Assessment of Production and Consumption Capacity of Conventional Ethanol in 2023-2025

Prepared for

Growth Energy

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1 Assessment of Potential U.S. Corn Ethanol Production in 2022/2023 on Pre-RFS Acres

1.1 2023 Potential Ethanol Production

EIA lists the U.S. ethanol nameplate production capacity at 17.38 billion gallons per year as of January 1, 2022.[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 2023: historical maximum, previous year, and potential expansion.

The highest year of ethanol production was 2018, when 16.091 billion gallons of ethanol were produced domestically.[2] In 2021, it is estimated that 15.016 billion gallons of ethanol were produced.[3] We believe that both these figures represent conservative estimates of how much ethanol could reasonably be produced in 2023. 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, 16.147 billion gallons could be produced domestically in 2023.

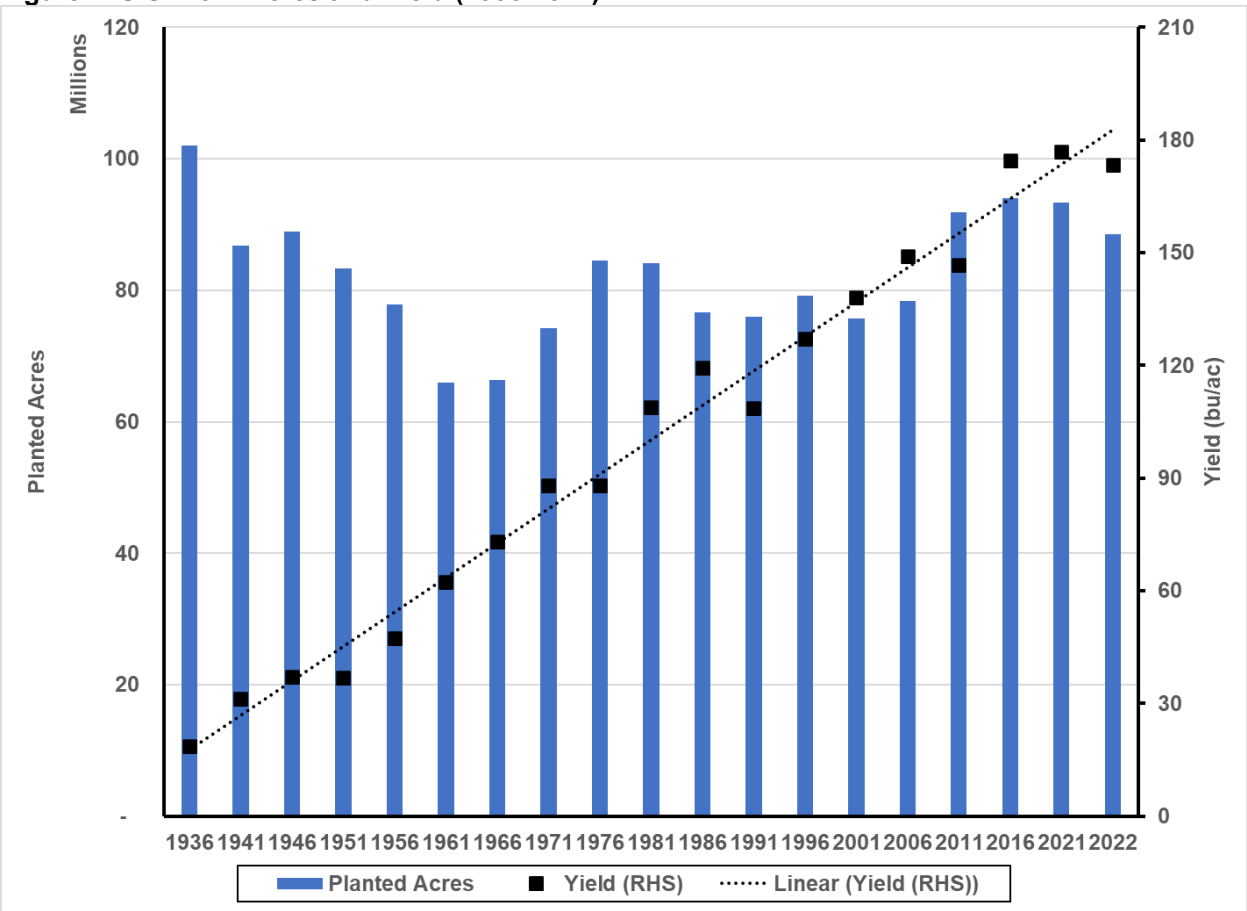
While the 16.147 billion gallons of ethanol for 2023 in Table 4 seems like an upper limit on ethanol production in 2023, it is in fact limited by the decision to keep the planted acres constant, the decision to keep the portion of corn used for ethanol constant, and the representation of new technology 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 Section 1.1.3 represent average conditions which can be increased or decreased by each farmer or ethanol production facility's market outlook. Indeed, corn yield rates and conversion efficiency have steadily increased over time.

1.1.1 Corn Supply

Review of U.S. corn production data through the Fall 2022 harvest shows that yields per harvested acre have continued their long-term growth trend. Figures 1 and 2 below illustrate 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 2022. The dashed red line in Figure 2 indicates the average annual corn plantings from 2008 through 2022 was 90.6 million acres; this is below the 93.5 million corn acres planted in 2007, the last crop planted prior to enactment of EISA 2007.

