Renewable Identification Numbers

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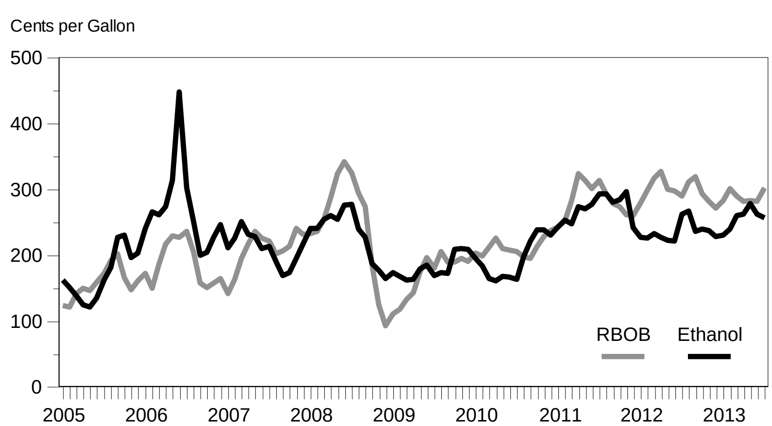
Ethanol has been blended into gasoline for years. It has a higher octane rating (113) than the regular-grade gasoline (87) marketed in the United States. This allows the base gasoline feedstock produced by refiners for blending, called RBOB (Reformulated Blendstock for Oxygenated Blending) or CBOB (Conventional Blendstock for Oxygenated Blending) to have a lower octane, which reduces the blendstock production cost.

On the other hand, adding large amounts of ethanol to gasoline cuts vehicle miles per tank because ethanol has less energy per gallon than petroleum-based gasoline feedstocks.

Today, companies have every incentive to blend as much ethanol into gasoline as possible because the ethanol price is lower than the gasoline price. Other things being equal, some refiners would blend gasoline containing fifteen or twenty percent ethanol if they could.

Figure 1
Spot RBOB and Ethanol Prices in the NY Harbor Barge Market, Monthly Data, 2005-2013



Source: Platts; Argus Media.

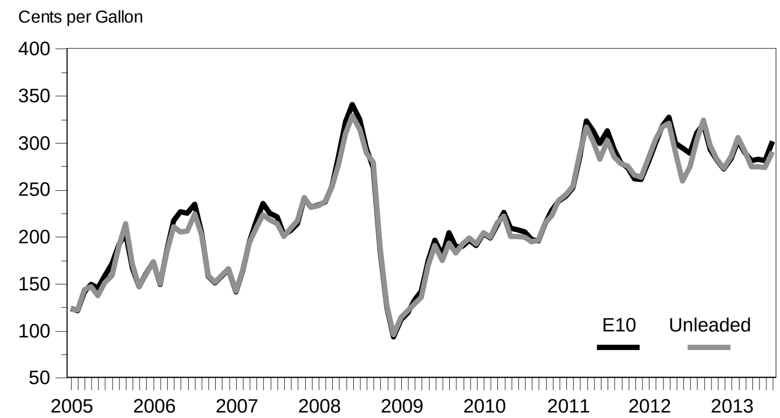


Figure 2
Unleaded Spot Gasoline Price vs. Computed E10 Price in NY Harbor Barge Market, Monthly Data, 2005-2013

Source: Platts; Argus Media; PKVerleger LLC.

By convention, gasoline that is ten-percent ethanol is referred to as E10 while gasoline with twenty-percent ethanol is called E20. E85 is a blend of eighty-five percent ethanol and fifteen-percent petroleum feedstock.

Technical issues with vehicles and distribution make marketing a wide variety of gasoline-ethanol blends difficult.

For example, most automobiles have been engineered to use a gasoline blend with limited ethanol. Some older models can accommodate gasoline containing no more than ten-percent ethanol. Other new vehicles can operate with higher percentages.

A limited number of cars and trucks, the so-called “flex-fuel” vehicles, can operate with blends containing as much as eighty-five percent ethanol. These vehicles get twenty-percent fewer miles per tank when operated with E85 instead of E10.

According to the Renewable Fuels Association (RFA), fifteen million flex-fuel vehicles are on the road today. RFA bases this estimate on information from auto manufacturers and states. The Energy Information Administration (EIA) puts forward a lower number but provides little support for its calculation.

Table 1. Flex-Fuel Vehicles in the United States by Year of Sale

Year	Number of Flex-Fuel Vehicles
1998	216,165
1999	426,724
2000	600,832
2001	581,774
2002	834,976
2003	859,261
2004	674,678
2005	743,948
2006	1,011,399
2007	1,115,069
2008	1,175,345
2009	805,777
2010	1,484,945
2011	2,116,273
2012	2,466,743

Source: RFA.

Some internal combustion engines require gasoline with no ethanol. These engines are used, for example, in recreational motor boats, in some lawnmowers and snow blowers, and in other small engine equipment.

A second technical issue relates to the distribution system (pumps) used to transfer any grade of gasoline from underground tanks to vehicles. Obviously, gasoline is flammable and hazardous. Consequently, local and national safety regulatory bodies have established design standards for fueling stations in general and the specific equipment used to deliver the product from storage tank to vehicle tank.

Many of the tanks, pipes, and pumps at stations today are not certified for handling products with ethanol content higher than ten percent. Ethanol tends to corrode rubber seals. Thus, special fittings must be used in E85 distribution systems.

The Energy Independence and Security Act of 2007 (EISA)

Ethanol became an issue following passage of the Energy Policy Act of 2005 (EPAct). That legislation required 7.5 billion gallons to be blended into US gasoline supply by 2012.

After President Bush's 2007 State of the Union message, Congress extended the renewables mandate with EISA, which increased the amount of ethanol and other biofuels that must be blended into the motor fuels pool. The act also expanded the renewables requirement to cover diesel fuel used for transportation and off-road activities such as agriculture. After EISA, truckers, farmers, construction companies, and even railroads joined motorists driving gasoline-powered vehicles under the mandate's purview.

In passing this legislation, Congress also directed that the US motor fuel mix contain increasing volumes of advanced biofuels such as cellulosic ethanol. Table 2 presents the required amounts.

