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# Behind the Battle for Octane

by OPIS Chief Oil Analyst Denton Cinquegrana

*What you need to know as the refining, agricultural and auto industries gear up to vie for their piece of a multi-billion-dollar market*



# Introduction

A phenomenon has been developing over the past couple of years in the gasoline market. After an extended period of relatively mild consumer cost differences, premium gasoline prices have vaulted over those for regular grade — signaling a jump in demand. Premium gasoline has clearly become a sought-after commodity for U.S. drivers.

Premium blends are an asset majors and independent refiners tout as a differentiator. Besides premium being the higher-margin product, major refiners spend quite a bit of time and capital on the research and development of additives that make their brand the superior one. Brands will brag about their proprietary additive package that will keep engines cleaner and offer the highest performance possible.

Premium's primary characteristic is higher octane — 91-93 points. It's measured in a few different ways. The most common globally is the Research Octane Number (RON), determined by running fuel through a 600-RPM test engine. Or, the Motor Octane Number (MON) is measured at 900 RPMs. In the United States, the posted number for octane at a gas pump is an average of the two, also known as the Anti-Knock Index (AKI), as octane in fuel is aimed toward eliminating “engine knock.”

Octane measures gasoline's performance. The higher the octane, the more compression the gasoline can stand before ignition. Higher octane can lift engine compression ratios and increase power. And the various additives that can boost octane can come from a number of different sources — each with its own benefits and drawbacks.

Oil market experts say wider spreads between regular and premium unleaded are expected to continue through the next decade, creating opportunities for those who can effectively boost octane in the multi-billion-dollar global motor fuels market.

## In this OPIS e-Book, you will learn:

1. Price and demand factors that have helped put premium gasoline on stronger footing.
2. How government programs have impacted octane's fortunes
3. The options for octane enhancement from the standpoint of refiners, the agricultural sector and natural gas liquids producers.

Automakers have been pushing for higher-octane gasoline in order to meet the CAFE standards set by the Obama administration. Even as the Trump administration considers relaxing some of those standards, it is clear that more octane will be needed.

But where will it come from?

## Part 1: How Did We Get Here?

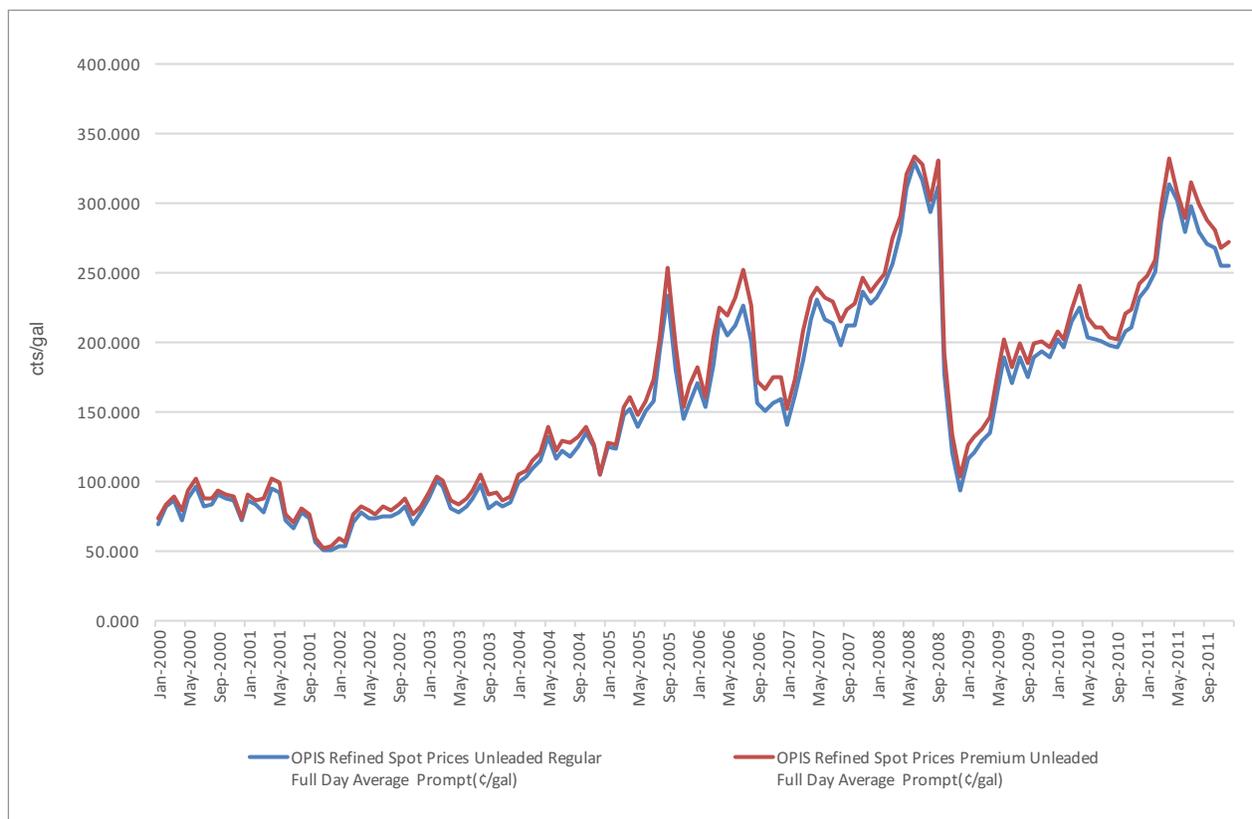
The rise in premium demand has been, in part, a byproduct of the overall trend in the oil market.

Record-high U.S. production and a global glut in crude supplies has led to a seismic shift in petroleum product prices overall. That move lower has helped shape consumer buying patterns for premium.

Between 2000-2011, the regular/premium spread (also referred to as the octane spread) was relatively narrow at the spot, rack and retail price level.