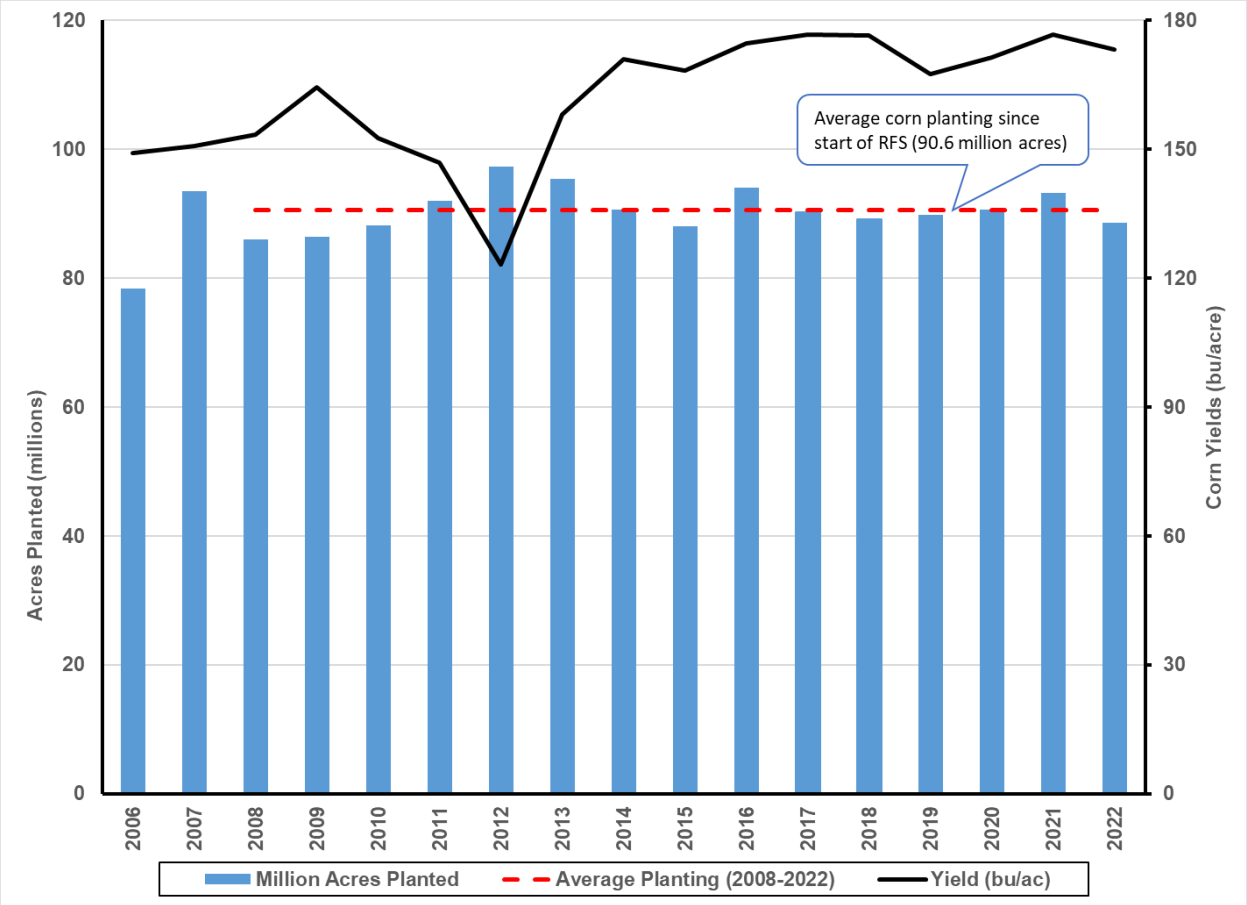
[1] https://www.eia.gov/petroleum/ethanolcapacity/index.php, U.S. Ethanol Plant Production Capacity
[2] https://www.eia.gov/dnav/pet/pet_pnp_oxy_dc_nus_mbbl_m.htm, Oxygenate Production
[3] *ibid.*
[4] USDA QuickStats, https://quickstats.nass.usda.gov/.

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)