Table 2. EISA 2007 Renewable Fuel Standard Volume Requirements (Billion Gallons)

Year	RFS1 Biofuel Mandate in EPAct of 2005	RFS 2 Total Renewable Fuels	RFS 2 Cap on Cornstarch-Derived Ethanol	Portion from Advanced Biofuels: RFS2 Total Non-Cornstarch	RFS2 Cellulosic	RFS2 Biomass-based Diesel	RFS2 Other
2006	4.0						
2007	4.7						
2008	5.4	9.00	9.0	0.00	0.00	0.00	0.00
2009	6.1	11.10	10.5	0.60	0.00	0.00	0.10
2010	6.8	12.95	12.0	0.95	0.0065	1.15	0.29
2011	7.4	13.95	12.6	1.35	0.006	0.80	0.54
2012	7.5	15.20	13.2	2.00	0.00	1.00	1.00
2013	7.6[e]	16.55	13.8	2.75	0.014	1.28	1.46
2014	7.7[e]	18.15	14.4	3.75	1.75	>1.00	1.00
2015	7.8[e]	20.50	15.0	5.50	3.00	>1.00	1.50
2016	7.9[e]	22.25	15.0	7.25	4.25	>1.00	2.00
2017	8.1[e]	24.00	15.0	9.00	5.50	>1.00	2.50
2018	8.2[e]	26.00	15.0	11.00	7.00	>1.00	3.00
2019	8.3[e]	28.00	15.0	13.00	8.50	>1.00	3.50
2020	8.4[e]	30.00	15.0	15.00	10.50	>1.00	3.50
2021	8.5[e]	33.00	15.0	18.00	13.50	>1.00	3.50
2022	8.6[e]	36.00	15.0	21.00	16.00	>1.00	4.00

[e] Estimated

Source: "Renewable Fuel Standard (RFS) Overview and Issues," Congressional Research Service, March 14, 2013 [http://goo.gl/QEfXy], p. 3.

The 2005 and 2007 energy acts made the Environmental Protection Agency (EPA) responsible for implementing the renewable fuels program. In this role, the EPA has likely issued thousands of pages of regulations and explanations. It serves no purpose to go into them here other than to put committee members to sleep. Besides, most of the EPA material is of no use in assessing the economic impact of the mandate. A few facts are necessary, however, to explain the program. I outline them here.

Renewable Identification Numbers: The Basis

To understand the renewable fuels program, one must recognize the importance of RINs. RINs (Renewable Identification Numbers) are a new paper commodity created by the EPA to implement the renewables requirement. RINs (measured in gallons) are generated by those who produce ethanol and other renewable fuels (for example, special cellulosic ethanol). To ensure compliance with the 2005 act, the EPA instituted an accounting system to track the creation and use of all ethanol gallons. Each batch manufactured is assigned a unique thirty-eight-digit identification number (that is correct, thirty-eight digits). These numbers move through the petroleum distribution system and permit the EPA, like the Internal Revenue Service, to audit the actions of every firm.

EPA also created the term "obligated party" as it implemented the 2005 and 2007 energy acts. This phrase, which I use frequently here, applies to firms obliged to comply with EPAct and EISA. Under the latter, an obligated party is defined as a refiner that produces gasoline and/or diesel, a firm that imports either fuel, or a blender (other than oxygenate blenders). This definition separates the process of producing renewable fuels from producing motor fuels. The ethanol producer creates the RINs. Obligated parties, on the other hand, must somehow obtain RINs to meet their ethanol requirement by the end of each reporting or compliance period. In establishing its rules, the EPA worried that ethanol producers could sell ethanol without transferring RINs. In practice, this has not happened because ethanol buyers have insisted on the transfer as part of these transactions.

EPA establishes an obligated party's "obligation" in November of the prior year. EISA requires EPA to publish fractions or percentages referred to as the Renewable Fuel Standard (RFS) for each year before the end of the prior year. The obligation sets the amount of various types of renewable fuels a firm must blend into motor fuel in the coming year, expressed as a percentage of the motor fuel (diesel fuel plus gasoline) volume the company markets. Thus a company selling ten million gallons of gasoline and diesel would have an obligation of one million gallons of conventional renewable fuels if the RFS were ten percent.

Table 3 captures the approach used to implement the calculations. The top four rows show the legislatively mandated renewables use for 2013 and 2015. For example, 16.55 billion gallons of renewable fuels must be used this year, as Row 4 shows.

Table 3. EPA Calculation of Required Ethanol Percentage to Be Blended into Motor Fuels in 2013

	2013 (Billion Gallons)	2013 (Million Barrels per Day)
1. Cellulosic Biodiesel	0.014	0.001
2. Biomass-based Diesel	1.280	0.083
3. Advanced Biofuels	2.750	0.179
4. Renewable Fuels	16.550	1.080
Projected Fuel Use		
5. Gasoline	133.70	8.721
6. Diesel Fuel	52.56	3.429
7. Renewables Blended into Gasoline	12.85	0.838
8. Renewables Blended into Diesel	1.23	0.080
EPA Proposed Standards Derived from These Data		
9. Renewable Fuels (%)	9.6	
10. Cellulosic Biofuel (%)	0.008	
11. Biomass-based Diesel (%)	1.12	
12. Advanced Biofuels (%)	1.6	

Source: US EPA.

The "obligation" is based on the requirement and projected gasoline and diesel fuel consumption. Rows 5 and 6 show the projections used in the calculation. These are based on estimates provided to EPA by EIA. In the EPA calculations for 2013, shown in Row 5, gasoline consumption is projected to be roughly one hundred thirty-three billion gallons.

The “obligation” is then adjusted by the projected use of renewable fuels in 2013. Rows 7 and 8 show these volumes. The obligation percentage is calculated by this formula:

$$\text{Percent} = 100 \times \frac{[\text{volume of renewable fuels mandated by Congress}]}{((G - EG) + (D - ED))}$$

where

G represents projected gasoline use,

EG represents the ethanol or renewable fuels amount projected to be blended in gasoline,

D represents projected diesel fuel use, and

ED represents the ethanol or renewable fuels amount projected to be blended in diesel.

EPA uses this formula. I recalculated the percentages shown in Rows 9 through 12. My numbers match those published by EPA. According to these figures, gasoline and diesel fuel must contain 9.6 percent of conventional renewable fuels in 2013. (I ignore requirements for advanced biofuels here.)

While my calculations match the EPA’s, I note in passing that the EPA formula seems strange because projected renewable fuel volumes are deducted in the denominator of the equation determining the percentage. However, there is a simple explanation. The law stipulates that the percentage be calculated as the ratio of renewable fuels to nonrenewable fuels. EPA receives information on projected total gasoline and total diesel sales from one agency and, separately, the ethanol levels expected to be included in the total marketed fuel. To construct the ratio, EPA must subtract the amount of ethanol projected for use in gasoline and diesel from the total to arrive at volume of pure petroleum.

Thus for 2013, EPA was advised that projected gasoline use would be 133.7 billion gallons (8.7 million barrels per day) and that 12.9 billion gallons (eight hundred thousand barrels per day) of renewable fuels would be blended into the gasoline total. It was also advised that diesel use would be 52.5 billion gallons (3.4 million barrels per day) and that 1.2 billion gallons of ethanol would be blended into diesel. To determine the RFS percentage, EPA subtracts the total projected ethanol use from the total projected gasoline and diesel use.

EPA did not meet the November 30, 2012 deadline for posting 2013 requirements as mandated by Congress. The obligations are still being debated. As noted, these percentages set the renewable fuel use required for various motor fuels. For 2013, EPA has proposed the following RFS percentages:

Cellulosic Biofuel	0.008%
Biomass-based Diesel	1.12%
Advanced Biofuel	1.16%
Renewable Fuel	9.63%

Under this proposal, in 2013 an obligated party's motor fuel pool would have to contain 9.63 percent of renewable fuels. The obligation could be met by blending 7.95 gallons of those fuels into every 92.05 gallons of gasoline or diesel fuel and/or by purchasing RINs to cover any deficiency.

