Comments to EPA on 2020-2022 RFS Rule

Prepared for

Growth Energy

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1 2022 Potential Ethanol Production

EIA lists the U.S. ethanol nameplate production capacity for 2020 at 17.38 billion gallons per year[1]. How much of this ethanol production capacity can be used is primarily a function of the available feedstock, corn, and the conversion capacity of ethanol plants. We consider three different approaches to determine the real world maximum potential ethanol production in 2022: historical maximum, previous year, and potential expansion.

The highest year of ethanol production was 2018, when 16.061 billion gallons of ethanol were produced domestically.[2] In 2021, it is estimated that 14.87 billion gallons of ethanol were produced.[3] We believe that both of these figures represent conservative estimates of how much ethanol could reasonably be produced in 2022. The 2021 volume was suppressed substantially by low demand for transportation fuel in response to the Covid-19 pandemic. And neither figure accounts for the continuing growth in the productivity of U.S. corn growers or the steady improvements in the efficiency of U.S. corn ethanol plants. As explained below in greater detail, these developments have allowed U.S. ethanol production to continuously increase their production capability without requiring increasing corn acreage or adversely impacting the supply of corn available for other domestic non-ethanol demands or export markets. In fact, we conclude that, accounting for these developments, 15.565 billion gallons could be produced domestically in 2022.

While the 15.565 billion gallons of ethanol for 2022 in Table 4 seems like an upper limit on ethanol production in 2022, it is in fact limited by the decision to keep the planted acres constant the decision to keep the portion of corn used for ethanol constant, and the representation of new technology implementation as a straight line. The reality is that market forces are always in play. A positive future market outlook may cause more acres to be planted in corn that year. It may cause plant maintenance to be delayed until next year. A very promising technology may be implemented earlier and to a larger extent than typical technology is implemented. Table 4 and the other tables in that section represent average conditions which can be increased or decreased by each farmer or ethanol production facility's market outlook. Indeed, as noted, the actual ethanol production in 2018 exceeded our projection for 2022 by a substantial margin, at a time when yield rates and conversion efficiency were lower than they are now.

1.1 Corn Supply

Review of U.S. corn production data through the Fall 2021 harvest shows that yields per harvested acre have continued their long-term growth trend. Figures 1 and 2 below illustrates annual per-harvested-acre yields and annual planted corn acres as reported by USDA[4]; Figure 1 presents the long-term trend since 1936 and Figure 2 focuses on 2006 through 2021. The dashed red line in Figure 2 indicates the average annual corn plantings from 2008 through 2021 was 90.8 million acres; this is below the 93.5 million corn acres planted in 2007, the last crop planted prior to enactment of EISA 2007.

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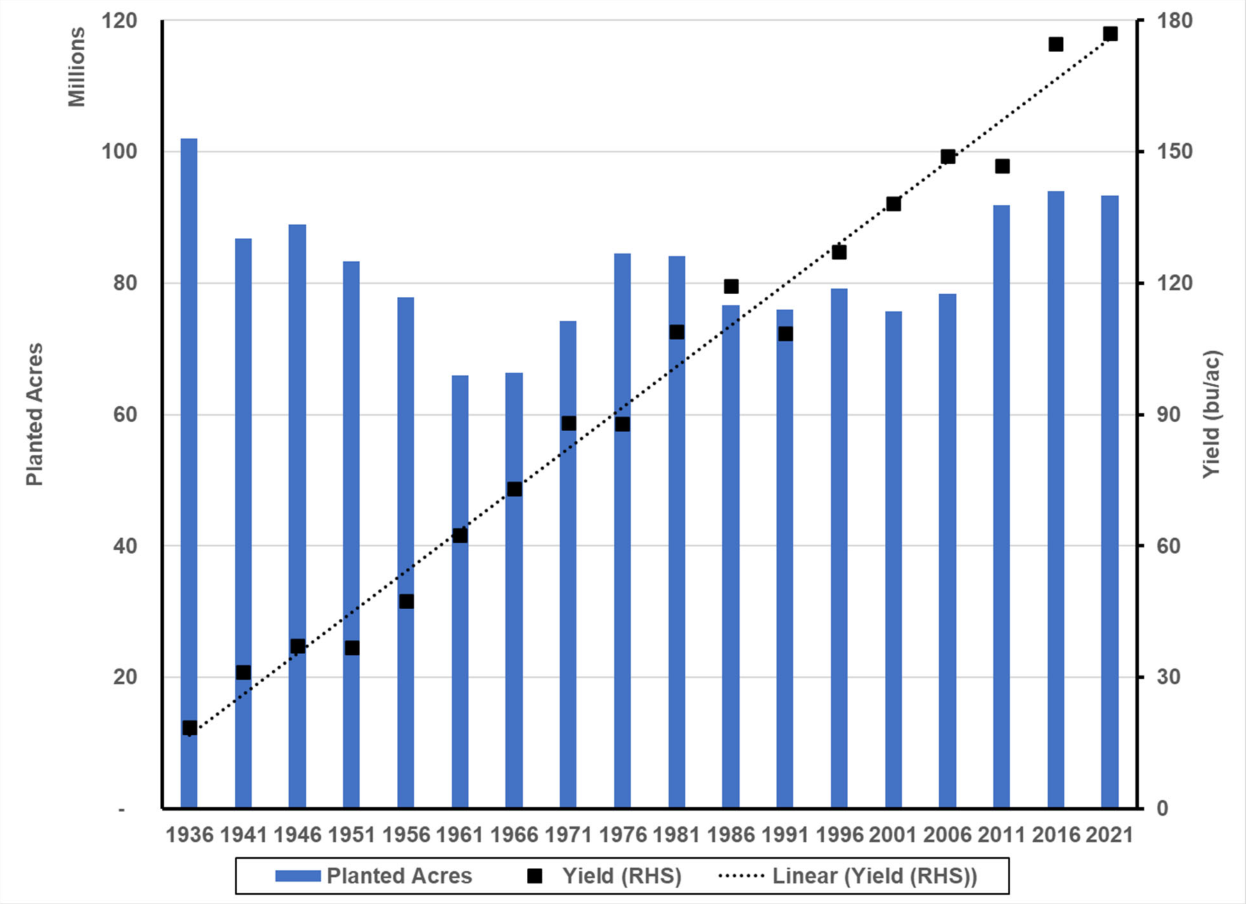
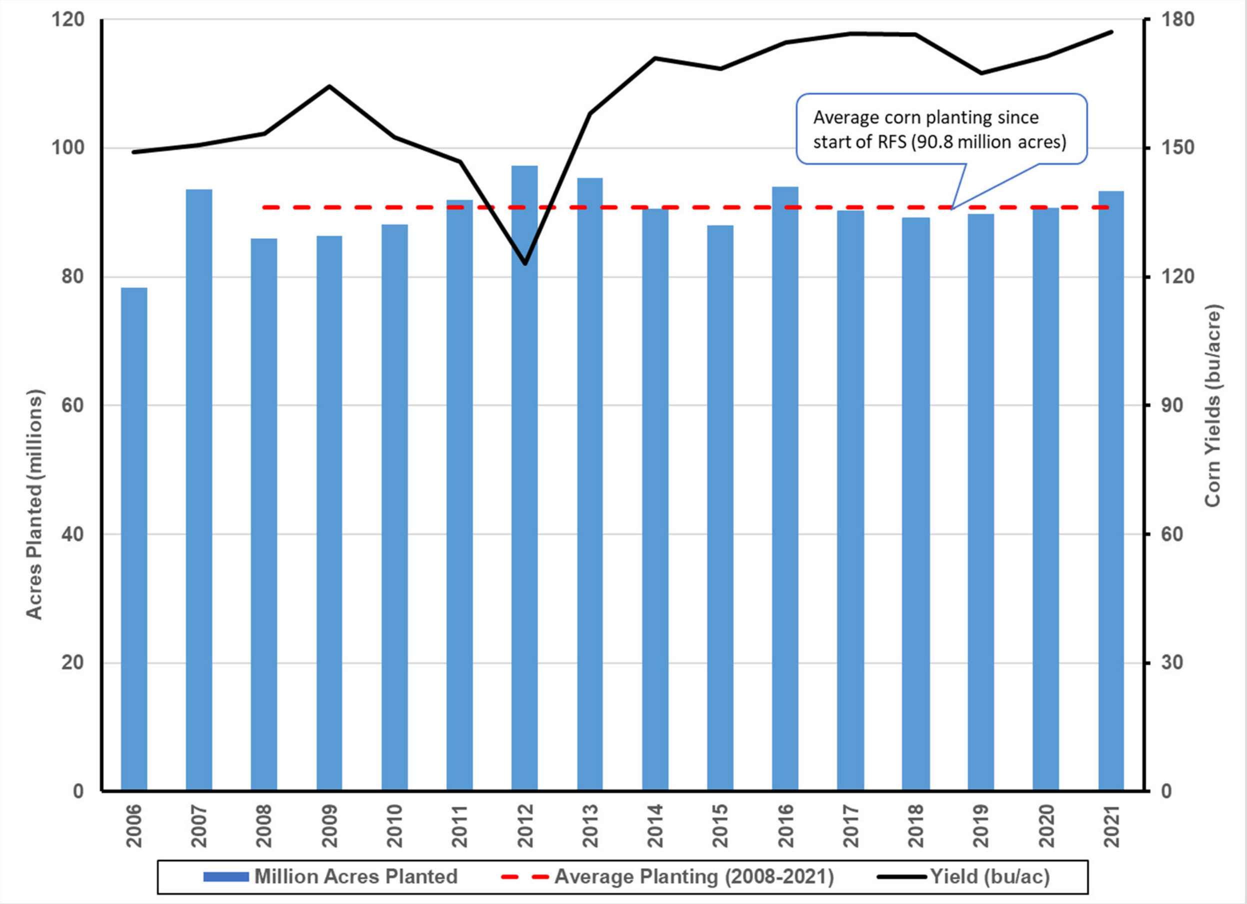
[1] https://afdc.energy.gov/data/10342, U.S. Ethanol Plants Capacity and Production
[2] https://afdc.energy.gov/data/10342, U.S. Ethanol Plants Capacity and Production
[3] http://ethanolproducer.com/articles/18648/eia-reduces-2021-2022-ethanol-production-forecasts
[4] USDA QuickStats, https://quickstats.nass.usda.gov/.

