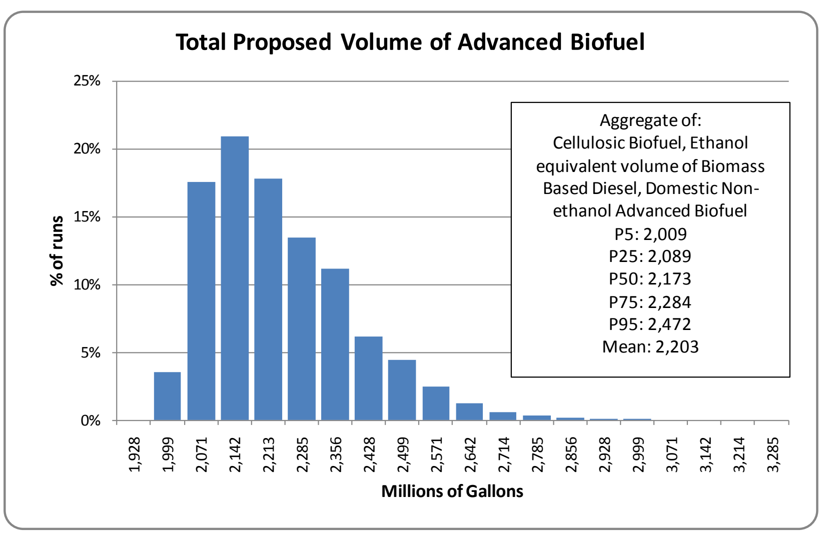
A2 – 2.5: Total Proposed Advanced Biofuels

Total Proposed Advanced Biofuels – Model Results Comparison (millions of gallons)						
	p5	p25	p50	p75	p95	mean
EPA	2,004	2,086	2,178	2,289	2,507	2,202
Decision Strategies	2,009	2,089	2,173	2,284	2,472	2,203

The EPA results from Memo to Docket: David Korotney – "Application of Monte Carlo process to the determination of proposed volume requirements for 2014 standards NPRM".



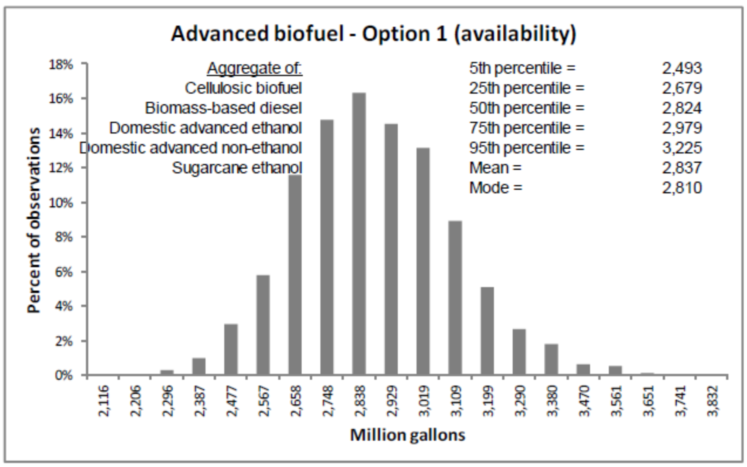
Decision Strategies results



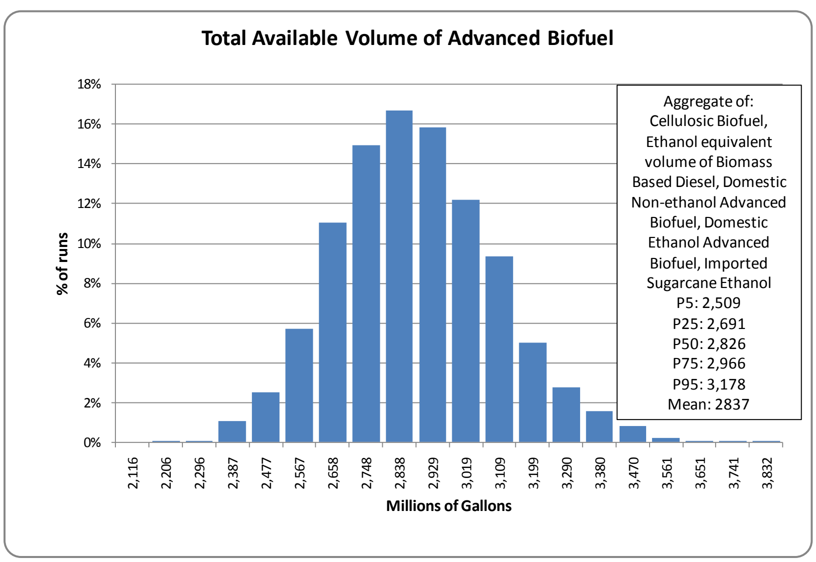
A2 – 2.6: Total Available Advanced Biofuels

Total Available Advanced Biofuels – Model Results Comparison (millions of gallons)						
	p5	p25	p50	p75	p95	mean
EPA	2,493	2,679	2,824	2,979	3,225	2,837
Decision Strategies	2,509	2,691	2,826	2,966	3,178	2,837

The EPA results from Memo to Docket: David Korotney – "Application of Monte Carlo process to the determination of proposed volume requirements for 2014 standards NPRM".



Decision Strategies results



A2 – 3: Total Renewable Fuels Results

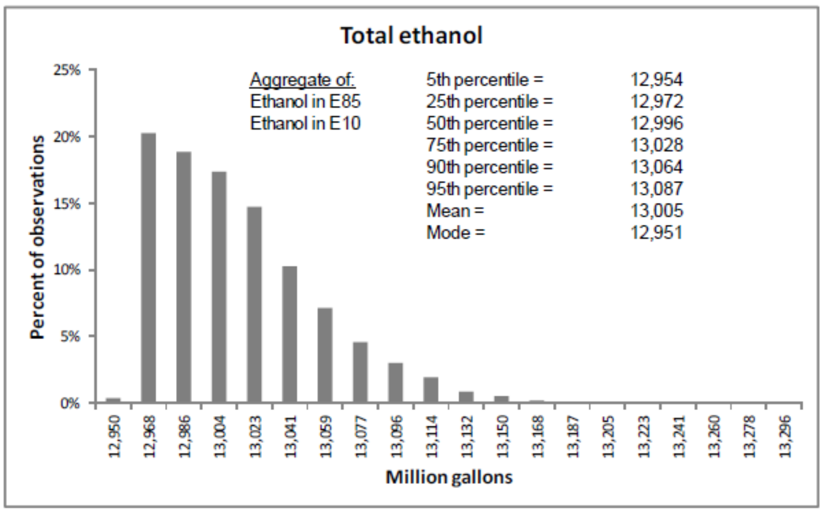
A Monte Carlo simulation was done to aggregate the volume ranges from the set of likely producers with approved pathways. The result of the simulation was a range of 14.9–15.5 billion ethanol equivalent gallons of total renewable fuels (P5-P95) with a mean value of 15.2 billion gallons.

Decision Strategies created a model to mirror the EPA Monte Carlo Simulation that produced results that are practically identical for the total ethanol that can be consumed in the US and the aggregate volumes for both the available and proposed total renewable fuels.