Petroleum product exports are exempted from this obligation, and RINs cannot be claimed for exports of products containing ethanol. The obligation applies to products marketed in the United States. Thus a firm that exports products does not need RINs.

Compliance periods correspond to the calendar year. Each year an obligated party must possess a number of RINs equal to its obligation to be in compliance. To accomplish this, firms are allowed to use RINs accumulated in the previous year to meet up to twenty percent of the current-year requirement. Thus, twenty percent of RINs accumulated in 2012 (or purchased from other parties) can be used to satisfy 2013 obligations.

Obligated parties can carry a deficiency from one year to the next *but only if they did not have a deficiency in the prior year*. Thus a firm could carry a deficit of one hundred thousand RINs from 2012 into 2013 but then must cover the shortfall in 2013 while acquiring enough 2013 RINs to cover its 2013 obligations.

Certain biofuels are more equal than others. Producing one gallon of conventional ethanol generates one RIN. Producing one gallon of soy oil blended into diesel fuel generates 1.5 RINs. Other products such as cellulosic ethanol create different numbers of RINs per gallon to reflect their higher energy content and greater value. However, the volumes of these renewables are miniscule today and so, as mentioned, I ignore the EISA provisions for these fuels here.

RINs can be carried forward to the next year to meet obligations up to a point. The 2005 and 2007 energy acts both stipulate a RIN lifespan of one year. To implement the rule, the EPA determined that a RIN created in one year could be used to meet an obligation in the next year if the party finished a year with surplus RINs. As explained above, firms must accumulate at least eighty percent of the RINs used to meet a given year's obligation during that year.

Compliance can be achieved by blending ethanol and the other renewable products into motor fuel or by purchasing RINs from others. Those who wrote the energy legislation anticipated that firms marketing fuel would blend ethanol. However, specific allowances were made to permit companies to "detach" RINs from ethanol volumes for separate sale. Thus a company could blend a larger volume of renewable fuels into its motor fuels and sell the excess RINs. A second firm that preferred not to blend renewable fuels into its motor fuels could purchase the first firm's extra RINs and use them for compliance. The sequence might occur as follows.

Firm A could market petroleum products containing twenty percent ethanol. (Again, I ignore requirements for advanced renewable fuels such as cellulosic ethanol.) It might do this by selling one million gallons of conventional gasoline containing ten-percent ethanol and 1.17 million gallons of E85. Firm A would thus have 1.1 million RINs with a requirement under the RFS program to possess only two hundred nine thousand RINs.

Firm A's accountants would submit (EPA uses the term "retire") the two hundred nine thousand RINs to the EPA to demonstrate compliance. Its traders could then sell the other eight hundred ninety-one thousand RINs to other firms, including, in this example, Firm B.

Firm B could buy all of Firm A's excess RINs. With these in hand, it could market up to 8.9 million gallons of gasoline and diesel fuel containing no renewable fuels. Firm B's accountants would then submit its RINs to EPA for retirement.

EPA tracks RINs by computer, including their generation by biofuels producers and the subsequent changes in their ownership and status. These changes can include transfers to a second party, division into smaller parcels, and the ultimate retirement.

Penalties for noncompliance are very stiff. Obligated parties that do not meet the RFS are in violation of the Clean Air Act.[1] The resulting fines can be substantial, making failure to accumulate sufficient RINs an impractical business decision.

In 2011, one individual was sent to prison for a long stretch for operating a sham corporation claiming to produce biodiesel. The fake firm sold the RINs it claimed were associated with its nonexistent output to a biodiesel trader, who sold them to other firms that used them to meet their RFS obligations. The individual who started this operation was convicted of felony fraud. In addition, the EPA forced the firms that bought fraudulent RINs to replace them with valid RINs to stay in compliance.[2]

Trading RINs, while permitted, is frowned upon by the EPA. The environmental policy officials who created the system apparently assumed obligated parties would keep transactions between themselves. EPA Director of Compliance Byron Bunker went to great lengths to explain his agency's thinking earlier this year. He did so before a group of firms that had to buy additional diesel RINs because they purchased the bogus credits described above. In a February 22 Platts article, Meghan Gordon reports that "EPA did not intend the underlying credits to become commodities." She then explains further, quoting Bunker along the way:

> It's a system refiners asked for when the EPA started rolling out the Renewable Fuel Standard in 2005. Refiners can either blend actual gallons of ethanol, biodiesel or other biofuels into their gasoline and diesel supplies, or they can buy paper credits on the open market to meet the mandate.
>
> Bunker went on to explain that the agency never meant for RINs to be traded as though they were all identical products that should fetch the same price at the same point in the market.

[1] EISA amends the Clean Air Act. In fact, all renewable fuels legislation is embedded within the Clean Air Act.
[2] Ed Crooks, "Jail Term for Fuel Credits Fraudster," *Financial Times*, February 23, 2013 [http://goo.gl/gAaOP].

> "The way we set up the program, this whole 'buyer beware' approach, fundamental at its heart was that these shouldn't be a commodity," he told the National Biodiesel Board earlier this month in Las Vegas.
>
> Bunker said refiners should have been scrutinizing each RIN deal individually, making judgments about the value of the credits based [on] what they knew about the biofuel producers from past experience or vetting.[3]

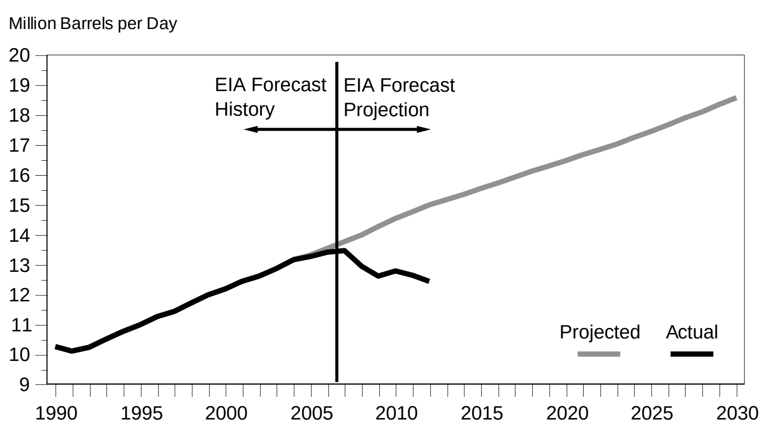
To address the issue of fraud, EPA created a distinction in 2013 between RINs created at facilities monitored constantly by outside auditors and RINs created at facilities that only have quarterly monitoring. The auditors watching the facilities producing the first type of RINs (called QA RINs) must cover any losses suffered by buyers. In contrast, buyers of RINs produced at the less-watched facilities are liable if those RINs are later determined to be invalid.

