OBSERVATIONS ON PETROLEUM PRODUCT SUPPLY

A Supplement to the NPC Reports:

U.S. Petroleum Product Supply–
Inventory Dynamics, 1998

and

U.S. Petroleum Refining–
Assuring the Adequacy
and Affordability
of Cleaner Fuels, 2000

NATIONAL PETROLEUM COUNCIL • DECEMBER 2004

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PREFACE

Study Request

In his address to the National Petroleum Council (NPC) at its June 22, 2004 meeting, Secretary of Energy Spencer Abraham expressed concern about the adequacy of U.S. refining capacity and petroleum inventory levels, stated that he would request a study on these subjects, and noted that he would like the Council's advice by September 30, 2004.[1]

By letter dated July 16, 2004, Secretary Abraham formally requested the National Petroleum Council to undertake a new study on refining and inventory issues that would provide advice on the challenges related to petroleum refining and product supply in the United States. Specifically, the Secretary's letter states:

> Accordingly, I request that the National Petroleum Council identify the factors that will impact the refining and distribution industry's ability to meet future product demand, and report on potential near-term options to meet demand for transportation fuels and heating oil over the next year. Additionally, I ask that the Council reexamine its 1998 advice on lower operational inventory levels for crude oil and petroleum products.
>
> Items to consider include the current and future demand for refined products, domestic capacity to meet this demand, potential barriers to efficient markets, the influence of petroleum product supply on price, industry actions to meet environmental requirements, and the capital investment and other factors that will drive supply growth. Additionally, I would appreciate the Council's insights on how refining capacity, inventories, and demand patterns outside the United States may impact meeting the consumer demand for refined petroleum domestically.

(Appendix A contains the complete text of the Secretary's request letter and a description of the NPC.)

As noted in the Secretary's request, inventory issues were most recently addressed by the Council in its 1998 report, *U.S. Petroleum Product Supply—Inventory Dynamics*. That report provided advice on the interrelationships between inventories and prices and estimated lower operational inventory (LOI) levels for crude oil and light petroleum products. Similarly, refining issues were last addressed by the Council in its 2000 report, *U.S. Petroleum Refining—Assuring the Adequacy and Affordability of Cleaner Fuels*. That report provided insights to help ensure a reliable supply of light petroleum products to consumers. Those reports had notional time frames of 2002 and 2005, respectively.

Study Organization

In response to the Secretary's request, the Council established a Committee on Refining and Inventory Issues to undertake a new study on these topics and to supervise the preparation of a draft report for the Council's consideration. The Council also established a Refining Subcommittee and an Inventory Subcommittee to assist the Committee in conducting the study.

[1] The Council's study was conducted during August and September, but due to unavoidable conflicts this report was not presented to the Secretary until December 1, 2004.

Lee R. Raymond, Chairman and Chief Executive Officer, Exxon Mobil Corporation, served as the Committee's Cochair for Refining; James J. Mulva, Chairman of the Board and Chief Executive Officer, ConocoPhillips, served as the Committee's Cochair for Inventory; and David K. Garman, Acting Under Secretary of Energy, served as the Committee's Government Cochair. Donald H. Daigle, Vice President, Refining, ExxonMobil Refining and Supply Company, chaired the Refining Subcommittee; Philip L. Frederickson, Executive Vice President, Commercial, ConocoPhillips, chaired the Inventory Subcommittee; and Mark R. Maddox, Acting Assistant Secretary, Fossil Energy, U.S. Department of Energy, served as Government Cochair of both Subcommittees.

The members of the Committee and its Subcommittees were drawn from the NPC membership, NPC member and other organizations, and government. These study participants represented broad and diverse interests including large and small petroleum refiners, transporters, marketers, and consumers as well as providers of financial and consultant services. They brought their substantial individual experiences to the collective effort of producing this report. (Appendix B contains rosters of the study's Committee and Subcommittees.)

Study Approach

Given the interrelated nature of refining and inventory issues, the Council determined that a single study would be the most efficient way to prepare a response to the Secretary's request for advice. Also given the study's limited time frame, the Council determined that the scope of the study would be to review and supplement the most recent NPC reports on these issues and would be qualitative rather than quantitative in its approach. In spite of this qualitative nature, the study results are soundly based in the depth of experience of the individual study participants. Broadly, the new study:

- Performed qualitative reviews of the NPC's 1998 inventory study and the 2000 refining study, and reaffirmed or modified recommendations as appropriate:
  - Reviewed and validated major assumptions
  - Assessed the government's response to recommendations
  - Focused on the remainder of this decade.
- Developed consensus on additional observations/recommendations based on industry experience since the 1998 and 2000 studies.

Specifically, the refining issues analysis:

- Assessed the 2000 refining study, as described above
- Evaluated refinery capacity growth versus demand since 2000
- Considered the most recent EIA demand forecast
- Identified factors affecting domestic refinery capacity expansions for the remainder of this decade, including notional grassroots refinery economics
- Identified factors affecting availability of imports to augment domestic supplies for the remainder of this decade
- Identified potential near-term government actions that could affect refinery capacity and import availability over the next year
- Identified how refining capacity outside the United States might affect industry's ability to meet domestic demand.

Specifically, the inventory issues analysis:

- Assessed the 1998 inventory study, as described above
- Identified the role of inventories in the supply system
- Identified inventory trends and evaluated LOI levels for crude oil and major petroleum products
- Assessed product price volatility
- Evaluated the 1998 study's conclusion regarding inventories' relationship to price.

Issues Not Analyzed

Given the limited time frame in which to complete the study effort, the Council and the Department of Energy agreed on a targeted scope of issues to be addressed. The Council recognized that this approach might preclude some issues, which could be important in public policy formation, from being adequately addressed and analyzed. That this study does not include quantitative analyses of these issues is a reflection of time and data constraints, and inferences should not be drawn on indications of their importance.

Specifically, the refining and inventory issues analyses used publicly available forecasts and did not:

- Provide a quantitative analysis or forecast of demand for crude oil and refined petroleum products, domestic or worldwide
- Provide a quantitative analysis or forecast of domestic or worldwide refining capacity and capability to meet changing product specifications
- Provide a quantitative analysis or forecast of the availability of imports into the United States
- Assess any additional infrastructure requirements (ports, tanks, pipelines, etc.) necessary to handle increased petroleum imports
- Assess any national security implications of the potential for increased reliance on imports
- Assess the potential for public policy actions to reduce fuel demand to worsen the investment climate for expansion of domestic refining
- Reassess 2000 refining study production cost estimates
- Forecast prices or the potential price effects of actions, but did make qualitative assessments of factors that impact price volatility.