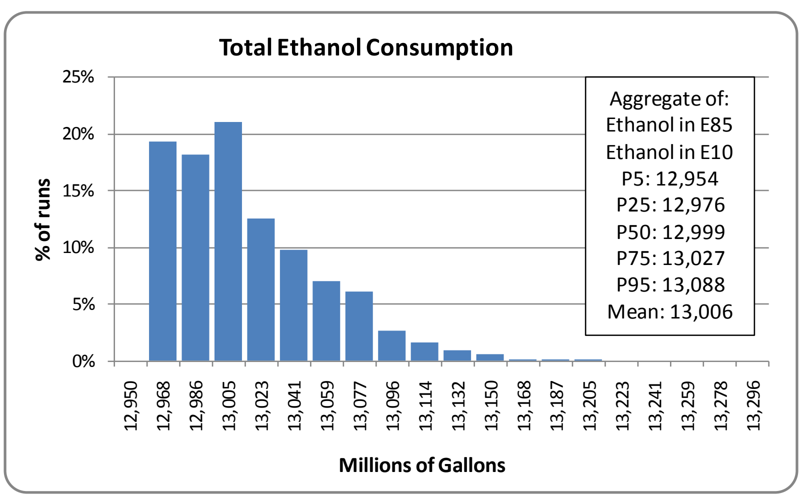
A2 – 3.1: Total Ethanol That Can be Consumed in the US

Total Ethanol that can be consumed in the US – Model Results Comparison (millions of gallons)						
	p5	p25	p50	p75	p95	mean
EPA	12,954	12,972	12,996	13,028	13,087	13,005
Decision Strategies	12,954	12,976	12,999	13,027	13,088	13,006

EPA results from Memo to Docket: David Korotney – "Application of Monte Carlo process to the determination of proposed volume requirements for 2014 standards NPRM".



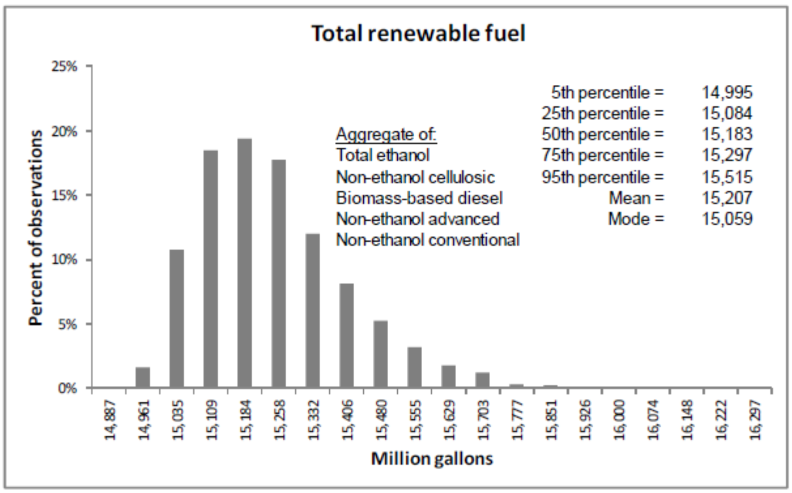
Decision Strategies results



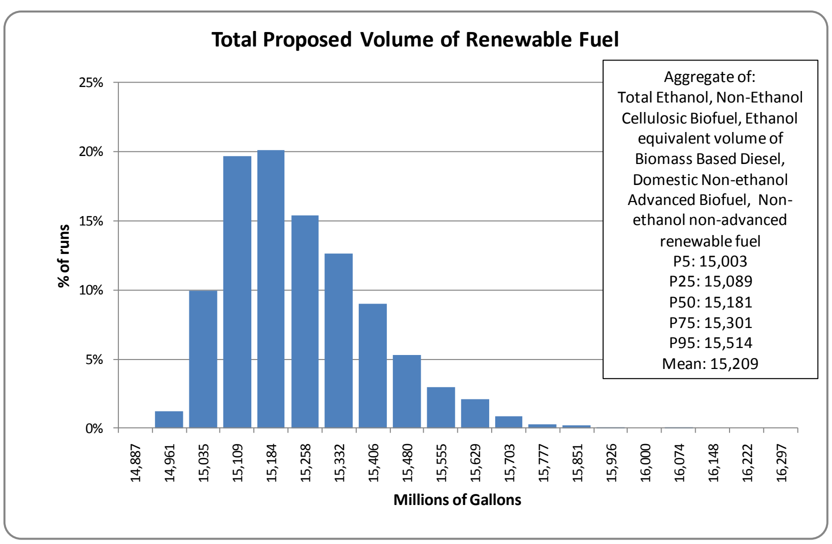
A2 – 3.2: Total Proposed Renewable Fuels

Total Proposed Renewable Fuels – Model Results Comparison (millions of gallons)						
	p5	p25	p50	p75	p95	mean
EPA	14,995	15,084	15,183	15,297	15,515	15,207
Decision Strategies	15,003	15,069	15,181	15,301	15,514	15,209

EPA results from Memo to Docket: David Korotney – "Application of Monte Carlo process to the determination of proposed volume requirements for 2014 standards NPRM".



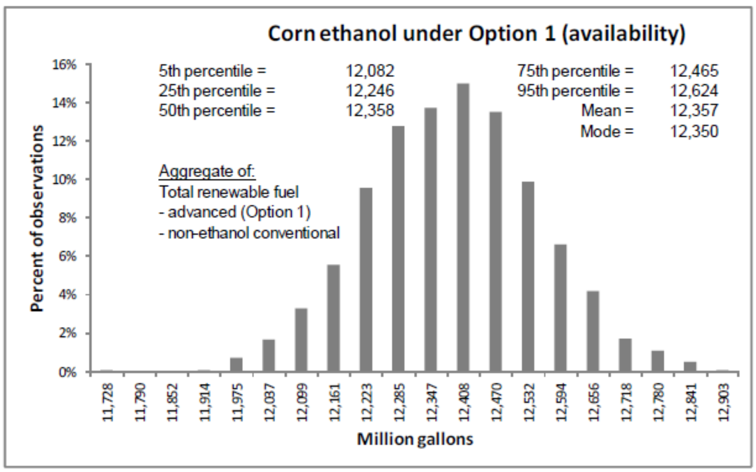
Decision Strategies results



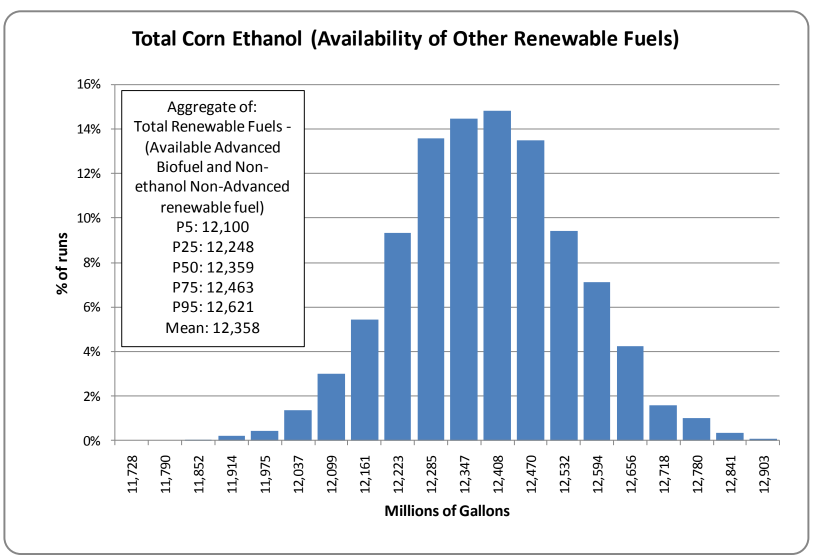
A2 – 3.3: Total Corn Ethanol based on available volumes of other renewable fuels

Total Corn Ethanol based on available volumes of other renewable fuels – Model Results Comparison (millions of gallons)						
	p5	p25	p50	p75	p95	mean
EPA	12,082	12,246	12,358	12,465	12,357	12,350
Decision Strategies	12,100	12,248	12,359	12,463	12,621	12,358

EPA results from Memo to Docket: David Korotney – "Application of Monte Carlo process to the determination of proposed volume requirements for 2014 standards NPRM".



