

ETHANOL CONSUMPTION BREAKS THROUGH THE “BLEND WALL” IN 2016



SUMMARY:

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Recent data from the U.S. Energy Information Administration (EIA) confirm that the so-called “blend wall”—the point at which ethanol makes up 10% of the U.S. gasoline supply—was exceeded nationwide for the first time ever in 2016. The data dispel the myth that 10% is the marketplace “limit” for ethanol content in U.S. gasoline, and demonstrate that the “blend wall” is not a real constraint on ethanol consumption.

Growing consumption of E15 (gasoline blends containing 15% ethanol), mid-level blends (containing 20-50% ethanol) and flex fuels (containing 51-83% ethanol) was responsible for the increase in the average ethanol content of U.S. gasoline in 2016. Based on EIA data and assumptions about the demand for ethanol-free gasoline (E0) from the American Petroleum Institute (API) and U.S. EPA, we estimate that consumption of mid-level blends and flex fuels was no less than 450 million gallons and as much as 1.7 billion gallons in 2016. Volumes at the high end of this range are based on API’s assumption that E0 consumption is approximately 5.3 billion gallons annually. A summary of key findings is provided below:

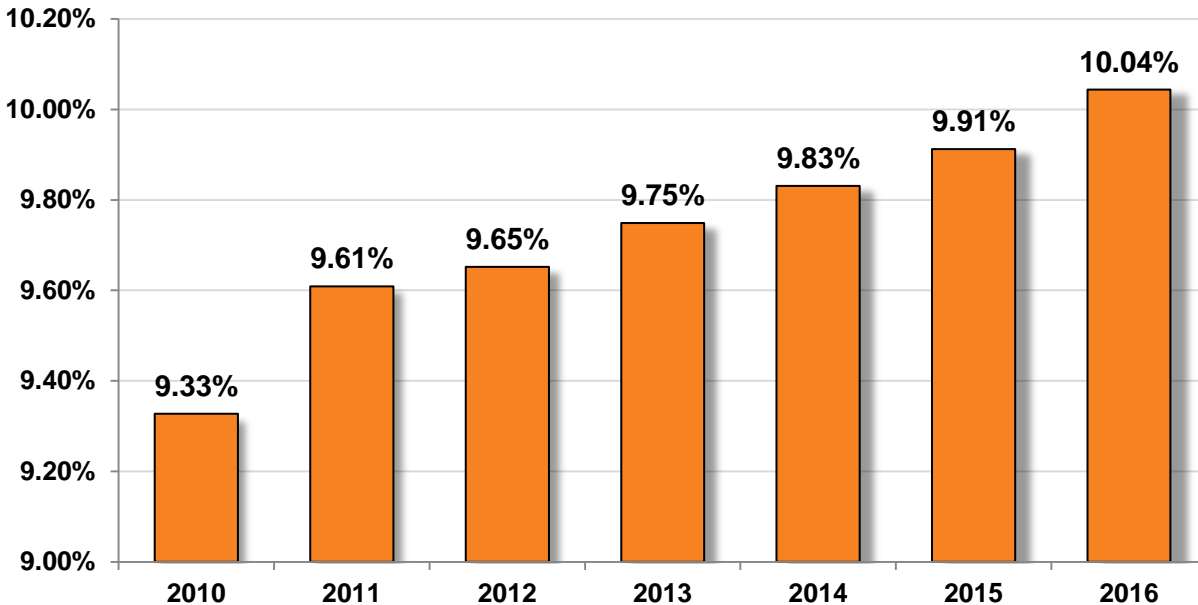
- Finished motor gasoline contained **10.04%** fuel ethanol on average in 2016, meaning nationwide ethanol consumption exceeded the so-called “blend wall” for the first time.
- National average ethanol content was 10.0% or higher in six of the last seven months of 2016, culminating with a record high monthly rate of **10.30%** in December.
- On a weekly basis, the ethanol blend rate surpassed 10.0% in 13 of the 20 weeks between Oct. 8, 2016, and Feb. 24, 2017, hitting a weekly record of **10.41%** in early January 2017.
- These data undermine the assertion by API and others that the gasoline market cannot accommodate more than 9.7% ethanol due to purported infrastructure and vehicle constraints. April 2015 was the last time average ethanol content was *below* 9.7%.
- Using the most conservative assumptions, EIA data imply that **447 million gallons** of mid-level blends and flex fuels (containing 313 million gals. of ethanol) were consumed in 2016.
- However, if API’s assumptions about E0 demand are used, then consumption of mid-level blends and flex fuels was **1.2 to 1.7 billion gallons** (843 mil. to 1.17 bil. gals. of ethanol).
- Logically, as the assumed volume of E0 sales is increased, the amount of ethanol consumed in E10 falls, but the amount of ethanol consumed in E15, mid-level blends, and flex fuels rises significantly.
- The EIA data demonstrate that the supposed “blend wall” is not a real constraint on ethanol consumption in the United States. The data further underscore that statutory Renewable Fuel Standard (RFS) blending obligations in excess of the 10.0% level can be readily satisfied by the marketplace.