Figure 1. U.S. Corn Acres and Yield (1936-2021)



Source: *USDA, Stillwater analysis*

Figure 2. U.S. Corn Acres Planted and Yield (2006-2021)



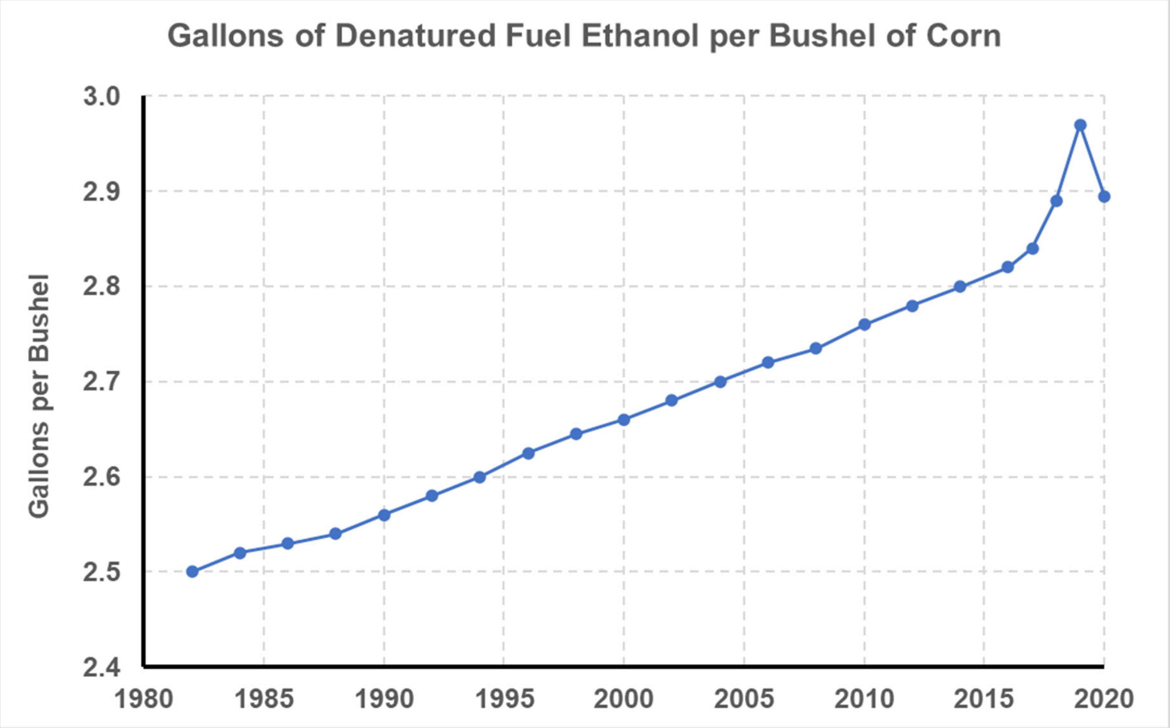
Source: *USDA, Stillwater analysis*

Since 2008, U.S. corn yields have grown from 153.3 bushel per harvested acre ("bu/ac") to 177.0 bu/ac in 2021, an increase of 1.8 bu/ac each year. This is nearly the same pace as the 1.9 bu/ac each year in the 85 years since 1936. Normally to be consistent with this durable trend, we would estimate that in 2022, the corn yield will be 178.8 bu/ac. However, this value is based on 177.0, which is itself a projection. To be conservative we have decided to keep the 2022 projection of corn yield at 177.0.

1.2 Ethanol Production

In addition to this steadily increasing trend in corn yields, the yield of ethanol from corn processed at U.S. ethanol plants has also steadily increased (according to data from USDA). These data, illustrated in Figure 3 below, indicate that yields have increased at a rate of over 0.010 gallons of denatured fuel ethanol (DFE) per bushel of corn each year from 1982 through 2020 and this rate has accelerated to over 0.012 gallons of DFE per bushel of corn each year from 2006 through 2020. These increases can be attributed to innovation enabled by growing industry operating experience and steady improvements in both the engineering designs of ethanol plants and the efficiency of the yeasts used in the fermentation process. Extrapolating the long-term trend (an average yield increase of 0.0101 gallons per bushel per year since 1982) illustrated in Figure 3 allows us to estimate that the reported industry-average ethanol yield of 2,894 gallons of ethanol per bushel of corn in 2020 would increase to 2.904 gallons of ethanol per bushel in 2021 and 2.914 gallons per bushel in 2022. As a result, the 3,049 million bushels of corn which produced 9,309 million gallons of DFE in 2008 would yield 9,919 million gallons of DFE at current yields, a 7% increase.

Figure 3. Improvement in Yields at U.S. Corn Ethanol Plants



***Source**: USDA QuickStats, Stillwater analysis*

1.3 Computation of Achievable Ethanol Supply

Combining each of the elements above, it is possible to estimate how much corn could be used for ethanol production in 2022—and hence how much ethanol could be produced—while continuing to supply the growing domestic market demands for corn required for all other uses (estimated based on the 10.9% growth in U.S. population since 2007) and maintaining corn exports at the same volume as 2007.

As a first step in this analysis, we can estimate the amount of corn which can be produced on the same number of planted acres as used in the 2007 market year.[5] This analysis is presented in Table 1 below. For purposes of this analysis, we assume that U.S. farmers plant 93.5 million acres of corn in the Spring of 2022, which is equal to the acreage planted in 2007. For the 2007 market year, we use USDA data reported in their World Agriculture Supply Demand Estimate (WASDE) report for January 2010. Importantly, the ratio of harvested acres to planted acres was about 92.5% in 2007, higher than 91.3% average for the most recent 10 years. We also assume that U.S. farmers will harvest 91.3% of the planted acreage, which is the average harvest rate over the past decade. Accordingly, we estimate that 85.4 million acres could be harvested in Fall 2022. Applying the yield of 177.0 bu/ac, we estimate an achievable 2022 corn crop of 15,116 million bushels.

Then to assess how much of that corn would be available for domestic use, we add corn imports (USDA estimates 25 million bushels for 2022) and subtract corn exports (using the most recent USDA figure of 2,437 million bushels in 2020/2021.) The net result is that the U.S. could have 12,704 million bushels of corn available for all domestic uses in 2022.

The other major demands for corn are for feed, food, seed, and non-ethanol industrial uses. Accordingly, assessment of how much corn is potentially available for ethanol production needs to also consider domestic demand for these other markets. Many factors influence corn demand in each of these markets.

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[5] The market year for corn runs from September 1st through August 31st. Thus, the 2007/08 market year begins with harvesting the corn planted in the Spring of 2007 (before EISA was enacted in December 2007) and ends prior to the harvest of the corn crop planted in the Spring of 2008.

Table 1. Potential 2022 Corn Harvest using 2007/08 Planted Acres and Current Yields

Market Year	2007/08	Estimated 2022/23 with 2007/08 Acres
Area Planted (million acres)	93.5	93.5
Area Harvested (million acres)	86.5	85.4
Yield (bushels per acre harvested)	150.7	177.0
Production (million bushels)	13,038	15,116
Corn Imports (million bushels)	20	25
Less Corn Exports (million bushels)	(2,437)	(2,437)
Available Corn Supply (million bushels)	10,621	12,704

***Source**: USDA, Stillwater analysis*

For the purposes of this analysis, we will assume that growth in U.S. population, which is projected to be 10.9% from 2008 to 2022, can be used as a proxy for overall demand growth.[6] Annual data on U.S. population as reported by the U.S. Census Bureau for 2007 through 2021 and U.S. population for 2022 as estimated by the United Nations[7] is summarized in Table 2.

Table 2. U.S. Population as Estimated by the United Nations

Year	Population as of December 31st
2007	301,903,167
2008	304,718,000
2009	307,373,750
2010	309,731,983
2011	311,918,250
2012	314,120,641
2013	316,266,088
2014	318,534,859
2015	320,822,902
2016	323,095,500
2017	325,142,676
2018	326,882,088
2019	328,460,928
2020	331,236,261
2021	332,182,892
2022 (forecast) *	334,805,269
*U.N. Forecast	

***Source**: U.S. Census Bureau, Macrotrends.net*

In estimating supply of corn for feed, it is also necessary to consider the feed co-products produced at ethanol plants (both wet mills and dry mills). The ethanol production process only utilizes the starch contained in the corn; all the protein, fiber, and minerals, along with much of the oil[8] are contained in the co-products[9] which are highly valued as feed. Production data for these coproducts is available from USDA

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[6] Other factors would include changing consumer dietary preferences (impacting feed demand for cattle, swine and poultry) and economic growth (impacting consumer demand for a wide range of products).

