MOTOR FUELS SUPPLY FUNGIBILITY AND MARKET VOLATILITY ANALYSIS

Part 1

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Introduction

In late 2002, the National Association of Convenience Stores (NACS) commissioned Hart Downstream Energy Services (Hart) to conduct a comprehensive analysis of the current gasoline market situation in the United States. NACS' member companies are very susceptible to price volatility and are interested in better understanding fuels policy options that will promote greater marketplace stability through increased fungibility in the gasoline supply and distribution system.

Specifically, NACS inquired about potential problems associated with the continued proliferation of unique, non-fungible federal, state and local fuel blends – commonly referred to as "boutique fuels." NACS requested Hart to analyze the current impact these boutique fuels are having on national and regional markets in the United States and the potential implications in the future. Hart was also commissioned to examine the refining industry's ability to produce sufficient quantities of these fuels, and the ability to distribute and deliver such fuels to the consumer. In addition, NACS requested assistance in the development of legislative and/or regulatory policy options that could aid in reducing the ongoing balkanization of these specialty fuels and, consequently, reduce marketplace volatility.

The Impact of Marketplace Volatility

The retail price of gasoline is perhaps the most recognized consumer price point in the United States. To a large extent, this is the product of a business decision made long ago to post gasoline prices in twenty-four inch numbers on the side of the road. On their drive to and from work, consumers see several of these signs and wonder why prices differ by location, date and sometimes hour.

Market research indicates the level to which consumers are sensitive to changes in the retail price of gasoline. A survey of more than 500 consumers conducted for NACS by Energy Analysts International, Inc. in 2001 found that approximately 40 percent of consumers would change gasoline retailers for a price differential of less than 3 cents per gallon. This sensitivity increases to more than 75 percent when the price differential expands to 7 cents per gallon. And, 59 percent of gasoline consumers surveyed reported they shop for the lowest price.[1]

Compounding this price sensitivity is the recent volatility in retail gasoline markets. Since 2000, the retail price of gasoline has fluctuated wildly. The factors that influence these sudden price fluctuations are often difficult to explain, causing consumer frustration during periods of market volatility.

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[1] Convenience Industry vs Hypermarkets: *Strategies for Competition*, National Association of Convenience Stores, 2001, pg. 14-6.

Figure 1: Weekly U.S. Retail Gasoline Prices (regular grade)

Source: Energy Information Administration

The prevalence of boutique fuels exacerbates this situation by limiting the flexibility of the system to accommodate unexpected changes in supply availability. Not only can product from one market often not be transferred to a neighboring market that has run short of supply, there are times when nearby refineries do not have the available capacity to increase production, let alone respond to niche-market shortages. The result is regional product shortages and price spikes that have been witnessed several times over the past few years.

Two examples illustrate the impact boutique fuels can have on gasoline price volatility.

First, in early August 2003, the 45-year-old Kinder Morgan pipeline that supplies approximately 30 percent of the gasoline sold in the Phoenix, Arizona market shut down. Because Phoenix requires the sale of a niche-market clean gasoline (California RFG or Federal RFG), with approximately 70 percent of supply met by California refiners, the overall U.S. gasoline supply/distribution network was less-able to quickly respond to the pipeline outage and offset any gasoline price increases in the Phoenix area. In order to meet demand, the Phoenix market was forced to pay more than $2.00 per gallon to purchase gasoline away from the California market, driving Phoenix gasoline prices up more than 50 cents in just two weeks. Nearly half of the retail stations and convenience store gasoline sales operations were forced to shut down. The increased pressure brought by Phoenix on California suppliers also tightened the California gasoline market, as well as that of much of the west.

Second, in August 2001, a Midwest refinery caught fire, taking approximately 165,000 barrels per day of refining capacity off the market. This refinery supplied product to the Midwest RFG market, where a specific gasoline/ethanol blend not used elsewhere in the nation is required. Because there is minimal excess capacity in the refining industry, additional RFG volumes could not be rapidly produced to offset the lost production. Furthermore, the unique gasoline specifications required in that market prevented neighboring refineries and terminals from quickly transferring supplemental supply. When unexpected events such as this occur, gasoline supplies run short and consumers pay higher prices for gasoline. In this particular incident, retail gasoline prices rose approximately 20 cents per gallon within two weeks, demonstrating how the limitations in operating capacity and flexibility in the distribution system can have a direct impact on the retail price of gasoline.

However, not all niche-market, boutique fuels have created these problems. The impact is strongly dependent upon the number of refiners supplying a given area. For example, according to the U.S. Environmental Protection Agency (EPA), the 7.8 psi RVP fuel program in eastern Texas has not had supply and price volatility problems due to the large number of refiners serving the area and the large number of fuel distribution options. Conversely, Southeast Michigan, which also requires 7.8 psi RVP fuel, is served primarily by one pipeline and just a couple of refiners and has consistently experienced high prices and price volatility. [2] However, EPA also correctly points out that the continued proliferation of various fuel types needed to be produced and distributed will add more and more stress on the U.S. gasoline distribution system and the ability to meet supply. According to EPA, the refiners and distributors

> "face investment hurdles to stay in existing markets and may choose to avoid the investment and merely narrow their market. This results in fewer fuel producers for any given fuel type. Pipeline capacity is decreased as unique fuel types must be delivered to isolated areas and added constraints are put on delivery schedules leading to a greater likelihood of low product inventories or even outages. Terminals either have to invest to carry more products or choose which products they carry, leading to fewer terminals carrying any particular fuel and again a greater likelihood of supply shortfalls. Marketers are then faced with different fuel requirements for different areas with fewer and less stable supply sources for each fuel. Where they used to be able to go to another terminal for supply during a supply shortfall, that terminal may not be carrying the required type of fuel. In some cases the nearest alternative fuel supply may be hundreds of miles away. This ultimately is reflected in greater price volatility to the consumers."[3]

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[2] Staff White Paper, Study of Unique Gasoline Fuels Blends ("Boutique Fuels"), Effects on Fuel Supply and Distribution and Potential Improvements, U.S. Environmental Protection Agency, October 2001, page 12.

[3] Id. At page 12.

NACS' Interest and Development of the Study

NACS represents one of the sectors of the refining/distribution industry most directly affected by consumer concerns about gasoline price volatility. NACS members bare the brunt of consumer frustration when gasoline prices increase, often forcing NACS members to accept an economic penalty for gasoline price volatility in order to preserve good will with their customers. With this recognition, NACS has approached this *Study* with the intent to investigate options to better understand the interconnection between gasoline supply and fungibility and to evaluate options for reducing the volatility that plagues the market and impacts the consumers.

Among other issues, this *Study* investigated the supply implications of several regulatory scenarios in order to demonstrate the impact of various policy options on both fungibility and supply production capacity, each of which impacts gasoline price volatility. The Flex Cases analyzed do not represent policy recommendations nor do they encompass the full range of policy options available. Rather, they provide a snapshot into the impact of certain potential policy decisions and should be taken in this context.

In developing the parameters of this study, NACS was sensitive to the fact that political considerations associated with certain policies could influence the outcomes. Indeed, NACS' own policy position advocating the removal of MTBE from the nation's gasoline pool is one such issue. NACS therefore took special care to prevent the intrusion of any political preferences in the preparation of this report. While NACS remains committed to its policy advocating the removal of MTBE, NACS also recognizes that doing so will result in supply challenges and that the role of MTBE in the gasoline system must be fully expressed in order to understand the conditions of the system and the implications of its removal.

Some readers might think that the *Study's* modeling regarding MTBE's presence in the market is inappropriate given current political pressures and state and federal legislative actions to ban its use. However, to omit such analyses would be to turn a blind eye to a significant factor affecting the future fuels marketplace. Reporting such information in this study in no way diminishes NACS' position relative to the future use of MTBE, but it does provide the reader with a comprehensive analysis of the gasoline system, which is necessary to reach informed conclusions and promote reasonable discussion.

Finally, NACS began the process of analyzing the boutique fuels situation by adopting three hypotheses which would guide the project to completion. These included:

- The proliferation of unique, regulatory fuel blends into specific markets is a major contributing factor to gasoline price volatility.
- Reducing the number of boutique fuel islands will restore flexibility to the distribution system and reduce the incidence of regional supply shortages and price spikes.
- The relationship between supply production capacity and consumer demand provides guidance to assessing the impact of policy options on gasoline prices.

From these hypotheses, decisions were made regarding the models which were to be run, the nature in which the report would be presented, and which policy considerations were recommended.

NACS fully believes that the domestic gasoline production and distribution system is operating under considerable strain and that, without a comprehensive policy adjustment to the regulation of motor fuels, it will continue to tighten and create more problems in the future. This "Motor Fuels Supply Fungibility and Market Volatility Analysis" is proposed to be a useful tool to help develop the appropriate comprehensive policy adjustments to benefit both the petroleum industry and the gasoline consumer.

Peer Review Acknowledgement

Upon completion of the original draft, NACS reached out to other experts within the petroleum community for their reactions to the report. The peer review comments received by NACS highlighted several areas in the original draft that required more explanation and/or exploration, and identified those areas in which errors had been made. In many cases, the comments are reflected throughout this final report. Where appropriate, the issues are addressed directly in the text. Other times, readers are referred to the Appendix for a more detailed examination of the issue than is appropriate for inclusion within the actual text.

All peer review comments are completely reproduced, as submitted, in the Appendix to this report. In addition, comments and suggestions that are not incorporated into the study itself are addressed in the Peer Review Section and noted as "Responses to Review Comments."

NACS extends its sincere appreciation to the following for their time and efforts in providing comments on this study:

American Petroleum Institute
Association of Oil Pipelines
National Petrochemical and Refiners Association
U.S. Environmental Protection Agency
U.S. Department of Energy
U.S. Energy Information Administration

The comments submitted by the above organizations have benefited the quality of the study and will serve to improve the policy discussions relevant to the issue of boutique fuels.

Executive Summary

In 1990, gasoline sold in the United States was distinguished only by three grades (regular, midgrade and premium) and volatility restrictions in two geographies (northern and southern) and two seasons (winter and summer). Today, the number of different U.S. gasoline blends has increased to no fewer than 15 (excluding the various octane grades). These new and varied gasoline formulations have proliferated over the intervening years primarily due to more restrictive federal, state and local air quality standards

In late 2002, the National Association of Convenience Stores (NACS) asked Hart Downstream Energy Services (Hart) to conduct a comprehensive analysis of the current gasoline market situation in the United States. NACS inquired about potential problems associated with the continued proliferation of unique, non-fungible federal, state and local fuel blends – commonly referred to as "boutique fuels." NACS requested Hart to analyze the current impact these boutique fuels are having on national and regional markets in the United States and the refining industry's ability to produce, distribute and deliver sufficient quantities of these fuels to the consuming public.

In particular, NACS was interested in assessing the impact of various regulatory scenarios on four primary criteria: overall gasoline supply, gasoline fungibility, ultimate costs to the consumer and environmental quality. To lay the foundation for this analysis, NACS requested that Hart examine the following eight cases:

- <u>Baseline Analysis 2001</u>: A characterization of the current "state of the refining industry" in terms of regional gasoline supply, demand and quality, and overall refining operations and production capability.
- <u>Baseline Analysis 2007</u>: Extends the 2001 Baseline through 2007 incorporating those market, regulatory and refining changes that are expected to occur. Baseline 2007 assumes state bans of MTBE in California, Connecticut and New York are implemented, the RFG oxygen standard remains in place and no renewable fuel standard is imposed. In addition, this Baseline assumes the implementation of Tier 2 sulfur standards for gasoline, the Mobile Source Air Toxics (MSAT) program and the ultra-low sulfur diesel rule
- <u>Flex Case 1 – No MTBE Bans</u>: Models market conditions if California, Connecticut and New York did not ban MTBE. Assumes the RFG oxygen standard remains in place and no renewable fuel standard.
- <u>Flex Case 2 – Based on House Energy Bill (H.R. 6)</u>: Assumes implementation of an MTBE ban in California, Connecticut and New York, without the RFG oxygen standard in place and with implementation of a renewable fuel standard.
- <u>Flex Case 3 – Based on Senate Energy Bill (S. 14)</u>: Assumes a Federal MTBE ban, without the RFG oxygen standard and with implementation of a renewable fuel standard.
- <u>Flex Case 4 – Four Fuels Program</u>: Assumes a Federal MTBE ban, with the RFG oxygen standard in place and no renewable fuel standard. Conventional gasoline

RVP grades are consolidated into one RVP grade. All RFG is consolidated into a single oxygen content grade.

- Flex Case 5 – Regional Fuels Program: Assumes implementation of an MTBE ban in California, Connecticut and New York, without the RFG oxygen standard in place and with implementation of a renewable fuel standard. Conventional gasoline RVP grades are consolidated into two RVP grades in each PADD (7.0 and 9.0 psi for PADDs 1, 3, 5 and 9.0 psi for PADD 2).
- Flex Case 6 – RFG Only Program: Assumes implementation of an MTBE ban in California, Connecticut and New York, without the RFG oxygen standard in place and no renewable fuel standard. Conventional gasoline is consolidated to meet RFG specifications.

Current Market Conditions

A comparison of the various U.S. summertime gasoline blends currently required in different parts of the country shows that the top four summertime blends represent approximately 83 percent of the U.S. gasoline market, while most blends are much less common, interchangeable and fungible; each representing only a small market, as well as a small portion of the U.S. gasoline pool.

Most of these gasoline blends are not fully fungible with other gasoline blends for a variety of reasons, including:

- Gasoline blended with ethanol cannot be mixed with other gasoline blends in the common carrier pipeline system or gasoline storage tanks.
- Low-RVP gasolines, while providing a less expensive way than RFG for localities to obtain air quality improvements, place additional strain on the distribution system.
- Seasonal changes to gasoline formulations (i.e. winter-to-summer transition) can reduce refiner flexibility, gasoline fungibility and distribution efficiency.
- Market-specific fuel requirements often prohibit the transfer of product from one region to another, thereby exacerbating gasoline shortages and regional price increases during supply disruptions.
- Segmenting the U.S. gasoline system means that fewer domestic and international refiners are able to provide product meeting the various clean-fuel requirements. This limitation on available gasoline supply prevents rapid response from neighboring refineries and/or gasoline terminals in the event of a capacity shortage, further pressuring the refining system and driving up gasoline prices.

Further complicating the boutique fuel issue is the overall reduction in U.S. refining capacity. Since 1981, the total number of refineries in the U.S. has fallen from 324 to only 149. Meanwhile, domestic refineries operate today at approximately 93 percent of maximum capacity.

Net oil imports are expected to increase from about 55 percent of U.S. oil consumption in 2001, to approximately 68 percent by 2025. Additionally, U.S. gasoline consumption is projected to rise from 8.7 million barrels per day in 2001 to 13.8 million barrels per day in 2025, with gasoline imports continuing to increase. Today, more than five percent of America's motor gasoline supply is imported; nearly all of that directly to the Northeast market.

Considering the nation's maximized operational capacity, increased reliance on imported oil, and strained refining infrastructure, any complicating factors in the gasoline distribution chain, refining outages, or multiple small-market fuel formulations can easily impact overall supply and consumer costs. Further, overall gasoline demand is expected to continue to grow at rates greater than two percent annually over the near-term, particularly in the Northeast U.S. – one of the regions most sensitive to gasoline supply volatility and price impacts due to its reliance on imports.

Many in the refining industry, environmental community, and government, as well as consumer groups, have called for a reasonable, gradual and consistent approach to implementing fuels standards.

Summary of Findings

Recognizing the ongoing public policy debate over fuels issues, NACS requested an examination of several possible real-world scenarios that would potentially impact current U.S. gasoline supply, distribution and delivery. The following summaries outline the impact on gasoline supply compared to the projected production capacity of Base Case 2007. Analyzing such production capacities provides valuable insight into the potential balance between supply and demand and the nation's projected reliance on imported gasoline, each of which can ultimately influence consumer costs.

While striving to preserve current air quality (a prerequisite in any fuels regulatory endeavor), the models produced two generally competing findings that should be carefully balanced in any future policy changes to the U.S. gasoline system: 1). Overall reduction in the number of gasoline formulations required throughout the nation can be expected to improve overall system fungibility and potentially reduce marketplace volatility associated with boutique fuels; and 2). Decreasing the number of fuel formulations reduces the domestic refining system's capacity to produce compliant fuels.

In general, findings included:

Production

- Base Case 2007: Growth in gasoline demand will continue to outpace domestic refining production capability. By 2007 the domestic gasoline shortfall (or reliance on imported product) will increase by 987 thousand barrels per day over 2001. Refinery capacity expansion will be necessary and utilization will approach the maximum.