The difference between the two grades in the U.S. Gulf Coast gasoline market, for example, averaged just over 9cts/gal, according to OPIS TimeSeries data.

**Gulf Coast Regular vs. Premium 2000–2011**

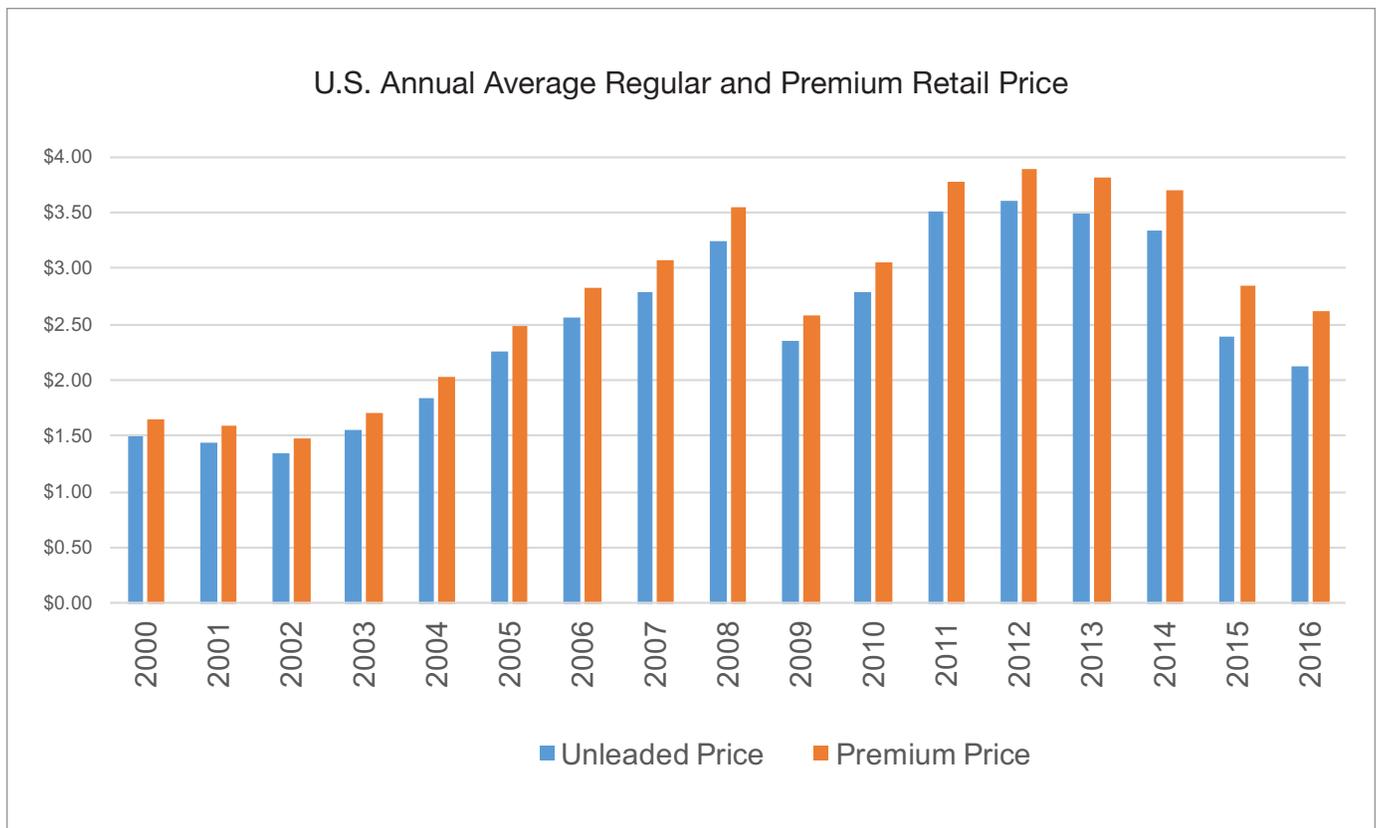


A major factor in the narrowed octane spread during this timeframe had to do with overall gasoline price direction.

In the following chart, notice the almost negligible difference between regular and premium gasoline at the start of the 2000s, when average gasoline prices were on an upward trudge. This period in time clearly featured greater pain points at the pump, so drivers were considered less apt to “splurge” on premium unless they had to.

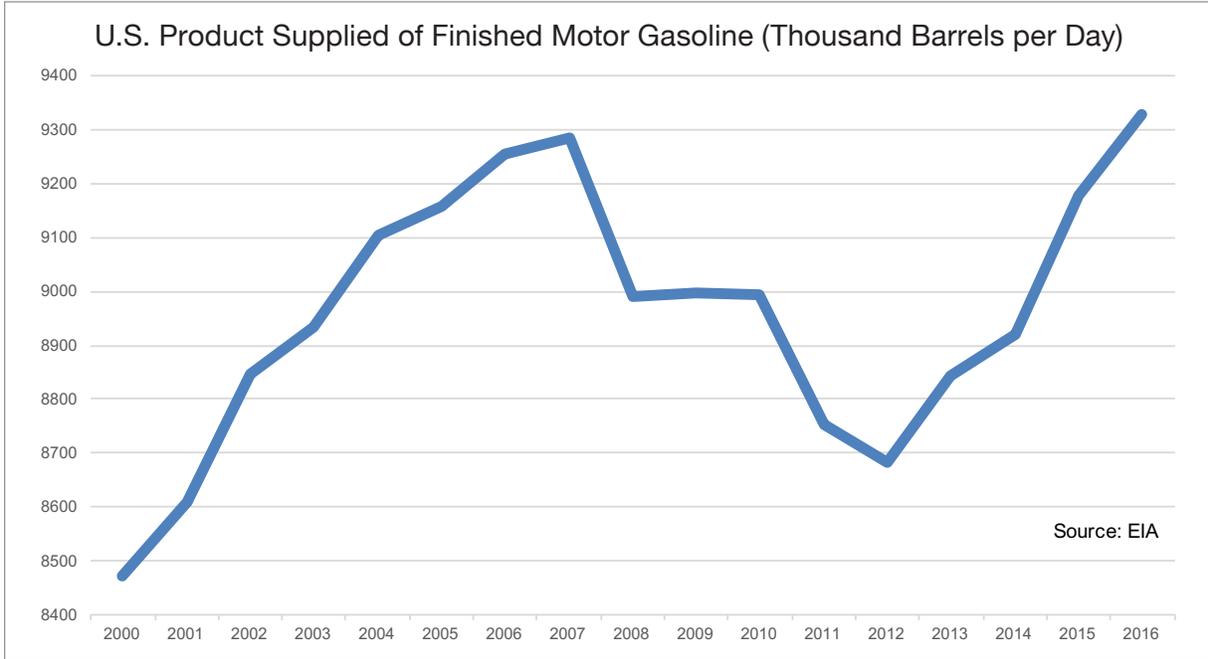
Now, look at recent years, as gasoline prices have receded. The spread has widened appreciably. We’ll dive deeper into that later on.