Study Report

Results of the 2004 NPC review of refining and inventory issues are intended as an update and supplement to the 1998 and 2000 NPC reports on these subjects and are presented in this report volume as follows:

- *Executive Summary of Findings and Recommendations* presents observations on petroleum product supply and an integrated response to the Secretary's request for advice on both refining and inventory issues. It provides insights on petroleum market dynamics as well as advice on actions that can be taken by industry and government to ensure adequate and reliable supplies of petroleum products to meet the energy and environmental requirements of American consumers. It includes an overview of the study's interrelated refining and inventory analyses and recommendations.
- Part I, *Refining Capacity and Product Import Availability*, contains the results of the Refining Subcommittee's review and update of the 2000 NPC refining report. This part of the report provides support for the findings and recommendations presented in the Executive Summary. It includes discussions of the items outlined in the refining issues analysis part of the Study Approach section above.
- Part II, *Observations on U.S. Petroleum Inventories,* contains the results of the Inventory Subcommittee's review and update of the 1998 NPC inventory report. This part of the report provides support for the findings and recommendations presented in the Executive Summary. It includes discussions of the items outlined in the inventory issues analysis part of the Study Approach section above.
- *Appendices* contain the Secretary's study request letter, a description of the NPC, rosters of the study's Committee and Subcommittees, and supporting materials for the report.

EXECUTIVE SUMMARY OF FINDINGS AND RECOMMENDATIONS

This supplemental report focuses on major light petroleum product (gasoline, jet fuel, heating oil, and diesel) supply and petroleum inventories in the United States. It is important to understand this market in the context of the larger flexible and responsive global petroleum market. Delivery of petroleum products to the consumer involves multiple separate activities, including refining, transportation, and storage of petroleum. Many different competitors participate in this supply chain. Some are integrated throughout the chain while others specialize only in certain segments. Competition in the global marketplace drives adoption of efficient strategies, including those related to inventory management and refining optimization.

In the near term, the NPC does not foresee significant hurdles to the availability of gasoline and heating oil supplies to meet consumer demand. However, there are concerns about meeting Ultra Low Sulfur Diesel (ULSD) demand during the transition to the 15 ppm maximum sulfur specification beginning in mid-2006.

The demand for light products in the United States is expected to continue to grow. Demand will be met with a combination of domestic production and imports. Imports have been growing for the last several years, and imports are expected to continue to be an economic component of U.S. supply. The amount of future demand growth supplied from domestic refineries will be dependent on several factors, including domestic investment decisions by individual companies. This report includes recommendations for government actions that would avoid impeding domestic refining capacity growth and improve the investment climate for domestic refining.

Companies continually strive to economically optimize their operations while reliably meeting consumer demand. Inventories are an integral part of the supply system and act as an interface between the various segments of the supply chain. The competitive nature of the industry drives companies to minimize working capital, of which inventory is a component, while ensuring reliable supply systems. Ultimately, consumers benefit from efforts to reduce petroleum supply costs.

The petroleum markets respond to supply/demand changes with price movements that provide the incentive to increase or decrease supply to correct any imbalance. This is an integral part of normal and effective market operation. Through the individual responses of various companies to these price movements, the petroleum industry as a whole reacts quickly and effectively to maintain the supply and demand balance in response to changes in local, regional, or global market conditions. Although the U.S. supply system is very complex, it is robust and has the flexibility to adjust to supply disturbances. Even major supply disturbances are typically rebalanced within a short period of time. Market mechanisms provide the fastest and most efficient response to supply disturbances.

Refining Capacity and Import Availability Findings

Capacity Growth

U.S. refining capacity has grown since the 2000 NPC refining study, but the rate of U.S. refining capacity growth has slowed in recent years. Domestic light product production has not kept pace with demand growth. Some of the factors that impede domestic capacity growth include:

- Investment economics, reflecting historical refining and marketing returns that are lower than other segments of the oil business and lower than the average of the S&P 500 companies
- An uncertain regulatory environment, resulting from issues such as New Source Review (NSR) enforcement, National Ambient Air Quality Standards (NAAQS) implementation schedules, and lack of a defined mechanism for the granting of waivers
- Resources used for regulatory-driven refinery projects.

The NPC expects that increases in domestic production will come from continued expansion of existing refineries, because expansion at existing sites is generally more economic than new refinery construction. Even the very recent improvement in refinery profitability does not appear to be sufficient to create an economic environment conducive to building new grassroots refineries. Recent increases in gasoline imports suggest that the economic and regulatory climate for investment in domestic refining capacity has not supported capacity expansion and utilization equal to the growth in gasoline demand.

Product imports are expected to continue to be an economic component of U.S. supply. The volume of imports in the future will depend upon a number of factors, including domestic demand growth and domestic refining capacity growth, as well as supply/demand factors outside the United States that affect the economics of imports versus domestic refining.

Emissions reductions and an improved environment benefit society in many ways. As they have in the past, U.S. refining industry participants expect to continue to devote significant resources to environmental improvement, including cleaner fuels production and reduction of emissions from stationary sources. However, the magnitude and uncertainty of environmental requirements and their enforcement increases cost and adversely affects domestic refinery investment. Foreign competitors that are not subject to these additional costs and uncertainties may have a competitive advantage, resulting in reduced domestic capacity growth.

Ultra Low Sulfur Diesel

The NPC believes that the transition period for ULSD is likely to be more difficult and longer than historically associated with major product specification changes. This is due to the difficulty anticipated in maintaining and assuring the specified sulfur level and needed volumes during distribution from refineries to the ultimate consumer. Enforcement of the 15 ppm maximum sulfur retail cap without an adequate tolerance for test reproducibility could result in large quantities of diesel being disqualified as ULSD for supply to consumers. In addition, pipeline companies could set a very low sulfur requirement at the refinery gate because of contamination concerns in the distribution system, which would reduce refinery production capability. It is uncertain whether domestic refinery production will be of sufficient volume and low enough sulfur content to overcome anticipated distribution issues. The NPC does not expect that imports of ULSD will be widely available to make up for the downgrade during distribution or reduced refinery production. Consequently, there is the potential for significant supply disruptions.

Inventory Findings

Inventory Trends

Crude oil inventory has continued the slow downward trend noted in the 1998 study. This trend, which is likely to continue, is attributed to delivery system efficiency improvements and declining domestic crude oil production. With declining domestic production, imports have increased. However, imports in transit are not counted in U.S. inventory data.

The long, slow decline of gasoline inventory primarily associated with finished gasoline inventory at terminals that was observed in the 1998 inventory study is no longer apparent. Distillate (heating oil and diesel) inventory has remained essentially flat through both the previous and current study periods. The NPC believes further efficiencies have taken place allowing for lower inventory levels, but these efficiencies have been offset by increases in product demand and the number of different fuel specifications, which have increased the need for inventories.

Lower Operational Inventory

As discussed in the 1998 NPC inventory study, U.S. petroleum inventories respond to both market and infrastructure changes in the supply system. A significant part of petroleum inventory is required to operate the product and crude supply systems and is not readily available to meet demand. In the 1998 study, the NPC redefined these inventories as "lower operational inventory" (LOI). The NPC defined LOI as the lower end of the demonstrated operating inventory range updated for known and definable changes in the petroleum delivery system. The LOI was introduced in the 1998 study in order to move away from the concept that there is some definable inventory level where supply system reliability becomes of greater concern. While generally not used by industry, the NPC recognizes LOI as a gauge to help the government assess current inventory levels.