ETHANOL CONSUMPTION BREAKS THROUGH THE “BLEND WALL” IN 2016

Gasoline consumed in the United States contained more than 10.0% ethanol on average in 2016, meaning the so-called “blend wall”—the point at which ethanol makes up 10% of the gasoline supply—was exceeded nationwide for the first time ever.

Data from the Energy Information Administration (EIA) show that U.S. fuel ethanol consumption was 14,399,140,000 gallons in 2016, while 143,367,042,000 gallons of finished motor gasoline were supplied to the U.S. market.¹ Thus, finished motor gasoline contained 10.04% fuel ethanol on average (Figure 1). These data demonstrate that the supposed “blend wall” is not a real constraint on ethanol consumption in the United States. Further, the EIA data underscore that statutory Renewable Fuel Standard (RFS) blending obligations in excess of the 10% level can in fact be satisfied by obligated parties.

Figure 1.
Annual U.S. Average Ethanol Content of Finished Gasoline, 2010-2016



Source: U.S. EIA

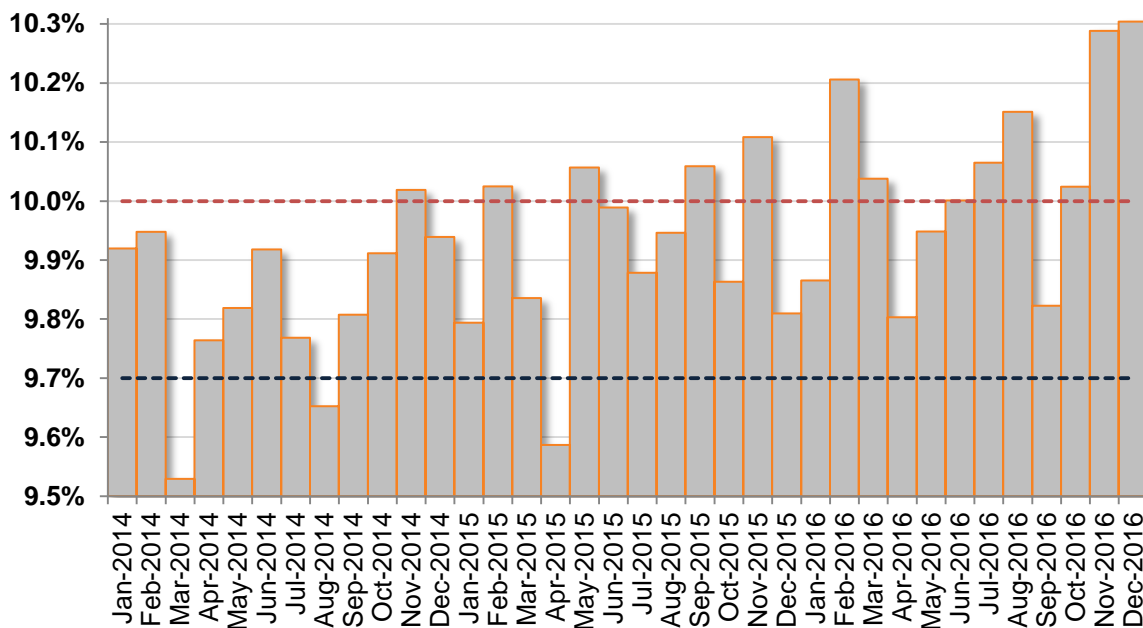
Nearly all of the gasoline consumed in the United States last year contained 10% ethanol by volume (E10). However, a small volume of ethanol-free gasoline (E0) was consumed as well. Thus, the average blend rate of 10.04% implies increased consumption of blends containing 15% ethanol (E15), “mid-level” blends containing 20-50% ethanol (e.g., E20 or E30), and flex fuels containing 51-83% ethanol (often colloquially called “E85”).