The Renewable Fuels Program in an Economic Context

The federal government imposed the renewable fuels program, together with the EPA's complicated implementation scheme, on the US economy as 2007 ended, just prior to the economic collapse that came after Bear Stearns and Lehman Brothers failed and oil prices nearly doubled. In other words, the mandate was written and passed while the country still enjoyed rapid growth, rising housing prices, and an optimistic outlook.

The legislators framed the renewables requirements under these circumstances and based their calculations on EIA's 2006 annual projections for gasoline and diesel demand growth. In doing so, they gave little thought to providing for economic contingencies or allowing for EIA's notoriously bad forecasting record. The rigid standards combined with the optimistic projections underlying them are now having a serious impact on the oil industry.

Figure 3
EIA 2006 Forecast of Gasoline and Diesel Consumption vs. Actual Gasoline and Diesel Consumption



Source: US EIA.

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[3] Meghan Gordon, "EPA on Renewable Fuels Fraud and What Makes a Commodity," *The Barrel*, Platts, February 22, 2013 [http://goo.gl/iC0pq].

Figure 3 compares the EIA's gasoline and distillate use predictions for the United States with actual consumption since 2007. (Note: Congress wrote the legislation referring to gasoline and diesel fuel, not gasoline and distillate. EIA, however, does not forecast diesel fuel use directly in its annual long-term forecasts. For exposition purposes, I use the EIA gasoline and distillate fuel numbers.) As Figure 3 shows, US fuel use began to fall below projected levels immediately after EISA passed. The shortfall was two percent in 2008, eight percent in 2009, and then reached twenty percent in 2012.

The burgeoning gap between projected and actual consumption stems from two factors: the economic recession and higher fuel prices. The recession had a very large impact. EIA expected the US economy to grow twenty percent between 2006, the base year of the forecast Congress used, and 2012 and then continue expanding at three percent per year. Actual growth was much slower. Real GDP expanded only five percent from 2006 to 2012. The expectations for longer-term growth rates are also lower today than they were in 2007.

The income shortfall of fifteen percent in 2012 (GDP was fifteen percent lower than projected) likely contributed to a fifteen-percent cut in gasoline use. This assumes an income elasticity of around unity for gasoline and diesel fuel.

However, other factors have also contributed to the consumption shortfall. After delaying for three decades, automakers have finally become aggressive regarding fuel economy. Technical progress has made it easier to produce more efficient vehicles. Still, the major driving factors behind reduced use are consumer revulsion of petroleum in response to high prices and the Federal Reserve Board's quantitative easing (QE).

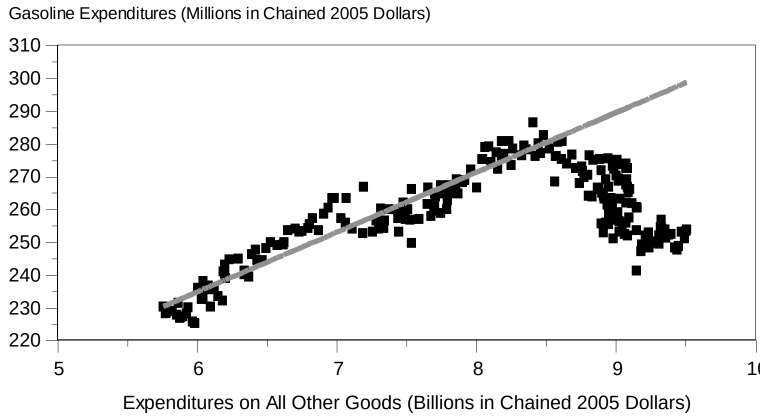
High gasoline prices caused consumers to finally begin changing their purchasing habits in late 2006. Vehicle fuel efficiency suddenly became important when they were confronted with stagnating and then falling income combined with rising gasoline prices.

The Federal Reserve Board's QE program then made it far easier for consumers to replace "gas guzzlers" with more efficient vehicles. The Fed's policies allowed auto dealers to offer loans for new cars at rates as low as four or five percent. At the same time, many consumers faced interest rates of twenty to thirty percent for unpaid credit card balances. These balances tended to rise when gasoline prices went up. In many cases, consumers could save as much as $100 per month by replacing a five-year old vehicle with a new, more efficient vehicle, even a more efficient truck. Auto sales have surged and gasoline sales collapsed.

Figure 4 captures the dramatic change. This graph compares constant dollar consumer spending on gasoline, shown on the vertical axis, with constant dollar consumer spending on all other items. These data are published by the Bureau of Economic Analysis (BEA). BEA is the only government agency that offers contemporaneous data on consumer gasoline buying. DOE only reports gasoline product supplied as published by EIA. EIA bases these numbers on inaccurate estimates of the volumes produced, exported, and imported.

The straight line in the graph shows the relationship trend observed from 1999 to 2006. Individual monthly observations appear as dots. From the graph, one can see a sharp divergence. Consumption today is *twenty percent below* the level that would apply had the historical relationship continued.

Figure 4
US Consumer Expenditures on Gasoline vs. Expenditures on All Other Goods, 1995-2013



Source: US BEA.

The recession, gloomier prospects for future economic growth, and consumers purchasing more efficient vehicles magnify the renewable fuel program's effect. Petroleum marketers and those distributing fuels will have to accelerate their adaptation to the program absent changes in the mandate.

Given the consumer preference for improved fuel economy and the surge in new vehicle fuel efficiency brought about by technology, the shortfall from projected gasoline demand could increase three to five percentage points per year. By 2015, then, the gap could amount to thirty percent. This could put the required renewable fuels blend as high as 13.7 percent. (Table 4 shows the calculation.)

Table 4. RFS Percentage for 2013 and 2015 (Billion Gallons)

EPA Calculations	2013	2015 High Demand	2015 Low Demand
Gasoline	133.7	132.4	120.0
Diesel	52.3	51.2	48.0
Renewable Fuels Used in Gasoline	12.9	14.1	16.0
Renewable Fuels Used in Diesel	1.2	1.4	2.0
Volume of Renewable Fuels Required	16.6	20.5	20.5
Calculated RFS (%)	9.6	12.2	13.7

Source: EPA.

An RFS of almost fourteen percent could cause severe difficulties for petroleum marketers because the equipment at most facilities can dispense fuels containing no more than ten percent ethanol. Indeed, refiners and marketers are already complaining publicly that the 2013 RFS target of 9.6 percent will create significant problems. Spokespeople from refiners such as Tesoro and Valero speak incessantly of the "blend wall" the industry faces. Most assert that, by 2014, the available RINs will not be sufficient to meet the standard. These "alarmists" assume, however, that marketers will not sell products with more than ten percent ethanol. They dismiss alternative fuels such as E15 (fifteen percent ethanol and eighty-five percent gasoline) and E85. To them, the blend wall is absolute.