Based on the observed crude oil inventory trends, the NPC concludes that the crude oil LOI should be a range of 260 to 270 million barrels, compared to the 1998 study conclusion of 270 million barrels. Since the 1998 study, crude oil inventory has been as low as 260 million barrels with no impact on crude oil supply to U.S. refineries. However, in September 2004, Hurricane Ivan had a significant impact on offshore oil platforms, pipeline movements, and oil imports. This created localized supply disruptions at a few refineries even though crude oil inventories were slightly above 270 million barrels. This reinforces the concept that the LOI is only one indicator of adequacy of supply and therefore a crude oil LOI range is recommended, rather than a single value, to better represent the degree of accuracy associated with the LOI methodology.

No change is appropriate at this time in the LOIs for gasoline or distillate fuel oil. Given the short time frame of this study, the potential impact of regulatory changes in diesel sulfur content on distillate inventory was not studied.

Price Volatility

Global crude oil prices continue to be the primary driver of product price levels. Even though the number and magnitude of product price up-ticks (increases of greater than 10% or more versus prior year period) has increased since 1997, most of these events were driven by events in the global crude oil market. Retail price changes continue to lag behind spot price changes, which has the effect of dampening and delaying price swings at the retail level.

Product and crude oil price levels and volatility have increased since the previous study, which focused on a time period of relative calm in oil markets (1992-1997). In the 1998 to 2004 time period, crude oil price volatility peaked in 1998, while gasoline price volatility peaked in early 2002. What has occurred since 2002 is an upward movement in product prices in line with an upward movement in global crude oil prices. Retail gasoline prices, however, have been observed to be less volatile than crude oil prices.

These conclusions are based on analysis of U.S. national data. Consumers at a local level may be subject to more or less volatility than the national average as a result of local factors that are not captured by this analysis.

Relationship of Inventories to Price

As addressed in the 1998 NPC inventory study, the expectation that inventories influence prices is based on the economic assumption that prices reflect the current supply/demand balance and that inventories provide a measure – however imperfect – of the changing balance between supply and demand. Inventories are a result of supply and demand fundamentals. Any factor that serves as a measure of the short-term supply/demand balance would be expected to influence prices.

Statistical analysis of the simple relationship between inventories and prices finds only a modest correlation. This conclusion is indicative of the fact that the interaction of inventories and prices is complex. Inventories are an imperfect measure of the supply/demand balance, and prices for crude oil and petroleum products are influenced by many other factors in addition to inventories. When petroleum inventory data are made public, it can potentially have a short-lived effect on petroleum prices, including futures prices. This appears particularly true when the inventory data deviate from market expectations.

Strategic Petroleum Reserve

The United States' Strategic Petroleum Reserve is the largest government crude oil stockpile in the world. The NPC remains strongly supportive of holding these inventories, but they should only be used during significant crude oil supply disruptions that threaten the system's ability to meet domestic demand.

While it is recognized that there is a strategic heating oil reserve in the Northeast, the concept of a products strategic reserve was discussed as part of this supplemental report and the NPC does not believe such reserves are appropriate for the United States.

Recommendations

The NPC provides the following recommendations to help ensure a reliable supply of light petroleum products to the U.S. consumer. These recommendations are aimed at avoiding hindrance of refining capacity expansion, improving the environment for investment in domestic refining and logistics capability, and allowing the current supply system to continue to operate efficiently. Allowing the market to work efficiently will benefit the customer as the market provides the fastest and most efficient response to supply disturbances.

The recommendations of the 2000 NPC refining study remain applicable and should be implemented. A summary of those recommendations and the current status are included in Appendix C.

New Source Review

Immediate implementation of comprehensive NSR reform is a very important policy step needed to improve the climate for investment in domestic refinery expansion. The NSR reforms promulgated by the Administration, including the Equipment Replacement Rule currently under judicial review, should be implemented as soon as possible. Attempts to delay or overturn the reforms should be vigorously opposed. Additional NSR reform proposals regarding de-bottlenecking and project aggregation should be issued and finalized.

National Ambient Air Quality Standards

The U.S. Environmental Protection Agency (EPA) should revise the NAAQS compliance deadlines and procedures to take full advantage of emissions reduction benefits from current regulatory programs such as cleaner fuels/engines and reduction of regional emissions transport. As currently structured, attainment deadlines precede the benefits that will be achieved from emissions reductions already planned. Thus, even though programs are already being implemented to provide emissions benefits, states with non-attainment areas will be required to pursue additional costly controls that might otherwise not be needed and might not be deliverable in the time frame currently required.

The current deadlines could result in:

- Requirements for additional emissions offsets for any refinery modifications, reducing the economic attractiveness of investment in refinery capacity expansion
- Additional investment in stationary source controls at refineries, reducing the overall profitability and viability of domestic refining versus imports
- Additional requirements for boutique fuels, reducing the efficiency of the distribution system and increasing the potential for supply disruptions.

These requirements would be disincentives to expansion of domestic refining capacity. If the states were given sufficient time to allow emissions benefits of clean fuels/engine programs and regional transport regulations to be considered in attainment demonstrations, the adverse impact of these regulations on domestic refining capacity would be greatly reduced.

Implementation of Ultra Low Sulfur Diesel Regulations

Although the timing and specification level of the ULSD regulations do not follow the NPC's 2000 recommendations, the timing requirement has been finalized and should not be changed this close to the implementation date, since refiners are already making investments to comply.

To reduce the potential for supply disruptions, EPA should work with the Department of Energy (DOE) and the various fuel supply industries to consider emerging information about the behavior of ULSD moving through the entire distribution system and to consider how to achieve the goals of the program while recognizing distribution system realities.

EPA's current testing tolerance for ULSD should be adjusted to reflect the reproducibility of the tests that will be available for regulatory compliance; otherwise, enforcement actions based on testing inaccuracy may result in disruption to the supply system.

National Energy Legislation

The NPC recommends passage of national energy legislation as embodied in the 108th Congress conference report on HR.6 as the vehicle with the highest probability of obtaining prompt action on the reformulated gasoline (RFG) oxygenate, oxygenate liability, and boutique fuel issues. While clearly a compromise, the package will help remove some of the uncertainty around the future of the domestic refining industry.

- ***Oxygenate Liability.*** Congress should enact limited liability protections against defective product claims involving methyl tertiary butyl ether (MTBE) and other federally required additives. This action would eliminate only defective product claims that penalize fuel manufacturers for meeting the Clean Air Act requirements. Negligence and other traditional causes of action for MTBE cleanup would be unaffected.
- ***Boutique Fuels.*** Requests for specialty fuels formulations, whether driven by NAAQS or otherwise, should be approved only where such programs are necessary and cost-effective relative to other emissions reduction options. Proliferation of boutique fuels has fragmented the market, increasing the potential for supply disruptions and price volatility. While the industry has been able to adapt to the current slate of boutique fuels without significant supply disruptions, continued proliferation would substantially increase the risk of supply disruption and price volatility. Implementation of state and local fuels programs, including any actions on MTBE, should be coordinated to avoid hindering operation of the distribution system and should provide sufficient lead time to implement any necessary refining and distribution changes. Repeal of the 2% oxygenation requirement for RFG could eliminate much of the incentive for boutique fuel proliferation.

  DOE and EPA should conduct a joint study of the boutique fuel issue, with participation by the stakeholders. This study should provide important information on the impact of boutique fuels on fuel production and distribution.