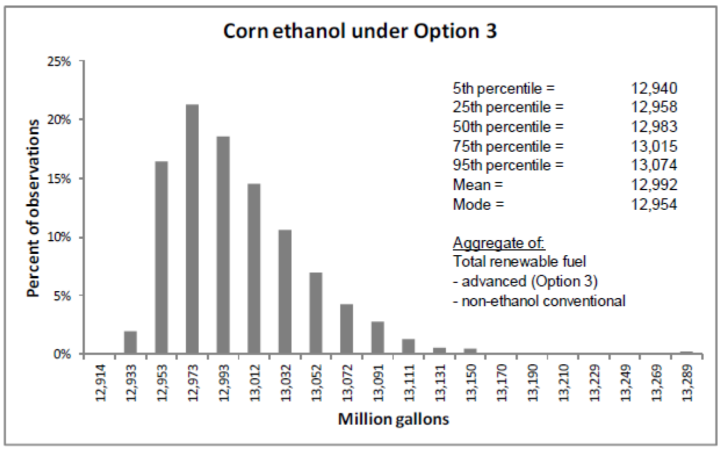
Decision Strategies results



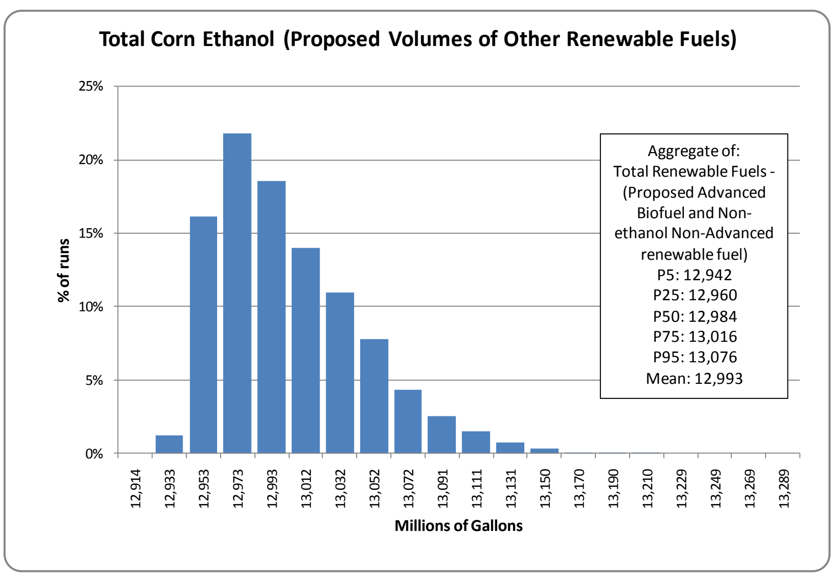
A2 – 3.4: Total Corn Ethanol based on proposed volumes of other renewable fuels

Total Corn Ethanol based on proposed volumes of other renewable fuels – Model Results Comparison (millions of gallons)						
	p5	p25	p50	p75	p95	mean
EPA	12,940	12,958	12,983	13,015	13,074	12,992
Decision Strategies	12,942	12,960	12,984	13,016	13,076	12,993

EPA results from Memo to Docket: David Korotney – "Application of Monte Carlo process to the determination of proposed volume requirements for 2014 standards NPRM".



Decision Strategies results

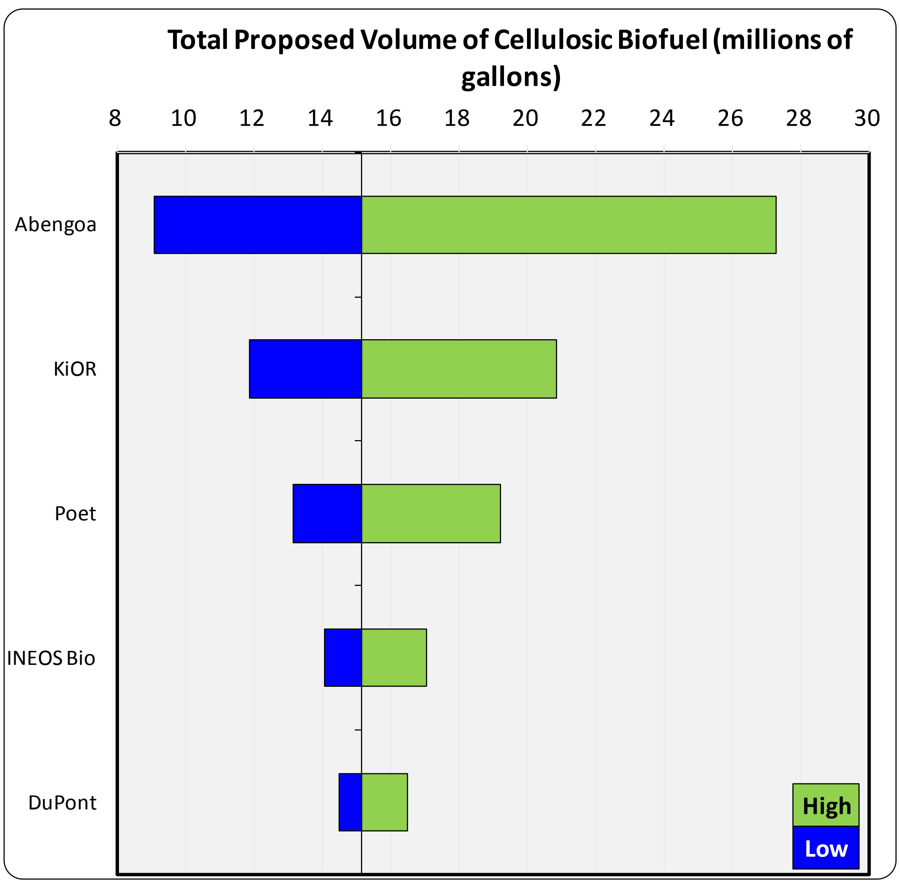


Appendix 3 – Tornado Charts of Decision Strategies Mirror Analysis Results

Decision Strategies routinely uses the Tornado charts to understand how the input values are influencing the output. The Tornado chart shows the impact of each of the variables independently on the output. The model records the output totals as it moves each variable from the low to the high end value (P5 to P95) while holding all other variables at their median values (P50). The width of each tornado bar is a measure of the impact of each variable. The following tornados show the impacts based on the original EPA data.