¹ U.S. Energy Information Administration (EIA). “Petroleum Supply Monthly: U.S. Product Supplied of Finished Motor Gasoline.” (<https://www.eia.gov/dnav/pet/hist/LeafHandler.ashx?n=p&s=mgfupus1&f=a>) (According to EIA, “product supplied...represents consumption of petroleum products because it measures the disappearance of these products from primary sources (emphasis added).”); and “Monthly Energy Review: Renewable energy: Table 10.3 Fuel Ethanol Overview.” (<https://www.eia.gov/totalenergy/data/monthly/>)

While half of the 50 states had already surpassed the 10.0% ethanol concentration level in 2015 due to broader use of E15, mid-level blends and ethanol flex fuels², 2016 marks the first time that the national average for ethanol content in gasoline exceeded 10.0%.

On a monthly basis, national average ethanol content trended higher throughout 2016. Ethanol content was 10.0% or higher in six of the last seven months of 2016, culminating with a record high monthly rate of 10.30% in December (Figure 2). Further, weekly EIA data (which tend to underestimate actual ethanol blending and consumption when later compared to EIA monthly data) show the average ethanol blend rate exceeded 10.0% in 13 of the 20 weeks between October 8, 2016, and February 24, 2017. The weekly ethanol blend rate hit a record high of 10.41% in early January. These data from EIA undermine the assertion by the American Petroleum Institute (API) and others that the gasoline market cannot exceed 9.7% denatured fuel ethanol content due to purported infrastructure and vehicle constraints.³ In reality, April 2015 was the last month in which the national average for ethanol content was *below* 9.7%. In the 20 months since, the ethanol content of finished gasoline has averaged 10.01% nationally.