Sound Science, Cost Effectiveness, and Energy Analysis

The 2000 NPC refining report recommended that: *"Regulations should be based on sound science and thorough analysis of cost effectiveness."*

Executive Order 13211, signed by President Bush in 2001, requires agencies to prepare a "Statement of Energy Effects" including impacts on energy supply, distribution, and use, when undertaking regulatory actions. The NPC recommends that Executive Order 13211 be made law and strictly enforced.

The NPC is not suggesting elimination or rollback of environmental requirements, but rather that the cost analysis of proposed regulations should include a thorough analysis of energy supply effects from production to end-use. Examples of regulations that the NPC does not believe reflect a thorough analysis of the energy supply effects include ULSD and NAAQS regulations. As a result, implementation of these regulations may impose unintended costs without commensurate benefit.

Regulatory cost/benefit analysis should be performed on an incremental basis, to ensure that the cost of each required increment is justified. Using a total and average analysis may result in adopting emissions reduction increments that are not cost effective.

Permitting

Streamlining the permitting process would help improve the environment for domestic refining capacity investment. Some activities are currently underway to review processes and identify streamlining opportunities; these activities should include industry and other stakeholders. Streamlining should provide for expeditious overall review and a clearly defined process for obtaining a permit, with agency roles and responsibilities well-defined and specific deadlines for making permit decisions.

Depreciation Schedule Adjustment

Adjusting the depreciation schedule for all refining equipment to five years from the current ten years, consistent with the treatment of similar process equipment in other manufacturing industries, would have a positive impact on expansion investment economics. This action would reduce the capital recovery period for investment in refining equipment, helping to offset the historically low returns in the refining/marketing business that have hindered investment in capacity expansion.

The depreciation adjustment should be applied to all new domestic refining investment. Attempts to apply revised treatment to some small sub-segment of investment may have the perverse effect of reducing the incentive for more significant additions in base capacity. The depreciation schedules for petroleum pipelines and storage facilities should be similarly reduced.

Fuel Waivers and Enforcement Discretion

Use of exemptions, exceptions, and waivers should be limited to serious supply disruptions that affect end users' ability to obtain petroleum products. States have sought and EPA has repeatedly considered and/or granted enforcement discretion, and this has increased uncertainty in the marketplace. EPA should issue a definitive variance procedure for allowing non-complying fuel to be sold in the marketplace. Proposed guidance on waivers has been recently released by EPA as a first step in this process.

Alternative Fuels

Mandates or subsidies for alternative fuels increase uncertainty and reduce the incentive for investment in additional domestic petroleum refining capacity. Therefore, these mandates and subsidies may not reduce petroleum product imports as intended and could increase the cost to consumers.

Distillation and Driveability Index

The 2000 NPC refining report recommended that the Driveability Index not be changed without thorough additional analysis. To date, EPA has resisted automakers' calls for a reduction in Driveability Index, or a change to Distillation Index (Driveability Index plus an ethanol adjustment). EPA should continue this position. A reduction in Driveability or a change to Distillation Index could result in a significant reduction in domestic refinery gasoline producibility.

Site Security

Site security enhancement should remain an industry responsibility with ongoing risk assessment coordinated with the Department of Homeland Security, which should retain the lead federal coordination role. Refining industry participants are committed to keeping their facilities secure from threats of violence and terrorism. Refiners have expended substantial resources to enhance security and expect to continue to do so. There are proposals being discussed that include provisions for refining technology changes and criminal liability. In the opinion of the NPC, these provisions do not provide an additional security benefit but have the potential to negatively impact light product production capability.

2005 Domestic Capacity

These recommendations are aimed at avoiding hindrance of capacity expansion, improving the environment for investment in domestic refining and logistics capability, and allowing the current supply system to continue to operate efficiently. These recommendations should be implemented as soon as practical.

Major refinery modifications can take four or more years lead time for all the activities necessary for implementation. Due to this long lead time, the capacity that will be available in 2005 is the result of regulatory actions and investment decisions over the last several years. The NPC has not identified any government actions that could significantly increase the domestic refining capacity available for 2005.

PART I

REFINING CAPACITY AND PRODUCT IMPORT AVAILABILITY

The downstream oil business is very competitive in the United States, and both refiners and marketers continuously look for the lowest cost means of supplying their customers. The demand for light products in the United States is expected to continue to grow. Demand will be met with a combination of domestic production and imports. For the last several years, imports have been growing. Likewise, domestic refining capacity has been growing and is expected to continue to grow. Product imports are expected to continue to be an economic component of domestic supply, because the United States is part of a flexible and responsive worldwide petroleum market. The amount of future demand growth supplied from domestic refineries will be dependent on domestic investment decisions by individual companies, as well as the economics of domestic production versus imports.[1]

One of the factors considered in evaluating potential distillation or conversion capacity expansion projects is the economic return under expected future market conditions. Since imported product has been and is expected to be an ongoing component of domestic supply, the relative economics of domestic production versus imports affects investment decisions by individual companies for domestic refining. Recent increases in gasoline imports suggest that the economic and regulatory climate for investment in domestic capacity has been such that individual domestic refiners have been unable to justify sufficient amounts of distillation and conversion expansions to satisfy all the growth in light product demand. This report includes recommendations for government actions that would avoid impeding domestic refining capacity growth and improve the investment climate.

This section discusses U.S. light product petroleum supply (gasoline, jet fuel, and distillates – both diesel and heating oil) in six segments:

- Observations on supply and demand since the 2000 NPC refining study, including domestic capacity and import trends
- Factors that can potentially impact the growth in domestic refining capacity
- A generic assessment of the economics of constructing a new grassroots refinery
- The outlook for the near term, covering observations on low sulfur gasoline and ultra low sulfur diesel implementation
- Recommendations that could reduce hindrances and improve the climate for investment in domestic capacity
- Brief comments on potential issues for the longer term.

Most of the data presented in this section include annual data through 2003. While partial year data for 2004 are available in some cases, the effort necessary to adequately annualize the information for valid comparison was beyond the scope of this study.

[1] The NPC did not develop a quantitative forecast for imports in the limited time frame of this study. The Energy Information Administration's 2004 Annual Energy Outlook forecasts that net petroleum product imports into the United States will increase by about 500 thousand barrels per day from 2003 to 2010. This increase represents about 20% of the 2.5 million barrels per day increase in domestic gasoline, jet fuel, and distillate demand forecast over that same period.

Observations on Light Product Supply and Demand Since the 2000 NPC Refining Study

U.S. light product supply is driven by demand and is provided from both domestic refinery production and imports. Since the 2000 NPC refining study, domestic supply and demand for light products has been slowly increasing. Figure I-1 shows domestic production of gasoline, jet fuel, and distillates as well as the total net imports of all these products.[2] A slowly growing overall trend is apparent for domestic production. While imports remain a small portion of domestic supply overall, the percentage growth in imports has been significant over the last few years. As discussed later in this section, the net import increase is primarily a result of increased gasoline imports from Europe.