- Flex Case 1 – No MTBE Bans: Gasoline production is 2.4 percent higher from the Baseline 2007. With no state MTBE bans, total MTBE use increased by 160 thousand barrels per day and ethanol use decreased by 65 thousand barrels per day.
- Flex Case 2 – Based on House Energy Bill (H.R. 6): Gasoline production is reduced 0.6 percent from Baseline 2007. With state MTBE bans as in Baseline 2007, with an RFS, but with no oxygen standard, MTBE blending is reduced by 35 thousand barrels per day versus the Baseline and ethanol increased by 50 thousand barrels per day to satisfy the renewable standard.
- Flex Case 3 – Based on Senate Energy Bill (S. 14): Gasoline production is reduced 5 percent from Baseline 2007. This case examined a national MTBE ban, coupled with an RFS and no oxygen standard. This resulted in the removal of 160 thousand barrels per day of MTBE from the gasoline pool. Ethanol use is roughly the same as Flex Case 2 to satisfy the renewable standard.
- Flex Case 4 – Four Fuels Program: Total gasoline production is reduced 16 percent from Baseline 2007. In this Flex Case, ethanol must be used in RFG to satisfy the RFG oxygen requirement, which remains in place. Gasoline production capability is further curtailed as a result of the additional requirement to lower the RVP of a large portion of the conventional gasoline.
- Flex Case 5 – Regional Fuels Program: Gasoline production is reduced 4.5 percent from Baseline 2007. This case considers the state MTBE bans and the oxygen standard of Flex Case 2. The additional requirement to consolidate conventional gasoline by reducing RVP of the higher volatility grades further reduces gasoline production (beyond Flex Case 2) by about 330 thousand barrels per day.
- Flex Case 6 – RFG Only Program: Gasoline production capability is reduced by about 9 percent over the 2007 Baseline. This Case represents the state MTBE bans without an RFG oxygen or renewable fuel standard. In addition, all gasoline is produced at RFG quality. The RFG requirements result in slightly higher ethanol use to ensure RFG quality. The more stringent RFG standards severely constrain gasoline production capability. However, increased MTBE use outside the ban areas makes up volume and minimizes production loss. Total MTBE use was 275 thousand barrels per day (only 115 thousand barrels per day above Baseline 2007).

These findings demonstrate that all future regulatory scenarios to a varying degree have the potential to reduce the nation's ability to produce sufficient quantities of gasoline to meet demand and, consequently, to increase the nation's reliance on gasoline imports. The analysis indicates that, under the given conditions, Flex Case 1 would have the most positive impact on the nation's supply balance while Flex Case 4 would have the worst impact. The Flex Cases rank according to the 2007 Base Case as shown in Table 1.

Table 1: Gasoline Production, Imports and Percent Change in Flex Cases

Case	**Net Production** *(MBPD)*	**Incremental Imports Needed** *(MBPD)*	**% Change in Production Relative to Baseline**
2007 Baseline	7,915	-	-
Flex Case 1	8,107	-192	2.4%
Flex Case 2	7,864	51	-0.6%
Flex Case 5	7,560	355	-4.5%
Flex Case 3	7,513	402	-5.1%
Flex Case 6	7,217	698	-8.8%
Flex Case 4	6,672	1243	-15.7%

This analysis further provides an indication of how each Flex Case *may* impact the ultimate price paid by the consumer. In general, the more out of balance the supply-demand relationship, and the greater the nation's reliance on imported gasoline, the more susceptible the consumer will be to higher gasoline prices. To this end, it can be assumed that the same rankings applied to production capacity and import reliance could also be applied to anticipated consumer prices.

Fungibility

Assuming the environmental impact of each Flex Case is constant or improved over Base Case, the final criteria of concern remains gasoline fungibility. An analysis of the Flex Case descriptions renders the following comparison in terms of impact on fungibility:

- Flex Case 1 – No MTBE Bans: Improves fuel fungibility and overall product availability by eliminating the pending California, New York and Connecticut bans on the fuel additive MTBE. In the Northeast, the product distribution infrastructure will be less stressed by not having to deliver segregated MTBE- and non-MTBE-gasolines to various markets in the region. In addition, the market will not have to accommodate two distinct oxygenates, one of which (ethanol) cannot be shipped in the pipeline. California likewise will not have to transport an oxygenate outside of the pipeline and will experience improved fungibility over Base Line.

- Flex Case 2 – Based on House Energy Bill (H.R. 6): Loosely modeled on the House passed energy bill (H.R. 6), this case examines an elimination of the RFG oxygenate mandate and an implementation of a renewable fuels standard. Like Base Line 2007, state MTBE bans remain in place, which reduces fungibility. The repeal of the oxygenate mandate could add additional flexibility to the system, but the presence of oxygenated and non-oxygenated RFG could also pose a fungibility challenge as the two fuels may not be commingled in storage tanks.

- Flex Case 3 – Based on Senate Energy Bill (S. 14): Loosely modeled on the Senate energy bill (S. 14), this case is similar to Flex Case #2 with the exception of a national ban on MTBE. The legislation simplifies the distribution system by removing the state-by-state bans on MTBE, thereby restoring fungibility.

- Flex Case 4 – Four Fuels Program: Along with Flex Case #6, perhaps the most fungible of the cases modeled, this case includes a national ban of MTBE, thereby removing the distribution challenges imposed by independent state actions. In addition, the model consolidates all conventional gasoline into one RVP grade and yields only one RFG formulation—ethanol-RFG. Distribution challenges arise with the delivery of ethanol throughout the nation.

- Flex Case 5 – Regional Fuels Program: Establishes a regional fuels program that will improve fungibility within each PADD, consolidating conventional gasoline to two RVP formulations and RFG, thereby simplifying the distribution system and restoring a large degree of fungibility.

- Flex Case 6 – RFG Only Program: Along with Flex Case #4, perhaps the most fungible of the cases modeled, this case eliminates all conventional gasoline and creates a market in which only RFG (northern, southern and California) is allowed in the market. Ethanol- and MTBE-RFG markets are regionally segregated, thereby limiting the distribution challenges to accommodate these two fuels.

The above analysis clearly indicates that restoring fungibility to the system will require a compromise in terms of production capacity and reliance on foreign product. As the more fungible cases were run through the model, production capacity of the domestic refining industry was sacrificed. The two most fungible cases (#4 and #6) produced the greatest reduction in production capacity and reliance on imported gasoline. The case with the most positive impact on production capacity (#1) is likely politically unrealistic due to current debate over the expanded use of ethanol and restricted use of MTBE.

The challenge for developing a new fuels program is to simultaneously assess the impact on production capacity with that of fungibility and determine the best overall solution for the market. This report provides the foundation for such an analysis.

Based on these findings, NACS presents to policymakers the following fundamental concepts that must be addressed when developing a comprehensive fuels policy:

1) Recognize that fuel "Balkanization" is a growing problem that contributes to price volatility;
2) Acknowledge that domestic gasoline supply will continue to contract;
3) Ensure that imports of finished gasoline are not restricted;
4) Develop a coordinated refining industry policy to promote domestic capacity expansion; and
5) Develop a coordinated distribution infrastructure policy to facilitate the efficient delivery of product to retail.

NACS looks forwad to working closely with the policymakers and other leaders in the fuel refining and distribution system to developo a coordinated, thoughtful approach that ensures government and industry work together toward a reasonable motor fuels policy.

Overview of the Proliferation of Boutique Fuels in the US

In general, gasoline is a fungible commodity with a large number of producers competing in the marketplace on price. This was especially true prior to 1990, when gasoline was distinguished only by grade (e.g. regular, midgrade, premium) and northern and southern, as well as winter and summer, volatility restrictions. Today, however, concerns about gasoline fungibility and price volatility have grown as the number of different U.S. gasoline blends has increased to no fewer than 15 (excluding the various octane grades). The proliferation of new gasoline blends is primarily the result of new federal, state and local air and fuel quality regulations. However, in some cases, individual refiners may have taken advantage of gasoline product differentiation strategies (e.g., gasoline blend and/or fuel additive packages) as a way to move away from a homogenous commodity market and create preference for specific products that command higher prices. The combination of these two drivers has led to a fragmentation of the domestic motor fuels market.

The development of boutique fuels occurred in two principal, parallel stages:

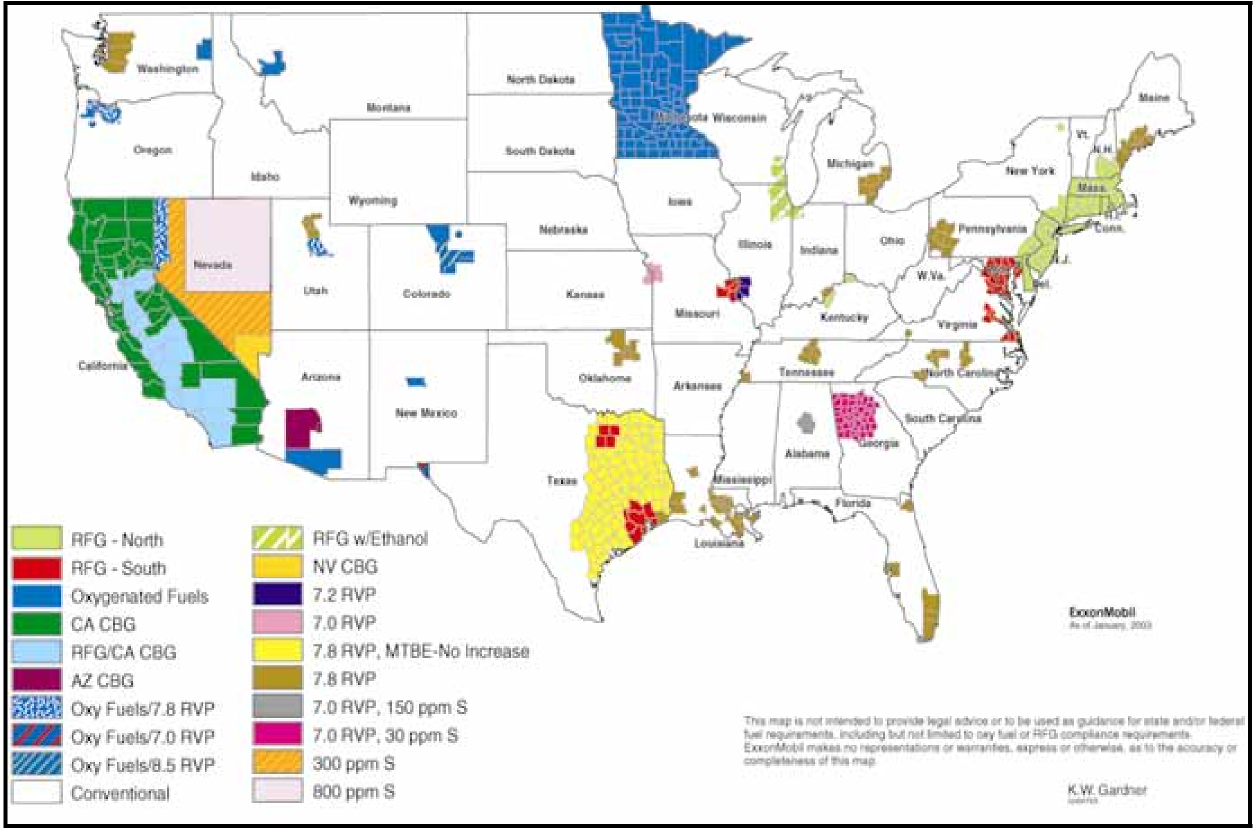
1. The Clean Air Act Amendments of 1990 created oxygenated gasoline and reformulated gasoline (RFG) blends, moving the U.S. gasoline system to three distinct formulations of gasoline (conventional, oxygenated and reformulated). Each of these gasoline formulations is also available in three grades, with volatility distinctions between northern/southern and summer/winter blends.
2. As States developed their State Implementation Plans (SIPS) to improve air quality, many were presented with evidence that they could achieve significant reductions in air emissions by requiring a low-RVP conventional gasoline, instead of RFG. In addition, California found it needed to use a cleaner fuel than Federal RFG (California RFG, or CaRFG), and the Midwest created a unique ethanol-blended RFG.

As a result, a “patchwork quilt” of gasolines – RFG, oxygenated and conventional gasolines, several low-RVP conventional gasolines, CaRFG and ethanol-blended RFG – is now required to be sold in various markets throughout the United States. The end-result of the various fuel requirements is represented in Figure 2.

Overall concerns about the proliferation of boutique fuels and their impact on supply and price stability have reached the highest levels of U.S. government interest in recent years.

The President's National Energy Plan called for an exploration of "ways to increase the flexibility of the fuels distribution infrastructure, improve fungibility, and provide added gasoline market liquidity." Following a White House directive, in 2001, the U.S. Environmental Protection Agency (EPA) released a report examining the “opportunities to maintain or improve the environmental benefits of state and local ‘boutique’ clean fuel programs while exploring ways to increase the flexibility of the fuels distribution infrastructure, improve fungibility, and provide added gasoline market liquidity..."[4]

Figure 2: US Gasoline Requirements



This map is not intended to provide legal advice or to be used as guidance for state and/or federal fuel requirements, including but not limited to oxy fuel or RFG compliance requirements. ExxonMobil makes no representations or warranties, express or otherwise, as to the accuracy or completeness of this map.

Source: ExxonMobil

Among the more notable EPA findings[5]:

- There is a growth in the number of state and local boutique fuels programs different from the federal RFG program and this growth presents challenges to the gasoline system.
- If there is a disruption, such as a pipeline break or refinery fire, it becomes difficult to move gasoline supplies around the country because of constraints created by these boutique fuel requirements.
- While the entire fuel market is being stressed by supply and demand forces, the markets where the most acute problems (supply shortfalls and price volatility) tend to appear first are those with unique, geographically isolated fuel programs

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[4] "Staff White Paper, Study of Unique Gasoline Fuel Blends ("Boutique Fuels"), Effects on Fuel Supply and Distribution and Potential Improvements," U.S. Environmental Protection Agency, EPA420-P-01-004, October 2001, page 3.

[5] Id.

such as the state boutique fuel programs. These fuels typically have fewer fuel producers, are less fungible, and have fewer distribution system supply options.

- The continued growth in the number of fuel types needed to be produced and distributed adds greater stress to the distribution system and further reduces supply flexibility. Fuel producers, both foreign and domestic, face investment hurdles to stay in existing niche markets and may choose to avoid the investment and merely narrow their market. This will result in fewer fuel producers for any given fuel type.
- Marketers are then faced with different fuel requirements for different areas with fewer and less stable supply sources for each fuel. Where they were once able to go to another terminal for product during a supply shortfall, that alternate terminal may not carry the required type of fuel. In some cases the nearest alternative fuel supplier may be hundreds of miles away. This ultimately is reflected in greater price volatility to the consumers.
- There is a fear that the resulting growth in the number of boutique fuels could change what is now an occasional and isolated supply problem into a much broader and frequent problem which will require significant investment on the part of the fuel production and distribution systems to address.
- With these systems operating near capacity, when the market tightens for whatever reason (e.g., refinery shutdown, pipeline failure, winter-to-summer transition, or unusually high demand), the system has a limited ability to respond and overcome the disruption. These tight market conditions manifest themselves in increased fuel prices and price volatility for consumers.

In January 2002, the American Petroleum Institute (API) released a document outlining their desire for federal legislation to revise the U.S. gasoline market. Among the principles API supported was a "reduction in the number of fuels from 15 to 5."[6] Many refining companies have expressed similar concern. J.S. Carter, ExxonMobil's Regional Director told a U.S. Senate Committee on April 30, 2002:

> There are three main causes of gasoline price volatility: changes in crude oil prices, market transparency, and the proliferation of fuel specifications…. Today's many "boutique" gasoline specifications place significant demands on the refining industry. Summer grades are more difficult and expensive to make because they require additional processing to meet environmental standards. This reduces refining capacity in summer, when demand is highest. A disruption at a single refinery can quickly upset the balance. Boutique gasolines also present logistics challenges. They limit distribution system flexibility and reduce interchangeability of supply among terminals.[7]

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[6] "Framework for Legislation," American Petroleum Institute, January 27, 2002.

[7] Statement of J. S. Carter, Regional Director, United States, ExxonMobil Fuels Marketing Company before the Senate Permanent Subcommittee on Investigations, April 30, 2002.

James Nokes, Executive Vice President of ConocoPhillips reported to the Independent Liquid Terminals Association on June, 10, 2002 that the United States needed:

> … a gradual, reasonable, and consistent approach to implementing cleaner fuels standards. Such an approach would decrease the likelihood of sudden shortages and sharply higher prices, which hurt the consumer. But achieving this type of approach will not be easy. Take the issue of boutique fuels, for example. Currently, there are 45 grades of gasoline being used throughout the United States because of various federal and state regulatory requirements. The results of this fragmentation…are predictable. Obviously, it is more expensive to produce designer fuels in the first place. In the second place, reducing the fungibility of gasoline grades makes it harder to respond to sudden shortages. Where grade requirements differ, you can't simply ship gas from one area of the country to another, because it's not formulated to meet local requirements. Consequently, areas that have boutique fuels requirements, like California and the Midwest, are prone to supply crunches and dramatic increases in the price of gasoline.[8]

In May 2001, the Natural Resources Defense Council also recognized the problems associated with boutique fuels, along with balancing the need to maintain air quality, stating:

> The Bush energy plan seeks to reduce the number of so-called "boutique" fuels that are sold in many regions of the country to help battle air pollution. NRDC supports a shift to a regional or national specification for reformulated gasoline -- so long as this common-sense approach does not compromise critical health protections provided by cleaner gasoline. NRDC does not support allowing dirtier fuels simply to increase oil company profits.[9]

As the above testimonies demonstrate, the proliferation of so many different gasoline blends causes two significant problems for the nation's gasoline supply: 1). Limitations to gasoline fungibility; and 2). Reductions in U.S. refining capacity. Each of these particular issues is examined more closely below.

Limitations to Gasoline Fungibility

Each of the more than 15 different gasoline blends may require different treatment, from refining processing to pipeline transport to storage, necessitating that each fuel blend be handled, shipped and/or stored separately from another blend. This constraint means gasoline blends are not interchangeable – one particular gasoline formulation sold in one market may not be sold in a neighboring market. Any limitation on gasoline fungibility

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[8] Keynote Address of Jim Nokes, *Executive Vice President*, Refining, Marketing, Supply and Transportation, Conoco, Inc., Before the Independent Liquid Terminals Association, June 10, 2002.