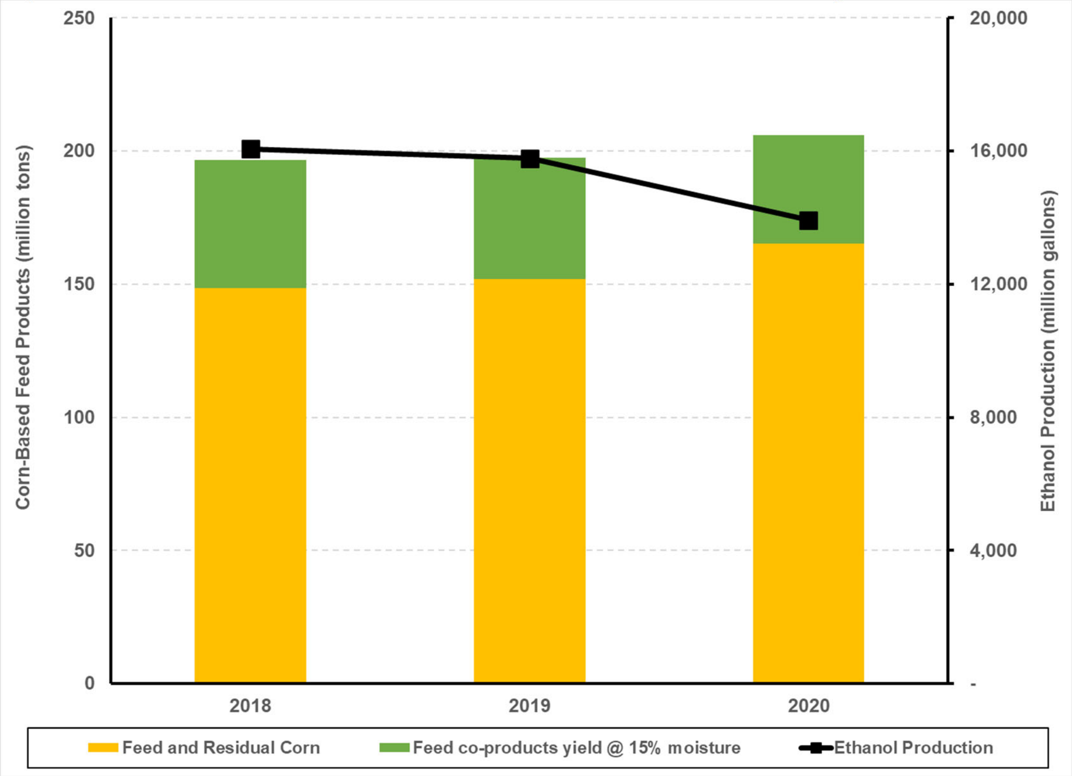
[7] Available at https://www.macrotrends.net/countries/USA/united-states/population

[8] A portion of the corn oil is separated out at most corn ethanol plants for use in applications other than feed. This corn oil product is, thus, excluded from this analysis of feed co-products.

[9] These co-products include distillers' grains and syrup produced at dry mills and corn gluten meal and corn gluten feed produced at wet mills.

in their monthly Grain Crushings and Co-Products Production report and Annual Summary[10] with annual data released in March of the following year. Figure 4 below illustrates, for the most recent three years, the combination of corn used for feed, as reported by USDA in their monthly World Agriculture Supply and Demand Estimate (WASDE) reports and feed co-products as reported in their Grain Crushings and Co-Products Production reports. This is compared to the corresponding annual ethanol production data and it can be seen that the large decrease in ethanol production in 2020 had only a minimal effect on feed availability.

Figure 4. U.S. Ethanol Production and Corn-based Feed Availability



***Source**: USDA, Stillwater analysis*

The next step in our analysis is to project current U.S. corn demand for uses other than ethanol production. USDA breaks down domestic corn demand into two categories – "Feed and Residual" (F&R) and "Food, Seed, and Industrial" (FS&I). USDA then breaks out fuel ethanol demand from the broader FS&I total. For our analysis, we will divide domestic non-ethanol corn demand into F&R and "Other FS&I" (i.e., the FS&I minus corn used for ethanol production). Complete analysis of the demand for feed, however, needs to include the feed co-products of ethanol production in addition to the direct use of corn for feed; we label this as Total Corn-based Feed.[11]

For this analysis, we assume that growth in domestic demand for Total Corn-based Feed and Other FS&I since 2007 can be estimated based on the growth in U.S. population since 2007. Estimation of the maximum ethanol production in 2022/23 which leaves sufficient corn to satisfy the U.S.'s growing demand for Total Corn-based Feed and Other FS&I is illustrated in Table 3 below. From the calculations in Table 1, we have projected 12,704 million bushels of corn to be available in the U.S. during 2022/23 to supply all domestic uses. From this, we subtract the 1,476 million bushels of corn required to satisfy demands for Other FS&I (calculated from the reported demand in 2007/08 and the growth in U.S. population). This leaves 11,228 million bushels of corn available to supply F&R plus ethanol production. Per USDA, Total Corn-based Feed

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[10] https://usda.library.cornell.edu/concern/publications/v979v304g?locale=en

[11] E.g., DDGS and corn gluten meal.

demand in the U.S. in 2007/08 was 6,839 million bushels which included 5,913 million bushels of corn and 926 million bushels of Feed Co-Products from ethanol production.[12]

Adjusting for population growth since 2007/08, the U.S. is estimated to demand 7,514 million bushels of Total Corn-based Feed in 2022/23. Allocating those 7,514 million bushels between corn and co-products requires an iterative calculation based on 17 pounds of co-products per bushel of corn used in ethanol production and a projected ethanol yield of 2.914 gallons per bushel in 2022/23 based on extrapolation of the yearly industry yield trend since 1982. Using these yields, production of 15,565 million gallons of ethanol in 2022/23 would be expected to consume 5,341 million bushels of corn and produce 1,621 million bushels of Feed Co-Products. This leaves an estimated 5,892 million bushels of corn available for use as F&R. These 5,892 million bushels of corn for F&R plus the 1,621 million bushels of Feed Co-Products adds up to the 7,514 million bushels of estimated demand for Total Corn-based Feed.

Table 3. Calculation of Maximum Ethanol Production in 2022/23

Marketing Year	2007/08	Projected 2022/23
U.S. Population	300,608,429	334,805,269
Corn Available for Domestic Use (million bushels)	10,621	12,704
Other FS&I (million bushels)	1,338	1,470
Corn Available for Feed and Ethanol (million bushels)	9,283	11,234
Feed and Residual (million bushels)	5,913	--
Estimated Feed Co-Products (million bushels)	926	--
Total Corn-based Feed (million bushels)	6,839	7,514
Estimated Feed Co-Products from 15.565 billion gallons of ethanol production		1,621
Required Corn to supply F&R Demand (million bushels)		5,892
Corn Available for ethanol production		5,341
Ethanol production at 2.914 gallons/bushel (billion gallons)		15.565

Source: *USDA, Stillwater analysis*

Table 4 below recaps the above allocation of corn volume in 2022/23 which produces 15.565 billion gallons of ethanol while planting the same number of acres planted in corn in 2007, keeping U.S. corn exports even with 2007/08, and supplying estimated growth in domestic demand for all other uses of corn.

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[12] Based on an average yield of 17 pounds per bushel of corn used for ethanol production, corrected to 15% moisture content.

Table 4. Summary of Corn Supply and Demand Calculations

Market Year	2007/08	Projected 2022/23
Corn Supply (million bushels)		
Corn Produced	13,038	15,116
Corn Imports	20	25
Corn Exports	(2,437)	(2,437)
Total Domestic Corn Supply	10,621	12,704
Corn Demand (million bushels)		
Feed and Residual	5,913	5,892
Food, Seed & Industrial	4,387	6,811
Ethanol for fuel	*3,049*	*5,341*
Other Food, Seed & Industrial	*1,338*	*1,470*
Total Domestic Corn Demand	10,300	12,704
Surplus/(Shortage)	321	--
Ethanol Production (billion gallons)	9.3	15.565
Ethanol Yield (gallons/bushel)	2.735	2.914
Feed Co-Products (mmillionbushels)	926	1,621
Feed Co-Product Yield (pounds per bushel) @ 15% moisture	17	17

***Source**: USDA, Stillwater analysis*

2 E85 and E15 Consumption Capacity

In EPA's RFS proposal for 2022, they state: "We do not anticipate that growth in the use of higher ethanol blends through 2022 will increase rapidly enough to result in significantly greater volumes of ethanol consumption in the U.S.[13]" This is dubious since in recent years governmental efforts such as USDA's Blender Infrastructure Program and Higher Blends Infrastructure Incentive Program have significantly added to E85 and E15 infrastructure. Much of this infrastructure will be underutilized if future RFS's do not encourage increased usage of E85 and E15.

2.1 E85

E85 consumption capacity is a function of two factors: (a) E85 dispensers and (b) E85-compatible vehicles.

2.1.1 E85 Dispenser Capability

The AFDC reports that there are currently 4,125 stations selling E85.[14] A report by Stillwater in 2018 estimated that these E85 stations would average 1.8 dispensers per station in 2022 that are already in service providing E85 and thus that are compatible with and approved for use with E85.[15] Therefore, in 2022, there will be about 7,425 E85 dispensers.

Each dispenser can dispense a typical volume of 45,000 gallons per month of E85, containing 33,300 gallons of ethanol per month. Therefore, the maximum E85 throughput capacity of the 7,425 existing E85 dispensers is 4.0 billion gallons of E85 containing 3.0 billion gallons of ethanol. [16] [17] EIA projects that 320 million gallons of E85 will be used in 2022 (See Figure 5, year 2022). Given 7,425 existing E85 dispensers, there is, therefore, the existing capability to dispense an additional 3.68 billion gallons of E85 containing 2.72 billion gallons of ethanol. That would in turn contain about 2.36 billion incremental gallons of ethanol, i.e., gallons beyond the ethanol in the E10 that would be replaced by the additional E85.

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[13] https://www.epa.gov/sites/default/files/2021-12/documents/rfs-2020-2021-2022-rvo-standards-nprm-2021-12-07.pdf, page 27

[14] https://afdc.energy.gov/fuels/ethanol_locations.html#/analyze?country=US&fuel=E85

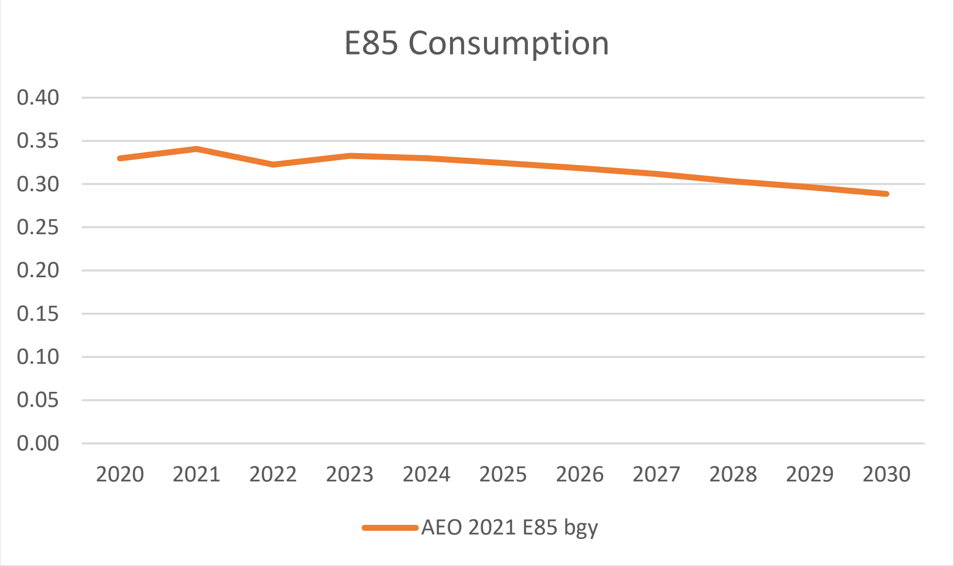
[15] **Potential Increased Ethanol Sales through E85 for the 2019 RFS, August 17, 2018**, Prepared for Growth Energy by Stillwater Associates LLC, Table 2