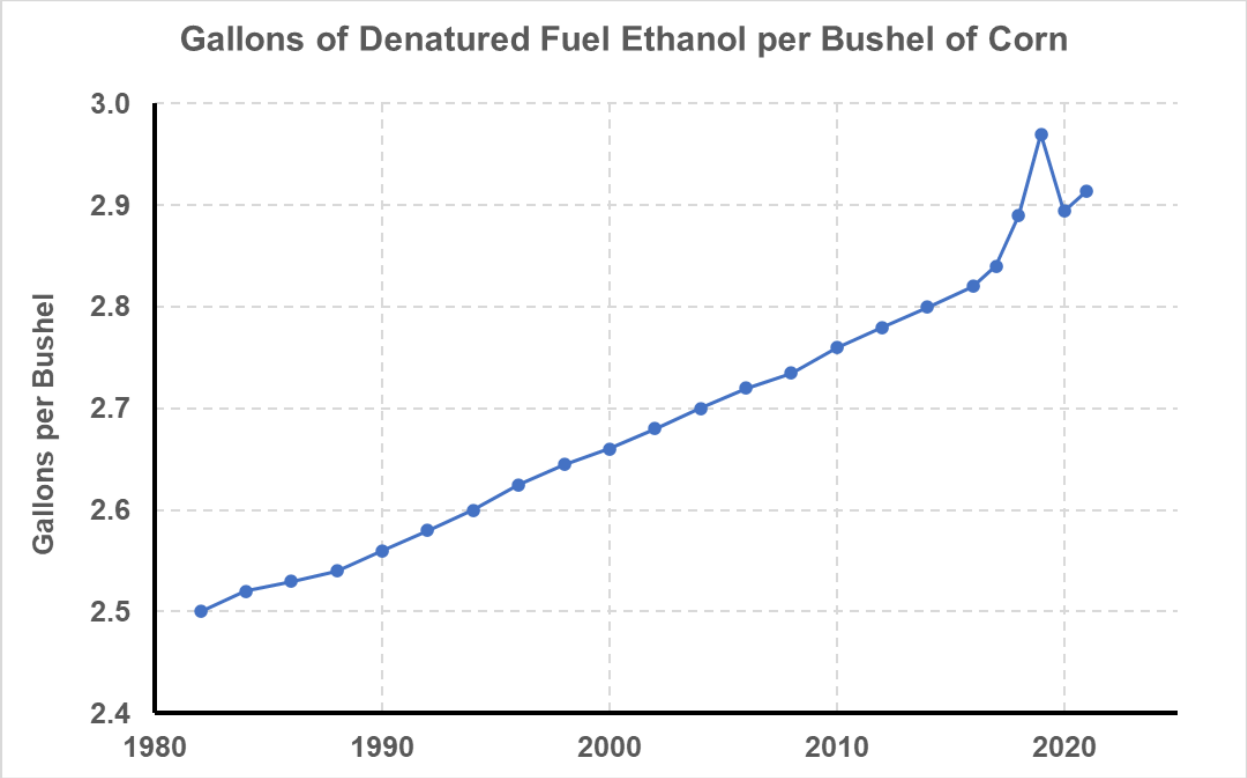
***Source**: USDA, Stillwater analysis*

Since 2008, U.S. corn yields have grown from 153.3 bushel per harvested acre ("bu/ac") to 173.3 bu/ac in 2022, an increase of 1.8 bu/ac each year. This is very close to but slightly faster than the 1.7 bu/ac each year in the 85 years since 1938. As corn yields in 2022 were adversely impacted by atypically hot and dry conditions for much of the growing season in the corn belt, we are basing our 2023 yield estimate on 2021's yield of 176.7 bu/ac plus the 1.8 bu/ac annual increases seen over the past ten years, or 178.5 bu/ac.

1.1.2 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 0.0106 gallons of denatured fuel ethanol (DFE) per bushel of corn each year from 1982 through 2021 and this rate has accelerated to nearly 0.0130 gallons of DFE per bushel of corn each year from 2006 through 2021. 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 0.0106 gallons per bushel per year since 1982) illustrated in Figure 3 allows us to estimate that the reported industry-average ethanol yield of 2.914 gallons of ethanol per bushel of corn in 2021 would increase to 2.925 gallons of ethanol per bushel in 2022 and 2.936 gallons per bushel in 2023. As a result, the 3,049 million bushels of corn which produced 9,309 million gallons of DFE in 2008 would yield 9,991 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

1.1.3 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 2023—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 2023, 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 issued in 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. Therefore, to be conservative, 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 2023. Applying the yield of 178.5 bu/ac, we estimate an achievable 2023 corn crop of 15,242 million bushels.

Then, to assess how much of that corn would be available for domestic use, we add corn imports (USDA estimates 50 million bushels for 2023) and subtract corn exports (using the same 2,437 million bushels exported in 2007/2008 per USDA). This is similar to the 2,471 million bushels which the U.S. is estimated to have exported in 2021/2022. Between 2007/08 and 2021/22 annual exports ranged from 730 to 2,747

[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.

million bushels per year, averaging 1,990 million bushels per year.[6] The net result is that the U.S. could have 12,855 million bushels of corn available for all domestic uses in 2023.

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.

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	178.5
Production (million bushels)	13,038	15,242
Corn Imports (million bushels)	20	50
Less Corn Exports (million bushels)	(2,437)	(2,437)
Available Corn Supply (million bushels)	10,621	12,855

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

For the purposes of this analysis, we will assume that growth in U.S. population, which is projected to be 11.7% from 2008 to 2023, can be used as a proxy for overall demand growth.[7] Annual data on U.S. population as reported by the U.S. Census Bureau[8] for 2007 through 2022 and estimated by the U.S. Census Bureau for 2023 is summarized in Table 2.

[6] In addition to available supplies, the largest factor which has impacted annual U.S. corn exports is demand from China. Chinese demand varies substantially from year-to-year in response to changes in the poultry and swine population in China and political relations between the U.S. and China.

[7] Other factors would include changing consumer dietary preferences (impacting feed demand for cattle, swine, and poultry), export market demand for U.S. produced meat (e.g., beef, pork, and poultry), and economic growth (impacting consumer demand for a wide range of products).