Figure 2.
Monthly U.S. Average Ethanol Content of Finished Gasoline



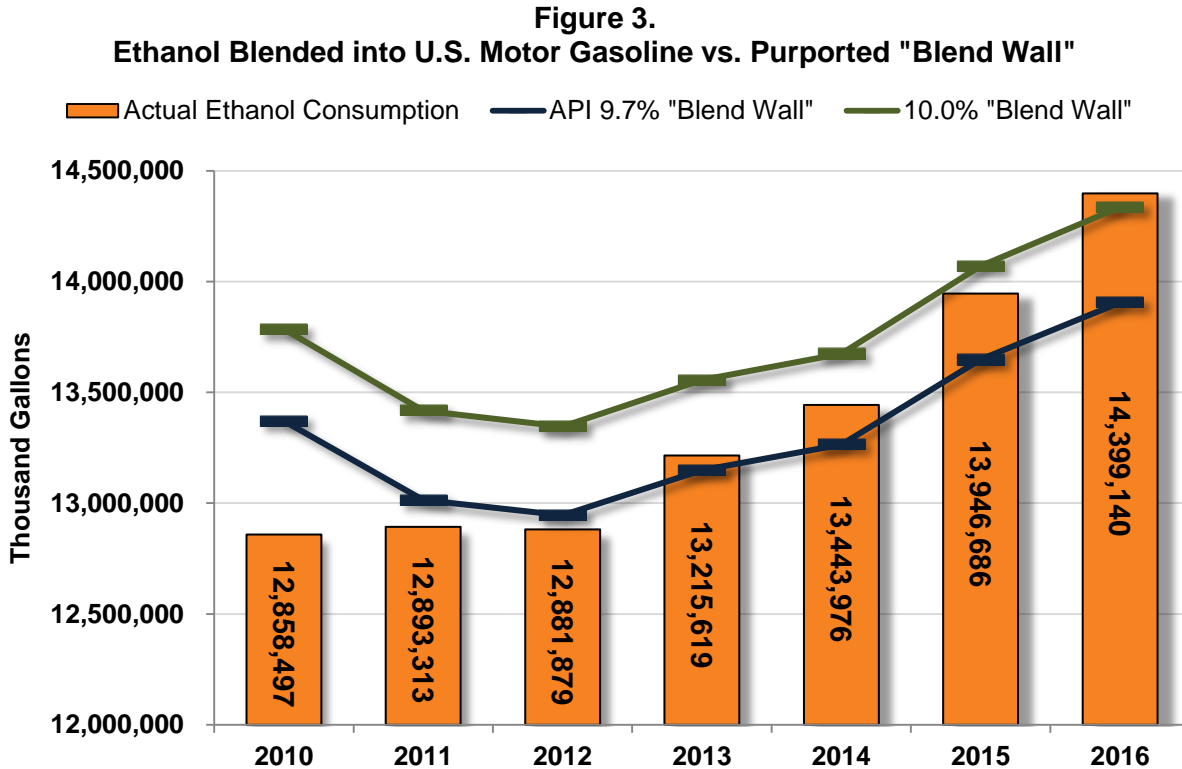
Source: U.S. EIA

The difference between ethanol concentration rates of 9.7% and 10.04% might at first seem trivial. But across billions of gallons of gasoline, the seemingly modest increase in the ethanol blend rate is actually quite significant. For example, if the gasoline market were truly limited to a

² RFA. "DOE Data: Half of United States Broke Through So-Called 'Blend Wall' in 2015." Dec. 13, 2016. (<http://www.ethanolrfa.org/2016/12/doe-data-half-of-united-states-broke-through-so-called-blend-wall-in-2015/>)

³ See, for example, Comment submitted by Frank J. Macchiarola, Group Director, Downstream and Industry Operations, American Petroleum Institute (API). July 11, 2016. (<https://www.regulations.gov/document?D=EPA-HQ-OAR-2016-0004-3512>)

maximum of 9.7% ethanol, total ethanol blending in 2016 would have been nearly 500,000,000 gallons lower. This is roughly equivalent to the annual output of six average-sized fuel ethanol plants. Due to incremental growth in both total gasoline demand and the ethanol blend rate, total U.S. ethanol blending in 2016 was more than 1,500,000,000 gallons higher (12%) than just five years earlier in 2012 (Figure 3).



Source: U.S. EIA

HOW MUCH ETHANOL WAS CONSUMED IN BLENDS ABOVE E10 IN 2016?

While a simple examination of U.S. ethanol and finished gasoline consumption data reveals the average ethanol content across the entire gasoline pool, it does not readily uncover the volume of ethanol consumed in blends other than E10. Some volume of gasoline contained no ethanol at all (E0), while other volumes contained significantly more than the average concentration (e.g., flex fuels like E70 or E85). The EIA data sets do not reveal the volume of E0 supplied to the retail market, nor do they show how much ethanol was specifically consumed in E10 blends versus higher-level blends (e.g., E15 and flex fuels). However, we are able to approximate the volume of ethanol consumed in mid-level blends and flex fuels based on various publicly available estimates of E0 consumption.

By subtracting total fuel ethanol consumption from total finished motor gasoline supplied, we are able to derive the total amount of “unblended” gasoline and gasoline blendstock consumed in 2016, which was 128,967,902,000 gallons. Some of this gasoline volume was indeed consumed at retail as E0, but most of it was blended with 10% ethanol before being distributed to retail

stations and sold to consumers. Based on the EIA data, we know a total of 14,399,140,000 gallons of fuel ethanol were blended with gasoline. Thus, making certain assumptions about E0 retail consumption allows us to estimate how much ethanol was consumed both in E10 blends as well as higher-level ethanol blends.

The amount of assumed E0 consumption significantly affects the implied volume of ethanol consumed in mid-level blends and flex fuels. That is, if it is assumed that a very small volume of E0 is consumed at retail (e.g., 0.5% of total gasoline consumption), then the amount of ethanol consumed in E10 blends will be larger, and the implied volume of ethanol consumed in mid-level blends and flex fuels will be relatively modest. Conversely, if it is assumed that a relatively large volume of E0 is consumed (e.g., 3.5% of total gasoline consumption), then E10 consumption will be lower, but the volume of ethanol consumed in mid-level blends and flex fuels will be much higher.