### Regular vs Premium Since 2000



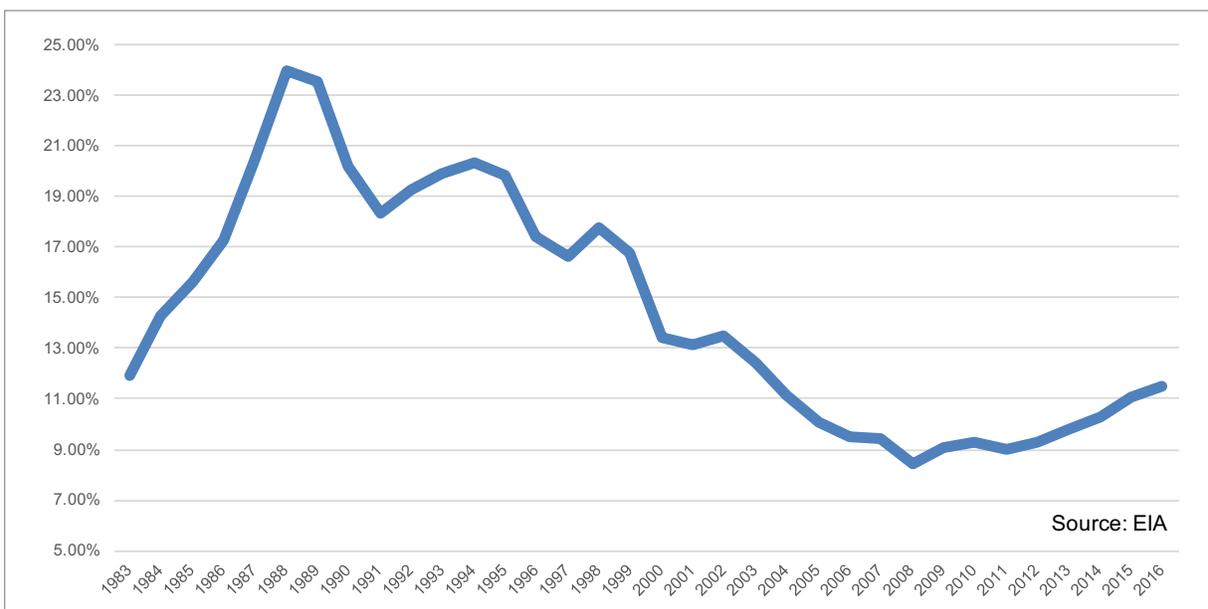
The fall and rise of the octane spread mirrors the historical demand curve. Note in the following chart the overall gasoline demand slump seen during the latter part of the first decade of the 2000s, as drivers pulled back due to higher pump prices.

### Annual Gasoline Demand 2000–2016



Not surprisingly, right around the time overall demand was dropping, premium gasoline as a percentage of sales slipped to a record low of less than 9%.