Domestic Light Product Production

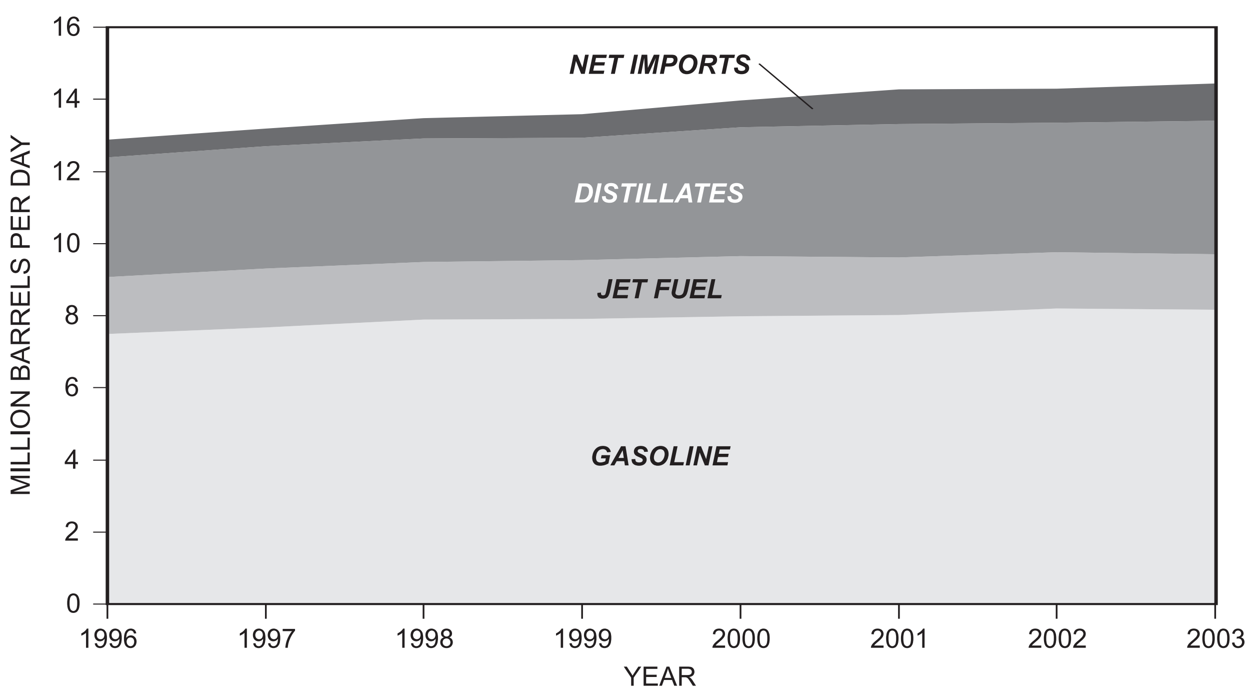
Increases in domestic light product production result from a combination of changes in both distillation and conversion capacity, the yields of products from crude oil, and refinery capacity utilization. The increase in domestic production of light products since the 2000 NPC refining study shown in Figure I-1 has resulted from capacity expansions and improvements in yield, which more than offset a slight decline in average utilization. Trends in capacity, yield, and capacity utilization are discussed in more detail in the following sections.

Refinery Distillation and Conversion Capacity Changes

Domestic atmospheric crude oil distillation capacity has been steadily increasing since 1996, as shown in Figure I-2. However, the rate of capacity addition has slowed since the 2000 NPC refining study. Factors that have affected the rate of capacity increase are discussed later in this report.

U.S. refinery capability is commonly assessed using atmospheric distillation capacity. This is a somewhat simplistic approach since, depending on the characteristics of the specific crude oil used, only 30 to 50% of an atmospheric distillation facility's output can be made directly into light products. U.S. demand is mostly light products and therefore the heavier materials produced from atmospheric

[2] Unless otherwise indicated, data are from U.S. Energy Information Administration or International Energy Agency Reports.



Source: Energy Information Administration.

Figure I-1. U.S. Light Product Supply

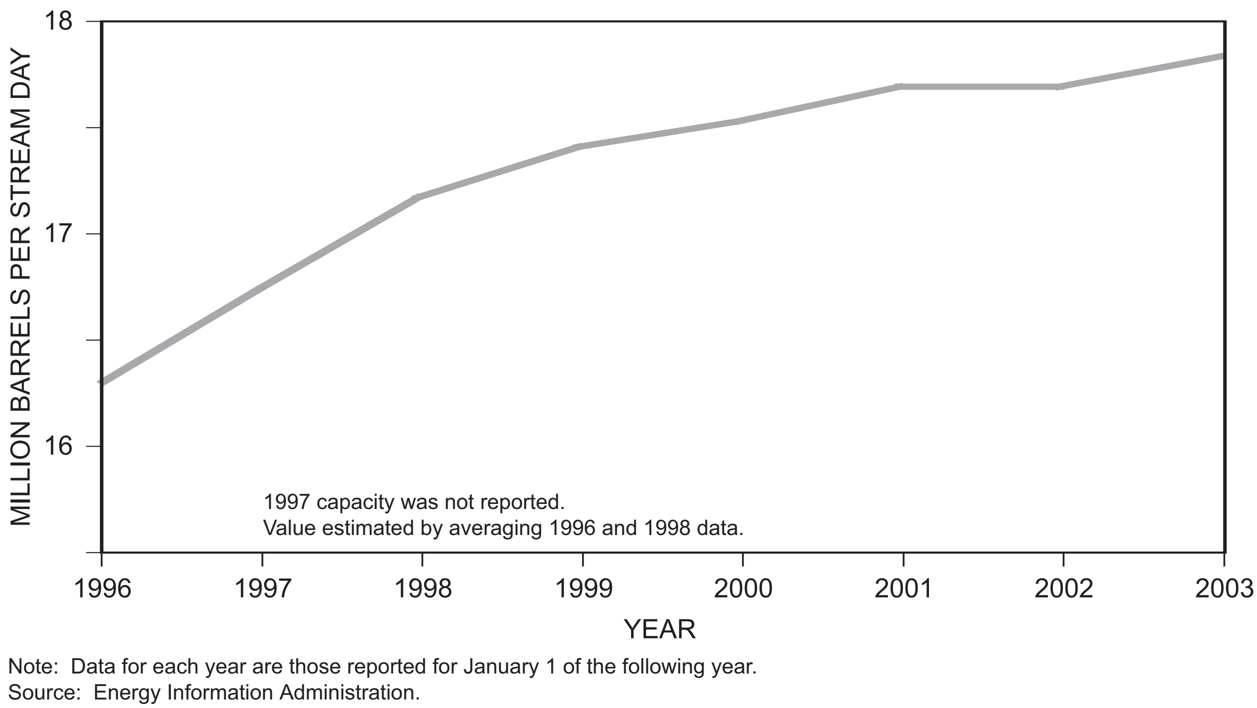


Figure I-2. U.S. Atmospheric Distillation Capacity

distillation must be processed further in a variety of conversion units to produce additional light products for the market.