[16] 7,425 dispensers X 45,000 gallons per month X12 months = 4.0 billion gallons

[17] 4.0 billion gallons of E85 X .74 gallons of ethanol per gallon of E85 = 3.0 billion gallons of ethanol

Citing 2020 data, EPA states that there are only about 3,947 stations at the end of 2020.[18] In an effort to examine a more conservative case, we assume that there are only 3,947 stations and that each station only has a single dispenser. In this case, the maximum E85 throughput capacity of these 3,947 dispensers is 2.31 billion gallons of E85 containing 1.71 billion gallons of ethanol. [19] [20] Again assuming that 320 million gallons of E85 will be used in 2022, there would be the existing capability to dispense an additional 1.99 billion gallons of E85 containing 1.47 billion gallons of ethanol. That would in turn contain about 1.27 billion incremental gallons of ethanol, i.e., gallons beyond the ethanol in the E10 that would be replaced by the E85.[21]

Figure 5. E85 Consumption projected in AEO 2021[22]



EPA's own estimate of the use of E85 in 2022 implies even lower utilization of existing E85 distribution infrastructure. EPA relies on three estimates of E85 usage from 2020: 297, 206, and 202 million gallons[23]. Using the largest value of 297 million gallons implies a utilization rate of 13% if there are 3,947 dispensers. This utilization rate would be 7.4 % if there are 7,425 dispensers.

Each 5-percentage point increase in utilization rate would provide in an additional 116 million gallons of E85, containing 85 million incremental gallons of ethanol, if there 3,947 dispensers and would provide an additional 200 million gallons of E85, containing 148 million incremental gallons of ethanol, if there 7,425 dispensers.

2.2 E85-compatible vehicles

Another constraint on E85 is that E85 can only be used in FFVs so FFV capacity to use E85 needs to be examined. In 2022, there will be about 20.4 million E85-compatible vehicles based on EIA's estimates from AEO 2021. These vehicles could use *588* gallons per year of E85, containing *435* gallons of ethanol (based on the projected number of vehicle miles driven).[24]

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[18] https://nepis.epa.gov/Exe/ZyPDF.cgi?Dockey=P1013KOG.pdf, page 192
[19] 3,947 dispensers X 45,000 gallons per month X12 months = 2.31 billion gallons
[20] 2.31 billion gallons of E85 X .74 gallons of ethanol per gallon of E85 = 1.71 billion gallons of ethanol
[21] 1.99 billion gallons of E85 X .64 gallons of ethanol per gallon of E85 = 1.27 billion gallons of ethanol
[22] https://www.eia.gov/outlooks/aeo/
[23] https://nepis.epa.gov/Exe/ZyPDF.cgi?Dockey=P1013KOG.pdf, page 38, Figure 1.7.1-2
[24] If a typical vehicle goes 12,000 miles per year. 12,000 miles divided by 25.4 miles per gallon (US fleet average in footnote 6 above) results in 472 gallons of E10 or 588 gallons of E85 needed each year., using the factor 1.22 to convert E10 to E85.

2.2.1 FFV

The latest Annual Economic Outlook from the EIA, AEO 2021, projects the number of ethanol-flex fueled vehicles (FFVs) expected to be in use to be about 20.4 million[25]. Again, EIA estimates that about 320 million gallons of E85 will be used in 2022, see Figure 5. When this is divided by the 20.4 million FFVs, it calculates out to be 15.7 gallons of E85 per FFV per year. Given that the average FFV is expected to travel about 12,000 miles per year and could use an estimated 588 gallons per year of E85 per FFV, this shows that there is a very large upside potential for E85 sales which can be reached with the existing E85 infrastructure.[26,27] If the 20.4 million FFVs used only E85, the maximum existing consumption capacity of E85 would be 12.65 billion gallons per year of E85 containing 9.38 billion of ethanol. Each 5% increment of E85 usage by FFVs would use 588 million gallons of E85 containing about 376.32 million incremental gallons of ethanol over E10.

Table 4 below shows that in 2022 15.565 bg of ethanol could be produced with no changes in the total farmland used for growing corn. EPA states that their proposed RFS would use 13.788 bg of ethanol[28]. This would leave 1.777 bg of ethanol which would be unused by the RFS. If that unused ethanol were instead used in E85, a total of 2.401 bg of additional E85 could be produced. Dispensing those additional gallons of E85 would increase total E85 consumption to 2.741 billion gallons, raising dispenser utilization to 68.5%, with the 7,800 dispensers, or 137% (the dispensers would be completely utilized dispensing 1.99 bg of E85), with 3,700 dispensers. With this 2.741 bg of E85 being consumed, the FFV fleet would be 21.7% fueled with E85.

2.3 Combining E85 Infrastructure and FFVs

As noted, EIA, in Figure 5, projects E85 consumption of 320 million gallons in 2022, which calculates to an average of 15.7 gallons of E85 use for each of the 20.4 million FFVs in operation in 2021. Making the reasonable assumption that the FFV vehicles are distributed in proximity to the E85 stations, 320 mg for the FFV fleet or 15.7 gallons per FFV represents only an 8.0% utilization rate of dispensers and 3% utilization rate of vehicles. [29] [30] So, there is clearly a huge opportunity to increase the use of E85 given existing infrastructure. The main barrier is pricing of E85 relative to E10.

There is sufficient existing E85 station infrastructure to dispense 4.0 bgy of E85 (3.0 bgy of ethanol). There are sufficient FFVs to consume this E85 volume (100% dispenser utilization) while filling FFVs with E85 only 35% of the time. The number of FFVs will not constrain major increases in E85 sales. As noted above, even devoting all additional ethanol production to E85 use (2.741 billion gallons) would raise existing-dispenser utilization to only 68.5% and FFV utilization to only 21.7%. It appears that market forces and pricing will continue to be the key factors impeding significant E85 growth. If EPA desires increased usage of ethanol, E85 sales offer more ethanol volume per gallon of fuel sold than any other option.

2.4 E15

2.4.1 E15 Dispensers

The Biofuels Infrastructure Program (BIP) had plans to install 4,880 blender pump dispensers capable of handling E15/E85 in 1486 stations by the end of 2018[31]. This calculates out to 3.3 dispensers per station. Other programs such as Prime the Pump and Higher Blends Infrastructure Incentive Program have added

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[25] https://www.eia.gov/outlooks/aeo/data/browser/#/?id=49-AEO2021&cases=ref2021&sourcekey=0, Table 39

[26] https://www.epa.gov/automotive-trends/highlights-automotive-trends-report

[27] 12,000 miles divided by 25.4 miles per gallon (US fleet average in footnote 6 above) results in 472 gallons of E10 or 588 gallons of E85.

[28] https://nepis.epa.gov/Exe/ZyPDF.cgi?Dockey=P1013KOG.pdf, page 51, Table 2.1-1

[29] 320 million gallons divided by 4.0 billion gallons of E85 capacity equals 8.0% utilization.

[30] 17 gallons divides by 588 gallons of E85 used by an FFV every year is 3% utilization

[31] https://www.fsa.usda.gov/programs-and-services/energy-programs/bip/index, state table

additional stations and dispensers to reach the 2,300 stations that EPA references in the RIA.[32] It will be assumed that all these stations also average 3.3 dispensers per station.

2.4.2 E15 Infrastructure

E15 is a relatively new fuel and E15 station and sales data is not regularly reported by government agencies. In the draft RIA for this proposal, EPA presents a figure which shows approximately 2300 E15 stations as of January 2021.[33] Stillwater has estimated that that these stations will average 3.3 dispensers per station offering E15 by 2022 (i.e., dispensers that are compatible with and approved for use with E15.[34] These 7,540 dispensers can handle about 4.1 billion gallons of E15 containing 0.205 billion gallons of ethanol can be dispensed in 2022.[35] [36]

Since E15 is not allowed the 1 psi waiver that applies to E10, the above station throughputs must be adjusted for 8.5 months instead of the 12 months used above. This reduces the distribution potential for E15 in 2022 to about 2.9 billion gallons containing 0.145 billion gallons of incremental ethanol above the E10 it would replace. If this infrastructure handles 1.2 billion gallons of E15 in 2022, then 1.7 billion gallons of E15 dispensing capacity is not being utilized. This represents 59% of the E15 capacity that is unutilized and 41% utilization of E15 dispensing capacity.

EPA in the RIA expresses some concerns about E15. One concern is that all existing or new hardware must be compatible with E15, new underground tanks must also be approved for E15, and it is expensive for station owners to pay for upgrading their hardware. The second concern is retailer liability for E15 damage and the additional cost associated with verifying E15 compatibility. These concerns are irrelevant to the analysis of the throughput capacity thus far, which is limited to the *existing* E15 infrastructure, i.e., infrastructure that is already acquired, compatible with E15 (by definition), and approved for use with E15. And with respect to the expansion of E15 infrastructure, EPA's concerns are misplaced or overstated. The manufacturers of nearly all dispensers have warranted them for E15 for many years, and most new dispensers made since 2012 have met the UL 87A requirements for E15. Because stations typically upgrade their pumps at high volume stations every 12 years, the population of E15 stations will continue to increase, and for little additional cost because the upgrade cycles would occur anyway regardless of a desire to expand E15 infrastructure.