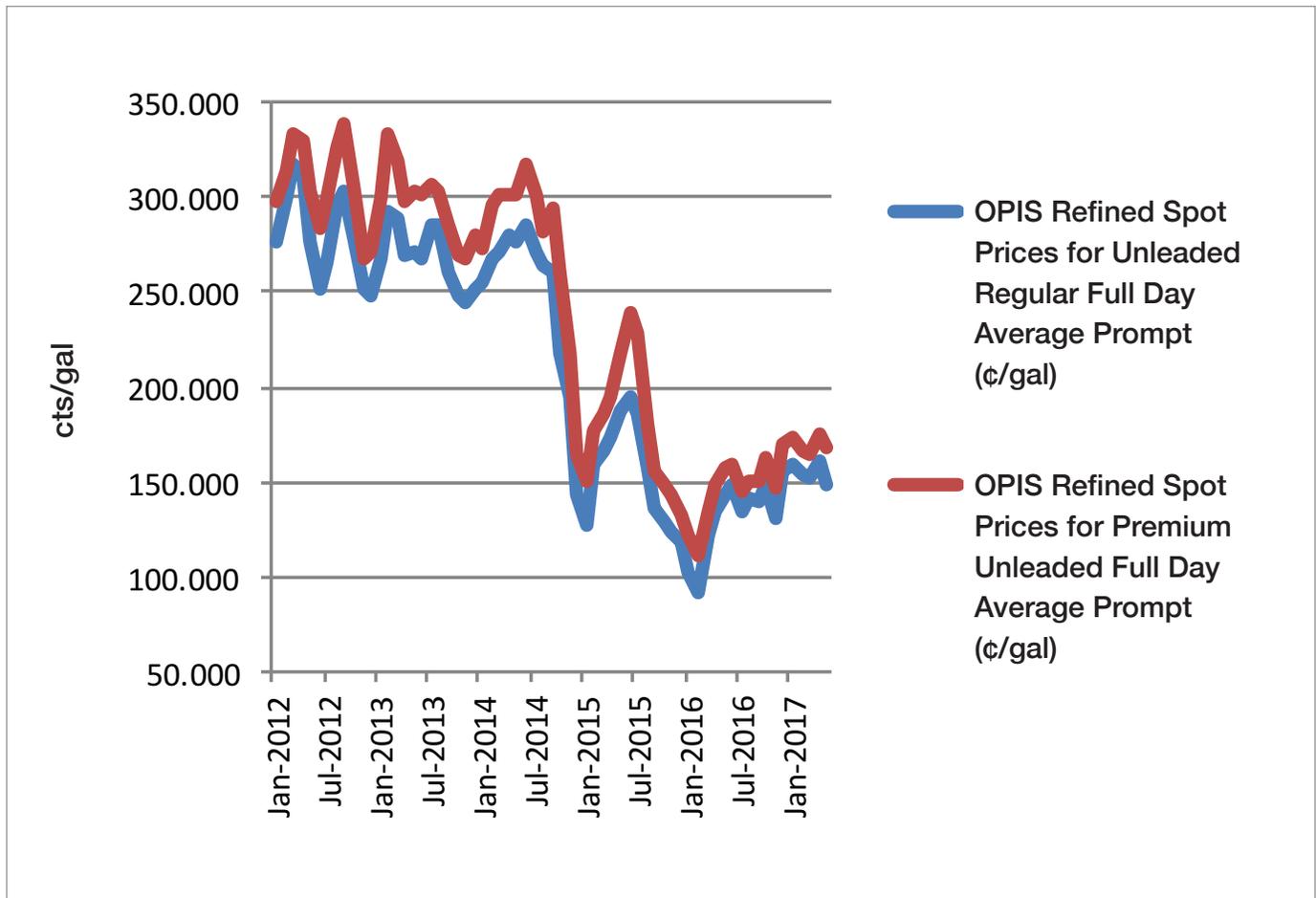
### Premium as a Percentage of Total Sales 1983–2016



Since 2012, the relationship between regular and premium gasoline has changed. Premium sales are on the rise.

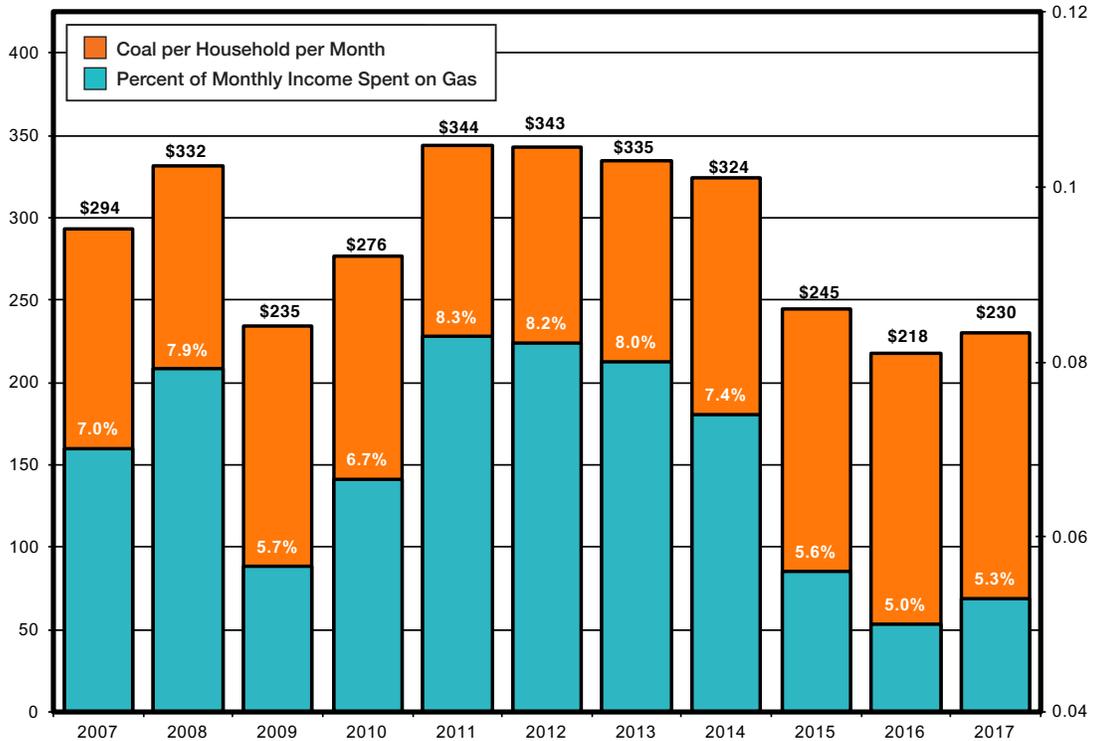
In the U.S. Gulf Coast spot market, for example, the price of regular versus premium gasoline has deviated by more than double the spread of the past decade. The average octane spread in this major refining sector has blown out to 22.75cts/gal.