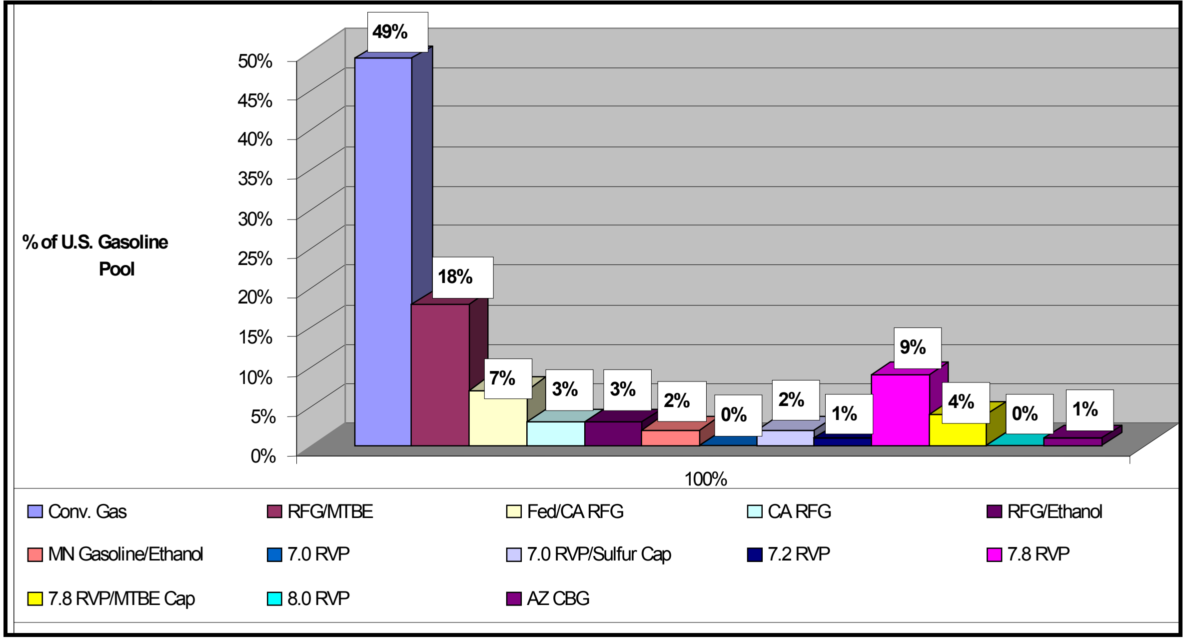
[9] "Slower, Costlier and Dirtier: A Critique of the Bush Energy Plan," Natural Resources Defense Council, May 17, 2001

ultimately increases operating costs and overall pressure on the gasoline supply system. Ideally, gasoline should be fully fungible; meaning that it can be:

- Shipped with other fungible product in common carrier pipelines and ocean-going vessels;
- Commingled in common community gasoline storage tanks;
- Commingled with other gasoline blends as necessary;
- Fully transferable between various gasoline markets;
- Available for sale/distribution in large volume markets;
- Able to maintain a low market cost;
- Produced by many gasoline producers (domestic and international);
- Made to achieve large emission reductions.

A quick comparison of just some of the U.S. summertime gasoline blends currently required shows that the top four blends represent approximately 83 percent of the U.S. gasoline market, while most blends represent only a small market, as well as a small overall portion of the U.S. gasoline pool (see Figure 3).

Figure 3: Comparison of US Summertime Gasoline Blends[10]



Compiled by Hart Downstream Energy Services from EIA, US Census & Dewitt

Most of the various gasoline blends represented in Table 2 are not fully fungible with other gasoline blends and, therefore, could lead to increased market volatility. For example:

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[10] Figure 2 does not represent the following fuels: 1). Wintertime oxygenated gasoline; 2). Nevada Clean Burning Gasoline; 3). The distinction between Northern and Southern RFG; and 4). Gasoline blends with specific sulfur content limitation of 300 ppm and 800 ppm, respectively.

1. When ethanol is blended in gasoline, the resulting blend cannot be mixed with other gasoline blends in the common carrier pipeline system or gasoline storage tanks because ethanol cannot be commingled with non-ethanol RFG. This prevents substitution flexibility in the gasoline market system.
2. Most of the various gasoline blends found in Table 2 represent less than 7 percent of the overall gasoline supply in the United States. These small market fuels put tremendous stress on the nation's gasoline distribution infrastructure, which must keep the blends segregated for delivery to specific markets along the system. Like the refining sector, the distribution system has limited excess capacity and minimal flexibility available to accommodate additional fuel requirements or to respond to market-specific supply variations and unanticipated supply disruptions. This, in turn, drives up market prices.
3. The proliferation of low RVP fuels exasperates gasoline supply tightness by shrinking supplies during a capacity limited market and inhibiting the efficient transfer of product between markets.
4. As the U.S. gasoline system becomes increasingly segmented – or balkanized – fewer domestic and international refiners are able to provide gasoline meeting the various clean-fuel requirements for all markets. This limitation on available gasoline supply prevents rapid response from neighboring refineries and/or gasoline terminals in the event of a product shortage, further pressuring the refining system and driving up gasoline prices.
5. Those states that attempted to contain gasoline prices by adopting various low-RVP types instead of RFG, inadvertently traded gasoline production cost savings for distribution system strain. In some instances, this translated to more potential for price volatility.

The winter fuel supply must be completely emptied before the summer fuel grade is added to tanks and other storage, further stressing the market. Seasonal changes to gasoline formulations (i.e. winter-to-summer transition) also impact refiner flexibility and gasoline fungibility. Some areas of the country require the use of oxygen in gasoline in the winter months to help reduce carbon monoxide pollution. Because many of these areas require the use of ethanol to meet this requirement, some refiners must overcome problems associated with transporting ethanol. Additionally, blending ethanol in the "shoulder seasons" of spring and fall can present some emission control issues. In other areas, gasoline formulations in the summer require lower RVP specifications than those required during the winter. The phase-in of these cleaner, more expensive gasoline blends often causes artificial supply shortages and regional price spikes.

The balkanization of the U.S. gasoline market can also stress the nation's gasoline distribution infrastructure. Like the refining sector, the distribution system (pipelines, storage tanks, and truck rack distribution terminals) has limited excess capacity and minimal flexibility available to accommodate additional fuel requirements or to respond to market-specific supply variations and unanticipated disruptions. According to comments submitted by the Association of Oil Pipelines, as more fuels come onto the market,

> the pipelines may ultimately not be able to carry all the fuel grades produced. Each new fuel adds to the strain on pipeline capacity because there is always some intermixing between batched fuels (interface), some of which may be downgraded to the least valuable product (e.g. premium and regular gasoline interface goes to regular gasoline) and some of which cannot be used because it is off-spec for either product. The smaller the batches being tendered on the pipeline systems, the greater the amount of interface in proportion to the batch. Unless enough of a specialized product is needed to make the transport and product loss worthwhile, it may not make sense to transport it by pipeline. Thus, the smaller the market needing specialized product, the less likely it is to be carried by pipeline. It may therefore have to reach the market by other means.

All this is occurring in an era in which it is becoming increasingly difficult to get government approval for new pipeline projects. And, the need for additional gasoline storage tanks continues to grow as more fuels need to be segregated. The U.S. distribution network is represented in Figure 4.

Figure 4: U.S. Gasoline Distribution System

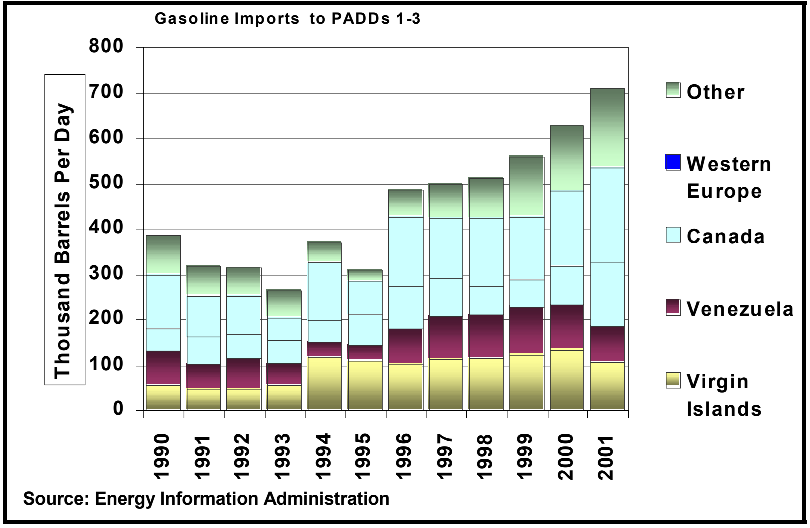
Graphic: Courtesy of NACS National Association of Convenience Stores
© Copyright 2000 PennWell MAPSearch (used with permission)

A recent example of the stress placed on the refining distribution network occurred in August 2001 when a Midwest refinery caught fire, taking approximately 165,000 barrels per day of refining capacity off the market. This refinery supplied product to the Midwest RFG market, where a specific gasoline/ethanol blend not used elsewhere in the nation is required. Because there is minimal excess capacity in the refining industry, additional RFG volumes could not be rapidly produced to offset the lost production. Furthermore, the unique gasoline specifications required in that market prevented neighboring refineries and terminals from quickly transferring supplemental supply. When unexpected events such as this occur, gasoline supplies run short and consumers pay higher prices for gasoline. In this particular incident, retail gasoline prices rose approximately 20 cents per gallon within two weeks, demonstrating how the limitations in operating capacity and flexibility in the distribution system can have a direct impact on the retail price of gasoline.

Reductions in U.S. Refining Capacity

The Department of Energy reports that net oil imports will increase from about 55 percent of U.S. oil consumption in 2001, to approximately 68 percent by 2025.[11] Additionally, U.S. gasoline consumption is projected to rise from 8.7 million barrels per day in 2001 to 13.8 million barrels per day in 2025,[12] with gasoline imports continuing to increase. Today, more than five percent of the motor gasoline is imported; nearly all of that directly to the sensitive Northeast market. This additional imported fuel has helped the U.S. meet growing demand without adding significant new refining capacity. The combination of increasingly complex U.S. fuel specifications and further expansion of small market, boutique fuels will likely diminish the availability of imported refined products. Export European refineries will endeavor to find outlets in the U.S. for their excess gasoline production but volumes may not be sufficient to cover losses from other importers (see Figure 5)[13] who may have the capacity but not the complexity to deliver fuels with exacting specifications. Overall, U.S. gasoline supply will become increasingly susceptible to international, regional and political volatility.

Figure 5: Gasoline Imports Into Atlantic Basin



Source: Energy Information Administration

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[11] *Annual Energy Outlook 2003 with Projection to 2025: Market Trends Oil and Natural Gas*, Energy Information Administration, Report #:DOE/EIA-0383(2003).

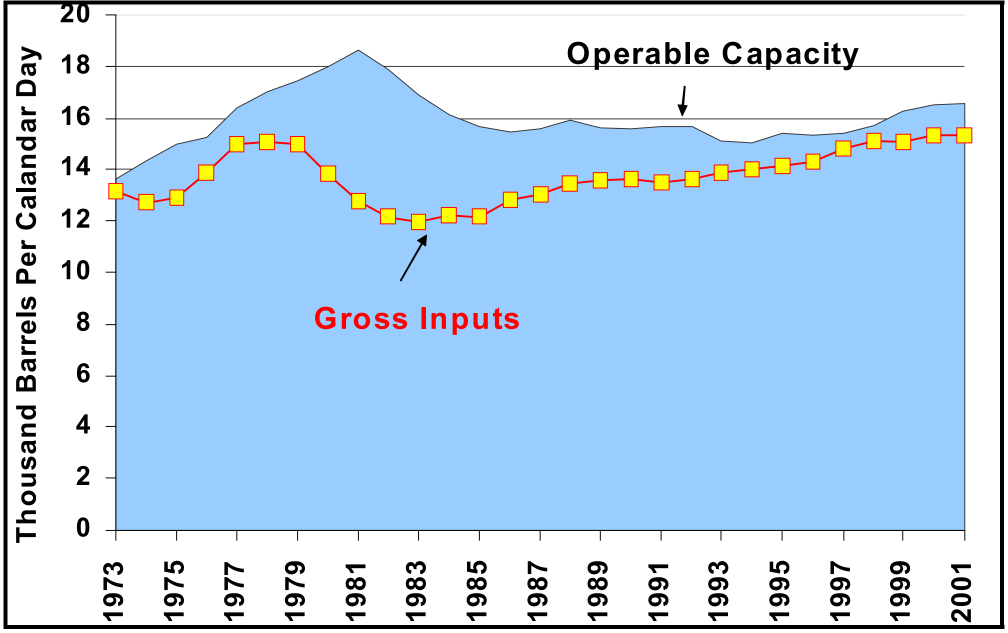
[12] Id.

[13] Gasoline Type Proliferation and Price Volatility, Energy Information Administration, September 2002, p 4; and Joanne Shore, Energy Information Administration, Presentation before the OPIS National Supply Summit, San Antonio, Texas, October 2002.

Since 1981, the total number of refineries in the U.S. has fallen from 324 to only 149 today. Domestic refineries operate today at approximately 93 percent of maximum capacity (see Figure 6)[14]. Production output may continue to decline while operational capacity remains at peak as smaller, regional U.S. refineries in the Midwest, East Coast and Rocky Mountain region struggle to remain on-line as a result of ever restrictive and expensive clean fuel regulations.

Of particular note is the fact that many refiners have struggled to remain online due to the investment costs associated with complying with new federal and state regulations, including regulations designed to improve air quality. According to EIA, since 1987, "about 1.6 million barrels per day of capacity has been closed. This represents almost 10% of today's capacity of 16.8 million barrels per calendar day… and closures are expected to continue in future years. Our estimate is that closures will occur between now and 2007 at a rate of about 50-70 MB/CD per year…All refineries face investments…But smaller refiners may find their lack of economies of scale and the size of the investments required put them at a competitive disadvantage and would keep them from earning the returns needed to stay in business."[15]

Figure 6: US Operable Capacity and Gross Inputs



Source: US Energy Information Administration

Considering the nation's maximized operational capacity, increased reliance on imported oil, and strained refining infrastructure, any complicating factors in the gasoline

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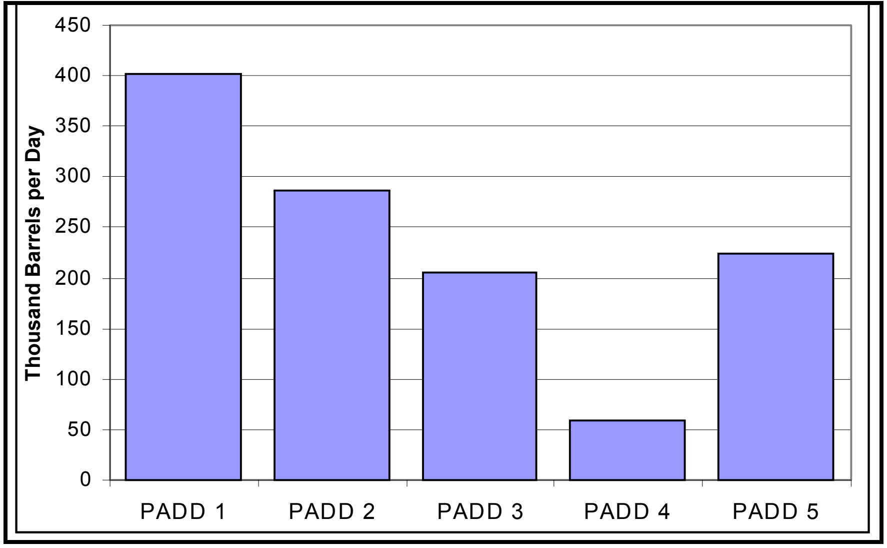
[14] The typical U.S. industry average operational capacity is approximately 82 percent.

[15] Supply Impact of Losing MTBE and Using Ethanol, Joanne Shore, Energy Information Administration, October 2002.

distribution chain, refining outages, or multiple small-market fuel formulations can easily impact overall supply and consumer costs. Further, overall gasoline demand is expected to continue to grow at rates greater than two percent annually over the near-term, particularly in the Northeast U.S. – one of the regions most sensitive to gasoline supply volatility and price impacts due to its reliance on imports (see Figure 7).

Figure 7: Potential Increases in Gasoline Demand (2001 – 2007)[16]



Source: Energy Information Administration

Several additional factors further complicate the U.S. refining capacity outlook.

MTBE, Ethanol & the Oxygen Standard:

Concern over MTBE's potential to contaminate groundwater when gasoline containing the fuel additive leaks from gasoline storage containers or is spilled, has led some states to ban MTBE. The U.S. Congress is also debating the future use of MTBE, while some in the refining industry have already chosen to voluntarily blend ethanol in gasoline, rather than MTBE. Congress is also considering removing the current federal oxygenate requirement from RFG. According to EIA, each of these actions could increase the number of boutique fuels used in the country.[17]

Putting aside the ongoing policy debate about the relevant environmental pros and cons associated with MTBE, it is not generally disputed that MTBE helps to extend the gasoline supply and moderate supply disruptions. If MTBE is ultimately removed from the nation's gasoline supply – either through federal or state action, or through market

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[16] Supply Impact of Losing MTBE and Using Ethanol, Joanne Shore, Energy Information Administration, OPIS National Supply Summit, October 2002.