Conversion units manufacture light petroleum products from heavier boiling material present in crude oil. Conversion capacity increases are illustrated in Figure I-3 as a ratio to 1996 capacity. Fluid catalytic cracking (FCC) capacity, which mainly adds to gasoline yield, has grown at about the same percent as distillation capacity. Both hydrocracking and coking have grown more than distillation capacity on a percentage basis, with coking capacity growing the most. Hydrocracking provides the most flexibility to vary the product slate but is the highest cost conversion capacity. Coking capacity allows refiners to reduce the yield of heavy fuel and/or process heavier crude oils. However, the coking process produces low quality products that require a significant amount of further processing before their quality is suitable for use as light petroleum product.[3]

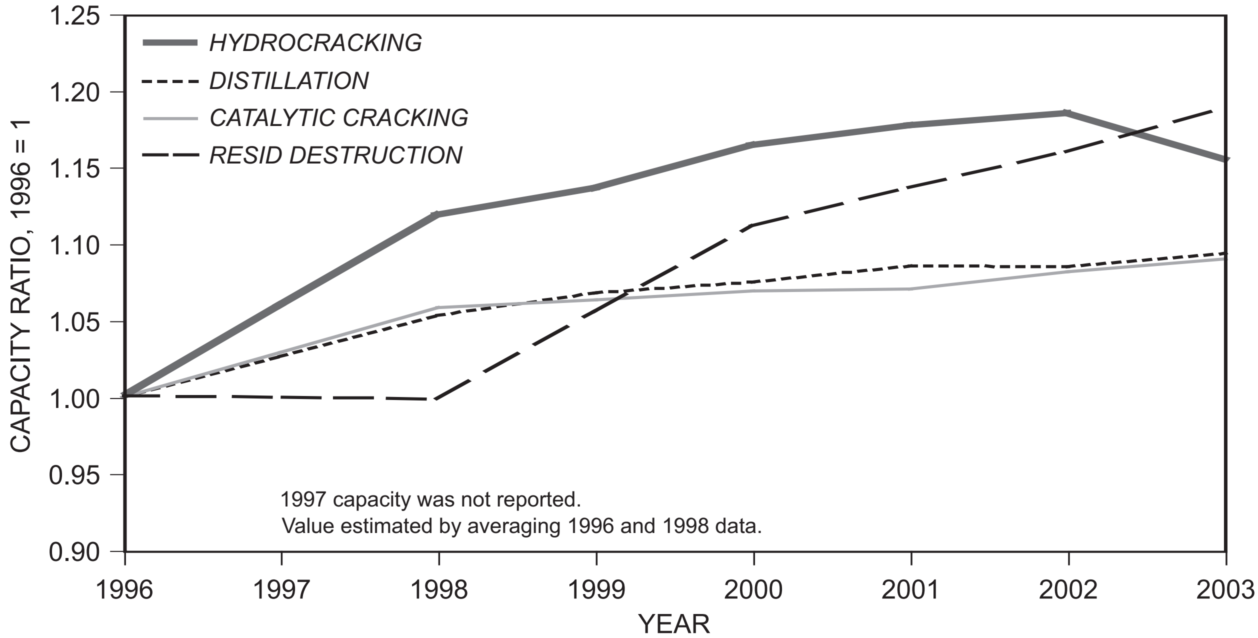
[3] For a detailed discussion of refinery processes, see Appendix C in the NPC's 2000 refining study, *U.S. Petroleum Refining—Assuring the Adequacy and Affordability of Cleaner Fuels.*

Light Product Yield Changes

The relative amount of light products produced per barrel of atmospheric distillation input is referred to as yield and has been slowly increasing over time as shown in Figure I-4. This increase indicates that the industry's overall capability to convert crude oil to light products has more than kept pace with distillation capacity increases. This results because expansions of conversion facilities have been faster than the increased production of heavier materials from atmospheric distillation capacity additions.

Overall yields of distillate and lighter products were about 86% at the time of the last study. Since then they have risen to an average of 87% over the last three years. Data for 2002 and 2003 both appear inconsistent with the general trend. Given the time available for this study, a detailed analysis of the recent data could not be performed.

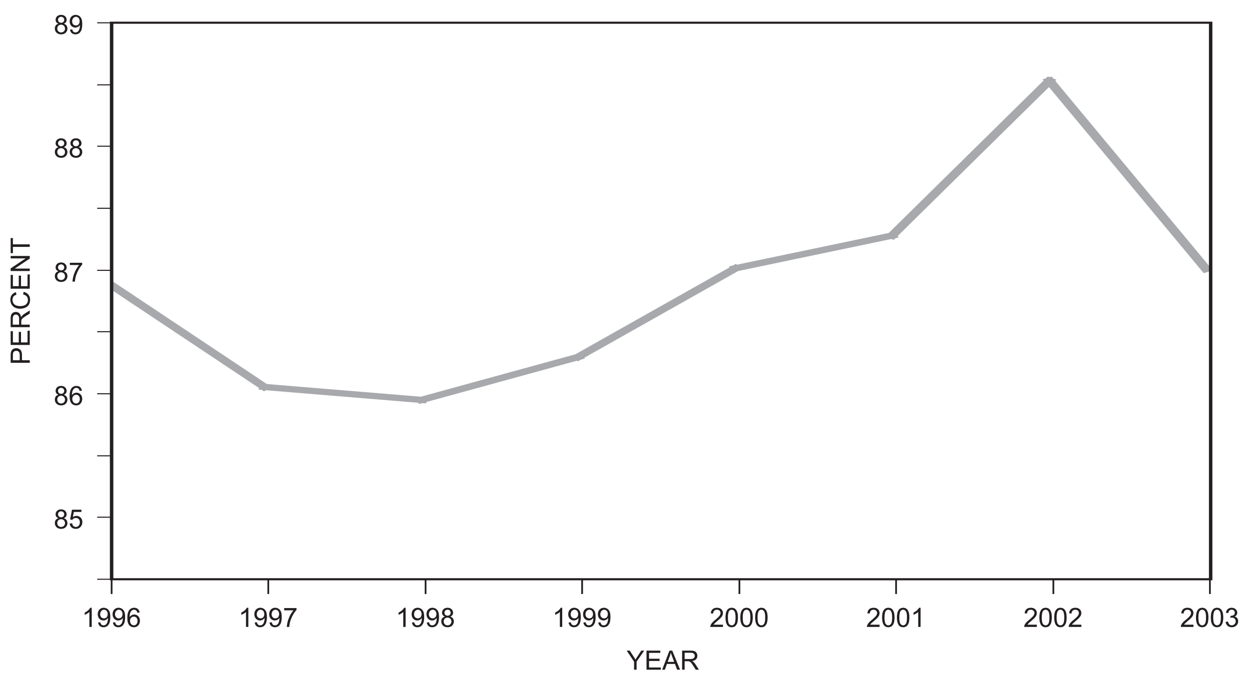
While overall yield has been improving, there are some factors that can offset potential yield improvement. Individual refiners have been and continue to process lower quality (heavier and higher sulfur)



Note: Data for each year are those reported for January 1 of the following year.

Source: Energy Information Administration.

Figure I-3. U.S. Refinery Capacity Relative to 1996 (Barrels per Stream Day)



Source: Energy Information Administration.

Figure I-4. U.S. Refinery Light Product Yield crude oil in response to economic drivers. When refiners add heavy oil processing capacity such as cokers and reduce the production of residual fuel, light product production will increase per barrel of crude oil input. However, if heavy oil processing is added primarily to process lower quality crude oil and results in no net residual fuel destruction, light product production per barrel of crude oil input will not increase. In the past, refiners have been adding heavy oil processing both to reduce heavy fuel oil production and to increase their ability to run heavier crude oils. Current U.S. domestic refinery fuel oil yield is less than 5%, therefore there is limited opportunity to further increase yield by converting heavy fuel oil.