**Gulf Coast Regular vs. Premium 2012–2017**



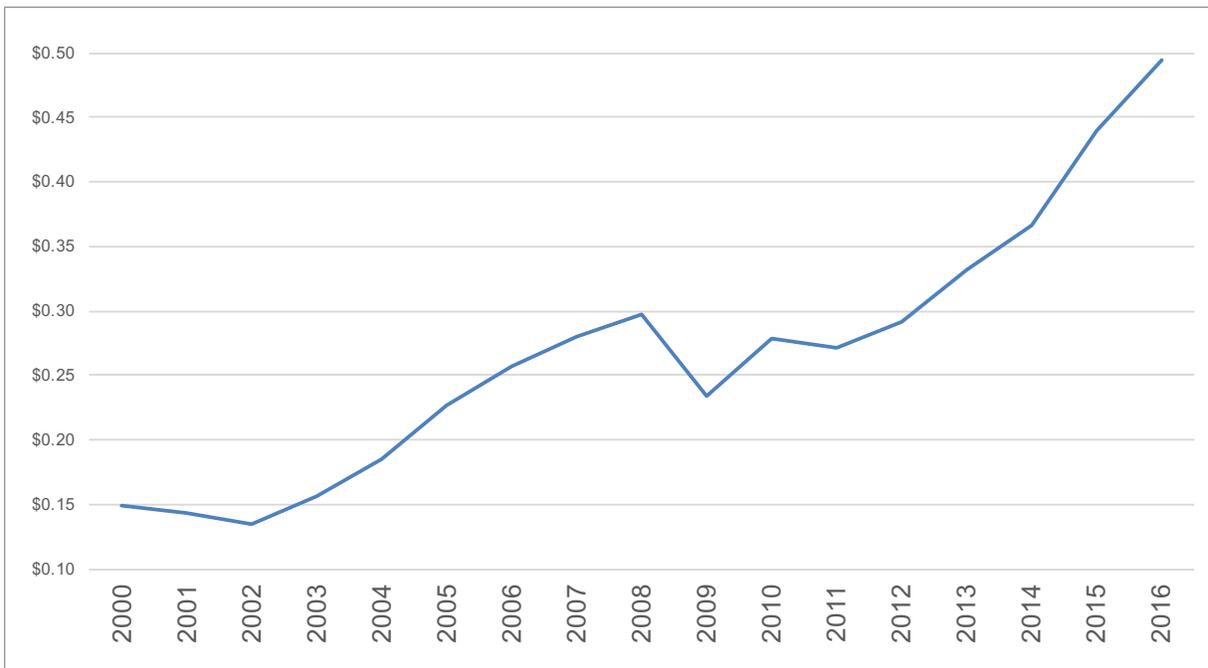
Over the past five years, assisted, in part, by the shale boom and general global oil supply glut, retail prices have dropped. Gas is “cheaper” now and causes less pain at the pump. The chart on the next page depicts how the percent of household income spent on gasoline has declined since 2012.

### Percent Income Including 2017YTD



The advent of “cheaper” gas has contributed to a mentality among modern drivers to “treat” their car to a tank of premium. And as sales have risen, the spread between regular and premium gasoline has taken off.

### Growing Difference Between Regular and Premium (Retail)





Lower prices have indeed stoked premium sales, but in addition to that, changes to the light-duty vehicle fleet have played a significant role as well. According to recent data from the EIA, in model year 2009 just 3.3% of the fleet was made up of turbocharged engines. By model year 2014, the market share for turbocharged engines jumped to 17.6%. The next section focuses more on turbocharging and premium gasoline.

## Part 2: Engines of Change

For some vehicles, the use of premium gasoline is a necessity, not a luxury.

In order to hit their CAFE target of roughly 50 miles per gallon for the U.S. vehicle fleet by 2025, automakers have had to change the way they make engines — with one eye focused on environmental standards and the other on drivers' need for speed.

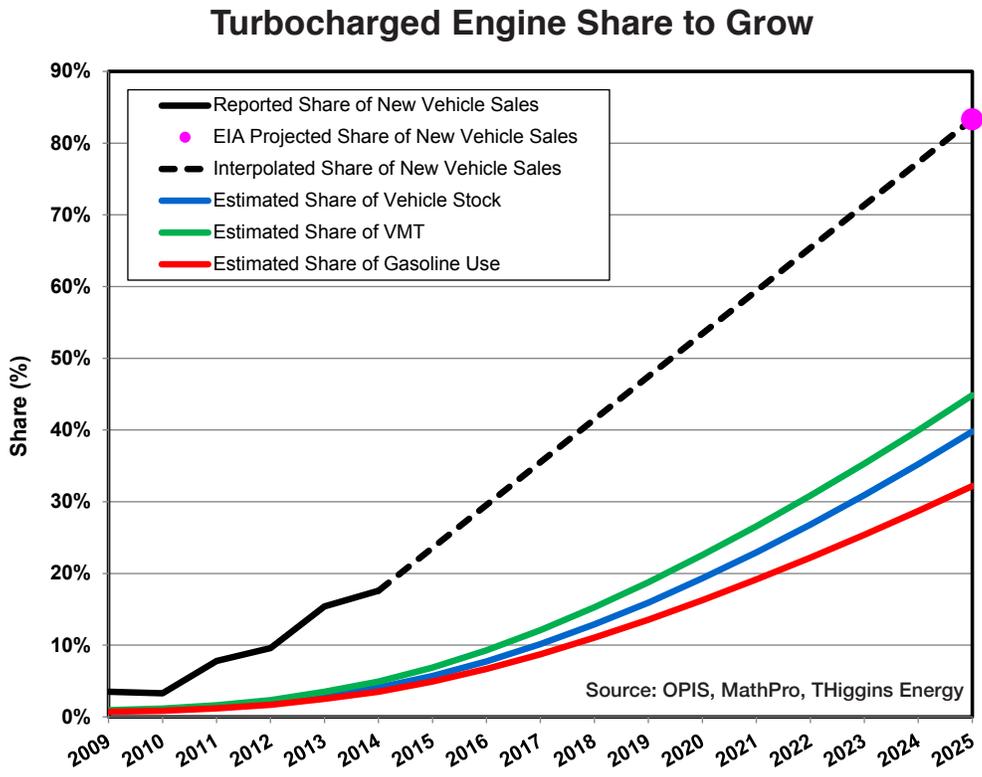
While CAFE standards are currently being reviewed by the Trump administration, targets remain in place for the time being, and there is no clear indication that they will be wholly dismantled anytime soon.