EPA raises concerns in the RIA page 196 that being classified as E15 compatible is not the same as being approved for E15 use. EPA points in particular to underground tanks and pipes. This point did not bother EPA when creating Figure 6 In any event, EPA's concern about approval is very misleading and overstated. First, E15 underground tanks are generally unnecessary for the expansion of E15 delivery capacity because most E15 today is produced by blender pumps, which do not need E15-certified tanks. Indeed, EPA admits this on page 195 of the RIA: "the majority of service stations offering E15 today do so through blender pumps which can produce E15 on demand for consumers through the combination of E10 (or E0) and E85…"[37] Thus for most E15 stations the underground tank requirements for E15 storage do not apply. With a blender pump there is no E15 in contact with pipes or tanks as the E15 is produced in the dispenser. Second, although underground tanks are not upgraded as frequently as dispensers and can be more expensive than dispensers, the additional burden of obtaining approval to use a new E15-compatible underground system is negligible

2.4.3 E15 Compatible Vehicles

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[32] Figure 6.4.3-2: Number of Retail Service Stations Offering E15, page 196

[33] https://nepis.epa.gov/Exe/ZyPDF.cgi?Dockey=P1013KOG.pdf, Figure 6.4.3-2: Number of Retail Service Stations Offering E15, page 196

[34] Potential Increased Ethanol Sales through E85 for the 2019 RFS, August 17, 2018, Prepared for Growth Energy by Stillwater Associates LLC, Table 2

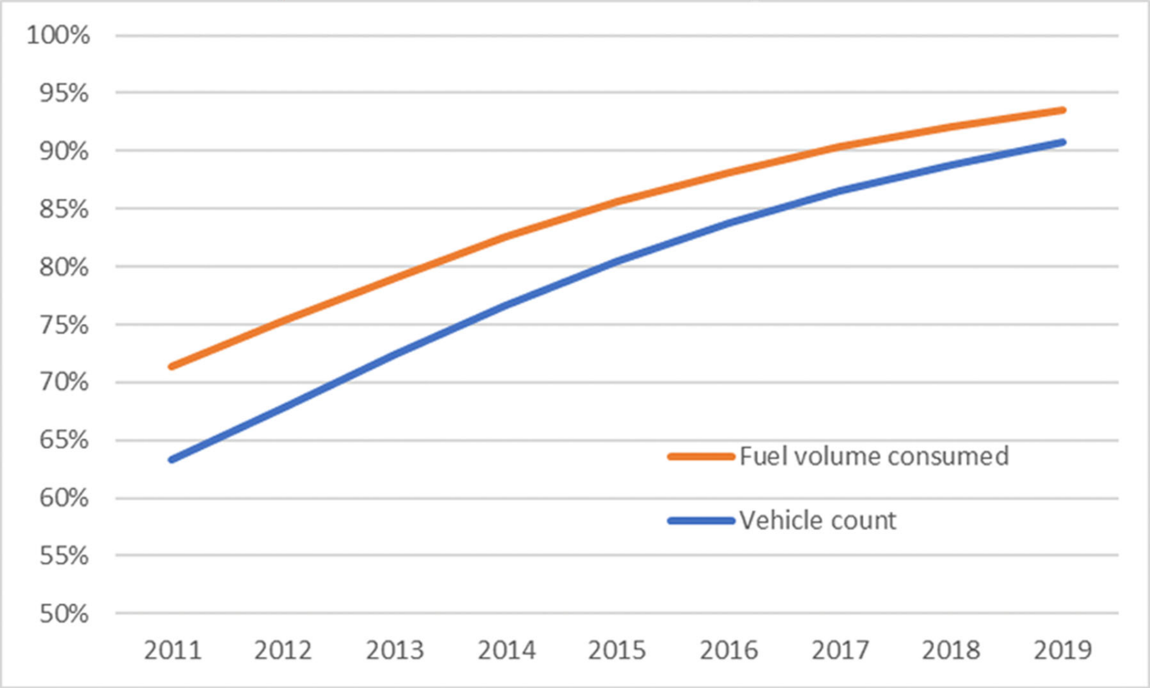
[35] 2,300 stations X 3.3 dispensers X 45,000 gal/disp/mo X 12 = 4.1 billion gallons

[36] 4.1 bg E15 X 0.05 gal etoh/ gal E15 = 0.205 bg etoh

[37] Draft Regulatory Impact Analysis: RFS Annual Rules (EPA-420-D-21-002, December 2021), page 194

As Figure 6 shows the vehicle pool is approaching the point where EPA claims that more than 90% of the vehicles are compatible with E15 (not counting FFVs, which can also use E15) and the noncompatible vehicles use less than 5% of the fuel used by the vehicle fleet.[38] As time moves on, these vehicles will become a smaller and smaller problem. Even in 2022, the capability for most of the nation's vehicles to use E15 far exceeds the small volumes of E15 available for this use.

Figure 6. MY2001 Or Later Fraction of In-Use Vehicle Fleet and MY 2001 or Later Fraction of In-Use Gasoline Consumption



Source: *EPA*

2.5 Combining E85 and E15 Capabilities

As can be seen from the E85 and E15 infrastructure analyses above in 2022 the additional ethanol capabilities of the E85 infrastructure, 2.72 bgy of incremental ethanol, vastly exceeds the capabilities of the current E15 infrastructure at 0.145 incremental bgy of ethanol per year. However, both sets of infrastructure can contribute to the goal of using more ethanol in the form of E85 or E15 with a total of 2.865 bgy of ethanol.

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[38] Draft Regulatory Impact Analysis: RFS Annual Rules (EPA-420-D-21-002, December 2021), page 199

3 E85 Pricing

In general, there is a lack of good data with information on E85 sales, production, and pricing. However, the Clean Cities Alternative Fuels Price Report is a fair source for E85 pricing data.[39] It is a quarterly report that collects samples of E85 prices by U.S. Department of Energy (DOE) PADDs for 15 days each quarter. These prices are averaged and then compared to E10 gasoline prices in the same PADD areas. The report also adjusts the E85 prices for energy content relative to E10 on a gasoline gallon equivalent (GGE) basis.

The most recent report was for October 2021 and the E85 and gasoline average prices from that report are shown in Table 5. The average E85 price nationally for October 2021 was $2.73 per gallon compared to $3.25 for E10 gasoline. These prices and the difference in prices of -$0.52 are about the same as most of the areas of the country except for New England and California. New England has an E85 price that is $0.32 above gasoline and California E85 is priced nearly $1.00 below California reformulated gasoline. This implies that in New England E85 sellers are not pricing competitively compared to gasoline on an energy basis but in California the market pricing is very competitive to E10 gasoline.

Table 5. E85 and Gasoline Average Prices by Region October 2021

Region	E85 Prices ($/gal)	Gasoline Prices ($/gal)	Price Difference
New England	$3.55	$3.23	$0.32
Central Atlantic	$2.68	$3.16	-$0.48
Lower Atlantic	$2.68	$3.08	-$0.40
Midwest	$2.69	$3.08	-$0.39
Gulf Coast	$2.52	$2.82	-$0.30
Rocky Mountain	$3.05	$3.54	-$0.49
West Coast	$3.35	$4.34	-$0.99
National Average	$2.73	$3.25	-$0.52

The Clean Cities Alternative Fuels Price Report also converted the E85 prices to a gasoline equivalent price by adjusting for the lower energy content of E85. A factor of 70% was used for adjusting the ethanol gallon energy content to a gasoline energy content equivalent. It was also assumed that E85 had on average 70% ethanol. EIA uses 74% in its E85 calculations. These GGE prices are shown in Table 6.[40] As can be seen, in all cases the E85 fuel was priced higher than gasoline on an energy equivalent basis. California alone seems to have E85 priced nearly equal to gasoline on an energy basis. The rest of the country has E85 prices that are adjusted to reflect some of the reduced energy, but it appears that stations in these areas are attempting to keep around half of the cost of the energy difference for themselves. This may reflect that many states have mandates for FFV and E85 usage in state and government fleets and the E85 retailers adjust their prices only enough to maintain some portion of the non-mandated E85 market.

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[39] https://afdc.energy.gov/files/u/publication/alternative_fuel_price_report_october_2021.pdf, Table 8

[40] https://afdc.energy.gov/files/u/publication/alternative_fuel_price_report_october_2021.pdf, Table 17a

Table 6. E85 and Gasoline Average Prices by Region (GGE) October 2021

Region	E85 Prices ($/GGE)	Gasoline Prices ($/gal)	Price Difference
New England	$4.62	$3.23	$1.39
Central Atlantic	$3.48	$3.16	$0.32
Lower Atlantic	$3.48	$3.08	$0.40
Midwest	$3.50	$3.08	$0.42
Gulf Coast	$3.28	$2.82	$0.46
Rocky Mountain	$3.96	$3.54	$0.43
West Coast	$4.36	$4.34	$0.02
National Average	$3.55	$3.25	$0.30

There is little doubt that 2020 and 2021 gasoline and E85 prices reflect the large drop in transportation fuel demand caused by the Covid-19 epidemic, but the pandemic’s effect may have been similar with respect to each type of fuel. In order to examine E85 pricing during a more normal time period, the same two tables used above have been copied from the Clean Cities Alternative Fuels Price Report for October 2019.[41] In 2019, the national average E85 price was $2.28 per gallon and the national average gasoline price was $2.68 per gallon. These prices are lower than the October 2021 prices and reflect an average of $0.40 less for E85 than for E10 gasoline. In 2019, New England had E85 priced above gasoline just as in 2021 and California again had the lower E85 prices relative to gasoline.

Table 7. E85 and Gasoline Average Prices by Region for October 2019

Region	E85 Prices ($/gal)	Gasoline Prices ($/gal)	Price Difference
New England	$2.85	$2.69	$0.16
Central Atlantic	$2.34	$2.45	-$0.11
Lower Atlantic	$2.26	$2.46	-$0.20
Midwest	$2.18	$2.49	-$0.31
Gulf Coast	$2.07	$2.25	-$0.18
Rocky Mountain	$2.27	$2.73	-$0.46
West Coast	$3.08	$3.93	-$0.85
National Average	$2.28	$2.68	-$0.40

Table 8 shows the 2019 GGE adjusted prices for E85.[42] The results are very similar to the results for 2021. Again, California was the only region that came close to pricing E85 at parity with E10, but it still priced E85 above E10 on an energy-equivalent basis.