Utilization rates and seasonal factors also affect yield. When refineries are run at very high throughput, such as during the high-demand summer months, on average they can suffer some light product yield decline. In the summer, the yield of gasoline goes down as shown in Figure I-5 even though total gasoline production may be higher. This results primarily because some lighter refinery streams cannot be blended into the summertime finished gasoline pool due to vapor pressure restrictions.

Switching from methyl tertiary butyl ether (MTBE) to ethanol as an oxygenate in gasoline increases emissions of volatile organic compounds (VOCs) unless the hydrocarbon portion of the gasoline blend is modified. During summer gasoline production, refiners must remove approximately 5% of other light gasoline components to compensate for the Reid Vapor Pressure (RVP) increase from ethanol blending as opposed to MTBE. Some of the materials removed from gasoline during the summer are stored and used during the winter and some are used in other ways and lost to the gasoline pool. In either case, they are not usable to produce gasoline in the summer.

Capacity Utilization Changes

At the time of the 2000 NPC refining study, U.S. refineries had operated at record high atmospheric distillation capacity utilization for the previous two years, averaging between 88 and 89% on an annual basis and rising to above 91% on average during the summer months (Figure I-6). Distillation capacity utilization has declined somewhat since that peak to more historical levels. The record low refining and marketing financial return in 2002 was likely a factor

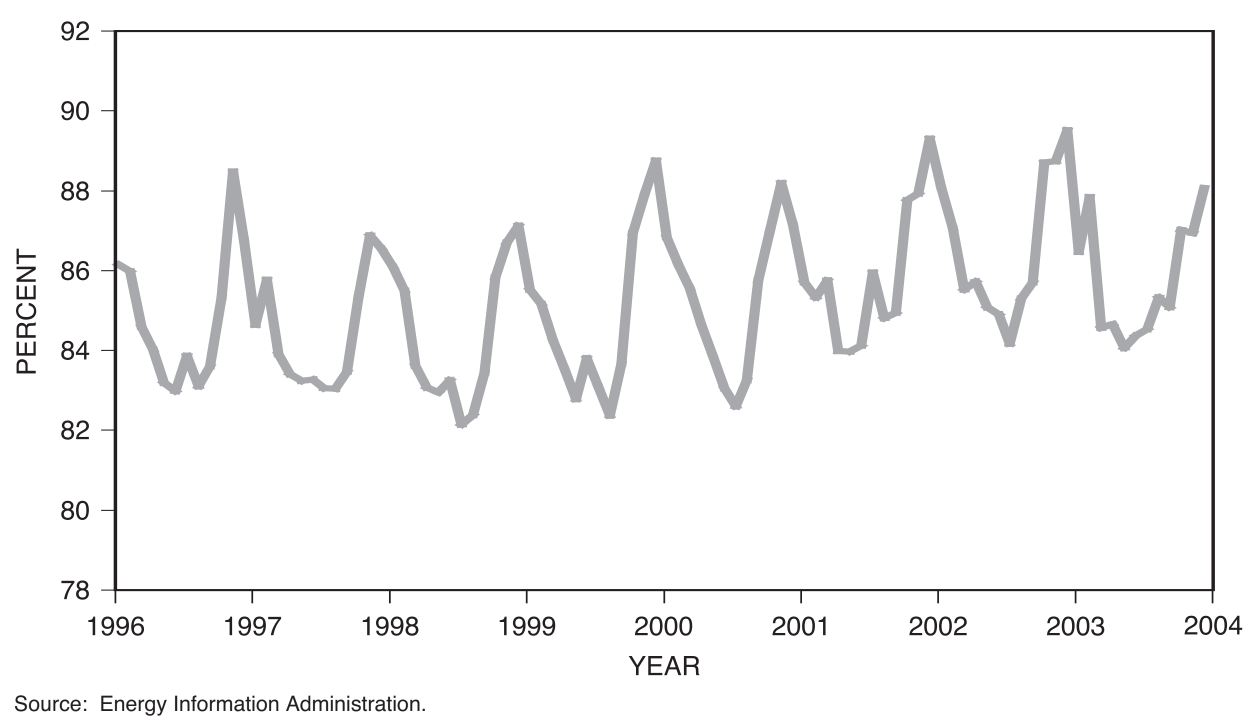


Figure I-5. U.S. Refinery Monthly Light Product Yield

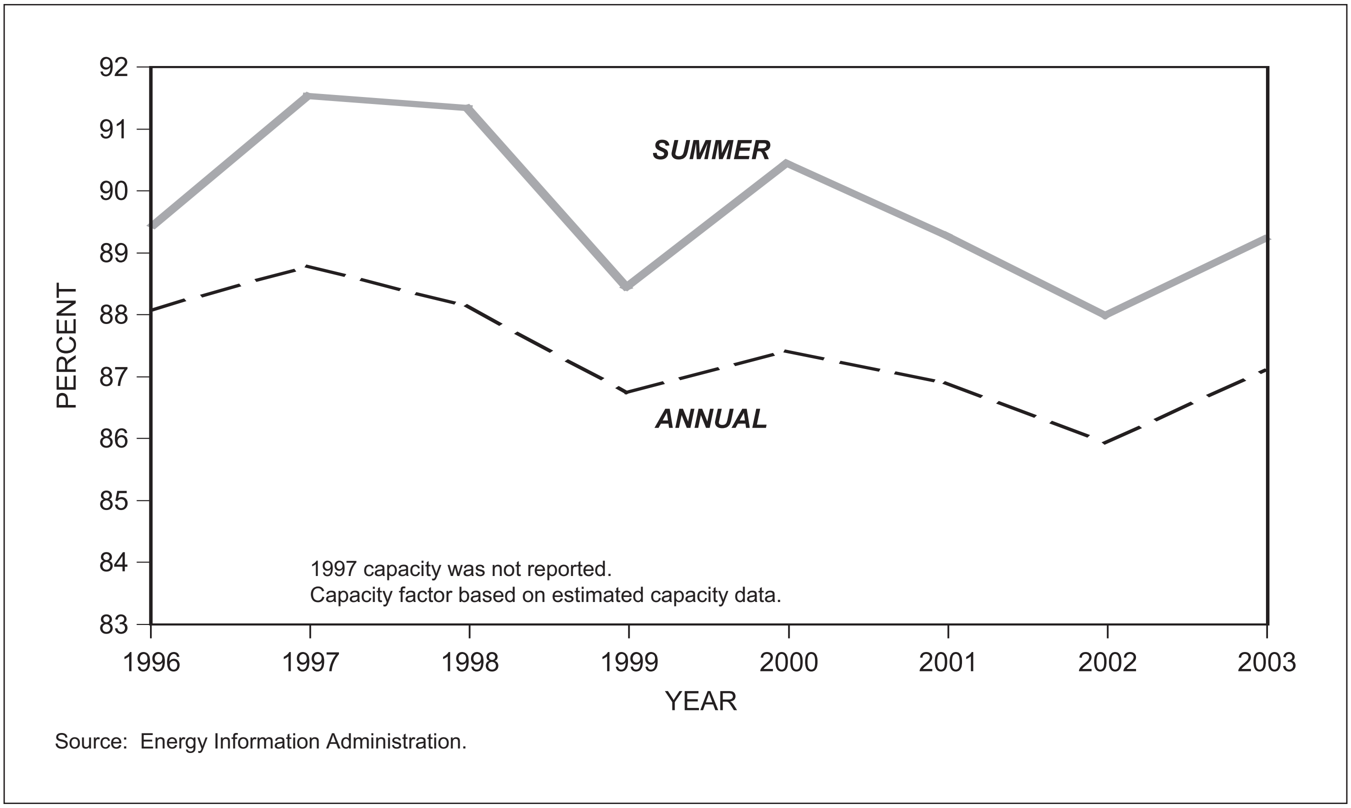


Figure I-6. U.S. Atmospheric Distillation Stream Day Utilization

behind reduced utilization that year. Utilization increased in 2003 and domestic gasoline production was at record levels for the first six months of 2004. Domestic crude oil runs for May and June of 2004 set new monthly records.