As a consequence, they are demanding relief from Congress or EPA. To add more pressure on politicians, oil industry representatives have threatened to punish US consumers by raising their gasoline exports and so boosting US prices. Valero CEO Bill Klesse stated it bluntly on March 19: "Exports are going to look more attractive and even more competitive versus the domestic market."[4] Klesse's March comment does not apply in 2013. Indeed, a refiner or marketer selling E10 earns 0.04 RINs for every gallon.[5]

The Situation in 2013

Klesse's view does, however, seem to be borne out by the RIN price surge. As Figure 5 shows the price of ethanol (D6) RINs has been skyrocketing. On July 18, the price for 2012 RINs (generated in 2012 but usable to satisfy 2013 obligations) rose to $1.41 per RIN. On the same date, the 2013 RIN price (RINs generated that can be used to satisfy 2013 or 2014 obligations) rose to $1.44 per RIN.

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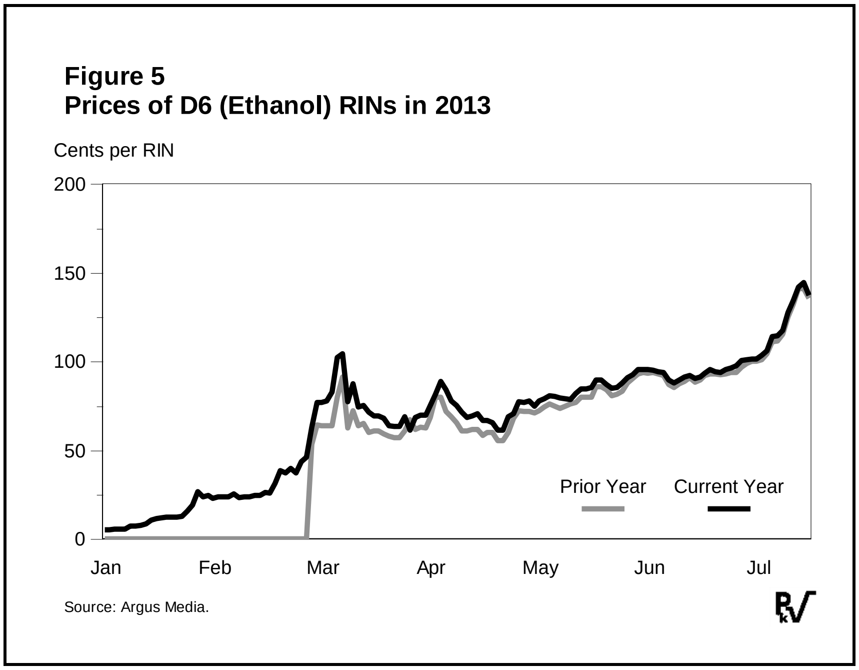
[4] See Beth Evans, "RINs Could Curb US Gasoline Supply during Summer Season: Valero CEO," Platts, March 19, 2013 [http://goo.gl/AsGlb].

[5] The RFS percentage for 2013 is 9.6 percent. This requires a refiner to have 9.6 RINS for every one hundred gallons blended. A refiner blending ninety gallons of RBOB and ten gallons of ethanol to produce one hundred gallons of E10 would generate ten RINs, 0.4 more RINs than required. Thus for every one thousand gallons of E10 produced, a refiner could sell four RINS. As a result, today the RIN program is lowering the E10 price ever so slightly.



The RIN price rise during 2013 has surprised numerous observers. Many believe the increase resulted from the inevitable problems expected to confront the industry in 2013 or 2014. However, a more likely explanation exists in research by finance experts into bubbles or anticipated shortages of physical commodities. Economists have chronicled such occurrences for centuries.

Manufacturers, for example, are notorious for acquiring excess inventories of commodities when shortages are anticipated. Often one observes situations where firms will reduce sales of a commodity to build stocks in advance of tight market conditions. At the same time, other market participants will bid aggressively for the limited amounts available.

In past years, this was not a problem in the petroleum market. Refiners and marketers blended far more ethanol into gasoline than EISA required. As a consequence, at their expiry in February 2012 and February 2013, the price of vintage 2010 and 2011 RINs was near zero.[6]

The situation is different today. In 2013, firms can use vintage 2012 RINs to satisfy their 2013 obligations while saving their 2013 RINs to meet 2014 requirements. Given the program's dynamics, in 2013 a firm producing only E10 will generate almost precisely the number of RINs it needs. The same firm must worry that in 2014 it may have to accumulate more RINs than it will create by producing E10. Under the circumstances, the firm will want to use 2012 RINs first, saving the 2013 RINs for 2014. Such a firm will not want to sell any RINs today. It may even want to buy them.

The company producing only E10 or perhaps E10 and E0 will be concerned that it will not be able to buy enough RINs to meet its obligations in 2014. For this reason, these companies may

[6] Recall that RINs can be used to satisfy obligations in the current year or the following year. The final settlement occurs in February of the second following year. Thus vintage 2011 RINs could trade until February 2012.

be rushing to the market today to accumulate RINs, just as manufacturers in years past hoarded aluminum and copper supplies.

The E85 Opportunity

Manufacturers confronting shortages of aluminum, copper, corn, soybeans, or coffee often have no choice but to bid up their prices. They recognize that they must acquire the necessary raw materials, cut production, or perhaps even shut down.

Some companies faced such a choice in 1980 when the Hunts bid up silver prices. Silver was then an essential input into photographic film and print production, for example. Film and photographic paper prices rose dramatically as silver prices increased, putting pressure on these firms if not forcing them out of business altogether.

Starbucks faces a similar supply problem now. Its primary product is coffee. Thus, when disease threatens the harvests of certain coffees, as it does today, the firm has no choice but to aggressively pursue the specific beans it needs to maintain product quality.

Today, petroleum refiners, marketers, and other involved parties do not face such a choice. Klesse was incorrect in asserting that Valero's only alternative regarding the renewable fuel mandate is to export gasoline. Another choice exists: E85. Valero could induce consumers that own flex-fuel vehicles to switch to this fuel.

Klesse and his colleagues believe consumers will not purchase E85. As Dave Hackett, a consultant with Stillwater Associates, bluntly told Platts, "You cannot sell something [E85] no one wants to buy."[7] Based on prior encounters with Hackett, I think he genuinely believes this.

Hackett, like most in the oil industry, loves to tout the "market" whenever prices and profits rise. In general, however, these individuals have only the vaguest idea of how markets work. They understand chemical reactions, not supply and demand.

What Hackett and oil company officials fail to comprehend—or refuse to acknowledge—is no one had ever done a market experiment to see if consumers want E85 until this year. As a consequence, their strategy has been to keep the fuel's price well above conventional gasoline.

The analysis begins with Figure 6. This graph shows the retail price of E10 and E85 as published daily by the American Automobile Association (AAA). AAA posts these data, which are collected by the Oil Price Information Service (OPIS), daily in its Fuel Gauge Report.[8] This report is the only source of retail E85 prices. The EIA does not collect such data. As Figure 6 illustrates, the E85 price at the pump is less than the E10 price.