[17] Gasoline Type Proliferation and Price Volatility, Energy Information Administration, September 2002, p 7.

deselection – the nation’s refining system will need to make up the gasoline volume shortfall left by MTBE.[18]

According to a recent report from the Energy Information Administration:

> Removal of MTBE from the gasoline pool requires not only the replacement of the lost volume but also the oxygen content, octane, and emissions-reducing properties it provides to RFG. The only oxygenate replacement that is currently considered is fuel ethanol. Although fuel ethanol has a high blending road octane value of 115 compared with 110 for MTBE, two qualities detract from its use:
>
> 1. Ethanol increases the vapor pressure (RVP) of gasoline while MTBE has only a small effect. Because ethanol increases the vapor pressure of gasoline, low cost high vapor pressure components such as butane and pentanes must be removed from the RFG pool, which makes it more difficult to maintain production volume and more costly to produce RFG.
>
> 2. Ethanol tends to separate from gasoline if stored for an extended period of time, and if an ethanol-gasoline blend is exposed to water or water vapor (as in a pipeline), the ethanol tends to bring the water into solution and the gasoline may be rendered unusable. Due to these handling problems, ethanol is shipped separately from gasoline (typically by rail car or truck, but not in pipelines) and is blended with the gasoline at the distribution terminal.[19]

Shifting to ethanol will impact refinery capacity in three ways, according to EIA[20]:

- A reduction in overall oxygenate volume (moving from 11 volume percent MTBE to 5.5 volume percent ethanol);
- Removal of additional light, high-RVP hydrocarbon volumes from gasoline to counter ethanol's higher RVP; and
- Removal of heavy, high-boiling-temperature hydrocarbon volumes from gasoline to counter the loss of high-RVP, low-boiling-temperature components and the net reduction in oxygenate volume.

Today, the majority of ethanol is blended into gasoline in the Midwest, although California has recently substantially increased its ethanol use as refiners in the state prepare to meet California’s January 2004 MTBE ban. Potential state MTBE bans in other regions, such as New York and Connecticut, may also require RFG suppliers to turn to ethanol to meet the federal oxygen standard for RFG. This is a complicated process that will impact refining capacity, costs, logistics and potentially retail gasoline prices.

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[18] The Department of Energy has estimated that removing MTBE from the U.S. gasoline pool is equivalent to removing four or five refineries or about 400,000 barrels of gasoline blendstock per day. *See* Bob Card, Undersecretary of Energy, *Hearings before the Senate Energy and Natural Resources Committee,* June 2001.

[19] Motor Gasoline Outlook and State MTBE Bans, Tancred Lidderdale, Energy Information Administration website: http://www.eia.doe.gov/emeu/steo/pub/special/mtbeban.html.

[20] Id.

In addition to the direct refining production and supply implications of switching from MTBE to ethanol, refiners will need to establish a way to transport and deliver ethanol from its traditional production facilities in the Midwest to New York and/or Connecticut. Refiners will also need to find sufficient tankage to segregate the ethanol from gasoline prior to splash blending in the gasoline trucks that deliver to the retail stations.

Any unexpected interruptions in the supply chain could contribute to price volatility. As more areas need the unique ethanol blended RFG, more suppliers will have to invest to produce the product. According to EIA, the Northeast is likely to see increased price volatility because of the greater difficulty to suppliers of refining the low-RVP blendstock and handling the ethanol oxygenate, in comparison to the existing MTBE RFG used there currently.[21]

Some state officials, refiners and members of Congress have also proposed removing the federal oxygenate requirement from RFG. While this would reduce the need to blend ethanol into gasoline in the Northeast, it could exacerbate the boutique fuel issue because ethanol-blended RFG and non-oxygenated (non-ethanol) RFG would need to be delivered and handled separately in the gasoline supply system to avoid emission increases associated with ethanol use.

It is not the mission of this study to advocate a resolution to the political debate surrounding ethanol and MTBE. Rather, the attention to this issue is to establish the overall supply impact the issue can have on the market.

8-Hour Ozone Standard:

In late 2003, EPA proposed a rulemaking to implement an 8-hour National Ambient Air Quality Standard for ozone. This proposal could also have an impact on refiner flexibility and the industry's ability to supply cleaner burning gasoline to various U.S. markets. According to its proposed rule, EPA considers the 8-hour ozone standard "more protective of human health than the 1-hour standard, and there are more areas that do not meet the 8-hour standard than there are areas that do not meet the 1-hour standard."[22]

The two primary emissions of concern under these revised standards are nitrogen oxides (NOx) and volatile organic compounds (VOCs). In areas where NOx is of greater concern, gasoline would likely not be affected, since Tier 2 low-sulfur gasoline has achieved about as much NOx control as possible. In areas where VOCs are the primary concern, the area may be forced to consider adoption of RFG or utilizing the lowest-RVP gasoline practical.

As a result of this new rule, it may be likely that other areas of the nation will seek to adopt fuel control measures as a way to help control ozone emissions. These additional state restrictions will impact refining capacity, flexibility and overall fuel fungibility. However, because EPA's proposal to implement the 8-hour ozone standard will not likely

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[21] Gasoline Type Proliferation and Volatility, Energy Information Administration, September 2002.

[22] Proposed Rule to Implement the 8-Hour Ozone National Ambient Air Quality Standard, U.S. Environmental Protection Agency, Fed.Reg. Vol. 68, No. 105, June 2. 2003.

be finalized until mid-2004, with final designations of new nonattainment areas due during the first quarter of 2004, it is difficult to determine with any precision the exact number of additional areas that will need more stringent clean-fuel formulations. As a result, the future impacts associated with the implementation of the 8-hour ozone standard were not included in the modeling for this study.

Study Methodology

To comply with the NACS request, Hart divided its analysis into two main parts. The first part of the report is a Baseline Analysis examining the current U.S. gasoline refining system both nationally and regionally. The second portion of the analysis is the Potential Future Supply/Fungibility Impacts Affecting Baseline Analysis.

Modeling and Key Assumptions

All analysis was conducted using HART's proprietary Linear Programming (LP) models to fully examine various fuel impacts and refinery supply implications. HART employed AspenTech's PIMS modeling framework to build four separate LP refining applications representative of PADDs 1, 2, 3, and 5. Each model comprehended a complete portfolio of refinery process units including clean fuel enabling technologies.

Specifications covering key qualities for a variety of gasoline and distillate products pertinent to each PADD were included in the model database. EPA and CARB emission equations (calculating various gasoline emission types such as Toxics, Nitrogen Oxide etc.) were also incorporated to enable imposition of pollutant reductions and antidumping/antibacksliding controls (such as MSAT).

Individual PADD models were driven by case information to produce solutions for each scenario. Case data were segmented in three categories; purchases (crude feed, intermediates, blendstock and finished product imports), sales (major product demands and options to sell intermediate and miscellaneous refinery streams), and process capacity throughput limits. In essence, each PADD was represented as a large refining facility.

Year 2001 was selected to establish a reference point for each PADD. The models were calibrated against PADD production data extracted from EIA's Petroleum Supply Annual 2001. Tables 4, 6, 8 and 12 in EIA's report were used to target input/output volumes for feedstock and refinery products in the respective PADDs.

Process capacity limits for 2001 were sourced mainly from the Worldwide Refinery-Capacities report published in the *Oil & Gas Journal* of Dec. 23, 2002. Standard on-stream efficiencies were applied to convert capacity rates from stream day to calendar day. Crude throughputs and crude qualities, however, were fixed at the actual 2001 values detailed in EIA's publication. The models were tuned to produce the reported 2001 product volumes utilizing EIA's crude throughput. The crude rates listed in Table 16, pages 48 to 49 in EIA's Petroleum Supply Annual 2001 are summarized below:

EIA 2001		
	MBPY	**MBPD**
PADD 1	547,272	1,499
PADD 2	1,205,747	3,303
PADD 3	2,656,652	7,278
PADD 5	929,537	2,546
TOTAL:		14,626

These statistics give a total of 14.6 MMBD, exactly the crude rate used to represent current system production in the study.

Capacity creep was held to a little below 1 percent annually consistent with recent industry trends. According to EIA Petroleum Supply Annual statistics, refinery crude and downstream capacity growth over the decade prior to January 2002 has been less than 1 percent annually. Through 2004, the rate of growth is projected to decline. While we agree that continued growth in U.S. demand will eventually promote growth in domestic capacity, we believe the assumed rate is reasonable for the 2007 time frame based in past and projected activity. We do not believe that an optimistic outlook for refining profits will necessarily have a measurable impact on 2007 capacity projections. Among other considerations, the large capital requirements associated with scheduled low sulfur requirements will compete for available capital resources.

Accordingly, year 2001 process unit capacities were augmented by 5% (assumed capacity creep to 2007) plus any known capacity expansion projects. For crude distillation this resulted in an overall 7 vol% increase. Process Unit rates for base cases 2001, 2007 and flexibility cases are presented for each PADD in the 'Refinery Capacity Utilization' tables (PART 2 of this report).

Gasoline and other product demand rates for 2001 were also extracted from EIA's tables in EIA's Petroleum Supply Annual 2001 (Volume 1, Table 1, page 1, item 31 (US Finished Motor Gasoline, 8,610 MBPD, PADD 4, Finished Motor Gasoline, p 42). Additional sources such as EPA's guide on Federal and State Summer RVP standards (by County), Census data, EPA's list of Federal RFG areas, and EIA's Petroleum Marketing Annual 2001 were used to breakdown volumes by gasoline category. The table below compares EIA's aggregate volumes to those used in the study.

2001 Gasoline Demand Actual - MBPD	
EIA Total US Gasoline Demand	8,610
Less EIA PADD 4 Demand	271
Total (PADD 1, 2, 3, 5):	**8,339**
HART Study total (PADD 1, 2, 3, 5):	**8,354**

Gasoline demand volumes for 2001 are displayed in more detail by grade and PADD in Table 3.

For year 2007, gasoline demand was assumed to increase by 14.4 vol%. The 2007 demands used in the HART analysis are consistent with those projected by EIA (Annual Energy Outlook 2003, Appendix Tables, p.45, Table 11, Heading: Refined Petroleum Products Supplied, column 2007, and Annual Energy Outlook, Supplemental TABLE 8 for PADD 4 projections). The next table compares AEO's projected volumes to those used in the study.

2007 Gasoline Demand Projections - MBPD	
EIA AEO Total US Gasoline Demand	9,890
Less EIA PADD 4 Demand	330
Total (PADD 1, 2, 3, 5):	**9,560**
HART Study total (PADD 1, 2, 3, 5):	**9,558**

Detailed gasoline demand volumes by PADD for 2007 are shown in Table 5.

With regard to distillates, total demand for jet was assumed to grow by 6.2 vol % (2001 through 2007). For diesel, the increase was assumed to be 18.1 vol %. Diesel distillate production was allowed to go higher, however, for those cases that required naphtha shifts (undercutting) to distillate.

Foreign gasoline blendstock quantities were also extracted from EIA's Petroleum Supply Annual 2001. Blendstock import increases in the 2007 cases varied between 13 and 24 vol %. These volumes are listed in Table 7. Imports included alkylate. Isooctane blendstock was added in 2007 in the amount of 15 MBPD (Envirofuels production capacity in Canada). Indigenous U.S alkylate production was not extended beyond the 5% capacity creep. Alkylate imports were not extended beyond the ranges mentioned above. Alkylate is a valuable gasoline blending component globally. In our opinion, non-US refiners having to contend with their own high quality fuel production problems, are not likely to make available larger quantities of alkylate for export.

Merchant MTBE plants were not assumed to convert to alkylation units. Conversion of MTBE plants to alkylation is far more complicated than generally believed. A common misperception is that this transition can happen by mere substitution of methanol feed and process retrofits. The fact is that several other issues need to be resolved prior to funding a conversion project. New alkylation units will immediately generate environmental and safety questions related to process catalyst. Sulfuric acid is not environmentally friendly and has poorer yields and qualities with isobutylene feedstock (MTBE feed), while hydrofluoric acid, best catalyst choice for isobutylene has had a history of incidents with vapor releases. Permitting problems are going to be significant. Catalyst regeneration will present by itself additional challenges to commercial MTBE plants as they are not equipped with facilities to handle such treatment. Spent acid catalyst will need to be transported safely to other locations for regeneration. Finally, sourcing the required isobutane feed for alkylation reactions could also prove problematic. Altogether, transitioning from merchant MTBE to alkylate is a lot more complex than casual substitution of feedstock.

Merchant MTBE producers are currently reviewing various options but there is no evidence of a rush to convert. Unfavorable operating margins and declining MTBE demand are severely hurting cashflows. To site some examples: Global Octanes have shut down while Texas Petrochemicals has sought bankruptcy protection. Deteriorating economics discourage risk taking and are not conducive to future investments. Furthermore, speculation in the current Energy Bill with a favorable outcome for merchant MTBE plants, although timely does not justify inclusion of additional alkylate volume in this study. Approval of subsidies is not tantamount to funding them, particularly in a fiscal climate of deficits and intense competition for scarce federal dollars.

Ethanol availability was forecasted at a maximum of 184 MBPD for non RFS scenarios. With RFS in place, the maximum limit was expanded to 209 MBPD. Some cases (such as Flex #4 and Flex #6) slightly exceeded these bounds. Ethanol was allowed to blend at 5.7 vol% max concentration in RFG gasoline. It was excluded, however, from conventional gasoline, the only exception being PADD 2 conventional blends. Ethanol's conventional gasoline 1 psi RVP waiver was assumed to remain in place

Baseline Analysis

The Baseline Analysis examined the current "state of the refining industry" including the impact associated with all the near-term (2001 – 2007) promulgated regulatory or legislative changes that will impact U.S. gasoline supply/fungibility. The Baseline Analysis included:

- **Analysis of U.S. gasoline markets for the years 2001 – 2007:**
  Hart examined the current state of the U.S. gasoline markets, and explored short-term changes that could reduce the number and proliferation of certain boutique fuels. Gasoline production in PADD 1 (East Coast), PADD 2 (Midwest), PADD 3 (Gulf Coast) and PADD 5 (West Coast) was analyzed.

  Hart focused on the accurate representation of the current level of summer production of the major gasoline grades as a function of existing refining system capabilities. Summer gasoline availability and flexibility is of critical importance as there is considerable supply expansion in the winter due to the incorporation of additional high vapor pressure components into the gasoline pool.

  The Baseline Analysis examined conventional, reformulated and California reformulated gasoline grades. Conventional blends were further classified according to various vapor pressure restrictions (9.0, 7.8, and 7.0 psi respectively). Similarly, reformulated gasoline was categorized per required volatile organic compound (VOC) reduction requirements into northern (VOC Control Region 2) and southern (VOC Control Region 1) areas. Variations among the two leading types of oxygenates (MTBE and ethanol) employed in each region were reflected. Special local requirements in other gasoline properties/specification were not examined individually unless specifically stated otherwise.

  Octane capability was represented in each region via the combination of a regular (i.e., 87RdON) and a premium (i.e., 91RdON or higher) grade. Midgrade production was not explicitly modeled under the assumption that midgrade is blended at retail by combing regular and premium.

Hart's Baseline Analysis was structured to quantify how much production flexibility exists in the current refining system to: a) meet current demand volumes for each grade, and b) produce incremental quantities of each grade at the various U.S. gasoline specifications currently being marketed.

Specifically, the following gasoline blends were represented in the LP models:

Reformulated Gasolines
- Premium, North
- Regular, North
- Premium, South
- Regular, South
- RBOBs

California Reformulated Gasolines
- Premium, Oxygenated
- Regular, Oxygenated
- Premium, Oxy-free
- Regular, Oxy-free

Conventional Gasolines
- Premium 7.0#
- Regular 7.0#
- Premium 7.8#
- Regular 7.8#
- Premium 9.0#
- Regular 9.0#
- Premium Gasohol (10% ETOH)
- Regular Gasohol (10% ETOH).
- RBOB

In terms of gasoline qualities and specifications, the following were carried and represented for all blends. Values for these qualities were assigned to all gasoline blending components:

Gasoline Qualities Represented
- Specific Gravity
- Sulfur, wppm
- Reid Vapor Pressure
- Benzene, vol%
- Aromatics, vol%
- Oxygen, wt%
- Road Octane Number
- Motor Octane Number

- ASTM @10% Evaporated, deg F (T10) [23]
- ASTM @50% Evaporated, deg F (T50)
- ASTM @90% Evaporated, deg F (T90)
- Percent evaporated @ 200 F (E200)
- Percent evaporated @ 300 F (E300)

Year 2001 (latest published data) was selected to establish volume/quality baselines for calibrating the models and for running pre-base cases for the four PADDs. Demand growth and refinery capabilities in terms of process capacity and operational shifts were then projected to a year 2007 basis which was utilized to load the four 2007 base case runs. All flex cases were keyed off their corresponding PADD 2007 base cases. On top of satisfying increased demand, 2007 base cases had to meet Tier 2 sulfur specifications[24] and also comply with the Mobile Source Air Toxics (MSAT) rule[25].

With regard to demand growth the following percentage rates were applied to each PADD and for the three main fuel products:

Percent Demand Growth (2001 to 2007)

- Gasoline: 14.4 vol% (2.27% annually)
- Jet: 6.2 vol% (1.01)
- Diesel: 18 vol% (2.8)

Capacity creep was projected to be 5.1 vol% for the period 2001 to 2007. This extra capacity was available to all process units. Additional desulfurization capacity required for Tier 2 regulations for gasoline and diesel was allowed. In certain flex cases some key gasoline production unit capacities (such as alkylation) were extended slightly beyond 5% to help alleviate tight specification situations that otherwise would render the case infeasible.