[8] https://www.census.gov/data-tools/demo/idb/#/table?menu=tableViz

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

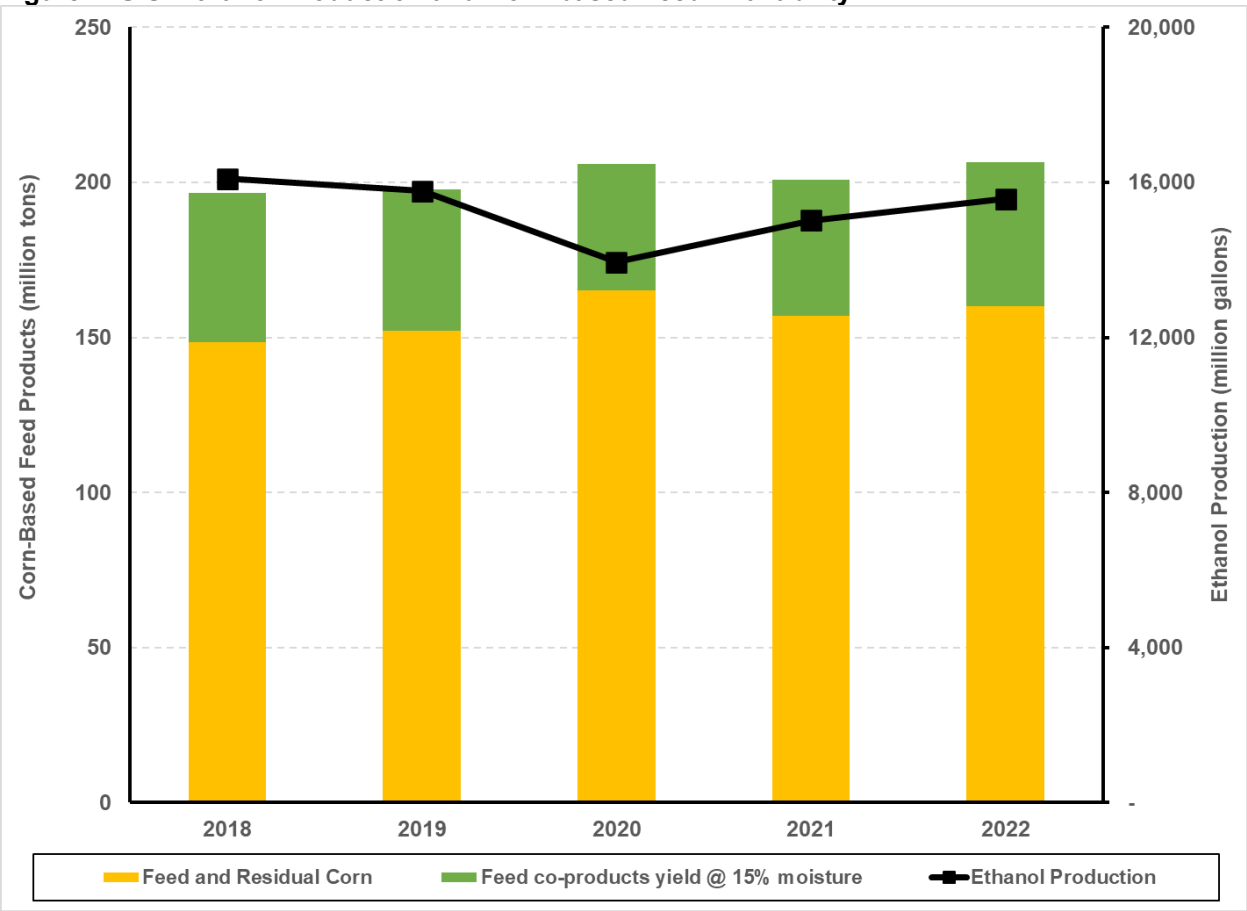
Year	Population as of December 31st
2007	301,231,207
2008	304,093,966
2009	306,771,529
2010	309,321,666
2011	311,556,874
2012	313,830,990
2013	315,993,715
2014	318,301,008
2015	320,635,163
2016	322,941,311
2017	324,985,539
2018	326,687,501
2019	328,239,523
2020	332,639,102
2021	334,998,398
2022	337,341,954
2023*	339,665,118
* Forecast	

***Source**: U.S. Census Bureau*

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[9] are contained in the co-products[10] which are highly valued as feed. Production data for these coproducts is available from USDA in their monthly Grain Crushings and Co-Products Production report and Annual Summary[11] with annual data released in March of the following year. Figure 4 below illustrates, for the most recent five 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 variation in ethanol production has no significant effect on feed availability.

[9] 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.
[10] These co-products include distillers' grains and syrup produced at dry mills and corn gluten meal and corn gluten feed produced at wet mills.
[11] https://usda.library.cornell.edu/concern/publications/v979v304g?locale=en

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.[12]

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 5, we have projected 12,855 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 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.[13]

Adjusting for population growth since 2007/08, the U.S. is estimated to demand 7,586 million bushels of Total Corn-based Feed in 2022/23. Allocating those 7,586 million bushels between corn and co-products

[12] E.g., DDGS and corn gluten meal.
[13] Based on an average yield of 17 pounds per bushel of corn used for ethanol production, corrected to 15% moisture content.

requires an iterative calculation based on 17.5 pounds of co-products per bushel of corn used in ethanol production and a projected ethanol yield of 2.936 gallons per bushel in 2022/23 based on extrapolation of the yearly industry yield trend since 1982. Using these yields, production of 16,147 million gallons of ethanol in 2022/23 would be expected to consume 5,500 million bushels of corn and produce 1,716 million bushels of Feed Co-Products. This leaves an estimated 5,870 million bushels of corn available for use as F&R. These 5,870 million bushels of corn for F&R plus the 1,716 million bushels of Feed Co-Products adds up to the 7,586 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	304,093,966	339,665,118
Corn Available for Domestic Use (million bushels)	10,621	12,855
Other FS&I (million bushels)	1,338	1,484
Corn Available for Feed and Ethanol (million bushels)	9,283	11,371
Feed and Residual (million bushels)	5,913	--
Estimated Feed Co-Products (million bushels)	926	--
Total Corn-based Feed (million bushels)	6,839	7,586
Estimated Feed Co-Products from 16.147 billion gallons of ethanol production		1,716
Required Corn to supply F&R Demand (million bushels)		5,870
Corn Available for ethanol production		5,500
Ethanol production at 2.936 gallons/bushel (billion gallons)		16.147

Source: USDA, Stillwater analysis

Table 4 below recaps the above allocation of corn volume in 2022/23 which produces 16.147 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.