Estimates of E0 consumption vary widely. The U.S. Environmental Protection Agency's (EPA) most recent estimate for E0 consumption was 700,000,000 gallons in 2015⁴, while the API asserts that E0 consumption in 2015 was 5,300,000,000 gallons.⁵ For the reasons stated by EPA in response to API's comments on the 2014-2016 RFS proposal, we believe EPA's estimate is far more credible than API's estimate.⁶ However, both estimates are used in this analysis as bounds for the range of E0 consumption, and to illustrate the importance of this assumption.

Further, to derive an estimate of the amount of ethanol consumed in mid-level blends and flex fuels, assumptions must be made regarding the actual ethanol content of E10 blends. The API states that E10 blenders "...blend slightly less than 10 percent [ethanol] to address measurement inaccuracies and avoid compliance issues."⁷ API suggests that blenders target 9.7% ethanol for E10 blends, though we believe the actual average ethanol content of E10 is likely closer to 9.9% ethanol. Again, we use both values as bounds for the range of actual ethanol content in E10.

Other Assumptions

Estimating the volume of ethanol consumed in mid-level blends and flex fuels in 2016 requires certain other assumptions to be made. Specifically, the volume of E15 sold and the average ethanol content of mid-level blends and flex fuels (grouped together in this analysis as E20-E85) must be estimated.

E15: Relatively small, but growing, volumes of E15 were consumed in 2016. Based on our knowledge of the number of stations selling E15 in 2016 and typical sales volumes per station, we estimate that a total of approximately 90,000,000 gallons of E15 were sold. Based on

⁴ 81 Fed. Reg. 89776 (Dec. 12, 2016)

⁵ Comment submitted by Frank J. Macchiarola, Group Director, Downstream and Industry Operations, American Petroleum Institute (API). July 11, 2016. (<https://www.regulations.gov/document?D=EPA-HQ-OAR-2016-0004-3512>)

⁶ 80 Fed. Reg. 77462 (Dec. 14, 2015)

⁷ Comment submitted by API and American Fuel & Petrochemical Manufacturers (AFPM). Re: Renewable Fuel Standard Program: Standards for 2014, 2015, and 2016 and Biomass- Based Diesel Volume for 2017. July 27, 2015. [https://www.afpm.org/uploadedFiles/Content/Policy_Positions/Agency_Comments/API%20AFPM%20RFS%20Comm](https://www.afpm.org/uploadedFiles/Content/Policy_Positions/Agency_Comments/API%20AFPM%20RFS%20Comments%20July%202015.pdf)

information provided by blenders and retailers, we further assume the actual average denatured ethanol content of E15 was 14.5%. Because the volume of E15 consumed was relatively small in 2016, varying these assumptions does not significantly change the resultant estimate of the amount of ethanol consumed above the E10 “blend wall.” That is, if the actual amount of ethanol consumed in E15 blends was lower than we estimated here, then actual ethanol consumption in mid-level and flex fuel blends will be marginally higher than we estimated. Conversely, if actual E15 consumption was higher than estimated, then actual consumption of mid-level and flex fuel blends was marginally lower than estimated.

Mid-Level Blends and Flex Fuels: Small volumes of mid-level ethanol blends like E20, E30, and E40 are also being sold commercially, while larger volumes of ethanol flex fuels (defined by ASTM International as blends containing between 51-83% ethanol for use in flex fuel vehicles) are also being sold at more than 3,700 stations nationwide. For the purposes of this analysis, we assume the volume-weighted average denatured ethanol content of E20-E85 blends sold in 2016 was 70%.⁸

Scenarios

To determine the potential volume of ethanol sold in blends other than E10 in 2016, we examined four scenarios where two variables were altered: 1) the actual average ethanol content in E10, and 2) the volume of E0 sold at retail. Using these assumptions, a simple equation was used to solve E20-E85 consumption (average 70% ethanol) based on known EIA values for gasoline blendstock consumption, fuel ethanol consumption, and total finished motor gasoline. That is, the sum of gasoline blendstock and fuel ethanol volumes for E10, E0, E15, and E20-E85 blends under all scenarios must equal the totals from EIA.