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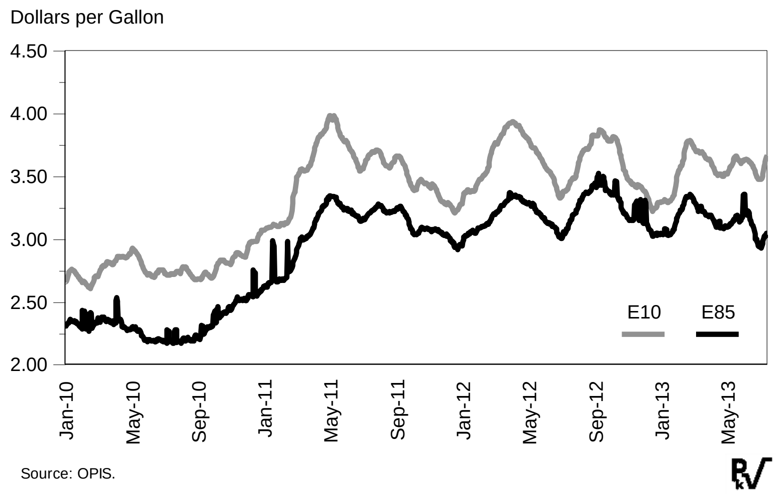
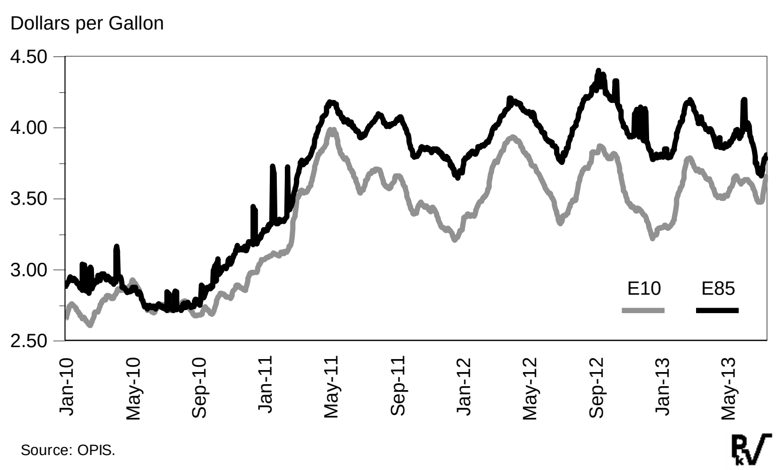
[7] Beth Evans, "Refiners Do Not See Significant US Renewables Changes," *Platts Oilgram News*, March 19, 2013, p. 8.
[8] See AAA's Daily Fuel Gauge Report [http://goo.gl/mK5AN].

Figure 6
National Average Retail Prices for E10 and E85, 2010-2013



However, Figure 6 is misleading because a gallon of E85 delivers only eighty percent of the distance delivered by E10. Figure 7 corrects for this by adjusting for the lower energy content. This graph shows that the E85 price has always exceeded regular fuel prices when adjusted for energy content.

Figure 7
National Average Retail Prices for E10 and for E85 Adjusted for Lower Energy Content, 2010-2013



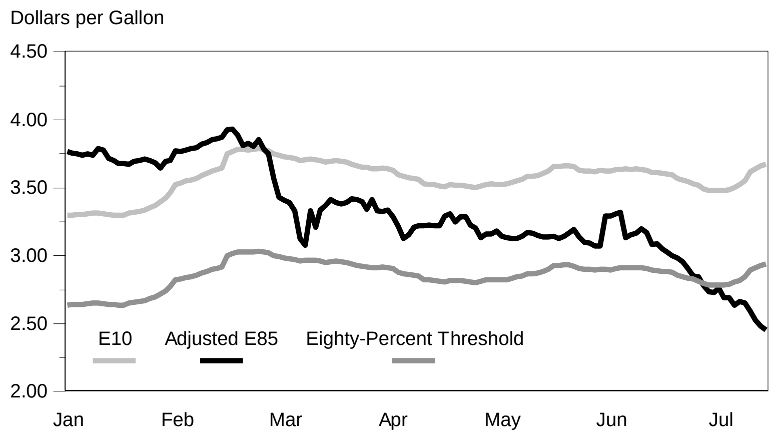
Until recently, firms had no reason to sell E85 for less than E10 after adjusting for energy content. Indeed, as can be seen from Figure 7, the retail E10 price has always been less than the retail E85 price after this adjustment. This situation would prevail today but for the current value of RINs.

The RIN price surge has changed the competitive balance. Today, the spot E85 price after adjusting for RIN values is more than eighty cents per gallon (twenty-five percent) less than the implied E10 price. Unless Hackett's assessment is correct, consumers owning flex-fuel vehicles would switch to the lower-priced fuel *if part or all of the RIN savings were passed on to them*.

At this juncture, though, most customers have not had the opportunity to purchase E85 at a sufficient discount. This can be seen from Figure 8. There I show the retail E10 price published by OPIS and the E85 price adjusted for lower energy content and including the RIN benefit. I compute this price to be eighty percent of the E10 price. Also shown in Figure 8 is the hypothetical eighty percent of E10 price. This is the price that should cause flex-fuel vehicle owners to begin switching. Figure 8 makes it clear that E85 consumption would surge if, as noted, the *RIN savings were passed on to users* instead of being held by marketers.

Figure 8

National Average Retail Prices in 2013 for E10, E85 Adjusted for Lower Energy Content and including RIN Benefit, and Eighty-Percent Threshold



Source: OPIS; PKVerleger LLC.

From Figure 8, one can observe that the retail E85 price should be low enough relative to E10 to prompt consumers to change over. However, most marketers have not made the adjustment yet.

This situation has begun to change. This April one retailer in Minnesota began offering E85 at significant discounts at some of its outlets.[9] OPIS reports indicate that discounts to E10 ranged from twenty-nine to thirty-five percent.

Data published by Minnesota's Department of Commerce suggest that the consumer response to the pricing experiment was positive. As Table 5 shows, E85 sales surged in May compared to previous months. Through April, these sales were running at an annual rate of ten million

[9] The firm's experiment was described in an April 13, 2013 OPIS dispatch.

gallons. For May, though, the volume was twenty-two million gallons at the annual rate. Anecdotal reports suggest that this surge has continued. *The conclusion, then, is that pricing E85 favorably relative to E10 caused a one-hundred twenty percent increase in sales, this despite the fact that the experiment took place at a limited number of stations.*

Table 5. Estimated Monthly E85 Volumes Sold in Minnesota, January through May 2013

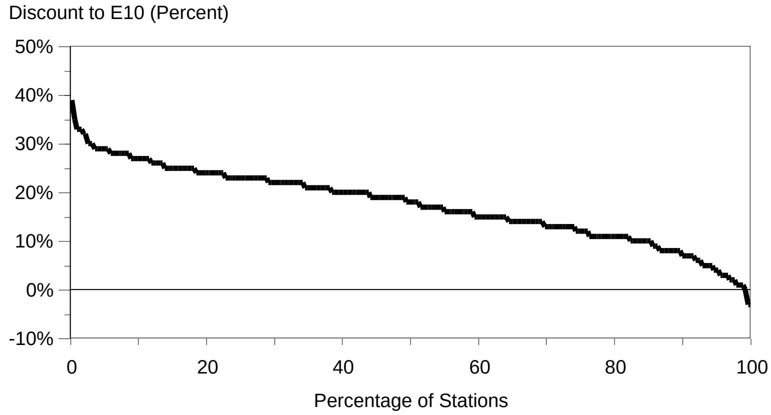
Month	Volume (Thousand Gallons)
January	711
February	875
March	946
April	1,039
May	1,885

Source: Minnesota Department of Commerce, 2013 Minnesota E85 + Mid Blends Station Report.