Table 4. Summary of Corn Supply and Demand Calculations

Market Year	2007/08	Projected 2022/23
Corn Supply (million bushels)		
Corn Produced	13,038	15,242
Corn Imports	20	50
Corn Exports	(2,437)	(2,437)
Total Domestic Corn Supply	10,621	12,855
Corn Demand (million bushels)		
Feed and Residual	5,913	5,871
Food, Seed & Industrial	4,387	6,985
Ethanol for fuel	*3,049*	*5,500*
Other Food, Seed & Industrial	*1,338*	*1,484*
Total Domestic Corn Demand	10,300	12,855
Surplus/(Shortage)	321	--
Ethanol Production (billion gallons)	9.3	16.147
Ethanol Yield (gallons/bushel)	2.735	2.936
Feed Co-Products (million bushels)	926	1,716
Feed Co-Product Yield (pounds per bushel) @ 15% moisture	17	17.5

1.2 U.S. Ethanol Exports

The above discussion does not consider U.S. exports of fuel grade ethanol. Over the past decade, the U.S. ethanol industry surpassed Brazil as the world's largest ethanol exporter as U.S. production capacity has outpaced domestic demand and U.S. producers were able to use some of their surplus capacity to supply export markets. Because annual operating rates at U.S. ethanol plants peaked in 2018, it may be inferred that incremental exports of U.S. corn were more profitable than incremental exports of U.S. ethanol and co-products.

EIA reporting of U.S. fuel-grade ethanol exports did not begin until 2010.[14] As shown in Table 5, EIA reports that exports in 2010 were 398 million gallons, increased to an annual maximum of 1,710 million gallons in 2018 (the same year when U.S. ethanol production peaked), and declined to an estimated 1,410 million gallons in 2022.[15] The linkage between production and exports suggests that production for the domestic market is generally more profitable than exports and U.S. ethanol producers will increase operating rates above domestic demand only when that incremental production is profitable.

[14] https://www.eia.gov/dnav/pet/pet_move_exp_dc_NUS-Z00_mbbl_a.htm
[15] Stillwater estimate, EIA reports 1,279 million gallons through November 2022.

Table 5. U.S. Ethanol Exports

Year	Fuel Ethanol Exports (million gallons)
2010	398
2011	1195
2012	742
2013	619
2014	846
2015	832
2016	1170
2017	1390
2018	1710
2019	1467
2020	1317
2021	1242
2022 thru Nov, annualized	1410

1.3 Potential for Food Price Impacts

The analysis in Section 1.1 of this report identifies the maximum U.S. corn ethanol production which could be achieved without increasing corn or food prices beyond what was observed in 2007: 16.147 billion gallons. This was the last year prior to the December 2007 enactment of the Energy Independence and Security Act (EISA 2007) which established the current RFS program. Achieving 16.147 billion gallons would not increase corn or food prices because per acre yields of corn have grown steadily since 2007 as has the volume of ethanol which can be produced from each bushel of corn. Our computation of 16.147 billion gallons is based on growth achieved entirely through those developments.

The key to this analysis is to control the variables most closely connected to potential corn and food price impacts.