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[41] https://afdc.energy.gov/files/u/publication/alternative_fuel_price_report_oct_2019.pdf, Table 7

[42] https://afdc.energy.gov/files/u/publication/alternative_fuel_price_report_oct_2019.pdf, Table 17a

Table 8. E85 and Gasoline Average Prices by Region (GGE) October 2021

Region	E85 Prices ($/GGE)	Gasoline Prices ($/gal)	Price Difference
New England	$3.70	$2.69	$1.01
Central Atlantic	$3.04	$2.45	$0.59
Lower Atlantic	$2.94	$2.46	$0.48
Midwest	$2.83	$2.49	$0.34
Gulf Coast	$2.69	$2.25	$0.44
Rocky Mountain	$2.95	$2.73	$0.22
West Coast	$4.00	$3.93	$0.07
National Average	$2.96	$2.68	$0.28

From looking at Tables 6 and 8, it appears that since 2019 and even through the Covid epidemic, E85 has consistently been priced above E10 gasoline on an energy equivalent basis on average in all regions of the country. If we assume that E85 purchasers are completely rational, it is obvious why utilization of E85 has not been higher: consumers recognize that it is too expensive. By and large, only price-insensitive E85 purchasers, such as those that are mandated to use E85 in their state, or through Federal mandate, or for fleet fueling for FFVs, purchase E85. Additionally, there are likely some consumers that are committed to E85 for non-economic reasons, who are also relatively price-insensitive; these can include corn farmers, those involved in ethanol production, and environmentalists. These groups of price-insensitive consumers have likely been the primary market for E85 retailers so far. Because they are few in number and not growing rapidly, the use of E85 has also not been growing much. In order to substantially increase the use of E85, it must be marketed to general consumers, who are highly price sensitive when purchasing fuel. And therefore, E85 must be priced at or below parity with E10 on an energy-equivalent basis. Put another way, retailers have been marketing E85 as a premium niche product, seeking high margins on low volume, but to take advantage of the infrastructure to markedly increase E85 use, they would need to market it as a mass-market low-cost, high-volume commodity.

In sum, the only real barrier to increasing the use of E85, and thereby the concentration of ethanol in the nation’s fuel supply, is the relative pricing of E85 to E10. E85 has consistently been priced more expensive than E10 and most consumers are highly sensitive to this premium. The solution, then, is to lower the relative price of E85 to E10. The RFS provides a direct mechanism to achieve this: higher RFS standards tighten the supply of RINs, increasing their price. Higher RIN prices translate into greater discounts relative to E10. And because E85 has such a higher concentration of ethanol, it can achieve a greater discount through higher RIN prices.

4 Encouraging Increased Use of Higher-Ethanol Blends

The RFS is designed to allow the lowest priced renewable biofuel to meet the demand for the conventional renewable biofuel requirement. Many parties believe that the conventional renewable biofuel category is designated to provide a mandate for ethanol D6 RINs but this category can be met by using any renewable biofuel allowed under the RFS. As a result, meeting this category’s requirements is based on acquiring the least expensive marginal RINs.

The marginal RIN is defined as the type of RIN which provides the lowest cost option for RFS-Obligated Parties to comply with the last increment of their annual obligation. This builds upon the assumption that an obligated party will seek to comply with its obligations in the most cost-effective manner available to it; thus, it will use the overall lowest cost option first to comply with as much of its obligation as possible and then, successively, utilize higher cost options in order of increasing cost to the extent needed to satisfy its total obligation for a year. As the RFS is comprised of four nested obligations, assessment of the marginal RIN is more complex than the assessment of the marginal supplier in most other market contexts.

Identifying the marginal RIN is useful as a tool for predicting the market response to potential changes to RFS policies.

Without the value of the D6 RIN export ethanol is more expensive than domestic RFS ethanol, so that anytime ethanol is desirable for RFS compliance, the market will first divert from exports. Put differently, anyone choosing to export U.S. ethanol chooses to lose the value of the D6 RIN he could get if he could use the ethanol domestically. This is important because it means that we have 1.3-1.5 billion or more gallons of ethanol, with existing land use and production capacity, ready to use domestically if the right price signals are sent through the RFS[43] [44]. There is no need to worry about marginal land use effects or marginal price effects for corn or food.

5 Market Challenge in Meeting Original 2020 Percentage Standards

EPA originally finalized the annual volume obligations and the corresponding percentage standards for the four RFS renewable fuel categories in February 2020.[45] The volumes and corresponding percentage standards are presented in Table 9 below. As each Obligated Party's obligations under the RFS are set by applying the percentage standards to the sum of their gasoline and diesel supply to the 49-state RFS market,[46] the finalization of the 2020 percentage standards enabled them to calculate their obligations and act to acquire all RINs needed for compliance with each their year-to-date obligations every day for the rest of 2020. Accordingly, when Obligated Parties closed their books for 2020, they were able to precisely know their obligations and take appropriate actions to secure any remaining shortfall in their required number of 2019 and 2020 RINs.

Table 9. RFS Final 2020 Volume Standards and Percentage Standards, February 2020

Fuel Category	2020 Final Volume Standard (billion gallons)	2020 Final Percentage Standards
Cellulosic biofuel	0.59	0.34%
Biomass-based diesel	2.43*	2.10%
Advanced biofuel	5.09	2.93%
Renewable fuel	20.09	11.56%
Undifferentiated Advanced Biofuels (Implied)	1.445	0.83%
Conventional Biofuels (Implied)	15.00	8.63%

*Established in the 2019 final rule (83 FR 63704, December 11, 2018)

In calculating the final percentage standards for 2020, EPA used data provided by EIA in their Short-Term Energy Outlook (STEO) for October 2019 and estimated the volume of small refinery volumes to be granted exemptions based on actual exemptions granted annually for 2016 through 2018. These volumes, originally published in Table VII.C-1 of the 2020 Final Rule are reproduced in Table 10 below along with the revised volumes in the December 2021 proposed rule.

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[43] https://www.fas.usda.gov/ethanol-2020-export-highlights
[44] https://www.fas.usda.gov/ethanol-2019-export-highlights
[45] Renewable Fuel Standard Program: Standards for 2020 and Biomass-Based Diesel Volume for 2021 and Other Changes, 85 FR 7016, February 6, 2020.
[46] Gasoline and diesel supplied to Alaska do not generate RFS obligations.

Table 10. Values for Terms in Calculation of the Final 2020 Standards (billion gallons)

		Value for 2020 Standards	
Term	**Description**	**February 2020 Final Rule**	**December 2021 Proposal**
RFVCB	Required volume of cellulosic biofuel	0.59	0.51
RFVBBD	Required volume of biomass-based diesel a	2.43	2.43
RFVAB	Required volume of advanced biofuel	5.09	4.63
RFVRF	Required volume of renewable fuel	20.09	17.13
G	Projected volume of gasoline	142.68	123.25
D	Projected volume of diesel	55.30	50.49
RG	Projected volume of renewables in gasoline	14.42	12.63
RD	Projected volume of renewables in diesel	2.48	2.15
GS	Projected volume of gasoline for opt-in areas	0	0
RGS	Projected volume of renewables in gasoline for opt-in areas	0	0
DS	Projected volume of diesel for opt-in areas	0	0
RDS	Projected volume of renewables in diesel for opt-in areas	0	0
GE	Projected volume of gasoline for exempt small refineries	4.24	0.00 – 4.80
DE	Projected volume of diesel for exempt small refineries	3.02	0.00 – 3.39

[a] The BBD volume used in the formula represents physical gallons. The formula contains a 1.5 multiplier to convert this physical volume to ethanol-equivalent volume.

In their proposed rule for volume requirements for 2020, 2021, and 2022, EPA proposes to revise the final volumes and percentage standards for 2020 on the basis that – [47]

Since we promulgated those standards, several significant and unanticipated events occurred that affected the fuels markets in 2020. The two most prominent of these events were:

- *The COVID–19 pandemic and the ensuing fall in transportation fuel demand, especially the disproportionate fall in gasoline demand relative to diesel demand, which significantly reduced the production and use of biofuels in 2020 below the volumes we anticipated could be achieved, and*
- *The potential that the volume of gasoline and diesel exempted from 2020 RFS obligations through small refinery exemption (SREs) will be far lower than projected in the 2020 final rule.*[48]

To evaluate the impact of these factors on obligated parties, we compare EPA's February 2020 Final Volume obligations for each of the four RFS categories with the volume obligations calculated by applying 2020 actual volumes to the finalized 2020 Percentage Standards (with and without inclusion of EPA's current estimates for exempted gasoline and diesel volumes) and to EMTS data for net 2020 RIN generation and 2020 RIN Separations (excluding separation for export). [49] [50] [51] These comparisons, which do not include any usage of carryover RINs, are presented in Table 11 below. This analysis shows that the inherent flexibilities in the RFS due to the use of percentage standards, the availability of cellulosic waiver credits (CWCs) to meet shortfalls in cellulosic biofuel availability, and the nested structure of the RFS obligations means that actual separations of 2020 vintage RINs were sufficient to sufficient to satisfy the cellulosic biofuel, biomass-based diesel, and advanced biofuel obligations for 2020 as previously finalized.[52] Additionally, net RIN generation for the Renewable fuels category was more than sufficient to enable compliance with the previously finalized 2020 Renewable Fuel obligation if EPA's estimate for small refinery exemptions (SREs) in 2020 is accurate, thus use of carry-over RINs to cover the shortfall in 2020 conventional RIN separation is appropriate.

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[47] Renewable Fuel Standard (RFS) Program: RFS Annual Rules, 86 FR 72436, December 21, 2021.

[48] RFS Annual Rules, Sub-Section I.B., December 21, 2021

[49] 4.80 billion gallons of gasoline and 3.39 billion gallons of diesel as indicated in the rightmost column of Table 6.

[50] Defined by EPA as the total number of RINs generated minus the number of invalid RINs generated.

[51] RINs associated with export volumes are not eligible for use in meeting RFS volume obligations. EIA data indicates that 1,317 million gallons of ethanol were exported from the U.S. in 2020. These would have been available to supply the domestic U.S. market if required for RFS compliance.

[52] While a portion of 2020 vintage RIN separations occurred in 2021, this analysis has not taken credit for the portion of 2019 vintage RIN separations which occurred in 2020.