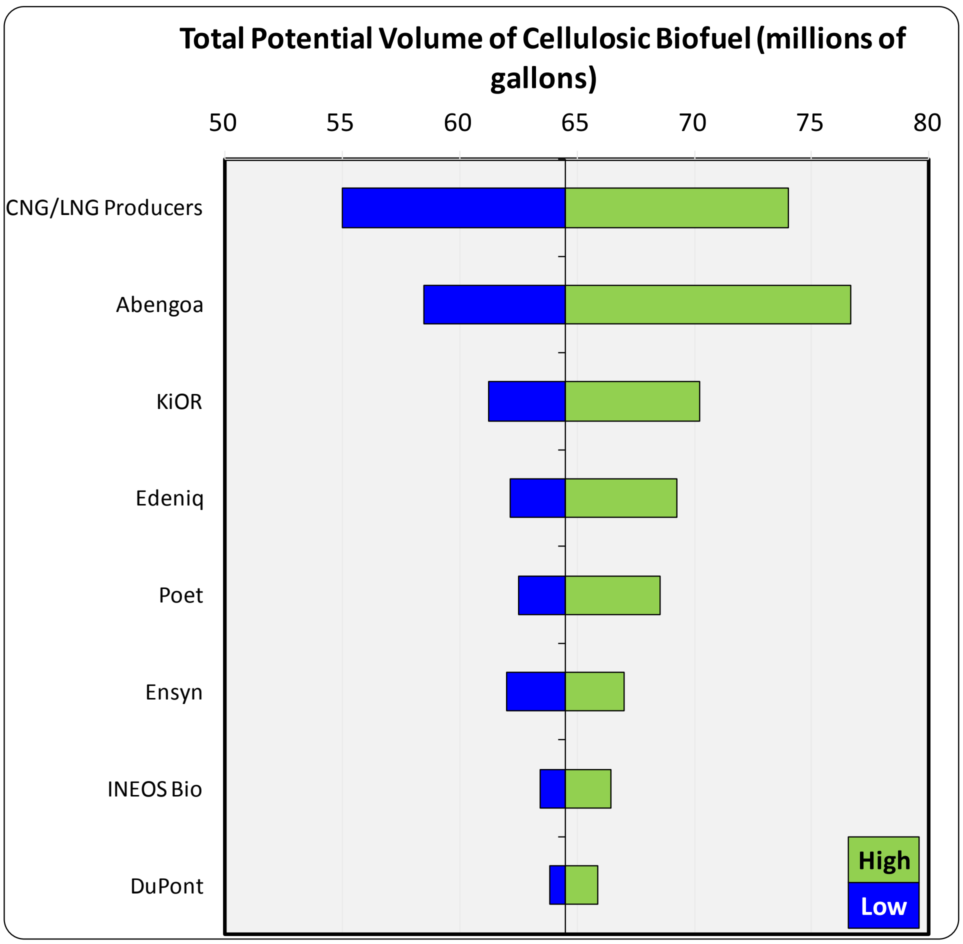
A3 – 1: Total Proposed Volume of Cellulosic Biofuel

This is the tornado chart for "The Proposed Volume of Cellulosic Biofuel". The chart shows that the volume produced by Abengoa has the largest impact (47.5%) on the variance of the total proposed volume and the combination of the two largest impacts (Abengoa and KiOR) is 71%. This would indicate that if there are any significant delays during completion of construction (for Abengoa) or ramp up problems with either of these producers the 2014 produced volume of cellulosic biofuels could be significantly impacted.



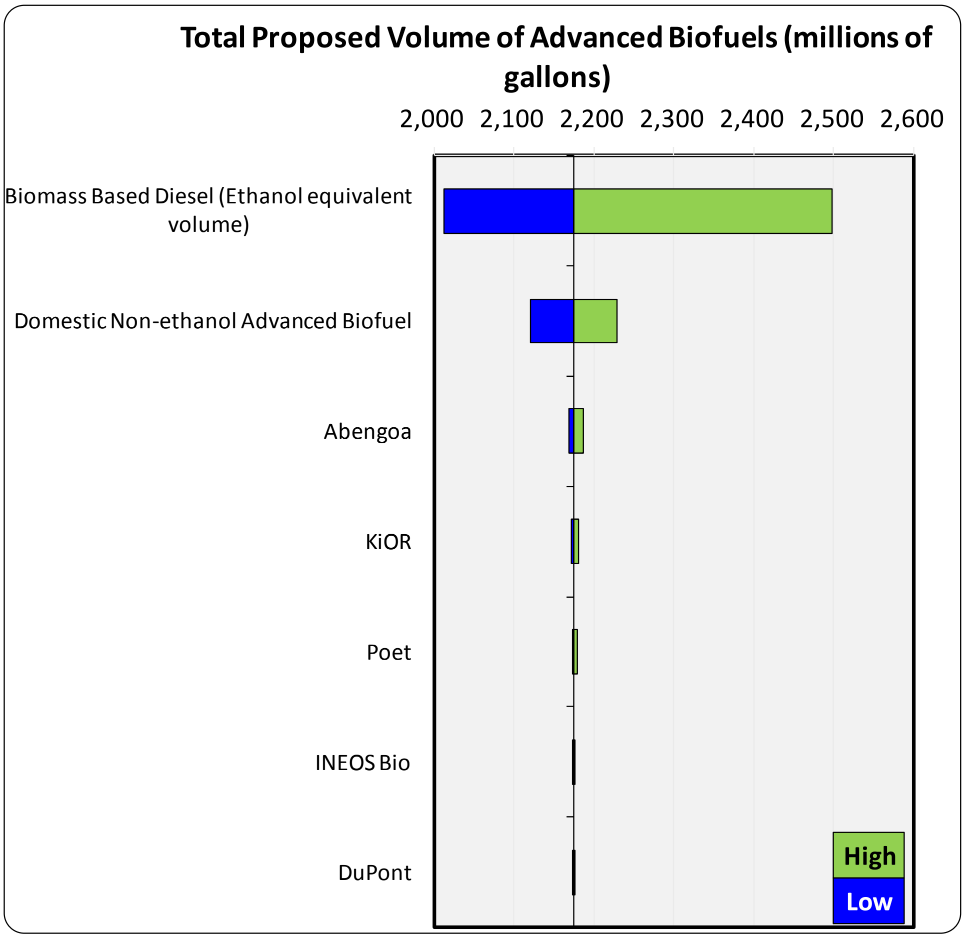
A3 – 2: Total Potential Volume of Cellulosic Biofuel

This is the tornado chart for "The Potential Volume of Cellulosic Biofuel (all inclusive)". As the chart shows the volume produced by CNG/LNG producers has the largest impact (27.4%) of the variability of the total potential volume and the combination of the two largest impacts (CNG/LNG producers and Abengoa) is 53.6%. Any significant delays or construction or ramp up issues for Abengoa or if the CNG/LNG producers are not approved for 2014 would significantly impact the potential 2014 production of cellulosic biofuel.



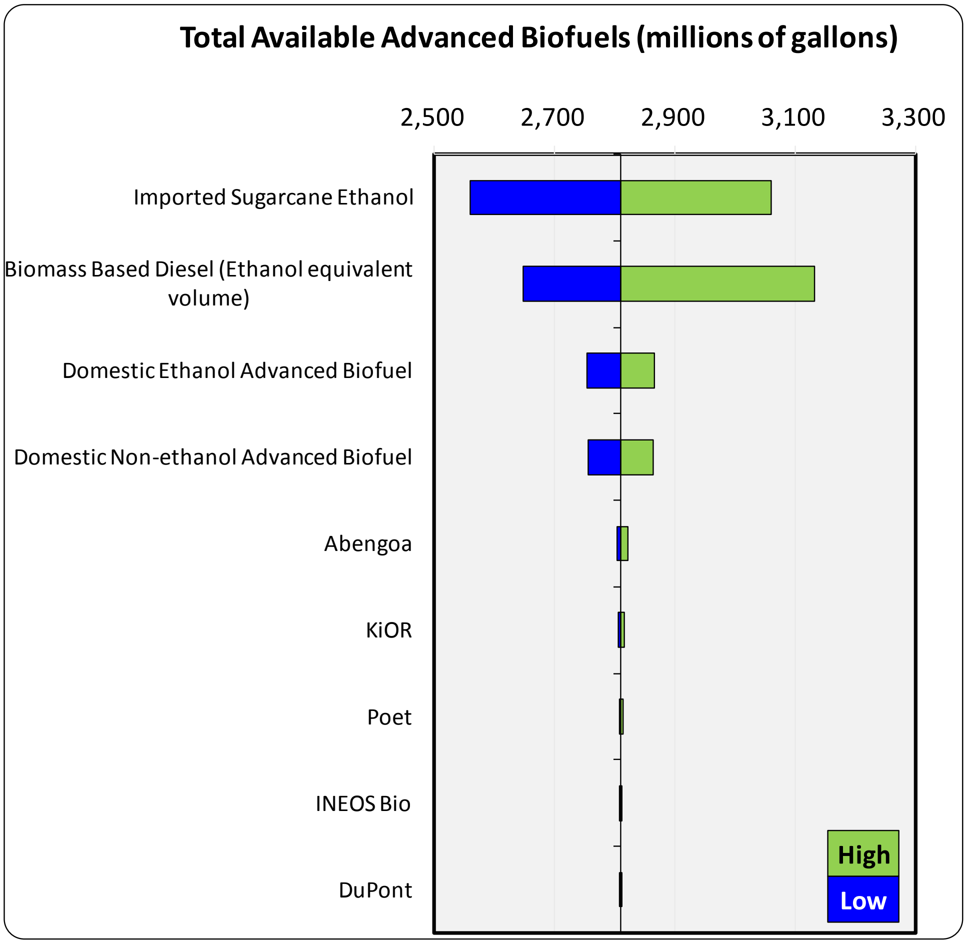
A3 – 3: Total Proposed Volume of Advanced Biofuel