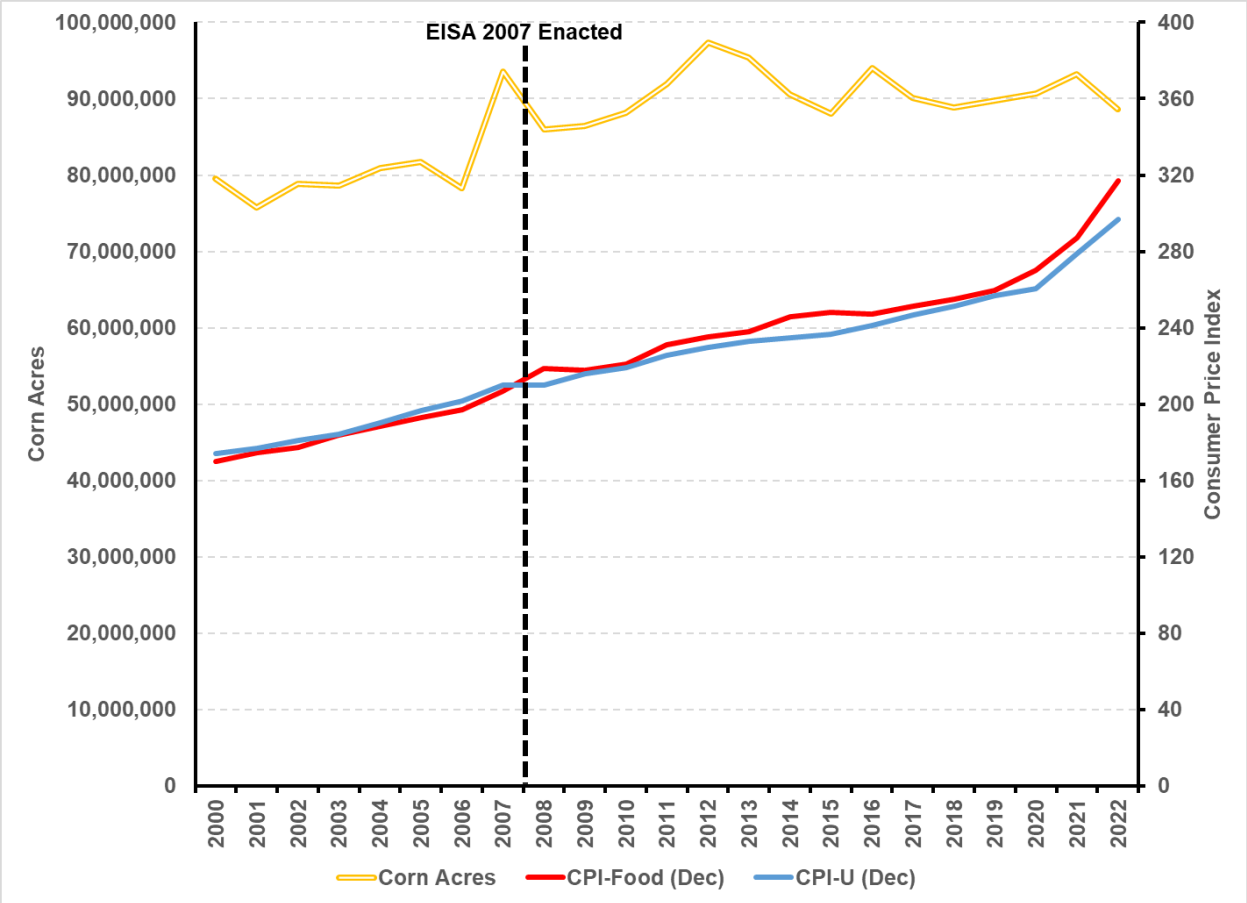
1. **Corn Acreage** – The distribution of U.S. farm acreage among different crops varies significantly from year to year due to global, national, and farmer-specific factors. This was true before the establishment of the RFS and remains the case today. Any increase in corn acres beyond what was planted in 2007 could reduce acres available to other crops (primarily soybeans and wheat) and thus risk increasing food or feed prices. Holding corn acres constant at 2007 levels, as was done in this analysis, avoids this risk.
2. **Non-ethanol use of corn** – Corn is a versatile crop which has long been used for a number of purposes in addition to ethanol. Livestock feed use is the largest of these non-ethanol uses. Additionally, corn starch, corn oil, and other portions of the corn kernel are used in a number of food and non-food products. Additionally, a small portion of the corn grown each year is required for use as seed. Estimating the evolution of demand for all of these uses is outside the scope of this analysis. In order to approximate the growth in demand for such non-ethanol products and in turn non-ethanol uses of corn, we assumed that the demand for them has grown since 2007 in proportion to U.S. population. Through that assumption, we ensure that the 16.147 bgal of ethanol production in 2023 can be achieved without reducing the supply of corn needed for non-ethanol uses and in turn ensure that producing 16.147 bg of ethanol would not raise prices for those uses, including food prices.
3. **U.S. Corn exports** – The U.S. is generally the world's largest exporter of corn; the actual amount exported each year, as discussed in Section 1.2, does vary significantly depending on the global economy, agricultural output in the rest of the world, and the status of U.S. trade relationships with potential corn importing nations. For this study, we held U.S. corn exports fixed at the same volume as reported by USDA for 2007. By doing so we eliminate any reduction of U.S. corn supplies to the

rest of the world as a potential contributor to global food price inflation and, therefore, a factor in any U.S. prices which are exposed to global markets.

In any event, market analysis strongly indicates that the RFS does not materially increase corn acreage or food prices. RFS demands for ethanol blending and the asserted increase in corn acreage to produce that ethanol has often been cited as a contributor to food price inflation in the U.S. market. To examine that relationship, we first look and historical data on U.S. corn acreage (as reported by USDA), U.S. ethanol production (as reported by EIA), and inflation metrics (as reported by the Bureau of Labor Statistics.)

Figure 5 below illustrates historical data on U.S. corn acres (yellow line), overall U.S. inflation[16] (blue line) and food price inflation[17] (red line). The time period of this analysis covers the years preceding enactment of EISA 2007 in December 2007 on through 2022. It may be observed that both overall inflation and food price inflation closely tracked each other at a steady rate from 2000 through 2020; both measures accelerated significantly in 2021 and 2022 as the economy recovered from the COVID-19 pandemic.[18] This occurred independent of corn acreage which ranged from a low of 75.7 million acres in 2001 to a high of 97.3 million acres in 2012 and ended the period at 88.6 million acres in 2022.