Scenario A: E10 actual ethanol content = 9.9% (RFA) E0 consumption = 700 mg (EPA)	Scenario B: E10 actual ethanol content = 9.9% (RFA) E0 consumption = 5,300 mg (API)
Scenario C: E10 actual ethanol content = 9.7% (API) E0 consumption = 700 mg (EPA)	Scenario D: E10 actual ethanol content = 9.7% (API) E0 consumption = 5,300 mg (API)

Results

When the most conservative assumptions are used regarding E0 consumption and the actual ethanol content of E10 (Scenario A), the data suggest nearly 450,000,000 gallons of E20-E85 (with an average ethanol content of 70%) were consumed in 2016. On the other hand, when API’s assumptions are used regarding E0 consumption and E10 ethanol content (Scenario D), the level of E20-E85 consumption needed to solve the equation rises to more than 1,600,000,000 gallons in 2016. This is logical because if E0 consumption is relatively large, as argued by API, then less gasoline blendstock is available to blend with the known volume of fuel ethanol that was consumed, necessitating larger volumes of mid-level blends and flex fuels. The

⁸ This assumption is based on the volume-weighted average ethanol content of mid-level blend (E20, E30, E40, E50) and E85 (70% ethanol October-April, 83% ethanol May-September) sales volumes reported by the Minnesota Department of Commerce for 2016.(<http://mn.gov/commerce-stat/pdfs/e85-fuel-use-2016.pdf>)

actual volume of mid-level blends and flex fuels consumed in 2016 is likely somewhere in between the lowest and highest volumes resulting from these four scenarios.

Scenario A

	Gasoline Blendstock (gals.)	Fuel Ethanol (gals.)	Total Volume (gals.)	% Ethanol
E10	128,056,949,000	14,073,459,000	142,130,408,000	9.90%
E0	700,000,000	-	700,000,000	0.00%
E15	76,953,000	13,047,000	90,000,000	14.50%
E20-E85	134,000,000	312,634,000	446,634,000	70.00%
Total	128,967,902,000	14,399,140,000	143,367,042,000	10.04%

Scenario B

	Gasoline Blendstock (gals.)	Fuel Ethanol (gals.)	Total Volume (gals.)	% Ethanol
E10	123,229,549,000	13,542,927,000	136,772,476,000	9.90%
E0	5,300,000,000	-	5,300,000,000	0.00%
E15	76,953,000	13,047,000	90,000,000	14.50%
E20-E85	361,400,000	843,165,000	1,204,565,000	70.00%
	128,967,902,000	14,399,140,000	143,367,042,000	10.04%

Scenario C

	Gasoline Blendstock (gals.)	Fuel Ethanol (gals.)	Total Volume (gals.)	% Ethanol
E10	127,913,149,000	13,737,872,000	141,651,021,000	9.70%
E0	700,000,000	-	700,000,000	0.00%
E15	76,953,000	13,047,000	90,000,000	14.50%
E20-E85	277,800,000	648,220,000	926,020,000	70.00%
Total	128,967,902,000	14,399,140,000	143,367,042,000	10.04%

Scenario D

	Gasoline Blendstock (gals.)	Fuel Ethanol (gals.)	Total Volume (gals.)	% Ethanol
E10	123,091,249,000	13,220,000,000	136,311,249,000	9.70%
E0	5,300,000,000	-	5,300,000,000	0.00%
E15	76,953,000	13,047,000	90,000,000	14.50%
E20-E85	499,700,000	1,166,092,000	1,665,792,000	70.00%
Total	128,967,902,000	14,399,140,000	143,367,042,000	10.04%

CONCLUSION

Recent data from EIA confirm that the so-called “blend wall” has been exceeded nationwide for the first time ever. The data dispel the myth that 10% is the marketplace “limit” for ethanol content in U.S. gasoline, and demonstrate that the “blend wall” is not a real constraint to future ethanol consumption. Based on known volumes of finished gasoline consumption and fuel ethanol consumption, and assumed volumes of E0 and E15 consumption, we were able to consumption of mid-level blends and flex fuels in 2016. When the most conservative assumptions are used, the data suggest nearly 450 million gallons of E20-E85 (with an average ethanol content of 70%) were consumed in 2016. On the other hand, when API’s assumptions are used, the level of E20-E85 consumption rises to more than 1.6 billion gallons in 2016. Regardless of the E0 assumptions used, the EIA data underscore that statutory Renewable Fuel Standard blending obligations in excess of the 10% level can be readily accommodated by the marketplace.