Potential Future Supply/Fungibility Impacts Affecting Baseline Analysis

Part B of the Hart study (Potential Future Supply/Fungibility Impacts Affecting Baseline Analysis) examined several potential near-term regulatory or legislative initiatives (e.g. variables) that could further impact the nation's gasoline supply. For this Analysis, Hart

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[23] T10, T50 and T90 were modeled for California Reformulated gasoline only.

[24] In late 1999, EPA finalized a rule to require refiners to lower sulfur content in gasoline over the next several years. Hart's Baseline Analysis assesses the impact this rulemaking will have on the refining industry, gasoline supply systems and associated costs.

[25] In late 2000, EPA issued a final rulemaking to regulate the emissions of 21 mobile source air toxics. With regard to the refining industry and fuels markets, this action sets new gasoline toxic emission performance standards that will ensure that refiners maintain their average 1998-2000 gasoline toxic emission performance levels. Hart's Baseline Analysis assesses the present and future practical impacts of the additional controls (on benzene and other air toxics in gasoline) provided by this Rule on gasoline availability and supply flexibility. Comments submitted by NPRA further analyze the impact of the MSAT rule may have on refinery operations. Please see pages 8-9 of NPRA's comments in Peer Review Section of this Report.

identified several of the primary potential policy initiatives that will likely impact the market. Hart specifically examined the following initiatives:

- Potential impact of the Renewable Fuels Standard now being considered by the U.S. Congress;
- Potential Federal and State Bans of MTBE;
    - Consideration given to certain states potentially delaying MTBE bans and/or market de-selection of MTBE as an alternative to potential bans;
- Potential removal of the federal oxygen standard for RFG; and
- Potential impact of reducing conventional gasoline formulations.

A total of eight cases were run for each PADD. On top of the 2001 and 2007 base cases, six flex cases comprehending various permutations of potential and/or proposed regulatory actions have been prepared. Key issues defining each case are listed below:

Pre-base case, 2001:
Current specifications, no MTBE state bans.

Base case, 2007:
- Tier 2, ULSD, MSAT implemented;
- No Renewable Fuels Standard (RFS);
- RFG Oxy-standard in place;
- MTBE banned in California, New York, and Connecticut;
- Demand growth as assumed (for this base case and all flex cases).

Flex case #1 – No MTBE Bans:
- Tier 2, ULSD, MSAT implemented;
- RFG Oxy-standard in place, no RFS;
- MTBE allowed throughout the nation.

Flex case #2 – Based on House Energy Bill (H.R. 6):
- Tier 2, ULSD, MSAT implemented;
- No RFG Oxy-standard, RFS in place;
- MTBE still allowed except as prohibited by state bans;
- CA/NY/CT can use ethanol as necessary.

Flex case #3 – Based on Senate Energy Bill (S. 14):
- Tier 2, ULSD, MSAT implemented;
- No RFG Oxy-standard, RFS in place;
- MTBE is banned.

Flex case #4 – Four Fuels Program:
- Tier 2, ULSD, MSAT implemented;
- RFG Oxy-standard in place, no RFS;
- MTBE is banned;

- RVP segregations taken out of each PADD (conventional gasoline);
- Oxy segregations taken out of each PADD (all reformulated gasoline blended with ethanol).

Flex case #5 – Regional Fuels Program:

- Tier 2, ULSD, MSAT implemented;
- No RFG Oxy-standard, RFS in place;
- MTBE Banned in CA/NY/CT;
- PADD 1, RFG is non-oxygenated, 7.0 & 9.0 psi conventional;
- PADD 2, all gasoline is oxygenated with ethanol (3.5 wt%), 9.0 psi conventional;
- PADD 3, RFG is oxygenated with MTBE as necessary, 7.0 & 9.0 psi conventional;
- PADD 5, RFG is oxygenated with ethanol as necessary, 7.0 & 9.0 psi conventional.

Flex case #6 – RFG Only Program:

- Tier 2, ULSD, MSAT implemented;
- No RFG Oxy-standard, No RFS;
- MTBE Banned in CA/NY/CT;
- Limited number of gasoline types, no conventional grades;
  (Northern, southern RFG, and CARB);
- Ethanol areas: PADD 2 and where MTBE is banned;
- MTBE areas: everywhere else.

It should be noted that ethanol availability is tiered depending on whether RFS is implemented or not for each of these flex case scenarios. Our assumption was that for non-RFS cases, the available ethanol volume would be in the neighborhood of 184 MBPD. With RFS, ethanol production and availability is expected to increase by at least 25 MBPD to 209 MBPD. A special effort was made to keep ethanol use within these limits.

Aggregate Supply Posture Impacts of Fuel Changes

Baseline Analysis: 2001

Supply/Demand Overview: 2001

The U.S. refined product supply/demand balance, and in particular the gasoline market, has continued to tighten in recent years. Refining capacity is stretched close to its limit, running at approximately 93 percent annual utilization and exceeding 95 percent in the peak summer driving season. Refining capacity has lagged behind growth in refined product demand, necessitating the high operating rates and increasing reliance on imported product.

Table 2 provides a summary of refined product supply and demand for 2001. The table shows refinery production, net product imports (imports less exports), and total supply broken down by major product category. In aggregate, U.S. refining capacity operated at a reported 92.6 percent utilization for the year. Likewise, downstream refinery processing capacity, critical for gasoline and other light fuel production, operated at close to maximum. The refining industry had limited ability to increase gasoline supply (or enhance product quality), particularly during the summer period.

Table 2: U.S. Refined Product Supply/Demand: 2001

Thousand Barrels per Day

	Production	Net Imports	Total Supply
Gasoline	8310	320	8630
Kero/Jet	1600	120	1720
Distillates	3690	220	3910
Fuel Oil	720	100	820
Other [1/]	1140	230	1370
Total	15460	990	16450

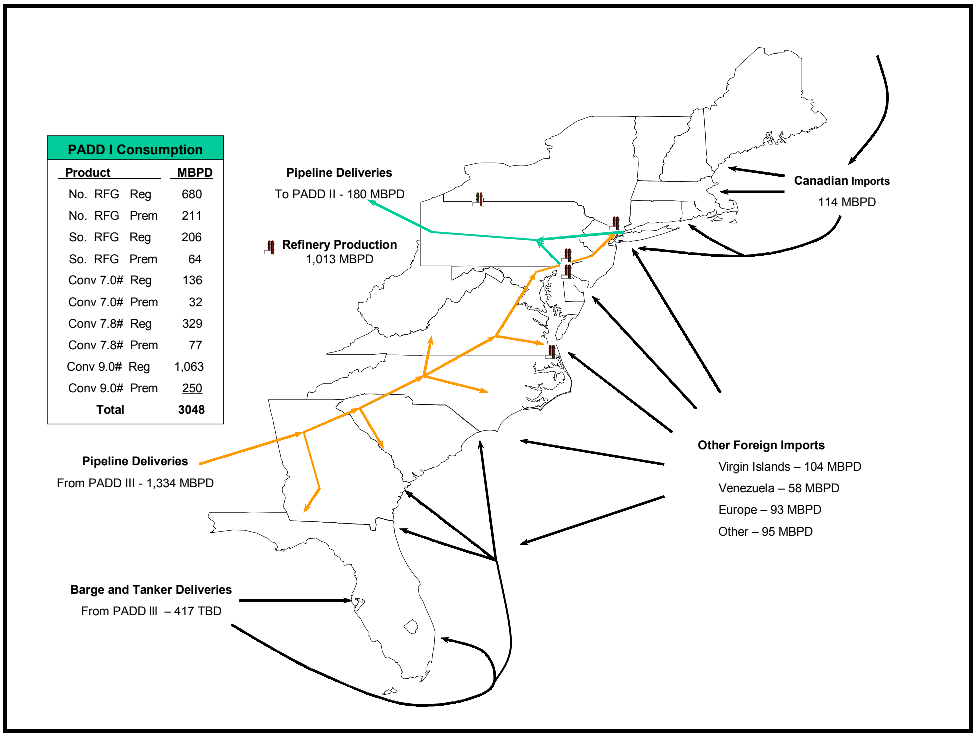
[1/] *Excludes LPG, coke and refinery fuel gas*

Energy Information Administration

In 2001, finished gasoline imports accounted for 5.3 percent of total U.S. demand. Some product is exported, primarily from the Gulf Coast to Mexico, so the net reliance on imports (imports less exports) was 7.8 percent. Imports of unfinished gasoline blending components contributed an additional 300 thousand barrels per day to supply (included in Table 1 production figures). Net imports of finished gasoline and gasoline blending components make up over 7 percent of U.S. gasoline supply.

There are large regional differences in U.S. gasoline supply/demand patterns and production capability that influence the overall U.S. supply posture. The East Coast represents a major portion of total domestic demand, but a much smaller portion of supply capability. The East Coast must rely on other regions (Gulf Coast) and imported product for a majority of its supply. As shown in Figure 8, local production in the East Coast, represented by PADD 1, accounts for only about one third of the region's supply. About 58 percent of supply comes from the U.S. Gulf Coast (PADD III) and another 14 percent is imported.

Figure 8: PADD 1 2001 Gasoline Supply



PADD I Consumption		
Product		MBPD
No. RFG	Reg	680
No. RFG	Prem	211
So. RFG	Reg	206
So. RFG	Prem	64
Conv 7.0#	Reg	136
Conv 7.0#	Prem	32
Conv 7.8#	Reg	329
Conv 7.8#	Prem	77
Conv 9.0#	Reg	1,063
Conv 9.0#	Prem	250
Total		3048

In contrast, gasoline production capability in the U.S. Gulf Coast far exceeds demand in the area. Less than 40 percent of Gulf Coast production is required to meet local demand. In addition to the shipments to the East Coast, the Gulf Coast supplies product to the Midwest, Rocky Mountains and the West Coast. Unlike the East Coast, local production in these other regions provides a majority of their supply (Table 3).

Table 3: Regional Gasoline Demand Versus Production

	Demand	Production	%
	Thousand Barrels Per Day		
East Coast	3050	1010	33
Midwest	2460	1960	80
Gulf Coast	1340	3620	270
Rocky Mountains	270	270	99+
West Coast	1500	1400	93
Total	8610	8260	96

Baseline Analysis: 2001

Hart's Baseline 2001 analysis first characterized the current "state of the refining industry" in terms of regional gasoline supply, demand and quality, and overall refining industry operations and production capability. Regional refining and gasoline production was analyzed for four PADDs (Figure 9): PADD I (East Coast), PADD 2 (Midwest), PADD 3 (Gulf Coast), and PADD 5 (West Coast). The Rocky Mountain region (PADD 4), which represents only about 3 percent of U.S. supply and ships/receives minimal product from other regions, was excluded from the analysis. Figure 10 represents gasoline shipments between each PADD and international imports and exports.

Figure 9: U.S. PADD System

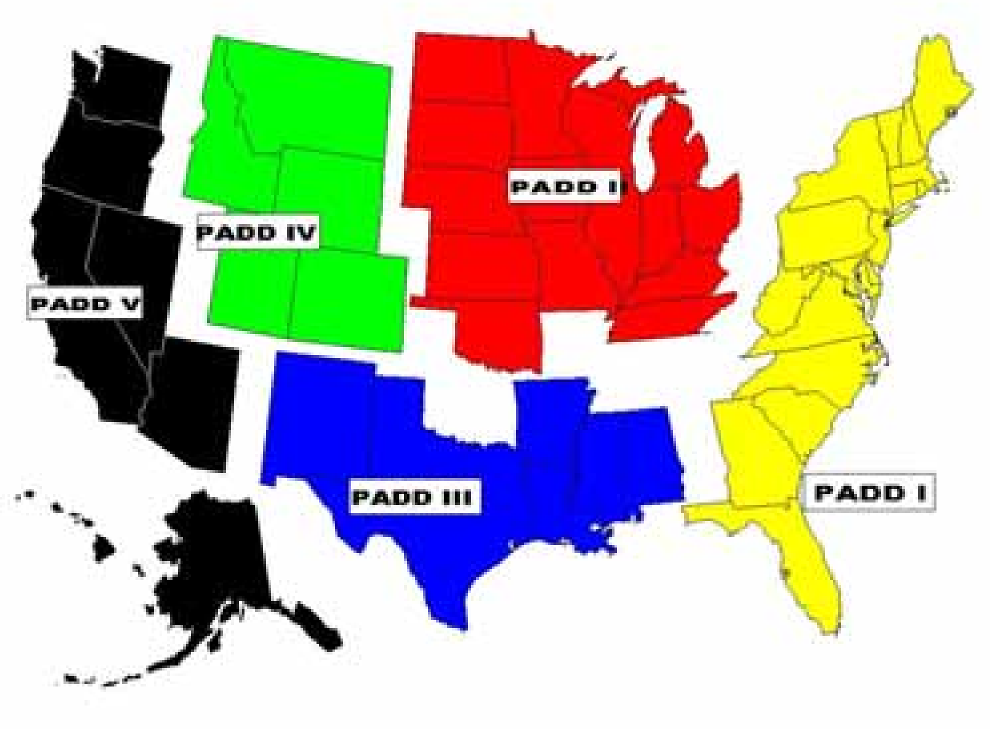
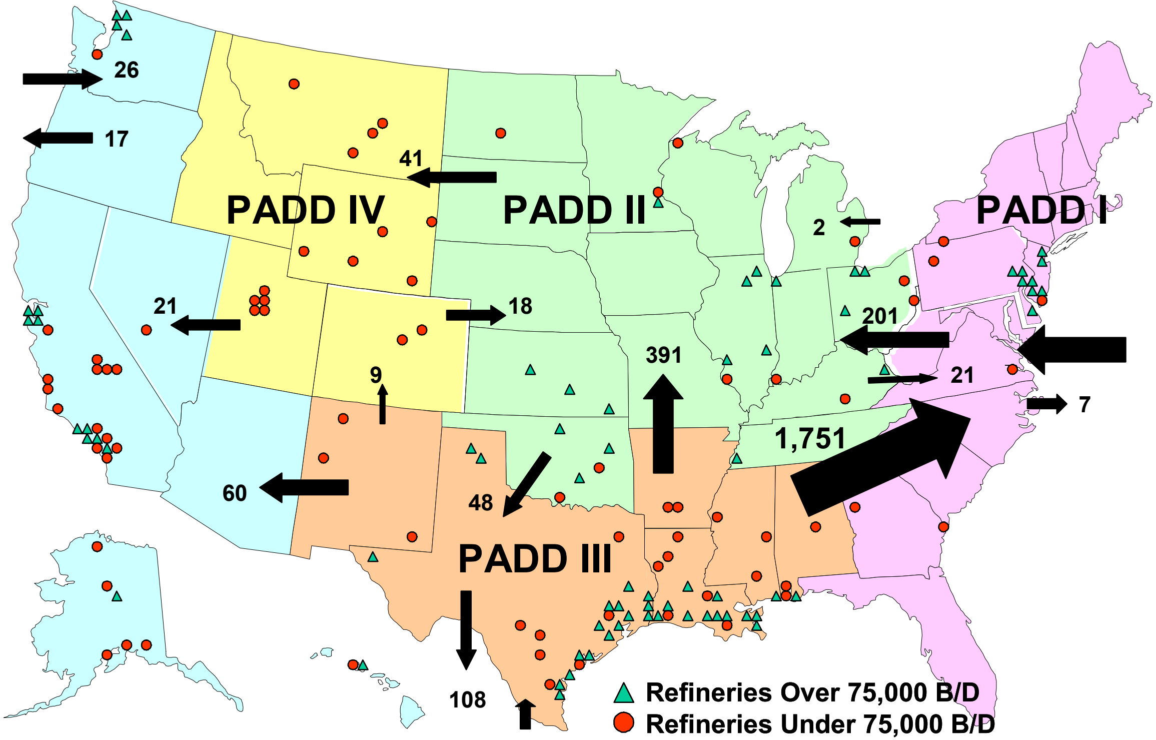


Figure 10: Gasoline Movements in 2001
(1,000 b/d)



NPRA 2002

As noted earlier, there are currently no fewer than 15 different gasoline blends sold in the U.S. (excluding the various octane grades). The Baseline Analysis examined conventional, reformulated and California reformulated gasoline grades, as well as regular and premium octane blends within each grade. The conventional blends were further classified according to various vapor pressure restrictions (9.0, 7.8, and 7.0 psi). Similarly, reformulated gasoline was characterized per required RFG regulatory volatile organic compound (VOC) reduction requirements into northern (VOC Control Region 2) and southern (VOC Control Region 1) areas. Variations among the two leading types of oxygenates (MTBE and ethanol) employed in each region were reflected for reformulated and conventional gasoline.

For this analysis, special local requirements in other gasoline properties/specifications were not examined individually. A total of 8 finished gasoline grades were examined (excluding the individual regular and premium octane grades also examined), along with a Reformulated Gasoline for Oxygenate Blending (RBOB) grade. The latter represents reformulated gasoline blends produced at the refinery to which oxygenate is added downstream to meet RFG requirements. The individual PADD model discussions in later sections of this report provide additional descriptions of gasoline representations.

The Baseline Analysis provided a regional breakdown of gasoline supply and demand for the gasoline grades identified above including regional production, imports and interregional shipments. Table 4 summarizes regional demand breakdown by grade for 2001. Reformulated gasoline (Federal plus California) represents about 35 percent of the total for the four PADDs. Nearly 70 percent of the conventional gasoline is the higher vapor pressure (9.0 psi) grade. The 7.8 psi and 7.0 psi conventional grades account for 19 and 5 percent, respectively. Conventional ethanol blends account for a little less than 7 percent of the conventional pool.