Figure 5. U.S. Corn Acres and Inflation



***Source**: USDA, Bureau of Labor Statistics, Stillwater analysis*

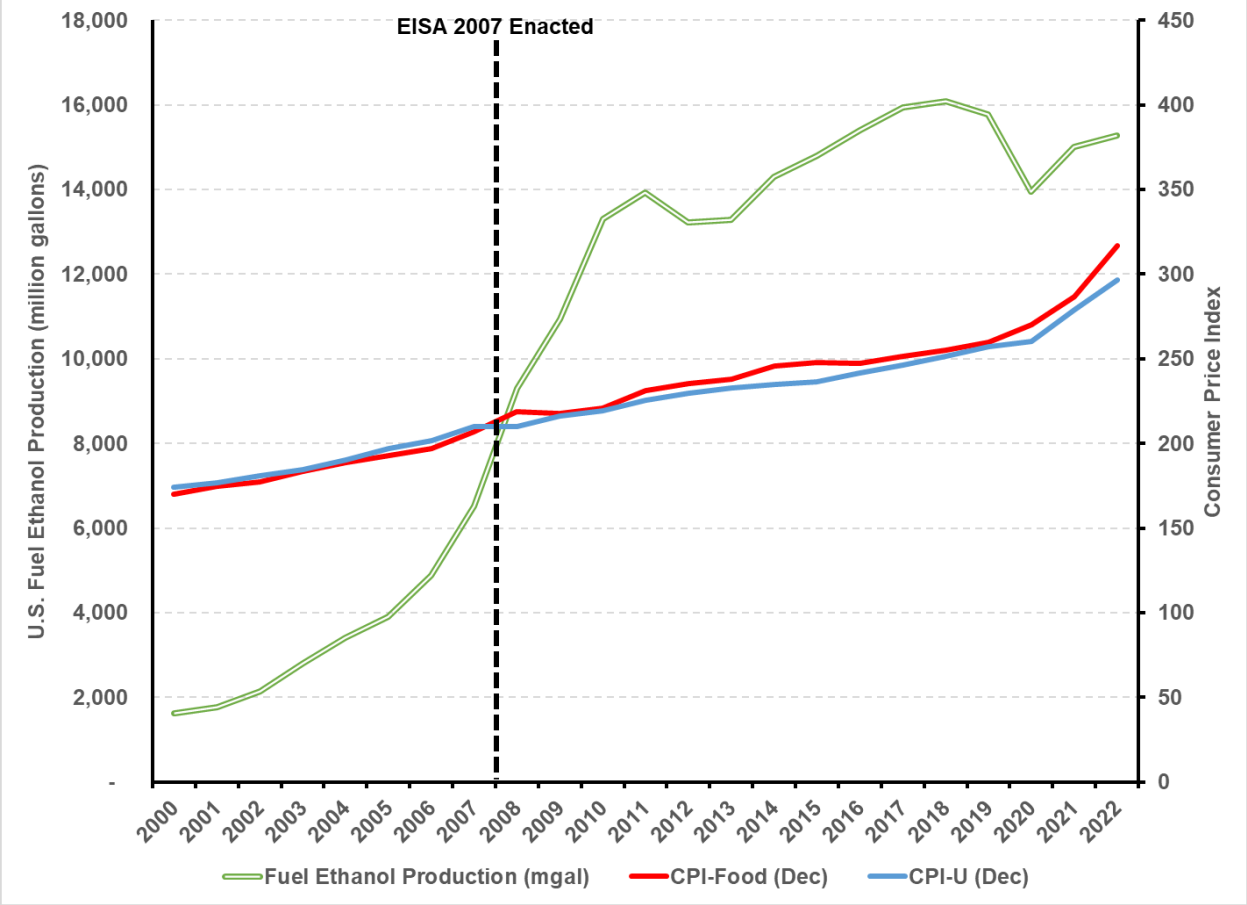
Figure 6 overlays the same inflation metrics with U.S. annual fuel ethanol production (green line, as reported by EIA). Over this time period, ethanol production increased rapidly from 1.6 billion gallons in 2000 to 13.9 billion gallons in 2011, increased more slowly to an all-time high of 16.1 billion gallons in 2018, and ended

[16] Consumer price index for all urban consumers (CPI-U)
[17] Food in U.S. city average, all urban consumers, not seasonally adjusted.
[18] Over the 2000 to 2022 time frame, food prices showed a 0.9955 correlation with overall inflation.

up at 15.3 billion gallons in 2022. As was the case compared to corn acres, food inflation shows no obvious linkage to ethanol production.

In summary, whether we look at corn acreage or ethanol production, there is no clear evidence that the RFS has been a primary driver of food price inflation in the U.S. Instead, we see that food prices have increased at a relatively steady pace since 2000; this includes years prior to enactment of the RFS, years when ethanol production was rapidly increasing, and years where ethanol production has remained fairly stable between 14 and 16 billion gallons per year. This is consistent with the fact that a great many inputs go into consumer food prices – this includes factors such as energy, labor, capital costs, regulatory compliance, changing

Figure 6. U.S. Ethanol Production and Inflation



Source: EIA, Bureau of Labor Statistics, Stillwater analysis

It was with this understanding of historical data that we structured the analysis presented in this report. We kept corn acreage fixed at the 93.5 million acres planted in 2007 levels as that was the last crop planted prior to the enactment of the current RFS regulations. Thus, our analysis does not rely on increasing corn planting in order to grow ethanol production. Further, we scaled all non-ethanol uses of corn with growth in U.S. population; this means that we have not diverted corn from other domestic demands in order to grow ethanol production. We held corn exports constant at 2007 levels to assure that corn was not diverted from international markets in order to grow ethanol production. What this analysis does take into account is the continuous improvement in the productivity of U.S. farmers and the steady increase in the conversion efficiency of U.S. ethanol plants. The combination of these two factors has allowed the amount of ethanol which can be produced from each acre of corn to steadily increase; these trends are not showing signs of slowing down; thus, we expect them to continue into, at least, the next several years.

2 Capacity of E15 and E85 Infrastructure

2.1 Station throughput

Reasonably achievable station throughput: In a prior report, Stillwater determined that a typical E15 station has an average of 3.3 dispensers per station[19] and a typical E85 station has an average of 1.8 dispensers per station[20]. Each dispenser is capable of handling a maximum of 45,000 gallons per month under ordinary conditions of use.[21]

2.2 Station count

Current station count: In its draft RIA, EPA estimates that there will be 3818 E15 stations and 4511 E85 stations online 2023, and that those counts will increase in 2025 to 5146 E15 stations and 4866 E85 stations.

Expansion of station count: In a prior report, Stillwater analyzed the cost of converting a station to be compatible with delivering E15 or E85.[22] Stillwater also determined that these costs would be markedly lower if the conversion occurred in the course of a station's ordinary upgrade cycle. As Stillwater's prior report explained, stations typically upgrade their pumps on average every 12 years and their USTs every 20 years.

2.3 Existing capacity to deliver E15 and E85

To estimate the capacity to deliver E15 and E85, we use EPA's estimates of current and future compatible stations and disregard the potential for additional station conversion in response to RFS-driven incentives. Further, we alternately use our own computation of the reasonably achievable per-station throughput. For each throughput assumption, we also compute the volume of incremental ethanol above E10. The results are shown in Table 6. Table 7 shows the results for EPA projected station volumes in 2025.