Turbocharging is an option — and a popular one at that. This allows manufacturers to downsize engines, leading to reduced vehicle weight and increased fuel economy. Turbochargers provide an extra power boost when needed.

To achieve full performance, turbocharged vehicles need premium gasoline. Turbochargers push compressed air into engine cylinders. As mentioned above, the higher the octane in a car's fuel, the more compression its gasoline can stand before ignition. Premature ignition can create the dreaded “engine knock,” which can lead to damage.

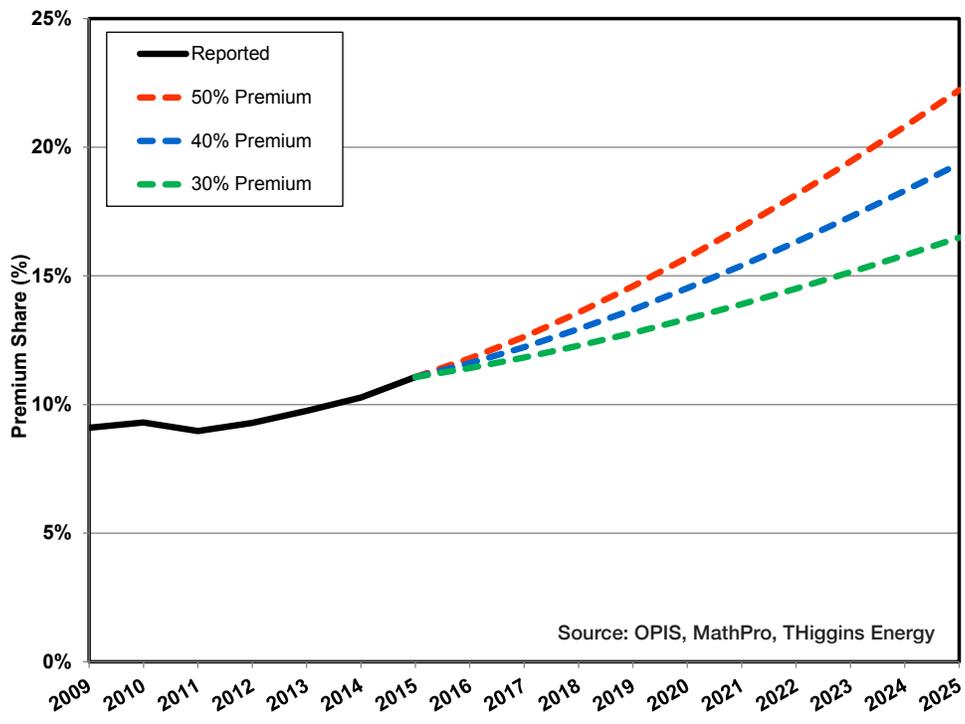
Manufacturers can design turbocharged engines to run only on premium, or to allow a little more flexibility with a “Premium Recommended” note in vehicle owners' manuals. Many high-performance engines, in high-end sport and luxury vehicles, require the use of premium gasoline.

Experts see turbocharging as a trend that will grow:



Alongside that trend, premium gasoline market share is poised to take off:

### Premium Market Share for Turbocharged Engines Fueling with Premium



But, there's also a consumer trend helping fuel premium demand and it may have to do with some misconceptions.

Though the trend may be toward more premium consumption in vehicles, experts note instances of overuse.

In late September last year, AAA in a study said that U.S. drivers wasted more than \$2.1 billion in a 12-month period. AAA noted that 16.5 million U.S. drivers put premium gasoline in their tanks even though their engines did not require premium gasoline according to manufacturer guidelines.

During its fuel evaluation testing, AAA found that there was no benefit to using premium gasoline over regular in regard to fuel economy and emissions when using industry-standard testing.

According to AAA, 70% of U.S. drivers presently own vehicles that requires regular gasoline while 16% require premium. The additional 14% have an engine that either requires mid-grade or uses an alternative energy source.

> <http://newsroom.aaa.com/2016/09/u-s-drivers-waste-2-1-billion-annually-premium-gasoline/>

Automotive information resource Edmunds last year also sought to inform drivers that they might be unnecessarily putting premium in their vehicles.

The group noted that years ago it may have been beneficial to buy a tank of premium gasoline to help clean the engine because detergents and additives helped reduce carbon deposits. But, the group further noted that, due to government regulations, regular gasoline today contains sufficient additives to protect engines and cut pollution.

Edmunds also noted that today's engines are "smarter" and that engine control systems can compensate for low-octane fuel through monitoring knock activity and adjusting the ignition advance to help avoid knocking.

> <https://www.edmunds.com/fuel-economy/to-save-money-on-gas-stop-buying-premium.html>

## Part 3: The Politics of Premium

U.S. initiatives to “clean up” its gasoline pool has had an impact on octane levels.

MTBE (methyl tertiary butyl ether) at one point was an attractive additive for use as an oxygenate to increase the octane level in gasoline as well as achieve the aims of the Clean Air Act. But, evidence that it is a groundwater pollutant led to refiners pulling this additive from their blending arsenal, leaving a hole for octane.

As well, the government-imposed removal of sulfur and benzene from gasoline increased refining costs and — as a side effect — also reduced the octane of some gasoline blendstocks.