The marketing experiment that occurred in April in Minnesota is not unique. The website E85prices.com publishes E85 prices at stations in many of the fifty states. While it is far from scientific in its price reporting, the website does indicate the availability of discounted fuel.[10] The site reports prices for approximately eight hundred of the more than three thousand stations offering E85. Due to duplications, though, it appears the dataset has prices from just three hundred separate stations. I created Figure 9, which presents the station distribution, after sorting the data and removing duplicates. This figure shows that, as of early July (the reporting dates for stations vary by station due to website's collection method), one hundred thirty-three of the three hundred stations for which data are available offered E85 at a discount of twenty percent or more to the E10 price.

[10] E85prices.com relies on price reports on individual stations emailed by individuals. It is thus a self-selecting reporting system. In some states, no prices are reported. Other states, such as Illinois, have a large number of reports.

Figure 9
Distribution Curve of Discount to E10 Offered to Consumers of E85 at 301 Stations Nationwide



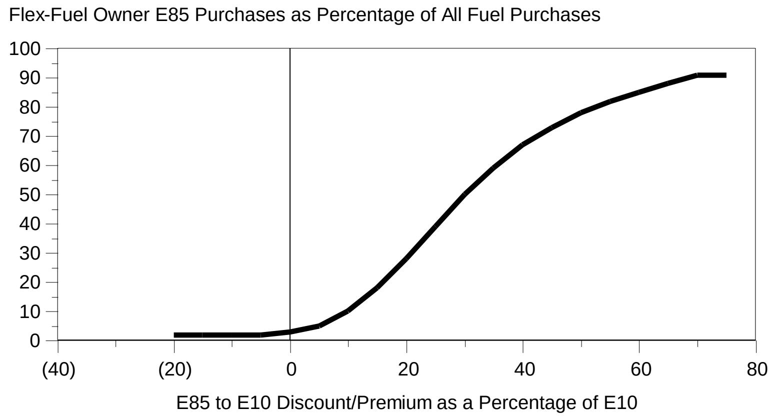
Source: PKVerleger LLC.

Examination these data reveals that one large company, Marathon Petroleum Corporation (MPC, the refining and marketing segment spun off from Marathon Oil) is making a large, concerted effort to market E85. Fifty-eight of the one hundred thirty-three discounting stations (forty-four percent) were Speedways owned by MPC. MPC will discuss its second quarter financial results on August 1, 2013. At that time, the company may release more information regarding its E85 marketing. Specifically, if the program has succeeded, the company will likely inform investors of significant income earned by selling RINs to other companies.

The limited data published by Minnesota and the possible forthcoming numbers from MPC will provide a basis for determining whether flex-fuel vehicle owners will embrace E85 adequately to resolve the blend wall issue raised by Valero and other companies. At this juncture, it is too early to predict a result.

Logically, one should expect to observe a shift of flex-fuel vehicle owners similar to the relationship shown in Figure 10. This graph presents the percentage or share of E85 use by flex-fuel vehicle owners as function of the discount to E10. At this point, I have used a common logistical curve to set out the likely trend. I hypothesize that flex-fuel vehicles would use E85 half the time if retail E85 is offered at a forty-percent discount to retail conventional gasoline. However, this is only a theory. Prior to this year, E85 has never been offered at a discount.

Figure 10
Percentage of Flex-Fuel Owners Choosing E85 vs. E85 to E10 Discount



Source: PKVerleger LLC.

The open question is could flex-fuel vehicle owners consume enough E85 to eliminate the blend wall referred to by oil industry executives and their biased supporters. I turn to this question next.

Can Flex-Fuel Vehicle Owners Rescue the Renewable Fuels Program?

As noted above, RFA estimates that fifteen million flex-fuel vehicles had been made available to Americans through the end of 2012. This number is significantly higher than EIA's estimate. The RFA count, however, has not been adjusted for normal scrappage rates. After making that calculation, I estimate the flex-fuel fleet at the end of 2012 to number 12.8 million vehicles. By the end of 2013, that number should rise to fifteen million, again using US Department of Transportation vehicle survival rates.

I estimate the fuel used by these vehicles using data on miles driven and average fuel economy published by the DOT's National Highway Traffic Safety Administration.[11] I also used this source to calculate the current fleet size. Assuming these vehicles get the same miles per gallon if operated solely with gasoline, I figure the E85 fleet would consume 5.3 billion gallons (three hundred fifty thousand barrels per day).

The same vehicles if operated solely on E85 would consume 6.4 billion gallons, (four hundred eighty thousand barrels per day). If operated solely on E85, these vehicles would generate 4.8 billion RINs, roughly one-third of the total required by the end of the year.

By the end of 2013, the E85 fleet could be consuming 6.7 billion gallons of E85, producing five billion RINs. This number of RINs would allow the blend percentage for other gasoline to be reduced to seven percent, a number the entire industry could achieve.

[11] National Highway Traffic Safety Administration, "Vehicle Survivability and Travel Mileage Schedules," January 2006 [http://goo.gl/vlPJn].

This means that the entire blend wall problem associated with the ethanol mandate would vanish *if all flex-fuel vehicles used E85 exclusively*.

Of course, one hundred percent penetration is not achievable. Today, the limited available data I have been able to collect suggest that no more than one percent of all gasoline sold contains eighty-five percent ethanol. However, as noted above, the price reductions being offered in the upper Midwest states may help increase sales.

In addition, the apparent market leadership of Speedway may prompt other marketers that distribute gasoline in the same states to respond competitively. Given consumer price sensitivity, this could lead to much higher E85 consumption in these states. Would this consumption be sufficient to avoid the blend wall?

Examining the data on E85 marketing, one finds two groups of states where the product seems widely available. These are the core states in the upper Midwest (Ohio, Indiana, Michigan, Illinois, Minnesota, Wisconsin, Iowa, Nebraska, the Dakotas, Kansas, and Missouri). These states account for approximately twenty percent of US gasoline consumption. A second group of states, which might be called the inland Appalachian (Georgia, Kentucky, Tennessee, Pennsylvania, and Arkansas) plus Florida group, account for a further twenty percent of consumption. I would expect to see E85 become a significant presence in these states *if consumers were offered a competitive price*. I expect to see significant market penetration in these states given their structure of petroleum distribution.

Based on these assumptions, I calculate that E85 use in 2014 could reach roughly one billion gallons, less than one-sixth of the maximum potential use. While modest, this would reduce the amount of ethanol refiners must blend in conventional gasoline by 0.5 to 0.8 percentage points, leaving them roughly in the same position as they were in in 2011. This would be unsatisfactory to many companies but would by no means be a disaster.