Regionally, PADDs 1 and 5 account for the majority of reformulated gasoline (39 and 35 percent, respectively). Reformulated gasoline in PADD 1 makes up 38 percent of the region's gasoline demand and in PADD 5 about 68 percent of the demand. The conventional gasoline pools in all regions include relatively comparable shares of higher and low vapor pressure grades. Nearly all the conventional ethanol blends are marketed in PADD 2.

Table 4: Regional Gasoline Demand: 2001

Thousand Barrels per Day

GASOLINE GRADE	PADD 1	PADD 2	PADD 3	PADD 5	TOTAL
RFG - PREMIUM NORTH	211	65	0	97	373
RFG - REGULAR NORTH	680	361	0	416	1,457
RFG - PREMIUM SOUTH	64	10	53	100	227
RFG - REGULAR SOUTH	206	60	224	412	902
REFORMULATED GASOLINE:	**1,161**	**497**	**277**	**1,026**	**2,959**
CG -PREMIUM (7#)	32	6	9	0	46
CG -REGULAR (7#)	136	50	47	0	233
CG -PREMIUM (7.8#)	77	35	48	9	169
CG -REGULAR (7.8#)	329	197	291	59	875
CG -PREMIUM (9.0#)	247	157	104	63	570
CG -REGULAR (9.0#)	1,067	1,161	570	342	3,141
PREMIUM GASOHOL 10% (9#)	0	41	0	0	41
REGULAR GASOHOL 10%, (9#)	0	320	0	0	320
CONVENTIONAL GASOLINE:	**1,887**	**1,966**	**1,069**	**473**	**5,395**
TOTAL GASOLINE:	**3,048**	**2,463**	**1,345**	**1,498**	**8,354**

For the Baseline 2001 case, PADDs 1, 2 and 5 all receive incremental supply from PADD 3 to varying degrees. Approximately 57 percent of PADD 1 gasoline is supplied via shipments from PADD 3. For PADDs 2 and 5, receipts from PADD 3 (including RBOB) account for 19 and 4 percent, respectively.

Over 90 percent of U.S. gasoline imports come into PADD 1 where they make up about 14 percent of PADD 1 supply. PADD 1 imports another 250 thousand barrels per day of gasoline blending components, much of which is RBOB type components that are then finished with oxygenate in the U.S. Combined gasoline and gasoline component imports account for about 22 percent of total PADD 1 gasoline supply.

Based on the 2001 supply and demand characterization for gasoline and other refined products, the refining analysis was structured to calibrate the refining models against historic operations and to quantify how much production flexibility exists in the current system to meet product demand and quality requirements. Refinery models were developed for each of the four regions including appropriate crude and other feedstocks, refinery processing representations and capacity limits, product quality requirements and regional supply/demand characteristics.

Detailed descriptions of the individual PADD models and results of the 2001 Baseline refining analyses are provided in the later regional report sections. Table 5 provides a general summary of key refinery input/output from the model results along with capacity utilization for major refining processing facilities.

Table 5: Summary Input/Output
And Refinery Capacity Utilization: 2001

	PADD 1	PADD 2	PADD 3	PADD 5	TOTAL
INPUT - MBPD					
Crude Oil	1499	3303	7278	2522	14602
Oxygenate	68	73	26	75	242
Other	348	208	573	167	1296
TOTAL	1915	3584	7877	2764	16140
OUTPUT - MBPD					
Gasoline	1013	1962	3618	1403	7996
Kero/Jet	97	232	834	411	1574
Distillate	466	866	1724	489	3545
Fuel Oil	105	66	160	176	507
Other	220	351	1227	163	1961
TOTAL	1901	3477	7563	2642	15583
UTILIZATION - Percent					
Crude Distillation	87	94	95	89	93
Isomerization	95	95	95	87	93
Alkylate	77	84	95	96	91
MTBE	87	80	84	85	84
Reforming	67	75	75	80	75
Hydrocracking	96	88	89	85	88
Catalytic Cracking (FCC)	87	85	87	91	87

The 2001 operations were met with the aggregate four regions running at 93 percent utilization. The model output indicate that gasoline production was close to the maximum sustainable with limited flexibility to expand volume or substantially improve quality without further capacity expansion. Conversion capacity (hydrocracking and catalytic cracking), the major gasoline production sources, match reported actual capacity utilization at close to 90 percent. Light oil clean fuel processing facilities (isomerization and alkylation) require utilization in excess of 90 percent.

Baseline Analysis: 2007

The 2001 Baseline Analysis was extended to 2007 incorporating those market, regulatory and refining changes expected to take place over this time frame. The 2007 case assumes major product demand growth across each PADD as follows: gasoline at 14.4 percent, kerosene/jet fuel at 6.2 percent and diesel at 18 percent. Table 6 summarizes regional demand breakdown by grade for 2007.

Table 6: Regional Gasoline Demand: 2007

Thousand Barrels per Day

	PADD 1	PADD 2	PADD 3	PADD 5	TOTAL
GASOLINE GRADE					
RFG - PREMIUM NORTH	241	74	0	112	427
RFG - REGULAR NORTH	779	413	0	476	1667
RFG - PREMIUM SOUTH	73	11	60	115	259
RFG - REGULAR SOUTH	235	69	256	472	1032
REFORMULATED GASOLINE:	**1328**	**568**	**316**	**1174**	**3386**
CG -PREMIUM (7#)	37	6	10	0	10
CG -REGULAR (7#)	156	57	53	0	53
CG -PREMIUM (7.8#)	88	41	55	10	55
CG -REGULAR (7.8#)	376	225	333	68	333
CG -PREMIUM (9.0#)	282	179	119	72	119
CG -REGULAR (9.0#)	1220	1329	652	392	652
PREMIUM GASOHOL 10% (9#)	0	47	0	0	0
REGULAR GASOHOL 10%, (9#)	0	366	0	0	366
CONVENTIONAL GASOLINE:	**2159**	**2250**	**1223**	**541**	**6172**
TOTAL GASOLINE:	**3487**	**2818**	**1539**	**1714**	**9558**

The 2007 Baseline Analysis assumes that recently promulgated gasoline and diesel sulfur regulations are in place including: Tier 2 low sulfur gasoline, Mobile Source Air Toxics (MSAT), and low sulfur on-road diesel. The 2007 Baseline case also assumed current requirements with regard to oxygenate and renewable fuels, i.e., MTBE bans are implemented in California, Connecticut and New York, the RFG oxygen standard is in place, and no Renewable Fuel Standard is implemented.

Refining capacity expansion is required over the 2001-2007 period to keep pace with growing demand and meet new product quality regulations. The Baseline Analysis assumes that existing refinery crude and downstream capacity could be expanded by approximately 5 percent. In addition, the analysis assumed that capacity required for compliance with gasoline and diesel sulfur regulations would be available by 2007.

Table 7 summarizes key aggregate refinery input/output from the Baseline 2007 model runs. The data also include capacity utilization figures for major downstream processing facilities. Refinery crude oil input increased 1,080 thousand barrels per day, or 7 percent over 2001. Gasoline production increased 6 percent and production of all other products increased by 13 percent.

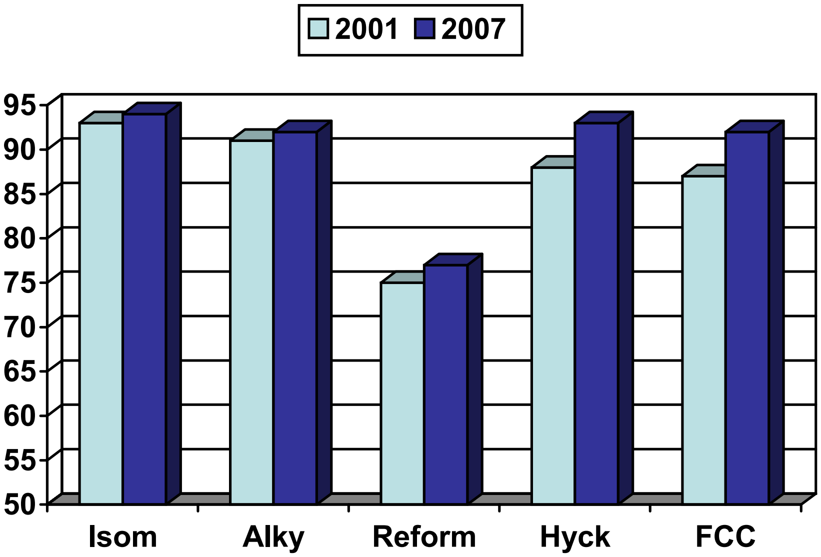
Table 7: Summary Input/Output And Refinery Capacity Utilization: 2007

	PADD 1	PADD 2	PADD 3	PADD 5	TOTAL
INPUT - MBPD					
Crude Oil	1,576	3,500	7,766	2,836	15,678
Oxygenate	56	80	61	45	242
Other	401	282	778	112	1,573
TOTAL	2,033	3,862	8,605	2,993	17,493
OUTPUT - MBPD					
Gasoline	1,074	2,031	3,741	1,440	8,286
Kero/Jet	103	247	888	437	1,675
Distillate	509	1,022	2,141	560	4,232
Fuel Oil	100	96	170	211	577
Other	234	350	1,351	218	2,153
TOTAL	2,020	3,746	8,291	2,866	16,923
UTILIZATION - Percent					
Crude Distillation	91	94	95	94	94
Isomerization	95	95	95	92	94
Alkylate	81	88	95	95	92
MTBE	91	85	87	85	87
Reforming	70	72	78	85	77
Hydrocracking	95	93	95	90	93
Catalytic Cracking (FCC)	91	92	92	92	92

For 2007, refinery crude oil and downstream processing capacity utilization increased across all facilities and regions. Refinery utilization increased to 94 percent of capacity and downstream processing capacity utilizations increased by 1 to 5 percent (Figure 9). In some instances capacity increased up to the allowable 5 percent expansion creep discussed above. As illustrated in Figure 11, refineries moved closer to their upper limit, diminishing flexibility to increase throughput, expand product production, or improve product quality.

The net growth in gasoline demand less incremental refinery production resulted in an increased gasoline shortfall of 745 thousand barrels per day over 2001 Baseline. The shortfall was assumed to be covered with incremental imported product. An additional 49 thousand barrels per day of gasoline blending components were also imported in the 2007 Baseline. Total finished gasoline plus gasoline blending component imports accounted for over 15 percent of the PADD 1, 2, 3 and 5 gasoline demand in 2007, up from just under 8 percent for 2001.

Figure 11: Refinery Capacity Utilization 2007 vs 2001: (Percent)



Potential Fuel Supply/Fungibility Impacts Affecting Baseline Analysis

There are several regulatory and legislative proposals currently under review that alter various aspects of oxygenate use in gasoline, including the possible elimination of MTBE use, implementation of a renewable fuel standard, and the elimination of the reformulated gasoline minimum oxygenate requirement. The outcome of these issues will impact gasoline supply and potentially further constrain refining capability. The oxygenate issues also create the potential for future proliferation of boutique fuels, i.e., individual state MTBE bans, localized ethanol blending requirements, etc.

In addition to the oxygenate issues, a number of options have been discussed to address the boutique fuels issue by reducing the number of fuel types. The various options have been developed with the underlying objective of improving fungibility throughout the supply/distribution system while maintaining or improving gasoline emissions performance. This goal will eventually involve trade-offs between supply/distribution efficiency improvement and refining production capability.

Utilizing the 2007 Baseline Analysis as a starting point, a series of Flex Cases were developed to examine the impact of various oxygenate and fuel consolidation alternatives under consideration. The specific cases examine the following initiatives:

- Flex Case 1 - Assumes no federal or state MTBE bans, the RFG oxygen standard remains in place and no renewable fuel standard.
- Flex Case 2 - Assumes implementation of an MTBE ban in California, Connecticut and New York, without an RFG oxygen standard in place and with implementation of a renewable fuel standard.
- Flex Case 3 – Assumes a Federal MTBE ban, without an RFG oxygen standard and with implementation of a renewable standard.
- Flex Case 4 - Assumes a Federal MTBE ban, with the RFG oxygen standard in place and no renewable fuel standard. Conventional gasoline RVP grades are consolidated into one RVP grade. All RFG is consolidated into a single oxygen content grade.
- Flex Case 5 - Assumes implementation of an MTBE ban in California, Connecticut and New York, without an RFG oxygen standard in place and with implementation of a renewable fuel standard. Conventional gasoline RVP grades are consolidated into two RVP grades in each PADD (7.0 and 9.0 psi for PADDs 1, 3, 5 and 9.0 psi for PADD 2).
- Flex Case 6 - Assumes implementation of an MTBE ban in California, Connecticut and New York, without an RFG oxygen standard in place and no renewable fuel standard. Conventional gasoline is consolidated to RFG (i.e., meets all RFG specifications).

Flex Cases 2 through 6 impose more restrictive requirements on the refining system and therefore reduce gasoline production capability. For Flex Case 1 the state MTBE bans were lifted and gasoline production increased. Table 7 summarizes the results in terms of a gasoline shortfall, which is defined as demand less the sum of domestic production from the four PADD regions. Refinery production is also adjusted to reflect imported gasoline blend components which are part of the initial refinery production figures shown. Table 8 also includes Baseline 2001 and 2007 for comparison.

Table 8: Impact of Fuel Policies on Gasoline Shortfall

Thousand Barrels per Day

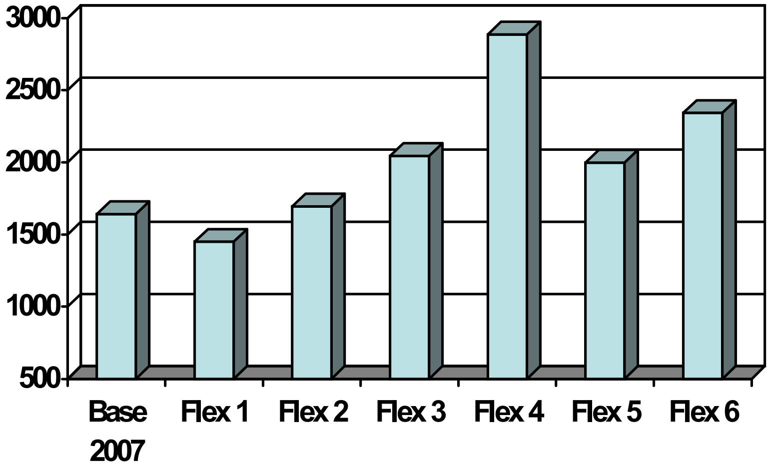
	Base 01	Base 07	Flex 1	Flex 2
Refinery Production	7996	8286	8454	8224
Component Imports	298	371	347	360
Net Production	7698	7915	8107	7864
Gasoline Demand	8354	9558	9558	9558
Shortfall	**656**	**1643**	**1451**	**1694**

	Flex 3	Flex 4	Flex 5	Flex 6
Refinery Production	7873	7009	7917	7584
Component Imports	360	337	357	367
Net Production	7513	6672	7560	7217
Gasoline Demand	9558	9558	9558	9558
Shortfall	**2045**	**2886**	**1998**	**2341**

A comparison of the estimated gasoline shortfall for the Baseline 2007 and Flex Cases is also provided in Figure 12. All of the Flex Case policies result in a significant shortfall over the Baseline 2001 case. The gasoline shortfall ranges from 1,450 (Flex Case 1) thousand barrels per day to a high of 2,890 thousand barrels per day (Flex Case 4). The product deficits shown require additional imported product or domestic refinery expansion beyond the 5 percent assumed for the analysis. For the maximum shortfall-Flex Case 4, the shortfall (or import requirement) represents a 75 percent increase in the product deficit over the 2007 base. In this case the shortfall (or import requirement) represents approximately 30 percent of gasoline demand. In the 2001 and 2007 Baseline Analyses, total imports accounted for 8 and 17 percent of demand, respectively.

Figure 12: Impact of Fuel Policies on Gasoline Shortfall

Thousand Barrels per Day



Summary of Findings

- Base Case 2007: Growth in gasoline demand will continue to outpace domestic refining production capability. By 2007 the domestic gasoline shortfall (or reliance on imported product) will increase by 987 thousand barrels per day over 2001. Refinery capacity expansion will be necessary and utilization will approach the maximum.

- Flex Case 1 – No MTBE Bans: Gasoline production is 2.4 percent higher from the Baseline 2007. With no state MTBE bans, total MTBE use increased by 160 thousand barrels per day and ethanol use decreased by 65 thousand barrels per day.

- Flex Case 2 – Based on House Energy Bill (H.R. 6): Gasoline production is reduced 0.6 percent from Baseline 2007. With state MTBE bans as in Baseline 2007, with an RFS, but with no oxygen standard, MTBE blending is reduced by 35 thousand barrels per day versus the Baseline and ethanol increased by 50 thousand barrels per day to satisfy the renewable standard.

- Flex Case 3 – Based on Senate Energy Bill (S. 14): Gasoline production is reduced 5 percent from Baseline 2007. This case examined a national MTBE ban, coupled with an RFS and no oxygen standard. This resulted in the removal of 160 thousand barrels per day of MTBE from the gasoline pool. Ethanol use is roughly the same as Flex Case 2 to satisfy the renewable standard.