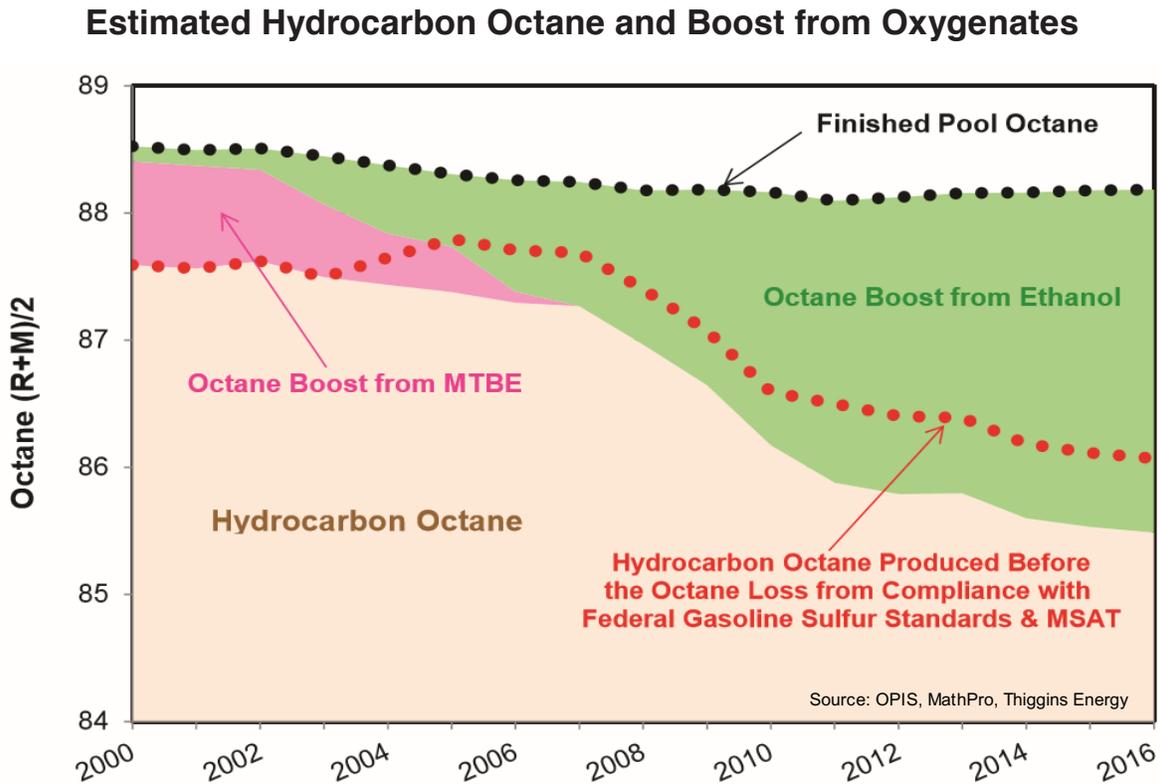
The Environmental Protection Agency capped benzene in reformulated gasoline at 1.0% volume in 1995. Then, MSAT2 (Mobile Source Air Toxins) regulations reduced benzene in all U.S. gasoline to below 0.62% volume earlier this decade. Removal of sulfur and benzene according to Federal Gasoline Sulfur Standards and MSAT regulations results in an octane loss of roughly 0.6 points.

However, the advent of the Renewable Fuels Standard, mandating the use of ethanol as an oxygenate additive, offered a saving grace for the hydrocarbon side of the fuel slate.

Ethanol has an octane rating of roughly 112 points. When added as a gasoline blendstock for oxygenated blending, it results in an octane boost about equivalent to what was lost with the removal of MTBE.



As this next chart shows, ethanol has compensated for the “heavy lifting” when it comes to the finished pool of octane.



## Part 4: Making the Octane Grade and the Side Effects of Shale

As higher octane blends of gasoline look like they will be needed over the next decade, the larger question is how do we get there?

As mentioned in the previous section, ethanol has been doing some heavy lifting in recent years. A straightforward increase of ethanol in gasoline (20%-25%) may be the simplest answer. It would be a boon to the agricultural sector, but would certainly be met with opposition from other key stakeholders in the energy space.

At the same time, total refining capacity has been on the rise, but not all refining capacity is created equal.

U.S. refining capacity growth has been impressive, as more than 1 million b/d of total capacity has been added so far this decade. However, the amount of key process units for gasoline output and high-octane blendstocks has been largely flat over this period of time.

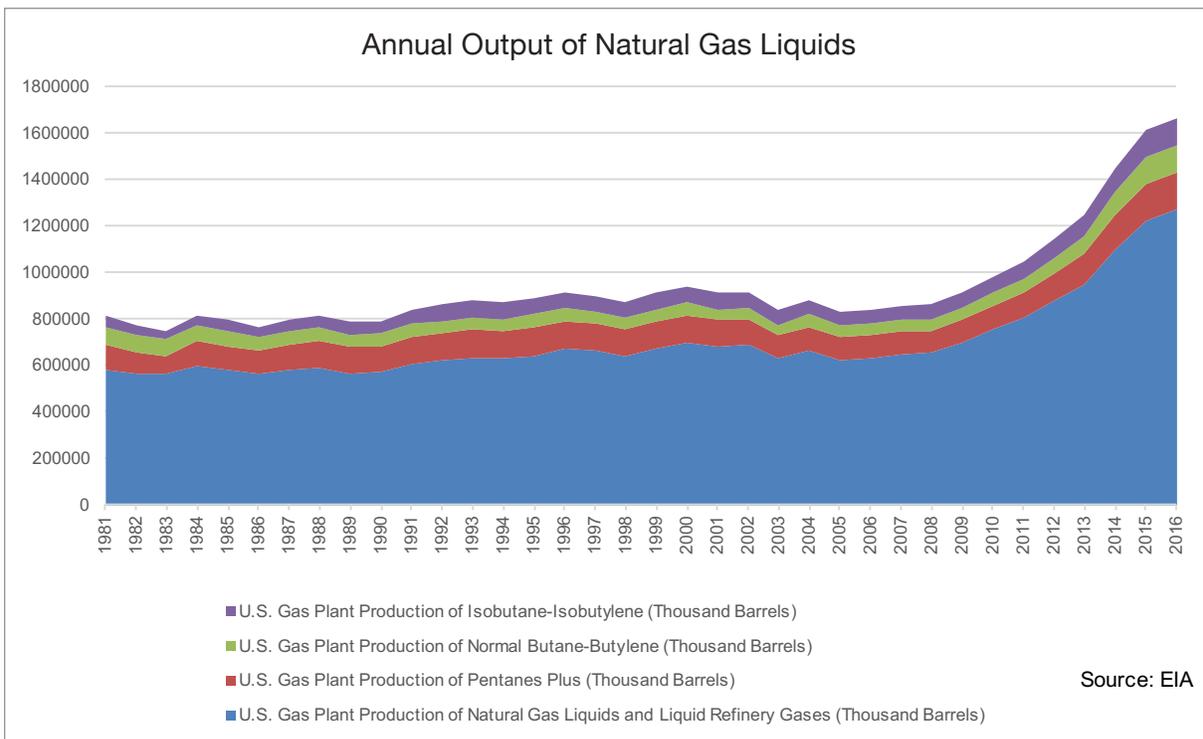
One of those key high-octane components is alkylate, and the amount of projects on the books to build more alkylate units is slim. With only a handful of projects proposed, a meaningful boost to supply is not in the offing.