To test the reasonableness of this calculation, I derived the number of daily visits implied by my calculation. Under this projection, every E85 station would see between sixty and seventy-five customers per day under this projection. I believe the petroleum distribution system has the capacity to accommodate this frequency.

I conclude, then, that adequate flex-fuel vehicle fueling capacity exists to accommodate consumers in 2013 and 2014. I also expect that additional capacity to distribute the fuel will be built quickly as consumers become aware of its lower price.

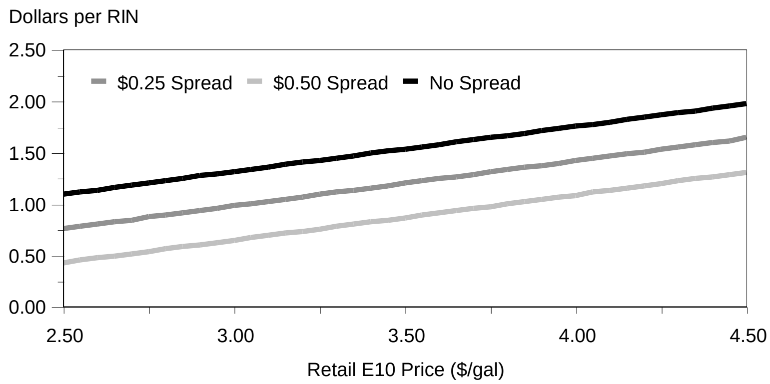
The D6 RIN Price Required to Motivate Customers

As noted above, my earlier research suggests that E85 would need to sell at a discount to conventional gasoline that is adequate to incentivize consumers to switch. On an energy or Btu parity basis, this discount must be at least five percent. After adjusting for E85's lower energy content, I expect the retail price of E85 must be roughly seventy-five percent of the conventional E10 gasoline price.

Depending on the gasoline price, then, the D6 RIN price must range from $0.90 to $1 per RIN. I show my calculation of market-clearing RIN prices in Figure 11. In this graph, the retail E10 price is graphed on the horizontal axis and the RIN price against the vertical axis. The retail price ranges from $2.50 to $4.50 per gallon. (The national price today is about $3.75.)

The calculation of the equilibrium RIN price shown in Figure 11 depends on the spread between ethanol and refinery blend stocks. Obviously, the RIN price can be lower if ethanol sells for a large discount to the refining blendstock. Equally obviously, the RIN price must be quite high if the ethanol price equals or exceeds the blend stock price.[12] Figure 11 shows the RIN prices required to achieve the twenty-percent discount for a situation where the gasoline blendstock price exceeded the ethanol price by $0.50 per gallon and $0.25 per gallon, as well as a case where there was no difference. Today, spreads are around $0.60 per gallon.

Figure 11
Equilibrium RIN Price for Various E10 Retail Prices
Given a Specific RBOB/Ethanol Spread



Note: Each line traces the RIN price based on the equilibrium price of gasoline, given a specific spread between wholesale gasoline prices and wholesale ethanol prices.
Source: PKVerleger LLC.

These calculations do not imply that the D6 RIN price will peak at $1 per RIN. Given the behavior of commodity prices, I would expect the price to rise to a fifty-percent premium to the equilibrium level toward the end of 2013 and again at the end of 2014. The price increase will be induced by the natural conservatism of obligated parties. All market participants will tend to hold RINs until they are sure of covering their requirements. Thus prices should rise as the year ends. Expiring RIN prices may then drop early in the following year.

The price cycle will be exacerbated by the lack of data.

[12] A simple thought experiment illustrates this point. The E85 price will be very low if the refining blend stock sells for $5 per gallon and ethanol sells for $0.50 per gallon. Under those circumstances, the E10 price would be $4.32 and E85 would be $0.43. In a competitive market, no incentive would be required.

The Role of Futures Markets

The Chicago Mercantile Exchange has created futures contracts for D6 ethanol and other RINs. Activity as of July 22 is minimal, with less than one hundred contracts open in any contract. The Intercontinental Exchange also has ethanol contracts. These are cash settled based on market assessments by Argus Media and other price-reporting agencies.

One would think futures contracts could be ideal mechanisms for managing the financial risks associated with the renewable fuels program. However, the assumption would be incorrect at this point. One reason for the lack of interest may relate to the uncertainty regarding the regulatory environment.

Regulatory Environment

Under the renewable fuels legislation, EPA must inform refiners of their obligations in a year by November of the preceding year. The agency has failed repeatedly to achieve this goal. For example, the 2013 obligations of parties operating under the renewable fuels laws still have not been finalized even though we are almost into August. The uncertainty linked to EPA's failure in this regard makes planning impossible for those firms required to comply with the law. For example, companies operating at the margin that may have some RINs to sell or may be required to buy a limited number of RINs will likely be unwilling to act until the rules are set.

Furthermore, many parties are working aggressively to get the rules changed. Firms in the oil industry as well as the American Petroleum Institute (API) continually petition Congress and EPA to lower obligations for 2013, 2014, and the years beyond.

The industry lobbying is understandable, as is the willingness of Congress to listen. The failure of EPA to administer the law properly, though, is not understandable. There may be good reasons for EPA's inability to finalize the 2013 regulations before November 2012, but the agency cannot be excused. The renewable fuels program is very large and very costly. It needs to be managed professionally, the way other economic agencies act, not in the amateurish, almost childish way it is being handled today.

EPA's failure to run the program in a professional way clearly discourages firms from investing in developing E85 distribution infrastructure. As noted above, E85 will only penetrate the market if the RIN price is above $1 given today's prices for gasoline and ethanol. Firms contemplating infrastructure investments understand the adjustments promoted by the API and industry lobbyists will drive the RIN price down and make investments less profitable. Thus, less investment will be forthcoming and the RIN price pushed even higher if EPA ultimately rejects the moderation proposals.

The renewable fuels program will only succeed if the EPA administrator and policymakers declare that it will not be changed unless Congress acts. EPA should further declare that it will meet the deadlines established by Congress using the best available information, letting the chips fall where they may. Such actions would remove the uncertainty associated with the program and likely lead to rapid adjustment by the industry because the market incentives created by the program would be clear.

Conclusion

EPA created the RIN system to track compliance with the renewable fuels standards established by Congress in EISA. The EPA program allows RINs to be traded by firms required to comply with the program to facilitate operations and make maximum use of market-related institutions.

The automobile industry and numerous firms have identified ways to achieve the renewable fuels program goals at relatively low costs given the EPA's market-oriented RIN program. The costs of these adjustment to RFS requirements will decline over time as suppliers, distributors, and marketers become more familiar with the options and innovate.

Wider use of E85 would speed the adjustment. However, marketers have just begun to push the fuel even as others assert the program is failing.

Unfortunately, intransigence on the part of some firms as well as the EPA not meeting congressionally mandated deadlines undermine the program's operation. EPA needs to give all a clear signal that the program will proceed as established. This would promote more efficient operation and probably lower the cost of compliance.