Table 11. Volume Obligations (2020 Final Rule) Compared to the Actual Volume Obligations (with and without EPA's estimate of SREs) and RIN Generation

Fuel Category	2020 Final Volume Standard (billion gallons)	Actual Volume Obligations with 2020 Percentage Standards, no SRE	Actual Volume Obligations with 2020 Percentage Standards, est SRE	2020 Net RIN Generation	2020 RIN Separation
Cellulosic biofuel	0.59	0.54	0.51	0.51	0.50
Biomass-based diesel	2.43	2.15	2.04	2.88	2.48
Advanced biofuel	5.09	4.66	4.42	5.33	4.66
Renewable fuel	20.09	18.38	17.43	18.26	17.06

***Source**: EIA, Stillwater analysis*

To understand the influence of EPA's estimate for SREs in their calculation of the 2020 Final Percentage Standards in February 2020, we recomputed these values with the gasoline and diesel exempt volume projections both set to zero. This effectively increases the denominator used in calculating the percentage standards. This revised calculation ("2020 Percentage Standards, no SREs") is compared to the February 2020 calculation ("2020 Final Percentage Standards") in Table 12 below.

Table 12. Recalculation of 2020 Percentage Standard with no SREs

Fuel Category	2020 Final Volume Standard (billion gallons)	2020 Final Percentage Standards	2020 Percentage Standards, no SREs
Applicable Volume (bgal)	--	173.82	181.08
Cellulosic biofuel	0.59	0.34%	0.33%
Biomass-based diesel	2.43	2.10%	1.34%
Advanced biofuel	5.09	2.93%	2.81%
Renewable fuel	20.09	11.56%	11.09%
Undifferentiated Advanced Biofuels (Implied)	1.445	0.83%	0.80%
Conventional Biofuels (Implied)	15	8.63%	8.28%

***Source**: EPA, Stillwater analysis*

These alternative percentage standards are next used to compute what the 2020 volumes would have been had EPA accurately projected both transportation fuel use and SREs for 2020. These calculations are presented below in Table 13 and can be compared with Table 12 above. With this alternative calculation, it can be seen that cellulosic biofuels RIN generation (0.51 billion) and RIN separation (0.50 billion) both fell slightly short of the actual volume obligation of 0.52 billion RINs. RIN separations in this calculation exceed the actual volume obligations for both biomass-based diesel and advanced biofuels. Renewable fuels separations, at 17.06 billion fall short of the actual volume obligation of 17.64 billion. However, we see that 2020 net RIN generation, at 18.26 billion significantly exceeded the actual volume obligation – this tells us that sufficient RINs were generated to meet the 2020 standards as originally finalized if the EPA's 2020 estimation of SREs is removed from the analysis.

Table 13. 2020 Actual Volume Obligations calculated with revised percentage standards (with and without EPAs current estimate of SREs)

Fuel Category	2020 Final Volume Standard (billion gallons)	Actual Volume Obligations with 2020 Percentage Standards, no SRE	Actual Volume Obligations with 2020 Percentage Standards, est SRE	2020 Net RIN Generation	2020 RIN Separation
Cellulosic biofuel	0.59	0.52	0.49	0.51	0.50
Biomass-based diesel	2.43	2.06	1.96	2.88	2.48
Advanced biofuel	5.09	4.47	4.24	5.33	4.66
Renewable fuel	20.09	17.64	16.73	18.26	17.06
Undifferentiated Advanced Biofuels (Implied)	1.445	1.27	1.20	0.29	0.31
Conventional Biofuels (Implied)	15	13.17	12.49	12.93	12.40

Source: *EIA, Stillwater analysis*

5.1 RFS Impacts on Imports and Exports of Petroleum and Ethanol

To examine the impact of the RFS on imports and exports of petroleum (crude oil and products) and ethanol, we will review data available from EIA. A key element of this analysis begins with EIA's assessment of U.S. ethanol production capacity and production. These data are summarized in Table 14 below. EIA reports U.S. fuel ethanol production capacity annually as of January 1st of each year; the most recent data available are for January 1, 2021.[53] EIA also reports monthly fuel ethanol production.[54] The ratio of the two gives us the annual capacity utilization which we measure in percent; the average utilization achieved in the years immediately preceding Covid-19, 2018 and 2019, was 95%. Assuming that the industry can regularly operate at 95% of capacity and that U.S. ethanol capacity remains unchanged from the 17.546 billion gallons per year cited by EIA at the beginning of 2021, this suggests that the U.S. ethanol industry has the capability to produce at a rate of 16.669 billion gallons per year if sufficient supplies of corn are available and if there is demand for the product.[55]

Table 14. U.S. Annual Ethanol Production and Capacity

Year	Annual Capacity (million gallons)	Monthly Capacity (million gallons)	Annual Production (million gallons)	Annual Utilization (%)
2018	16,542	1,379	16,091	97%
2019	16,908	1,409	15,778	93%
2020	17,378	1,448	13,941	80%
2021 (estimated)[56]	17,546	1,462	14,716	84%
Potential 2022[57]	17,546	1,462	16,669 (@ 95% utilization)	95% (assumed)

Source: *EIA, Stillwater analysis*

Figure 7 below illustrates the monthly supply and demand for U.S. ethanol from 2018 through October 2021. As seen in this chart, monthly production (orange line) averaged 95% of capacity (blue line) in 2018 and 2019. Capacity utilization dropped to a low of 49% in April 2020 due to the impacts of the pandemic and operating rates have only recovered to 84% of capacity in 2021 (based on data for January through October). Domestic demand (green bars) for March through October of 2021 has nearly recovered to pre-Covid levels of about 1.2 billion gallons per month while export volumes (light gray bars) continue to be below pre-pandemic levels. The black line on the chart corresponds to the finalized implied conventional biofuels obligation of 15 billion gallons per year (1250 million gallons per month) for 2018 through 2020;

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[53] https://www.eia.gov/petroleum/ethanolcapacity/

[54] https://www.eia.gov/dnav/pet/pet_pnp_oxy_dc_nus_mbbl_m.htm

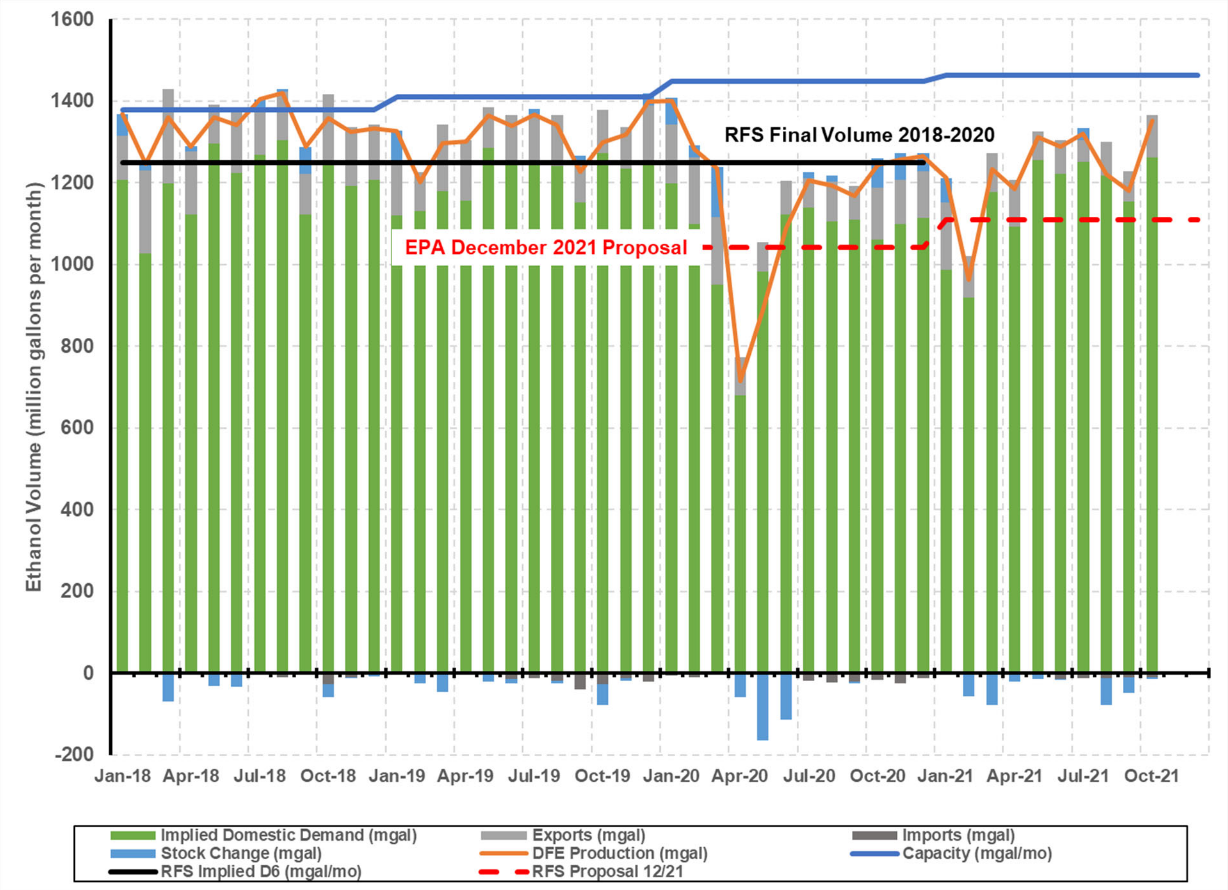
[55] https://www.eia.gov/petroleum/ethanolcapacity/

[56] Annual production estimated based on data through October 2021.