- Flex Case 4 – Four Fuels Program: Total gasoline production is reduced 16 percent from Baseline 2007. In this Flex Case, ethanol must be used in RFG to satisfy the RFG oxygen requirement, which remains in place. Gasoline production capability is further curtailed as a result of the additional requirement to lower the RVP of a large portion of the conventional gasoline.

- Flex Case 5 – Regional Fuels Program: Gasoline production is reduced 4.5 percent from Baseline 2007. This case considers MTBE bans in California, New York and Connecticut, repeal of the oxygen standard and implementation of a renwable fuel standard as provided for in Flex Case 2. In addition, the requirement of this case to consolidate conventional gasoline by reducing RVP of the higher volatility grades further reduces gasoline production by about 300 thousand barrels per day beyond Flex Case 2 and 350 thousand barrels per day beyond Baseline 2007.

- Flex Case 6 – RFG Only Program: Gasoline production capability is reduced by about 9 percent over the 2007 Baseline. This Case represents the state MTBE bans without an RFG oxygen or renewable fuel standard. In addition, all gasoline is produced at RFG quality. The RFG requirements result in slightly higher ethanol use to ensure RFG quality. The more stringent RFG standards severely constrain gasoline production capability. However, increased MTBE use outside the ban areas makes up volume and minimizes production loss. Total MTBE use was 275 thousand barrels per day (115 thousand barrels per day above Baseline 2007).

A breakdown of each of these Flex Cases is provided in Table 9.

Table 9: Impact on Gasoline Production, Imports, Ethanol and MTBE

Thousand Barrels Per Day -- % Change

Volume MBPD	Net Gasoline Production	Gasoline imports	MTBE Use	Ethanol Use
Baseline 2007	7915	1643	158	144
Flex 1	8107	1451	319	79
Flex 2	7864	1694	123	194
Flex 3	7513	2015	0	194
Flex 4	6672	2886	0	189
Flex 5	7560	1998	73	210
Flex 6	7217	2341	274	191

Percent Change From Base 2007	Production	Imports	MTBE	Ethanol
Flex 1	2.4	-11.7	101.9	-45.1
Flex 2	-0.6	-18.8	-22.2	34.7
Flex 3	-5.1	2.6	-	34.7
Flex 4	-15.7	55.1	-	31.3
Flex 5	-4.5	-0.1	-53.8	45.8
Flex 6	-8.8	20.1	73.4	32.6

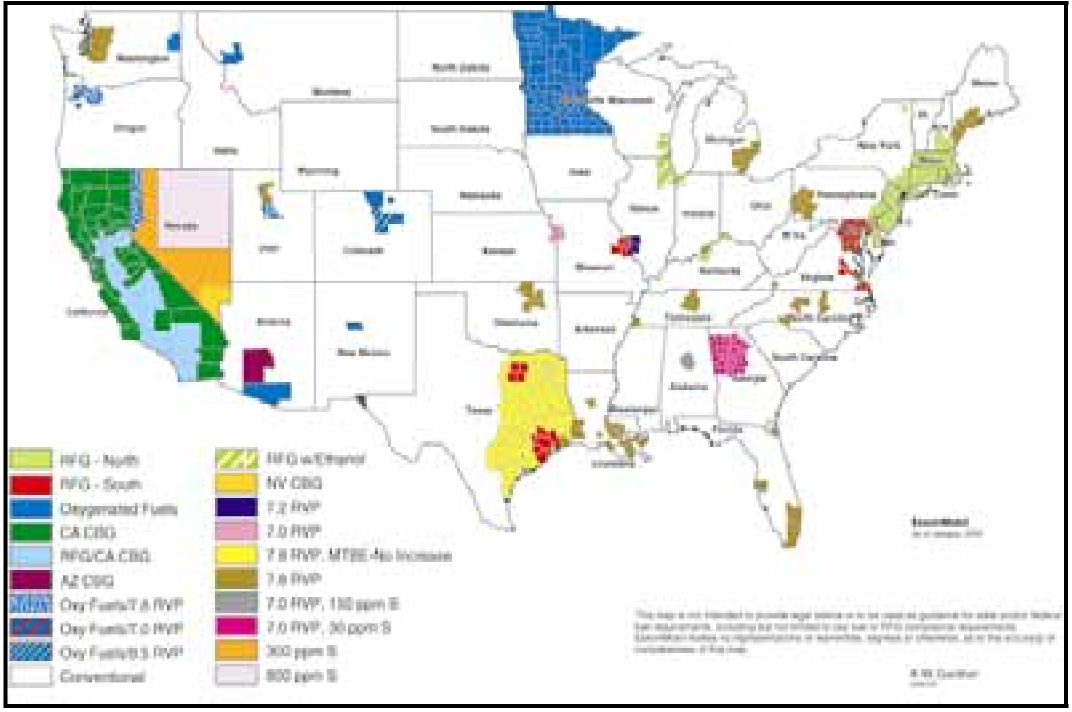
Additional detail for the Flex cases and regional refinery operations are provided in the PADD sections which follow.

Aggregate Fungibility Posture Impacts of Fuel Changes

Market Conditions in 2001

By 2001, the impact of Clean Air Act reformulated gasoline and oxygenated gasoline requirements, combined with the implementation of State Implementation Plans and their adoption of volatility controlled gasolines, resulted in a "patchwork quilt" of gasolines characterized by "boutique" fuel islands. Most agree that these fuel islands have complicated the distribution infrastructure and removed a great deal of efficiency and flexibility from the system. The end-result of various fuel requirements is represented in Figure 13.

Figure 13: U.S. Gasoline Requirements



Source: ExxonMobil

In 2001, the United State fuel supply was comprised of no fewer than 15 distinct fuel formulations, excluding various octane grades. Of these 15, the top four blends represented approximately 83 percent of the U.S. gasoline pool. This left the remaining 11 fuel blends to account for only 17 percent of the gasoline supply, with each contributing less than 5 percent. This composition is reflected in Figure 14.

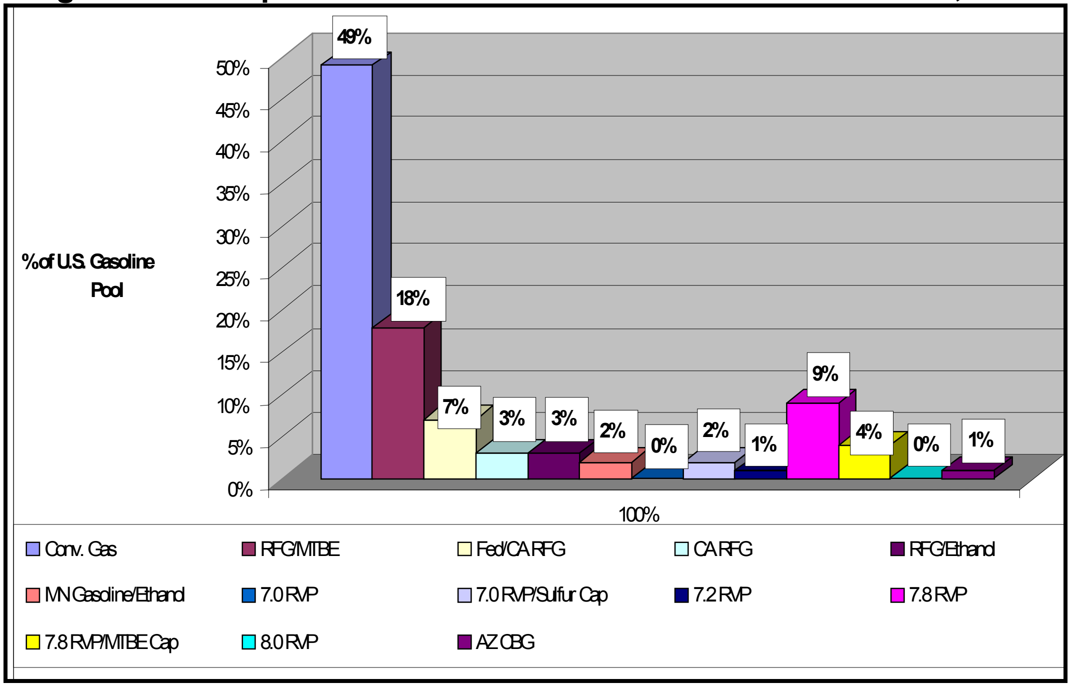


Figure 14: Comparison of US Summertime Gasoline Blends[26], 2001

As noted in comments submitted by the Association of Oil Pipelines, the smaller the volume of each required gradient of fuel, the more difficult it is for the pipelines to ensure product quality due to the unavoidable volumes of interface (the intermixing of batched fuels in the pipeline system). The smaller the batch, the larger the percentage lost to interface and the fewer gallons that are delivered to retail. Furthermore, unless there is sufficient volumetric demand for a specific fuel type, it may not make economic sense for a pipeline to transport that fuel.

The map provided in Figure 13 demonstrates the regional diversity in fuel specifications. Comparing that illustration with the Gasoline Distribution System illustrated in Figure 14 provides an indication of the complexity of the motor fuels supply and distribution infrastructure.

The U.S. demand for gasoline in 2001 was 8.6 million barrels per day. As the previous section demonstrated, the transport of gasoline from one PADD to another is considerable. The following map illustrates once again the volume of product (comprised of the fuel grades represented in Figure 14) that is shipped throughout the nation on the distribution system (Figure 15) to specific fuel markets (Figure 13).

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[26] Figure 2 does not represent the following fuels: 1). Wintertime oxygenated gasoline; 2). Nevada Clean Burning Gasoline; 3). The distinction between Northern and Southern RFG; and 4). Gasoline blends with specific sulfur content limitation of 300 ppm and 800 ppm, respectively.

Figure 15: US Gasoline Distribution System

Graphic: Courtesy of NACS National Association of Convenience Stores
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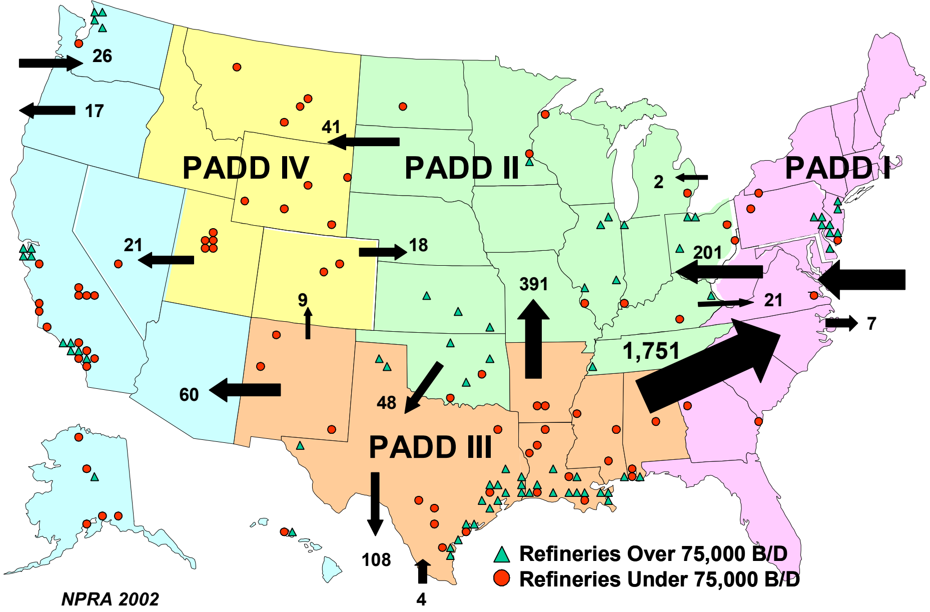
Figure 16: Gasoline Movements in 2001 (1,000 b/d)



NPRA 2002

The market conditions prevalent in 2001 were inherently capable of providing sufficient quantities of fuel to satisfy regional levels of demand, so long as there were no disruptions in the system. However, the frequency of disruptions in recent years has had a significant impact on regional gasoline supply availability and retail price volatility. The lack of excess capacity within the distribution system and the complexity of delivering unique formulations to specific markets have exacerbated the impact of these disruptions.

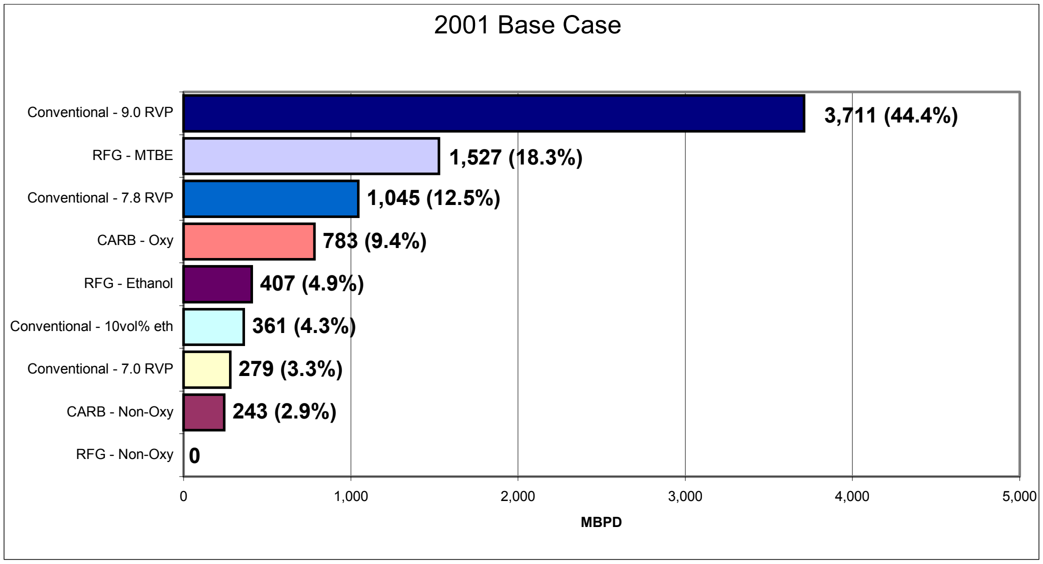
Reducing the number of fuel blends delivered throughout the system will increase the sizes of the batches and reduce the strain on the pipelines. Harmonizing fuel requirements in neighboring markets will further simplify the logistics required to maintain segregated batches for delivery to boutique markets. A combination of the two will restore flexibility to the system and improve the efficiency with which disruptions can be offset, thereby reducing the duration and severity of regional product shortages.

Given the fuel specification requirements of 2001 and understanding the nature of the distribution system required to satisfy regional consumer demand, one can begin to assess the fungibility implications of the various Flex Case scenarios based upon their impact on fuel supply composition. By combining the approximate volumes contributed to the overall U.S. gasoline pool by specific fuel blends with a rational examination of the fungibility impacts of policy decisions, one can begin to assess the impact each scenario may have on distribution flexibility.

Baseline Analysis: 2001

For purposes of this *Study*, the Baseline Analysis examined only conventional, reformulated and California reformulated gasoline grades, as well as regular and premium octane blends within each grade. The conventional blends were further classified according to various vapor pressure restrictions (9.0, 7.8, and 7.0 psi). A total of 8 finished gasoline grades were examined, along with a Reformulated Gasoline for Oxygenate Blending (RBOB) grade. The relative contribution of each grade to the overall U.S. gasoline supply is represented in Figure 17.

Figure 17: Gasoline Demand by Type (2001 Base Case)

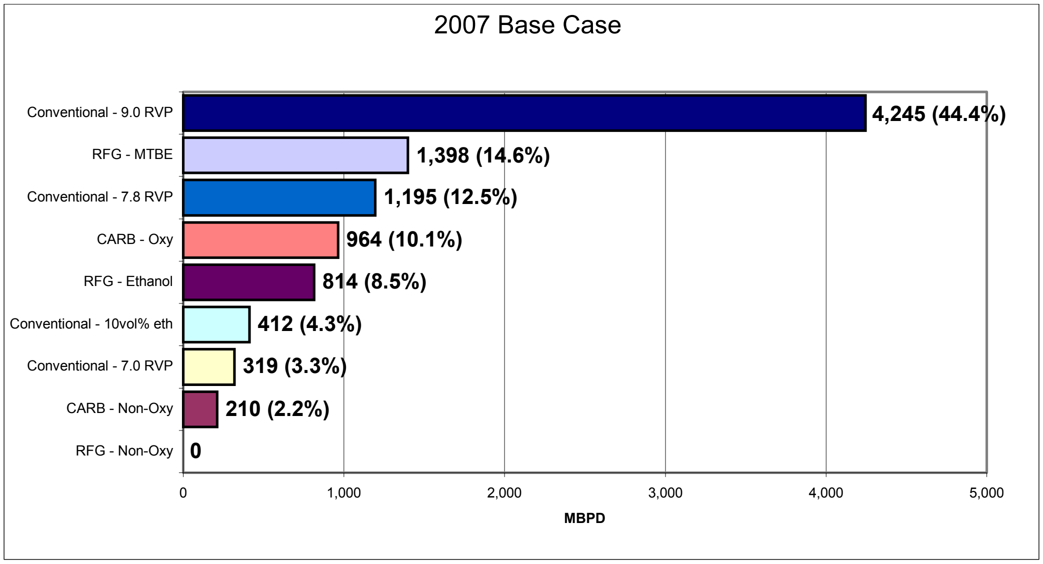


As in the true market conditions of 2001, the top four fuel blends of the 2001 Baseline represent 84.6% of the overall gasoline pool. Reformulated gasoline with MTBE represented 18.3% of the market and California reformulated gasoline, primarily blended with MTBE, contributed another 9.4%. Ethanol was blended in federal RFG to a volume of 4.9% and in conventional gasoline (10% volume blend) at 4.3%. The remaining two fuels combined for less than 7% of the fuel supply.