This is the tornado chart for "The Proposed Volume of Advanced Biofuels". As the chart shows the volume of Biomass Based Diesel has the largest impact (76.8%) of the variability of the total potential volume and the combination of the two largest impacts (Biomass Based Diesel and Domestic Non-Ethanol Advanced Biofuel) is 93.9%. If any of a number of economic impacts (including non-renewal of the Biomass Based Diesel subsidies for 2014) or any significant production delays or ramp up issues for the Domestic Non-Ethanol Advanced Biofuel would significantly impact the potential 2014 production of advanced biofuels.



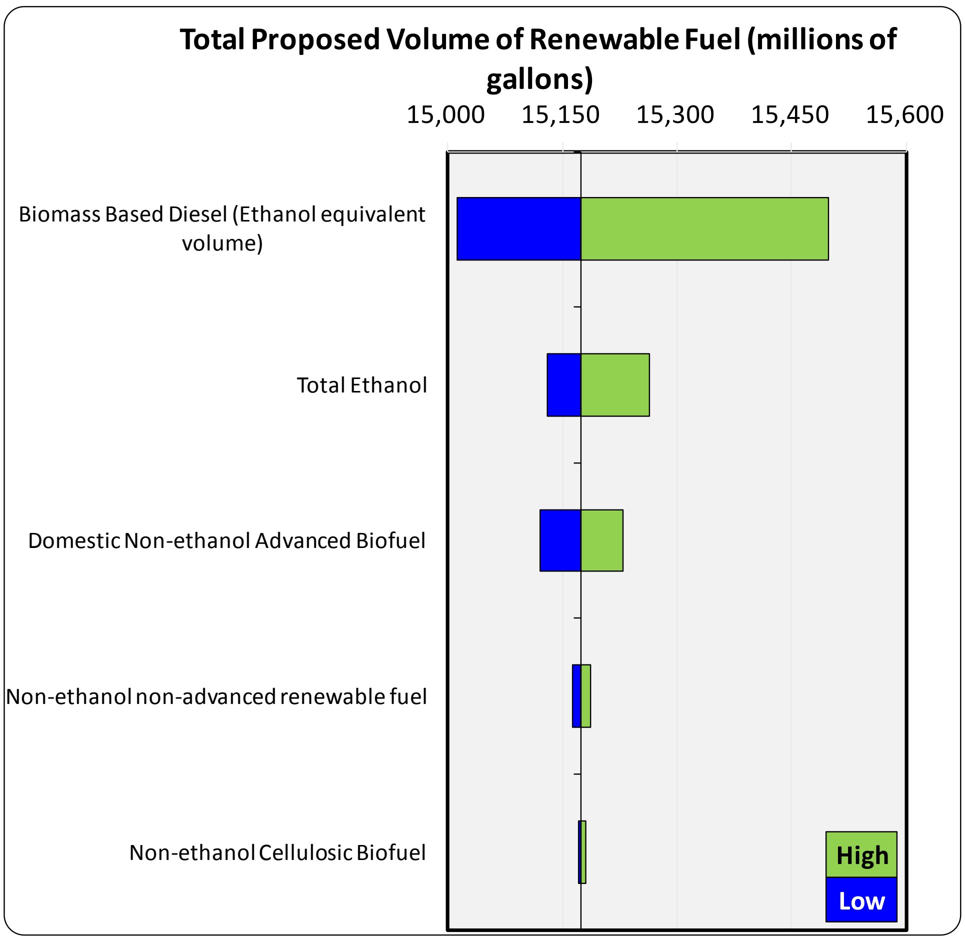
A3 – 4: Total Available Volume of Advanced Biofuel

This is the tornado chart for "The Available Volume of Advanced Biofuels". As the chart shows the volume of Imported Sugarcane Ethanol has the largest impact (40.1%) of the variability of the total available volume and the combination of the two largest impacts (Imported Sugarcane Ethanol and Biomass Based Diesel) is 79.1%. If any of a number of impacts (including non-renewal of the Biomass Based Diesel subsidies for 2014, poor sugarcane crop in Brazil, regulatory or economic issues in Brazil) would significantly impact the available 2014 advanced biofuels.



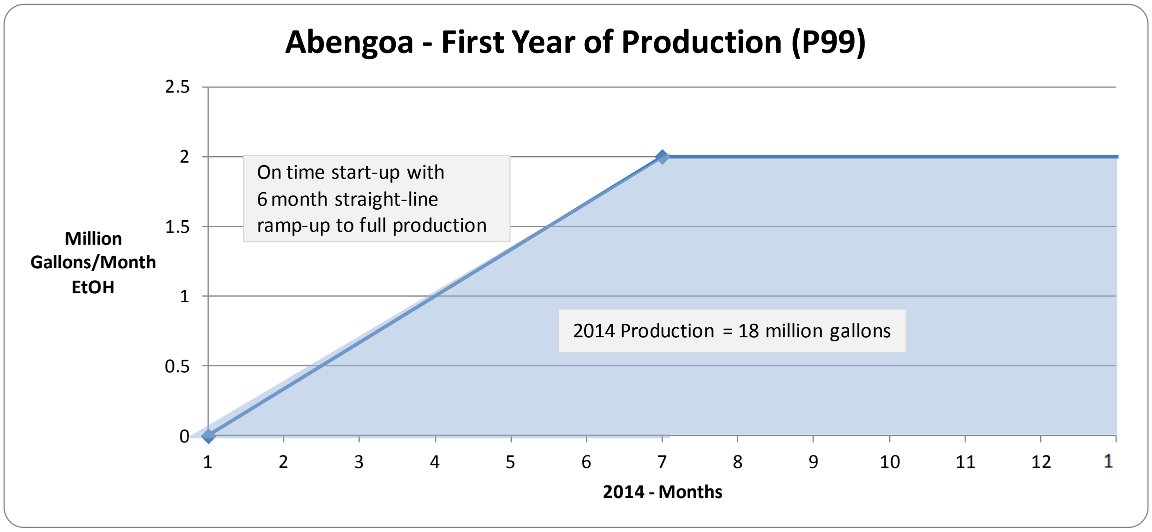
A3 – 5: Total Proposed Volume of Renewable Fuel