[57] Assumes no change in operable capacity since January 1, 2021.

while domestic ethanol demand in 2020 was clearly below this level, pre-pandemic ethanol demand averaged near this target.[58] The dashed red line represents the 2020 and 2021 volumes in EPA's December 2021 proposal. In summary, these data demonstrate that the U.S. ethanol industry has significant unused capacity which could be used to supply as much as about 16.7 billion gallons per year of ethanol for the U.S. fuels market.[59]

Figure 7. Monthly U.S. Ethanol Supply, Demand and RFS Volume Standards (2018-2021)



Source: *EIA, Stillwater analysis*

Exports continue to play a major role in U.S. petroleum and ethanol markets. Figure 8 below illustrates the recent trends in U.S. exports of crude oil, petroleum products, and ethanol. U.S. crude oil exports pre-pandemic were increasing steadily from over 42 million barrels per month in January 2018 to a high of 112 million barrels in March 2020; since the onset of the pandemic, they have varied in the range of about 80 to 100 million barrels per month. U.S. exports of petroleum products (including gasoline, diesel fuel, and other products) generally ranged around 100 million barrels per month pre-pandemic, dropped to a low of 58 million barrels in May 2020, and then rapidly recovered to a range of 80-90 million barrels per month since mid-2020. In contrast, U.S. ethanol exports are considerably smaller and have been generally declining since 2018 – from an average of 3,400 barrels per month in 2018 to an average of 2,300 barrels per month in 2021 (January through October). This decline in ethanol exports since before the pandemic is attributable to restrictive trade policies implemented by China and Brazil, two of the largest markets for U.S. ethanol exports.

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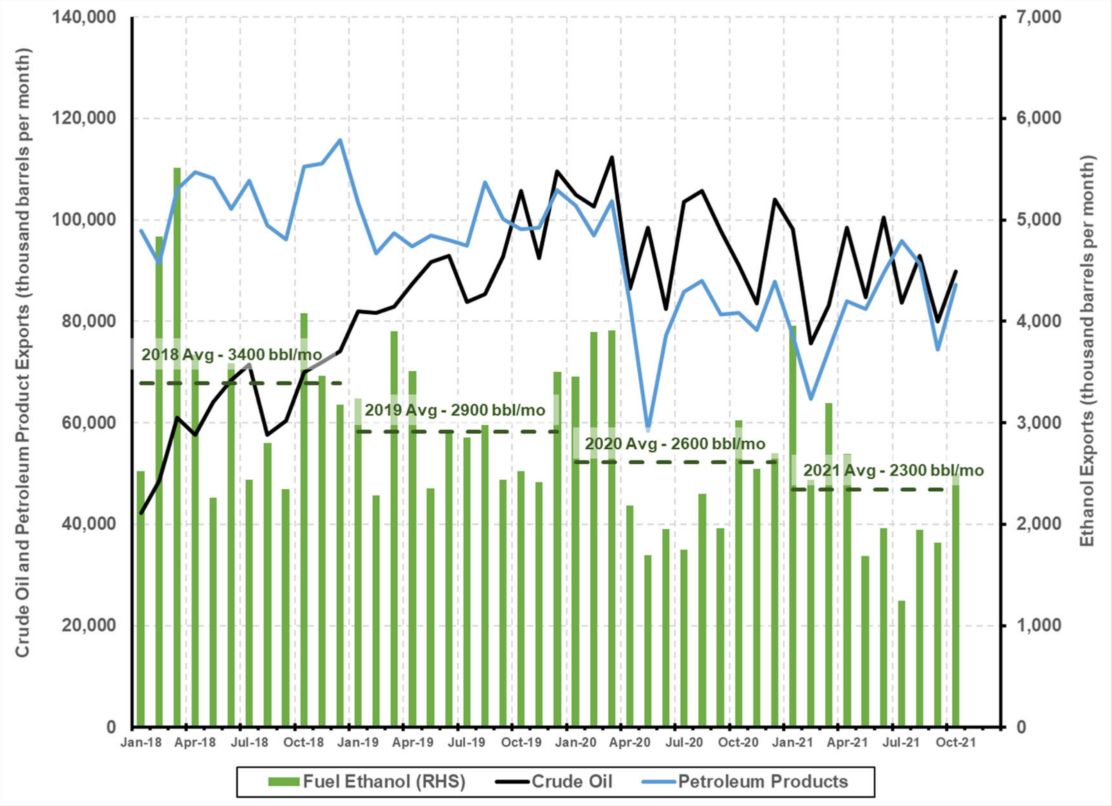
[58] The actual RFS obligation scales with annual gasoline and diesel demand each year. As discussed in Section 5 page 25 of this report, this regulatory scaling mechanism effectively eliminates any need for EPA to reduce the obligation volumes for 2020 as they currently propose.

[59] Based on current nameplate capacity of 17.5 billion gallons per year and the 95% sustained capacity utilization achieved in 2018 and 2019.

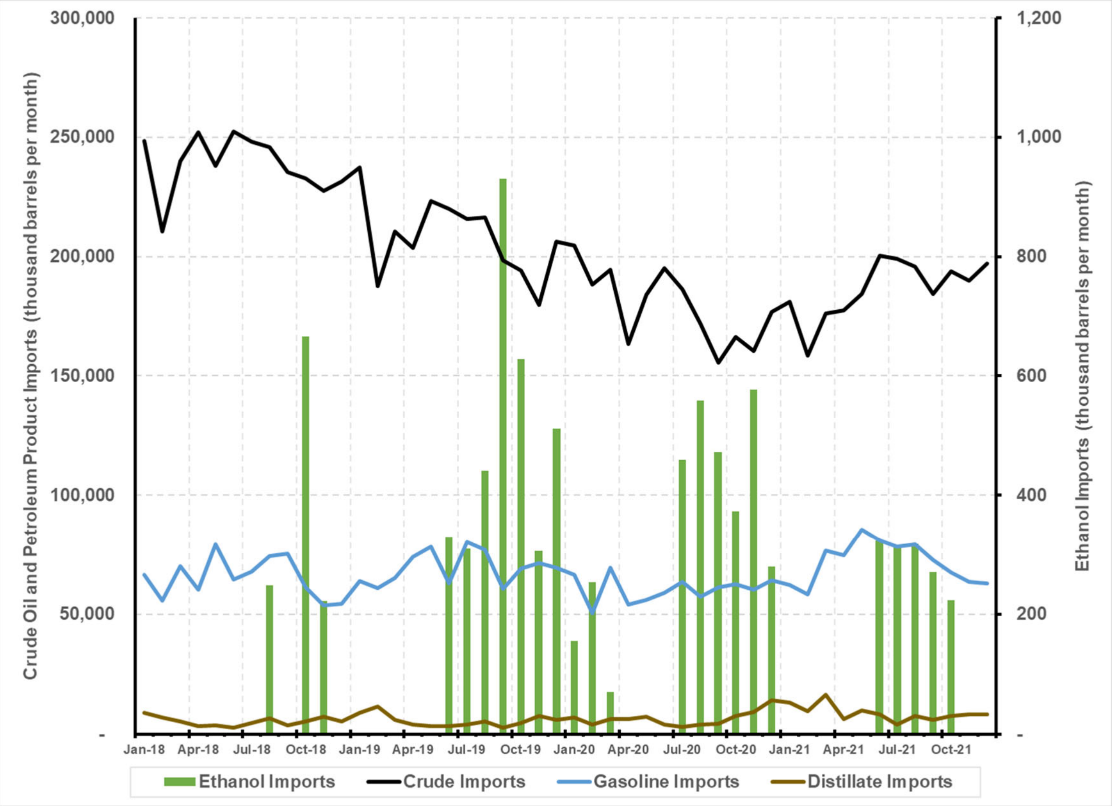
Figure 8. Monthly U.S. Exports of Crude Oil, Petroleum Products, and Ethanol (2018-2021)



***Source**: EIA, Stillwater analysis*

Looking at U.S. Imports, as shown in Figure 9 below, shows a somewhat different pattern than U.S. exports reviewed above. Crude oil imports are roughly double the amount of crude oil exports, with recent highs of 250 million barrels per month during the summer of 2028 followed by a gradual decline to a recent low of 155 million barrels in September 2021 because of growing U.S. production and exports and the loss in domestic demand with the pandemic. Since September 2021, crude imports have risen to recent levels near 200 million barrels per month. During this time period, U.S. gasoline and diesel imports have been relatively steady, averaging nearly 67 million barrels per month and 6.5 million barrels per month, respectively. U.S. ethanol imports during this time period have been small and irregular, comprised primarily of opportunistic imports of Brazilian sugarcane ethanol during Brazil's harvest season and directed primarily towards California's LCFS market where the low carbon intensity is highly valued. Over the time frame shown, ethanol imports averaged less than 0.2 million barrels per month.

Figure 9. Monthly U.S. Imports of Crude Oil, Gasoline, Diesel, and Ethanol (2018-2021)



Comparing exports and imports, the U.S. remains a large net importer of crude oil and a net exporter of petroleum products. The U.S. is also the world's largest ethanol exporter with net exports declining in recent years due to the combined effects of trade frictions with China and Brazil and the impacts of Covid-19. With the U.S. ethanol industry operating well below capacity, it has the capability of significantly increasing supply to U.S. and international markets if current regulatory and trade barriers were relaxed.

Based on the above analysis, increasing the implied RFS obligation for conventional biofuels would be expected to increase demand for domestic ethanol production. As U.S. ethanol plants are currently operating below demonstrated capacity, this increase can be accommodated without the need for the U.S. to reduce its current level of exports. As U.S. ethanol imports are currently small, opportunistic, and driven by LCFS value it is unlikely that increased RFS obligations would result in material increases of ethanol imports. With higher levels of ethanol in the U.S. gasoline pool, petroleum refineries would be expected to re-optimize between lower rate (reducing U.S. crude imports) and increased net exports of petroleum products (reducing crude demand in the rest of the world) depending on short-term market conditions. Regardless of how the U.S. refining industry were to re-optimize, global GHG emissions would be reduced.

6 EPA Cost Analysis of Ethanol Costs

In the RIA, EPA has projected an increased cost for ethanol in 2022.[60] Table 7.4-1 in the RIA projects a 3% increase in corn ethanol prices for 2022 and Table 7.5-1 sets the price increase at $0.14 per bbl of corn. Historically, the process of producing corn and ethanol have gotten more efficient each year. If this is coupled with a drop in gasoline demand and the resulting drop in demand for blending ethanol, it would be expected for corn and ethanol prices to drop slightly rather than increase as EPA is proposing.

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[60] Draft Regulatory Impact Analysis: RFS Annual Rules (EPA-420-D-21-002, December 2021), page 214