A key deterrent to alkylate projects is cost. For example, Valero is looking to build a 13,000-b/d alkylation unit at its Houston refinery and the price tag is reportedly in the \$300 million area.

The permitting process for building a new alkylation unit is also daunting. Because the process to make alkylate uses hydrofluoric or sulfuric acid — very dangerous and potentially deadly chemicals — permitting is not easy.

Besides help from the traditional refining process, there is a handful helpful gas liquids that boost octane. The boom in production in that sector may ultimately become a more significant portion of the octane pool.

### The Boom in Gas Liquids Output



Isobutane stands to be one of the key NGLs for boosting octane, and, in the wintertime, normal butane can be a cheap octane booster. But in summer-grade gasoline, normal butane does not work in higher quantities due to its elevated Reid Vapor Pressure content. Isobutane has more versatility, though, even with the boom in NGL output, isobutane only makes up about 10% of the NGL stream.

There are some projects that could help boost supply. Earlier this year, Enterprise announced it was going to build an isobutane dehydrogenation unit at its Mont Belvieu, Texas, facility. The unit's planned capacity is 425,000 tons per year of isobutylene and should be completed by the fourth quarter of 2019. At the time of its announcement, Enterprise said the isobutylene will be used to boost octane-enhancing equipment and petrochemical facilities.

Due to the growth in U.S. oil and gas production, companies have tried to become creative. For example, Marathon was toying with the idea of building a standalone alkylation plant near its MarkWest NGL fractionation facility in Ohio. The concept was to take advantage of some of the local production in the Marcellus shale play.

While the increase in U.S. shale oil and gas has helped bolster the supply of octane-boosting NGLs, there has also been a side effect to the shale boom that has increased demand for higher-octane components.

The shale process has brought about an abundance of the gasoline-blending components naphtha and natural gasoline. However, the naphtha and natural gasoline that come with shale production is considered to be lower quality as it has a low-octane rating.

## Looking Ahead

Although the OEMs are calling for more octane in gasoline, they are not apt to pick winners and losers. OEMs want more octane for gasoline, that much is clear, but do not particularly care where it comes from. There will need to be collaboration among all the key stakeholders, including OEMs, regulators, refiners and agricultural interests, to solve this 21st century octane supply conundrum.

Though OEMs will probably need time for the research and development stage, this process may be somewhat slow moving. Studies show that it takes roughly 12 years (longer during a recession) for the vehicle fleet to turn over in the U.S.

## About the Author



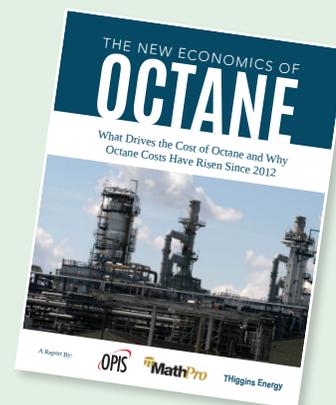
### Denton Cinquegrana, Chief Oil Analyst, OPIS

In more than a decade with OPIS, Denton has covered nearly all markets that OPIS has price discovery for. Before being named Chief Oil Analyst, he was Executive Editor for U.S. Refined Products, overseeing the day-to-day market coverage operations. During his time as a Markets Editor, his primary focus was on the U.S. West Coast. OPIS West Coast prices are heavily benchmarked and the West Coast Spot Market Report relied upon daily publication for gasoline, diesel and jet fuel. He graduated from Rutgers University in 1997 with a degree in Journalism and Mass Media.

## About OPIS

Oil Price Information Service (OPIS) believes there should be complete price transparency across the oil supply chain so that all stakeholders can buy and sell petroleum products confidently. We provide that transparency through educational courses, software tools, real-time news and pricing services, and market-specific benchmark pricing reports. Being a reliable information source with world-class customer service is important to us, as it helps fulfill our mission to enable customers to make smarter, more informed decisions. Navigating oil price volatility is tough — OPIS strives to make it a little easier. OPIS is an IHS Markit company. Learn more at [www.opisnet.com](http://www.opisnet.com).

For a more in-depth look at octane and the factors surrounding the rise in its value, order a copy of OPIS's special report, **The New Economics of Octane**. Written by energy experts with 125+ years of combined energy experience, this 84-page study is packed with insightful analysis and commentary. Examine octane market prices and production costs, assess the relative importance of supply & demand factors to U.S. octane economics and evaluate the outlook for the international octane market by reading this exclusive report.



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