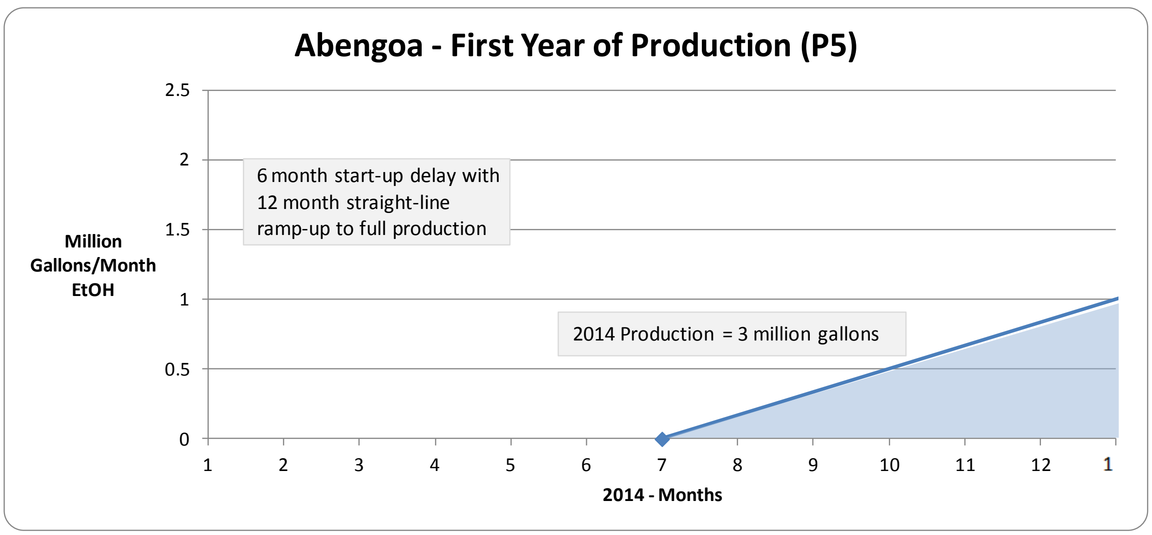
This is the tornado chart for "The Total Proposed Volume of Renewable Fuel". As the chart shows the volume of Imported Biomass Based Diesel has the largest impact (63.8%) of the variability of the total proposed volume and the combination of the two largest impacts (Biomass Based Diesel and Total Ethanol) is 81.5%. If any of a number of economic impacts (including non-renewal of the Biomass Based Diesel subsidies for 2014, changes in the amount of gasoline that is used in the US, significant increase in use of E85) would significantly impact the 2014 renewable fuels volume.



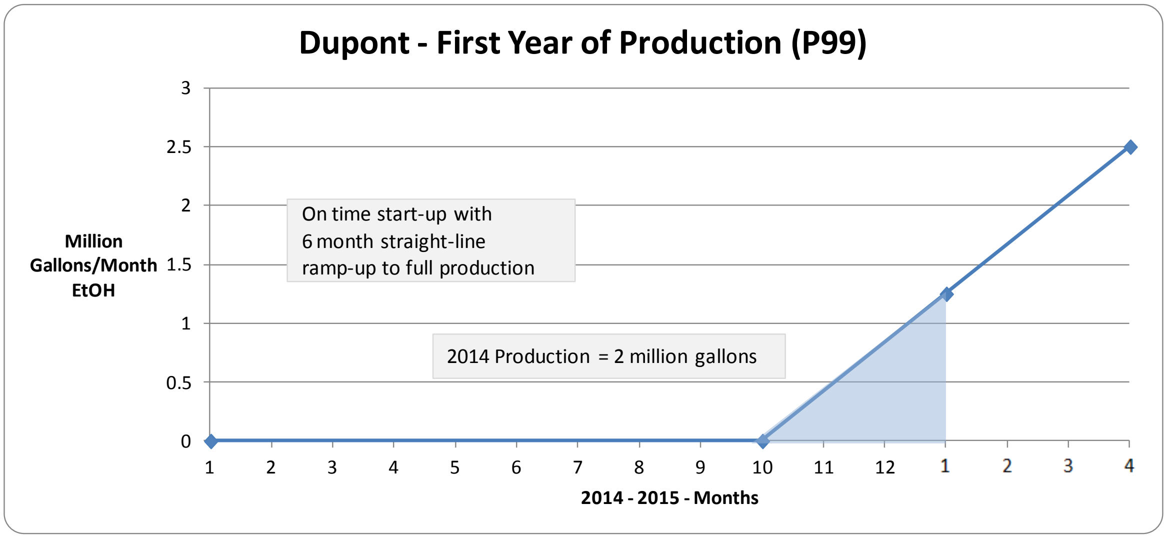
Appendix 4 – Data Graphs for Sensitivity Test