Baseline Analysis: 2007

By 2007, regulatory requirements affecting gasoline and diesel sulfur content have been implemented, as have the refinery requirement for Mobile Source Air Toxics controls. The regulatory scenario in this model has not greatly affected fuel fungibility, but has changed slightly the composition of fuel grades as reflected in Figure 18.

Figure 18: Gasoline Demand by Type (2007 Base Case)



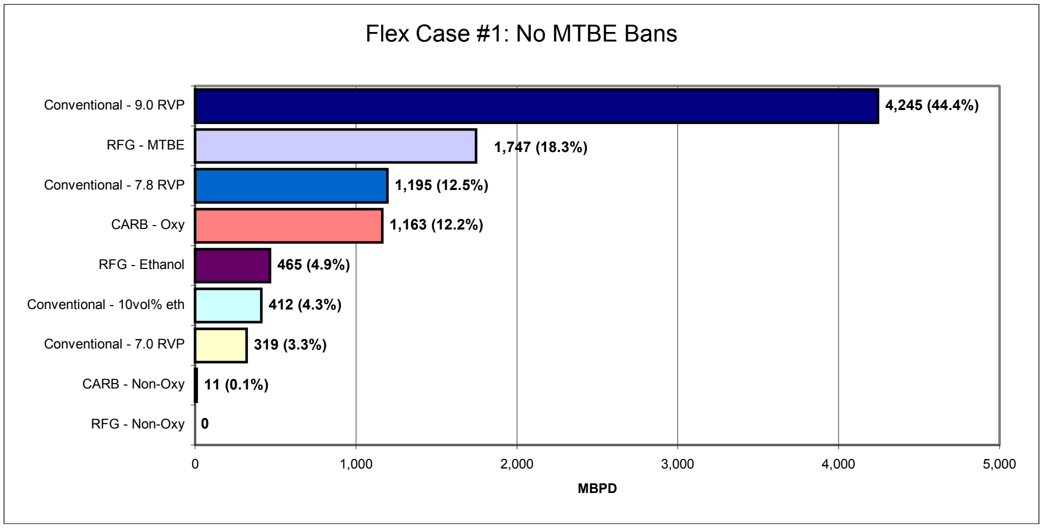
The MTBE bans in California, New York and Connecticut combined to reduce the volume of RFG with MTBE by 3.7%. This helped change the top four fuels' contribution to the overall gasoline supply from 84.6% in 2001 to 81.6% in 2007. The use of ethanol in Federal RFG nearly doubled to 8.5% of the market and ethanol blended into California RFG comprised another 10.1% (included in top four fuels). Ethanol was also blended into conventional to represent an additional 4.3% of the market. The remaining three fuels combined for less 10% of the pool and each contributed less than 5 percent market share.

Flex Case #1

By eliminating the pending California, New York and Connecticut bans on the fuel additive MTBE, this case improves fuel fungibility and overall product availability. In the Northeast, the product distribution infrastructure will be less stressed by not having to deliver segregated MTBE- and non-MTBE- gasolines to various markets in the region. In addition, the market will not have to accommodate two distinct oxygenates, one of which (ethanol) cannot be shipped in the pipeline. California likewise will not have to transport an oxygenate outside of the pipeline and will experience improved fungibility over Base Line (assuming refinery deselection out of MTBE is reversed). The fuel composition of this Flex Case is shown in Figure 19.

This case represents a reversion back to the fuel composition modeled for Baseline 2001. The only significant change is in the volume contribution of oxygenated California RFG which increased from 10.1% of the fuel supply to 12.2%.

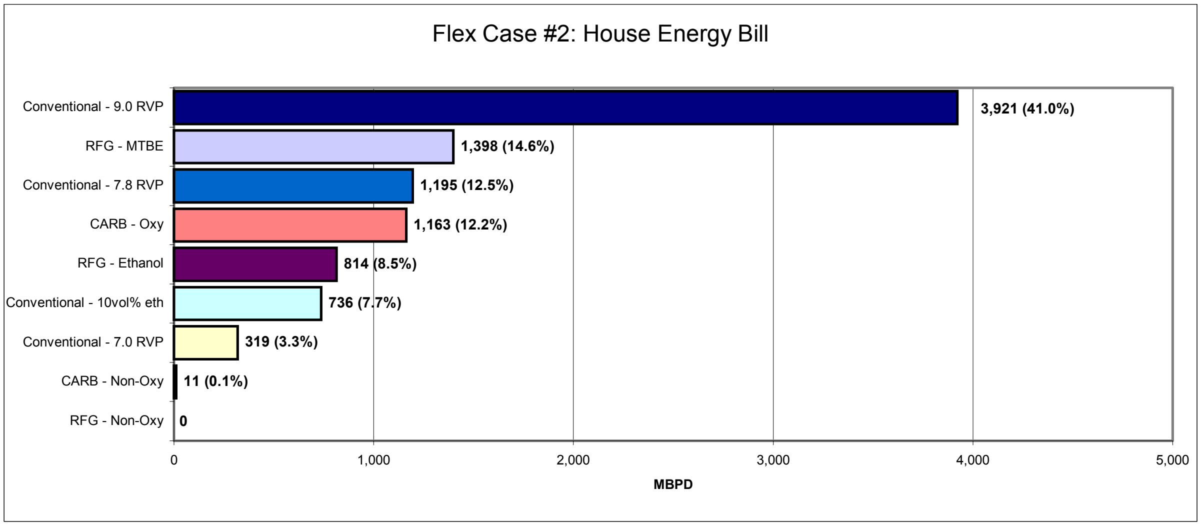
Figure 19: Gasoline Demand by Type (Flex Case #1)



Flex Case #2

Loosely modeled on the energy bill that passed the House in 2003 (H.R. 6), this case examines an elimination of the RFG oxygenate mandate and an implementation of a renewable fuels standard. Like Base Line 2007, state MTBE bans remain in place. The repeal of the oxygenate mandate could add additional flexibility to the system, but the presence of oxygenated and non-oxygenated RFG could pose a fungibility challenge. When both are present in the same market, current regulations prohibit a retailer from switch between ethanol and non-oxygenated RFG without first draining the appropriate underground storage tank. Such a situation removes the fungibility currently afforded RFG markets in which only one oxygenate is present. The fuel composition of this Flex Case is represented in Figure 20.

Figure 20: Gasoline Demand by Type (Flex Case #2)

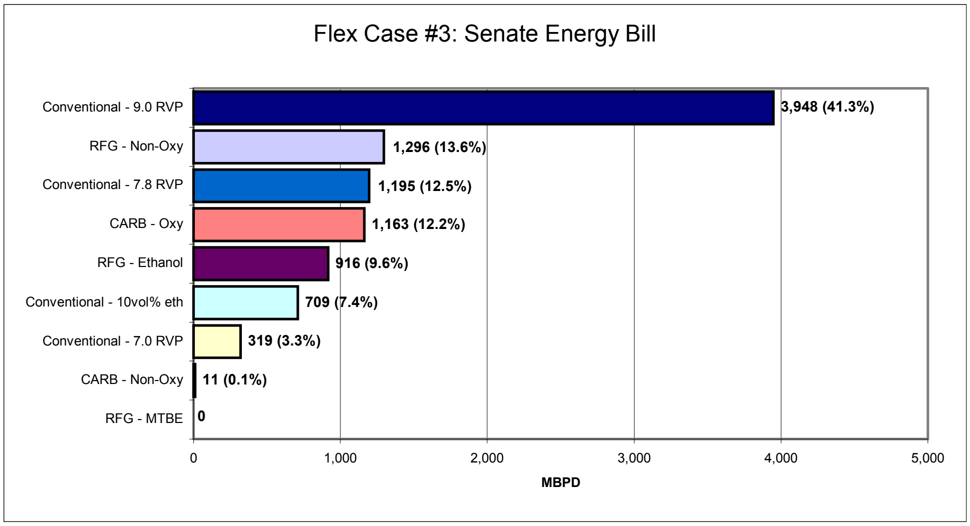


Under this Flex Case, the most obvious development was the increase in the use of ethanol-blended conventional gasoline to satisfy the RFS. The repeal of the oxygenate requirement limited the introduction of ethanol into this supply stream as MTBE remained prevalent in many RFG markets. California oxygenate RFG, blended with ethanol, grew by slightly more than 2% market share, most likely due to increased consumption in that state. This provided an increased market opportunity for ethanol and, along with the conventional market, helped satisfy the RFS requirement. The top four fuels lost market share as they represented only 80.3% of the gasoline pool.

Flex Case #3

Loosely modeled on the energy bill that passed the Senate in 2003 (S. 14), this case is similar to Flex Case #2 with the exception of a national ban on MTBE. The legislation simplifies the distribution system by removing the state-by-state bans on MTBE. The fuel composition of this Flex Case is displayed in Figure 21.

Figure 21: Gasoline Demand by Type (Flex Case #3)

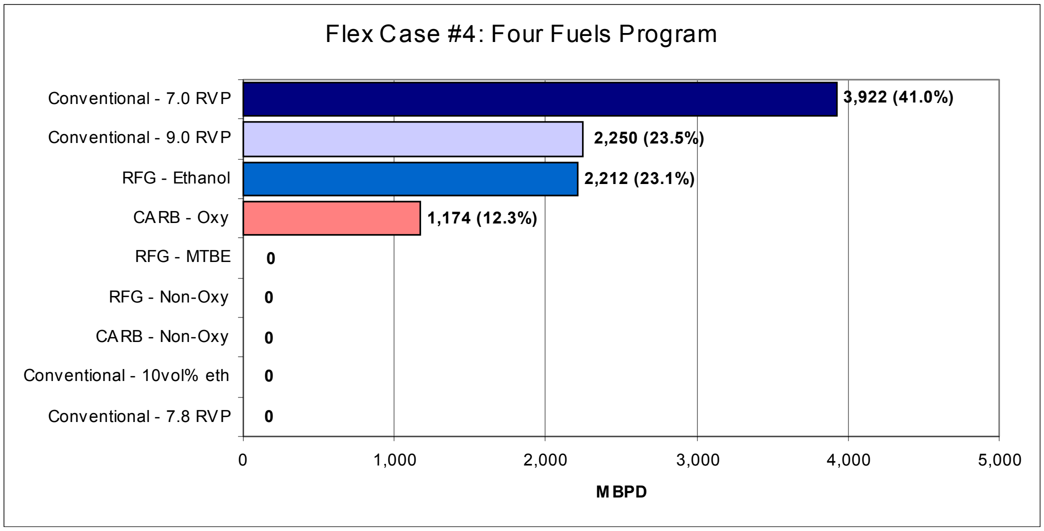


The removal of MTBE and the repeal of the oxygenate requirement substantially increased the market share for non-oxygenated RFG, which increased from 0% market share in the Baseline to 13.6% market share in this Flex Case. Ethanol's use in federal RFG improved over Flex Case 2 by 1.1 percent, but ethanol-blended conventional declined by 0.3%. Over baseline, ethanol-RFG increased by 1.1% and ethanol-conventional increased by 3.1% market share. Conventional gasoline at 9.0 psi declined by 3.1%. The top four fuels under this case continued to lose market share, representing only 79.6% of the gasoline pool.

Flex Case #4

Along with Flex Case #6, perhaps the most fungible of the cases modeled, this case includes a national ban of MTBE, thereby removing the distribution challenges imposed by independent state actions. In addition, the model consolidates all conventional gasoline into one RVP grade and yields only one RFG formulation—ethanol-RFG. The fuel composition of this Flex Case is represented in Figure 22.

Figure 22: Gasoline Demand by Type (Flex Case #4)

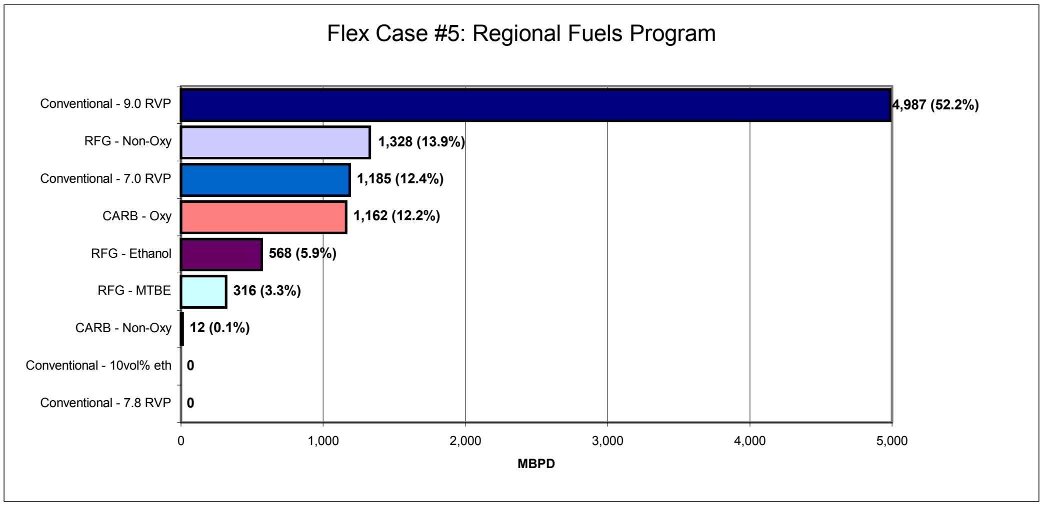


This case conveniently increases the market share for the top four blends to 100%. The removal of MTBE combined with the retention of the oxygenate standard greatly increases the market share of ethanol-RFG to 23.1%, an increase of 12.6% over 2007 Baseline. In addition, California RFG is oxygenated with ethanol to comprise 12.3% of the market. With only three fuels marketed outside of the California area, fungibility can be expected to improve considerably.

Flex Case #5

Establishes a regional fuels program that will improve fungibility within each PADD, consolidating conventional gasoline to one RVP formulation and RFG, thereby simplifying the distribution system. Fungibility concerns associated with the repeal of the oxygenate requirement and implementation of an RFS in Flex Cases 2 and 3 remain as retailers are not permitted to commingle ethanol and non-oxygenated RFG in their petroleum storage tanks. The fuel composition of this Flex Case is shown in Figure 23.

Figure 23: Gasoline Demand by Type (Flex Case #5)

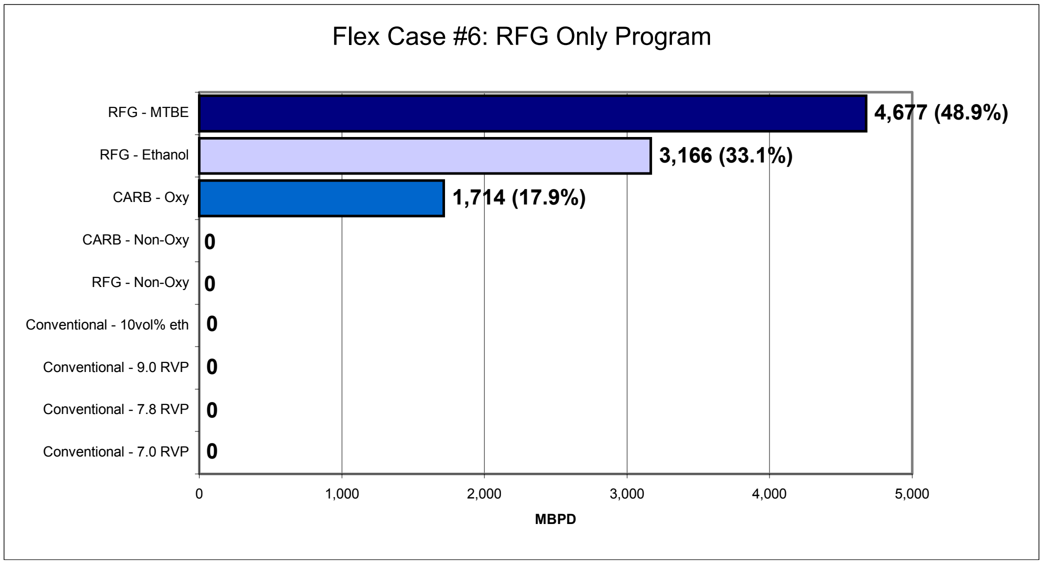


The consolidation of conventional gasoline into two grades greatly expands the market share of the top four fuels to 90.5%. The presence of three grades of RFG, however, does pose a concern. Non-oxygenated RFG has become the second largest batch of gasoline in the nation at 13.9%, but oxygenated RFG (either ethanol or MTBE) continues to comprise another 9.2%. The model assumes, however, that each PADD will utilize only one grade of oxygenated RFG combined with non-oxygenated RFG, which restores some fungibility to the PADD-specific supply. California RFG oxygenated with ethanol increases as in other cases to 12.2%.

Flex Case #6

Along with Flex Case #4, perhaps the most fungible of the cases modeled, this case eliminates all conventional gasoline and creates a market in which only RFG (northern, southern and California) is allowed in the market. Ethanol- and MTBE-RFG markets are regionally segregated, thereby limiting the distribution challenges to accommodate these two fuels. The fuel composition of this Flex Case is shown in Figure 24.

Figure 24: Gasoline Demand by Type (Flex Case #6)



The consolidation of all gasoline into RFG greatly simplifies the distribution process. Ethanol is blended into RFG in PADD 2 and in markets where MTBE is banned, while MTBE is utilized at its optimum elsewhere. With California RFG isolated to that region, the nation's supply is basically comprised of two fuels: ethanol-RFG and MTBE-RFG. Fungibility concerns associated with the state-MTBE remain, but simplification of available fuel grades essentially negates this challenge.