Table 6. E15 and E85 sales capacity using EPA projected stations for 2023

Gasoline Type	EPA Existing Stations	National Capacity with Stillwater bgy	Incremental Ethanol over Displaced E10, bgy
E15	3,818	6.8	0.34
E85	4,511	4.4	2.81

Table 7. E15 and E85 sales capacity using EPA projected stations for 2025

Gasoline Type	EPA Projected Stations	National Capacity with Stillwater bgy	Incremental Ethanol over Displaced E10, bgy
E15	5,146	9.2	0.46
E85	4,866	4.7	3.03

The large potential capacity for E15 and E85 sales shown in Table 6 and 7 lead to the conclusion that there is currently a large excess in station capacity to deliver E15 and E85 to the public. This means that in the near future, there is a zero cost for E15 or E85 infrastructure.

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

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

[21] ibid

[22] **Infrastructure Changes and Cost to Increase RFS Ethanol Volumes through Increased E15 and E85 Sales in 2016, August 27, 2015,** Prepared for Growth Energy by Stillwater Associates LLC, Table 4 and table 5.

2.4 Vehicle Impacts

The 6.8 bgy of E15 in 2023 can be used in any highway vehicle built since 2000 that is currently using E10. This volume would fill around 15.5[23] million current highway vehicles if they only used E15 throughout the year. For E85, which can only be used in FFVs, there are more than 21 million FFVs[24]. If the 4.4 bgy is used in FFVs which only use E85 for the whole year, it would fill 6.6 million FFVs.[25]

Thus, the vehicle capacity to consume E15 and E85 far exceeds all the E15 and E85 that could be reasonably delivered.

3 Estimate of the additional volume of E15 which can be used in RFG nationwide

There has been much confusion around the use of E15 during ozone season as EPA has attempted to extend the E10 RVP waiver to E15 and as courts have overridden that decision. However, since EPA has determined that RFG produced by blending 15% ethanol with RBOB designed for 10% ethanol meets all of the environmental requirements of RFG, the use of RFG with 15% ethanol should be allowable in all areas that require RFG. The exceptions to this are states where E15 is illegal due to state regulations. Table 8 below lists those states where E15 is illegal. When these states are removed from the list, there are twelve states where RFG can be produced with 15% ethanol. These are shown in Table 9. Many of these states have sales of conventional gasoline in counties that are in ozone attainment.

Table 8. States Where E15 is Illegal

States Where E15 is Illegal
California (E10 cap)[26]
Montana (E10 cap)

Table 9: States Where RFG can have 15% Ethanol

States Where RFG can have 15% Ethanol
Arizona
Connecticut
Delaware
DC
Illinois
Indiana
Maryland
Massachusetts
Missouri
New Hampshire
New Jersey
New York
Pennsylvania
Rhode Island
Texas
Virginia

The 2019 RFG data was used to calculate the projected RFG and ethanol volumes for these states in 2023. 2020 and 2021 RFG demand was influenced by the COVID-19 pandemic and final data for 2022 has not been published to date. The 2019 state percentages of the total RFG demand were calculated. These were then used to calculate the state RFG demands for 2023 assuming the AEO 2022 total gasoline consumption value of 139.783 bgy. These demands are displayed in Table 10. This shows that legal RFG with 15%

[23] 6.8 bgy/(12,500 mpy per vehicle/ 28.5 mpg) =15.5 million vehicles
[24] https://www.thompsonsales.com/should-you-purchase-a-new-vehicle-with-a-flex-fuel-engine/
[25] 4.4 bgy/12,500 mpy per vehicle/(28.5 mpg X .66 (energy adjustment)) = 6.6 million
[26] California has a requirement for a multimedia evaluation to be completed as part of the E15 approval process. This process is in progress.

ethanol could potentially total 43.29 bgy. This could provide an additional ethanol demand of 2.16 bgy (43.29 X 0.05). Similar calculations can be performed for 2024 and 2025 and these also result with the same additional ethanol demand of 2.16 bgy.

Table 10. State by state Potential RFG demand for E15

State	Percentage	2023 Projected RFG Demand	2024 Projected RFG Demand	2025 Projected RFG Demand
		BGY	BGY	BGY
Arizona	6.3%	8.79	8.78	8.76
Connecticut	1.1%	1.52	1.52	1.51
Delaware	1.2%	1.66	1.66	1.66
DC	0.1%	0.10	0.10	0.10
Illinois	3.1%	4.34	4.33	4.32
Indiana	0.3%	0.38	0.38	0.38
Maryland	1.8%	2.46	2.45	2.45
Massachusetts	1.9%	2.63	2.62	2.62
Missouri	1.5%	2.06	2.06	2.06
New Hampshire	0.5%	0.71	0.71	0.70
New Jersey	3.0%	4.23	4.23	4.22
New York	9.0%	12.58	12.56	12.53
Pennsylvania	0.9%	1.28	1.28	1.28
Rhode Island	1.1%	1.59	1.59	1.59
Texas	3.3%	4.65	4.65	4.64
Virginia	2.2%	3.10	3.09	3.08
Total	31.0%	43.29	43.23	43.13

This 2.16 bgy is a significant volume in a future ethanol space where the volume of ethanol used in E10 could be gradually decreasing. Since there are no prohibitions against 15% RFG in these states, this new market for ethanol is available in RFG stations that are compatible with E15. That means E15 compatible dispensers, piping, pumps, tanks, etc.