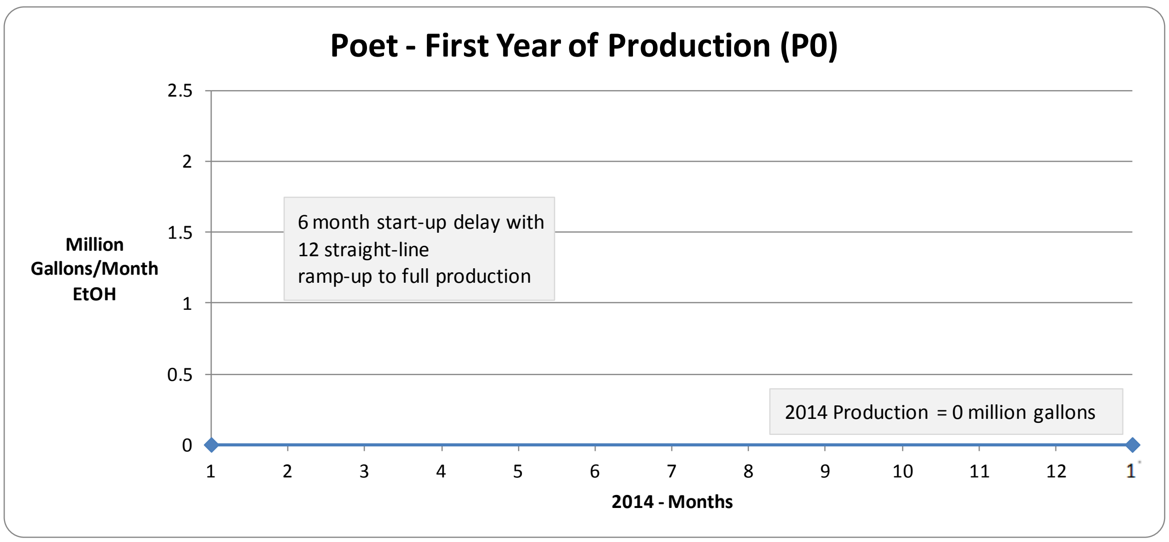
A4 – 1: Abengoa



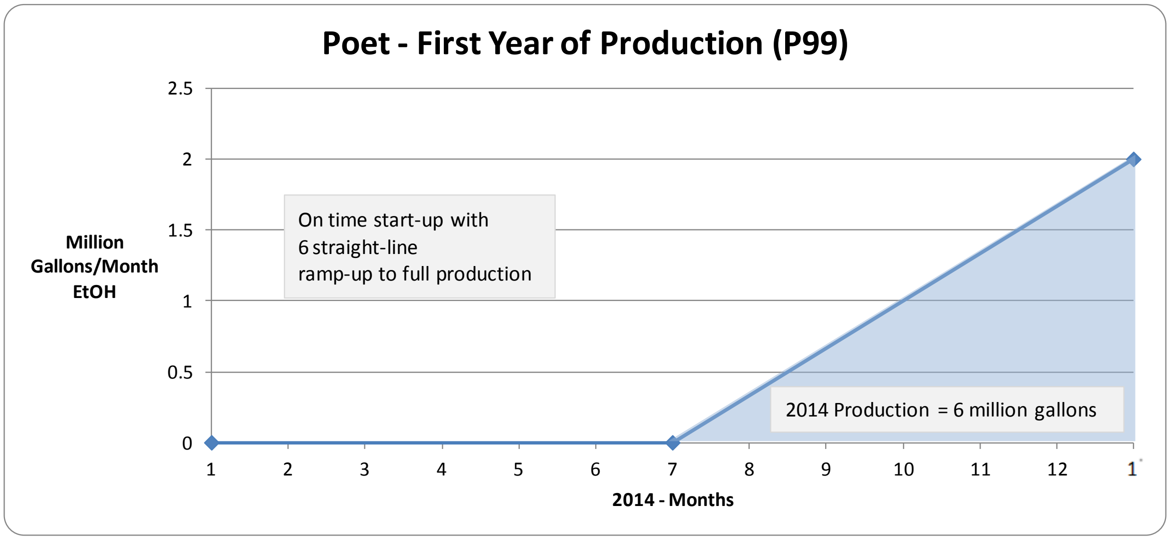


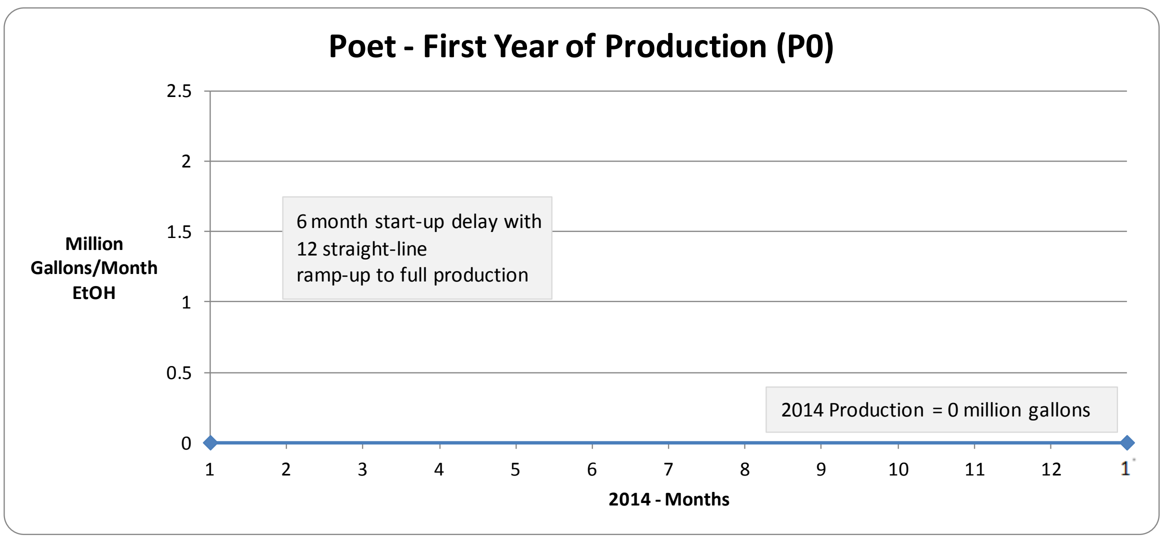
A4 – 2: DuPont


Dupont - First Year of Production (P99)
Million Gallons/Month EtOH
3
2.5
2
1.5
1
0.5
0
On time start-up with
6 month straight-line
ramp-up to full production
2014 Production = 2 million gallons
1 2 3 4 5 6 7 8 9 10 11 12 1 2 3 4
2014 - 2015 - Months

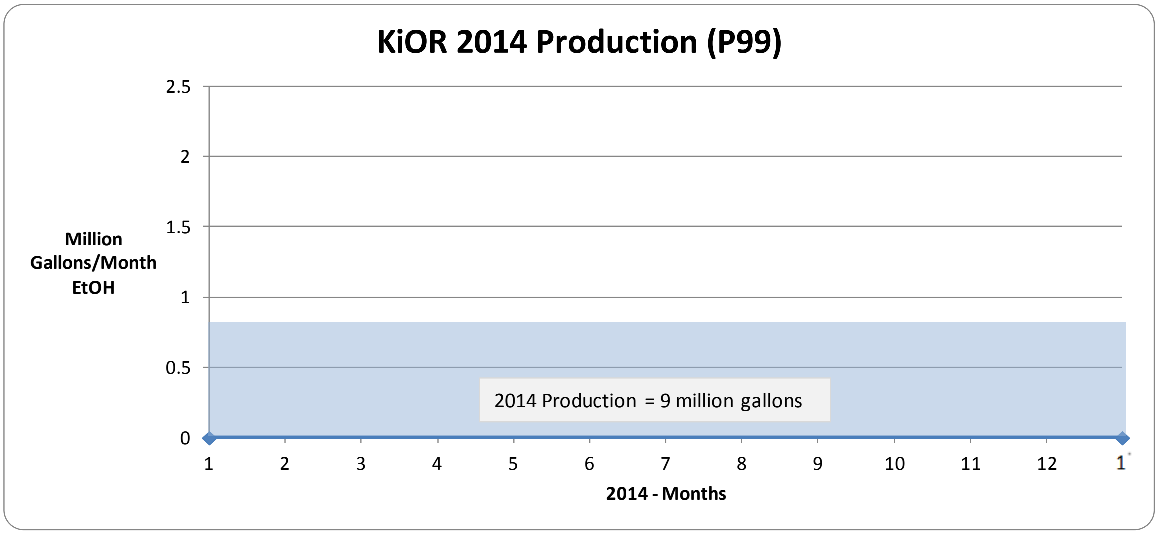

Poet - First Year of Production (P0)
Million Gallons/Month EtOH
2.5
2
1.5
1
0.5
0
6 month start-up delay with
12 straight-line
ramp-up to full production
2014 Production = 0 million gallons
1 2 3 4 5 6 7 8 9 10 11 12 1
2014 - Months

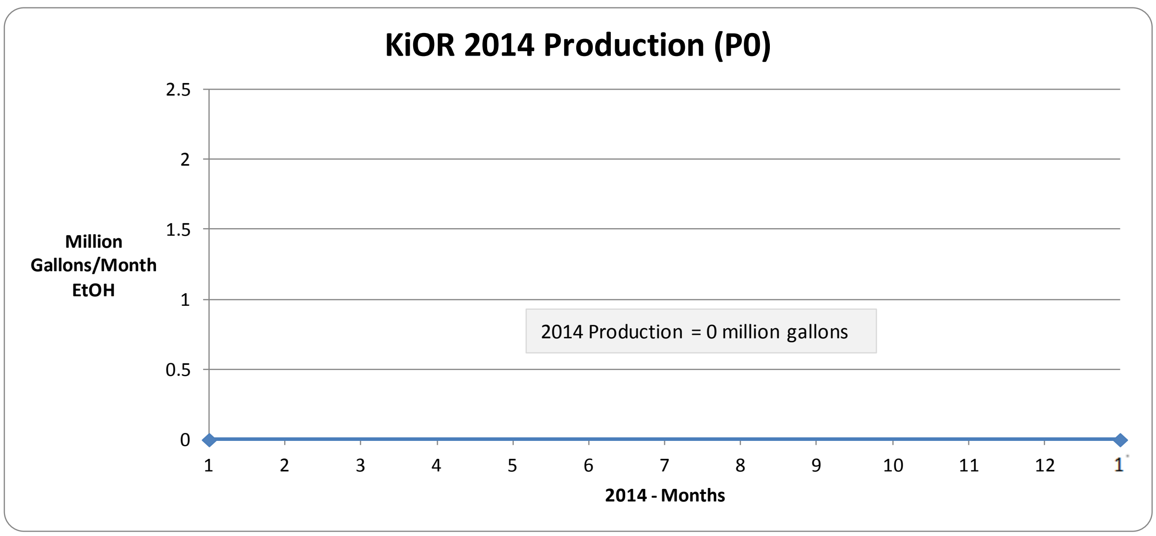
A4 – 3: Poet


Poet - First Year of Production (P99)
Million Gallons/Month EtOH
2.5
2
1.5
1
0.5
0
On time start-up with 6 straight-line ramp-up to full production
2014 Production = 6 million gallons
1 2 3 4 5 6 7 8 9 10 11 12
2014 - Months


Poet - First Year of Production (P0)
Million Gallons/Month EtOH
2.5
2
1.5
1
0.5
0
6 month start-up delay with 12 straight-line ramp-up to full production
2014 Production = 0 million gallons
1 2 3 4 5 6 7 8 9 10 11 12
2014 - Months

A4 – 4: KiOR


KiOR 2014 Production (P99)
Million Gallons/Month EtOH
2.5
2
1.5
1
0.5
0
2014 Production = 9 million gallons
1
2
3
4
5
6
7
8
9
10
11
12
2014 - Months


KiOR 2014 Production (P0)
Million Gallons/Month EtOH
2.5
2
1.5
1
0.5
0
2014 Production = 0 million gallons
1
2
3
4
5
6
7
8
9
10
11
12
2014 - Months

Appendix E
Applicable provisions of EPACT 2005 and EISA 2007

2005 LAW, EISA 2005:

‘‘(2) RENEWABLE FUEL PROGRAM.—
‘‘(A) REGULATIONS.—
‘‘(i) IN GENERAL.—Not later than 1 year after the date of enactment of this paragraph, the Administrator shall promulgate regulations to ensure that gasoline sold or introduced into commerce in the United States (except in noncontiguous States or territories), on an annual average basis, contains the applicable volume of renewable fuel

‘‘(iii) PROVISIONS OF REGULATIONS.—Regardless of the date of promulgation, the regulations promulgated under clause (i)—
‘‘(I) shall contain compliance provisions applicable to refineries, blenders, distributors, and importers, as appropriate, to ensure that the requirements of this paragraph are met; but
‘‘(II) shall not— ‘‘(aa) restrict geographic areas in which renewable fuel may be used; or ‘‘(bb) impose any per-gallon obligation for the use of renewable fuel.

‘‘(3) APPLICABLE PERCENTAGES.—
‘‘(A) PROVISION OF ESTIMATE OF VOLUMES OF GASOLINE SALES.—Not later than October 31 of each of calendar years 2005 through 2011, the Administrator of the Energy Information Administration shall provide to the Administrator of the Environmental Protection Agency an estimate, with respect to the following calendar year, of the volumes of gasoline projected to be sold or introduced into commerce in the United States.
‘‘(B) DETERMINATION OF APPLICABLE PERCENTAGES.— ‘‘(i) IN GENERAL.—Not later than November 30 of each of calendar years 2005 through 2012, based on the estimate provided under subparagraph (A), the Administrator of the Environmental Protection Agency shall determine and publish in the Federal Register, with respect to the following calendar year, the renewable fuel obligation that ensures that the requirements of paragraph (2) are met.
‘‘(ii) REQUIRED ELEMENTS.—The renewable fuel obligation determined for a calendar year under clause (i) shall—
‘‘(I) be applicable to refineries, blenders, and importers, as appropriate;
‘‘(II) be expressed in terms of a volume percentage of gasoline sold or introduced into commerce in the United States; and
‘‘(III) subject to subparagraph (C)(i), consist of a single applicable percentage that applies to all categories of persons specified in subclause (I).

‘‘(7) WAIVERS.—
‘‘(A) IN GENERAL.—The Administrator, in consultation with the Secretary of Agriculture and the Secretary of Energy, may waive the requirements of paragraph (2) in whole or in part on

petition by one or more States by reducing the national quantity of renewable fuel required under paragraph (2)—
‘‘(i) based on a determination by the Administrator, after public notice and opportunity for comment, that implementation of the requirement would severely harm the economy or environment of a State, a region, or the United States; or
‘‘(ii) based on a determination by the Administrator, after public notice and opportunity for comment, that there is an inadequate domestic supply.

2007 EISA Amendments to EPACT 2005, as relevant here

SEC. 202. RENEWABLE FUEL STANDARD.
(a) RENEWABLE FUEL PROGRAM.—Paragraph (2) of section 211(o) (42 U.S.C. 7545(o)(2)) of the Clean Air Act is amended as follows:
(1) REGULATIONS.—Clause (i) of subparagraph (A) is amended by adding the following at the end thereof: ‘‘Not later than 1 year after the date of enactment of this sentence, the Administrator shall revise the regulations under this paragraph to ensure that transportation fuel sold or introduced into commerce in the United States (except in noncontiguous States or territories), on an annual average basis, contains at least the applicable volume of renewable fuel, advanced biofuel, cellulosic biofuel, and biomass-based diesel, determined in accordance with subparagraph (B) and, in the case of any such renewable fuel produced from new facilities that commence construction after the date of enactment of this sentence, achieves at least a 20 percent reduction in lifecycle greenhouse gas emissions compared to baseline lifecycle greenhouse gas emissions.’’.

(b) APPLICABLE PERCENTAGES.—Paragraph (3) of section 211(o) of the Clean Air Act (42 U.S.C. 7545(o)(3)) is amended as follows:
(1) In subparagraph (A), by striking ‘‘2011’’ and inserting ‘‘2021’’.
(2) In subparagraph (A), by striking ‘‘gasoline’’ and inserting ‘‘transportation fuel, biomass-based diesel, and cellulosic biofuel’’.
(3) In subparagraph (B), by striking ‘‘2012’’ and inserting ‘‘2021’’ in clause (i).
(4) In subparagraph (B), by striking ‘‘gasoline’’ and inserting ‘‘transportation fuel’’ in clause (ii)(II).

(e) WAIVERS.—
(1) IN GENERAL.—Paragraph (7)(A) of section 211(o) of the Clean Air Act (42 U.S.C. 7545(o)(7)(A)) is amended by inserting ‘‘, by any person subject to the requirements of this subsection, or by the Administrator on his own motion’’ after ‘‘one or more States’’ in subparagraph (A) and by striking out ‘‘State’’ in subparagraph (B).

2007 cellulosic adjustment provision
(2) CELLULOSIC BIOFUEL.—Paragraph (7) of section 211(o) of the Clean Air Act (42 U.S.C. 7545(o)(7)) is amended by adding the following at the end thereof:

‘‘(D) CELLULOSIC BIOFUEL.—(i) For any calendar year for which the projected volume of cellulosic biofuel production is less than the minimum applicable volume established under paragraph (2)(B), as determined by the Administrator based on the estimate provided under paragraph (3)(A), not later than November 30 of the preceding calendar year, the Administrator shall reduce the applicable volume of cellulosic biofuel required under paragraph (2)(B) to the projected volume available during that calendar year. For any calendar year in which the Administrator makes such a reduction, the Administrator may also reduce the applicable volume of renewable fuel and advanced biofuels requirement established under paragraph (2)(B) by the same or a lesser volume.

2016 Adjustment Provision

‘‘(F) MODIFICATION OF APPLICABLE VOLUMES.—For any of the tables in paragraph (2)(B), if the Administrator waives—

‘‘(i) at least 20 percent of the applicable volume requirement set forth in any such table for 2 consecutive years; or

‘‘(ii) at least 50 percent of such volume requirement for a single year, the Administrator shall promulgate a rule (within 1 year after issuing such waiver) that modifies the applicable volumes set forth in the table concerned for all years following the final year to which the waiver applies, except that no such modification in applicable volumes shall be made for any year before 2016. In promulgating such a rule, the Administrator shall comply with the processes, criteria, and standards set forth in paragraph (2)(B)(ii).’’.