Due to the limited time available, a quantitative analysis of the reasons for capacity utilization changes was not performed as part of this study. Capacity utilization can vary for a number of reasons:

- Refining facilities periodically need to be shut down for planned and unplanned maintenance. When a crude oil distillation unit is shut down, no crude oil is processed. When other refinery facilities are shut down for maintenance, distillation utilization may also have to be reduced to contain the unfinished products from distillation.
- Regulatory requirements for industry-wide investment in a narrow time frame, such as for low sulfur gasoline, can tend to group refinery shutdowns for maintenance and modification together and result in lower capacity utilization for that period than the historical trend.
- Economics of incremental operation of domestic refining compared with the cost of imported product supplies will affect utilization. If incremental crude oil runs do not recover their cost in the market, domestic refinery capacity will not be fully utilized.
- Limitations on capacity use can be imposed by environmental permit requirements.

Even though utilization in the years since the 2000 NPC refinery study was lower than the record years in 1997 and 1998, light product production has increased as the result of capacity additions and the higher yields achieved.

Recent Import Trends

Imports are not new to the U.S. supply system, as the U.S. has been importing products routinely since World War II. The U.S. is a net importer (imports minus exports) of all three light products – gasoline, distillates, and jet fuel. Imports have provided an economic balance between domestic refinery production and U.S. consumer demand and have increased over the last decade. The U.S. is part of a global petroleum products market. If it is more economical to produce a product outside the U.S. and import it into the U.S., lower prices result than if the product were produced in less economic operation of domestic facilities.

The economic flow of oil products into a country can be impeded by government policy. Commonly used programs designed for this purpose have taken the form of restrictive import tariffs or import quota systems. During the 1950s and 1960s, the United States employed a quota system to limit the flow of internationally produced products into the U.S. Currently the U.S. does not have a program in place that restricts the flow of oil products to U.S. markets. Consequently, the U.S. is part of the international oil market, and oil product imports that supply U.S. markets are provided on an economic basis, resulting in lower cost products to U.S. consumers.

Jet Fuel Domestic Production and Imports Respond to Demand Changes

Figure I-7 shows domestic production, demand and, by difference, net imports of jet fuel. Imported jet fuel increased slowly between 1995 and 2000. The events surrounding September 11, 2001 resulted in a sharp reduction in U.S. jet fuel demand and decreases in both U.S. production and imports. These jet fuel data illustrate the economic selection of supply sources into the marketplace. Domestic production of jet fuel in 2000 essentially equaled U.S. demand for jet fuel in 2002 and exceeded 2003 demand. Both domestic production and imports declined in response to lower domestic demand in 2003, but some imports remained even though domestic refining had demonstrated capacity to produce the entire domestic demand volume. This response indicates that the U.S. supply system rebalanced in an economic fashion.

Increased Distillate Imports Tied to Canadian Refinery Expansion

Figure I-8 shows that between 1996 and 2000, net imports of distillate increased from relatively small volumes to more than 100 thousand barrels per day. Since 2001, distillate imports have remained at about 200 thousand barrels per day, varying seasonally with the demand for heating oil.

Distillate net imports by quality are shown in Figure I-9. Lower sulfur distillate imports (500 ppm sulfur maximum) have been in the range of

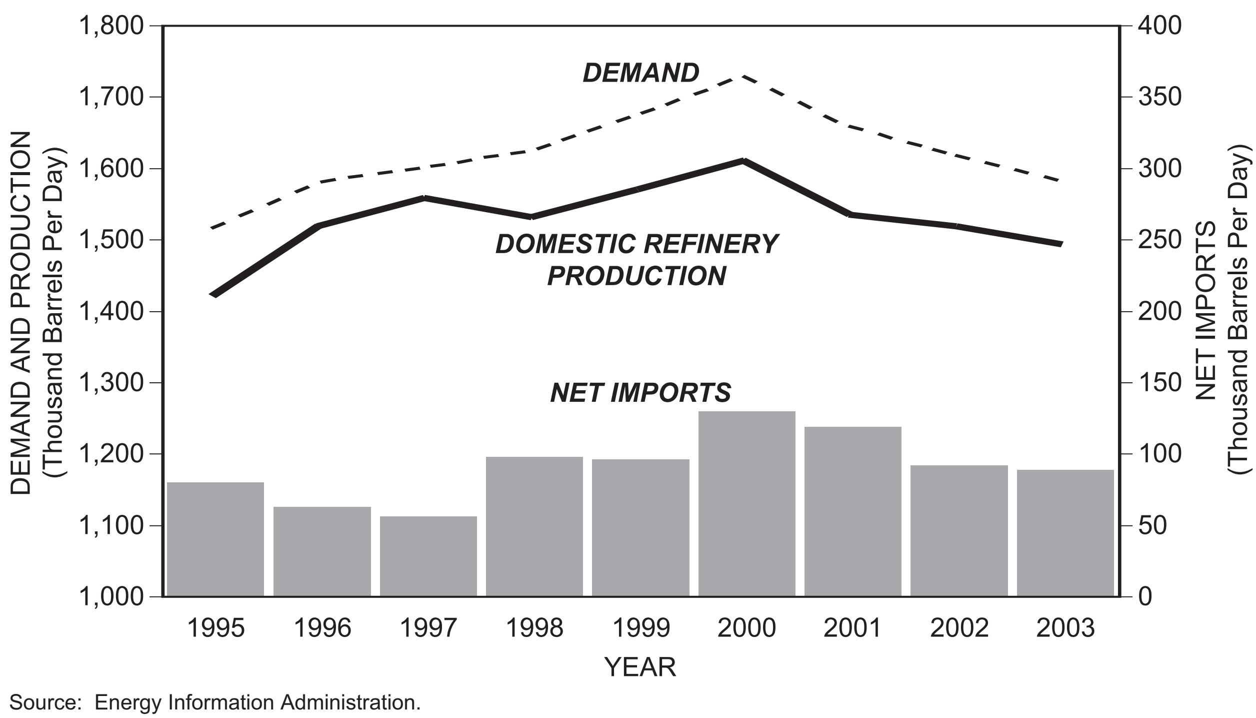


Figure I-7. U.S. Jet Fuel Production, Demand, and Net Imports

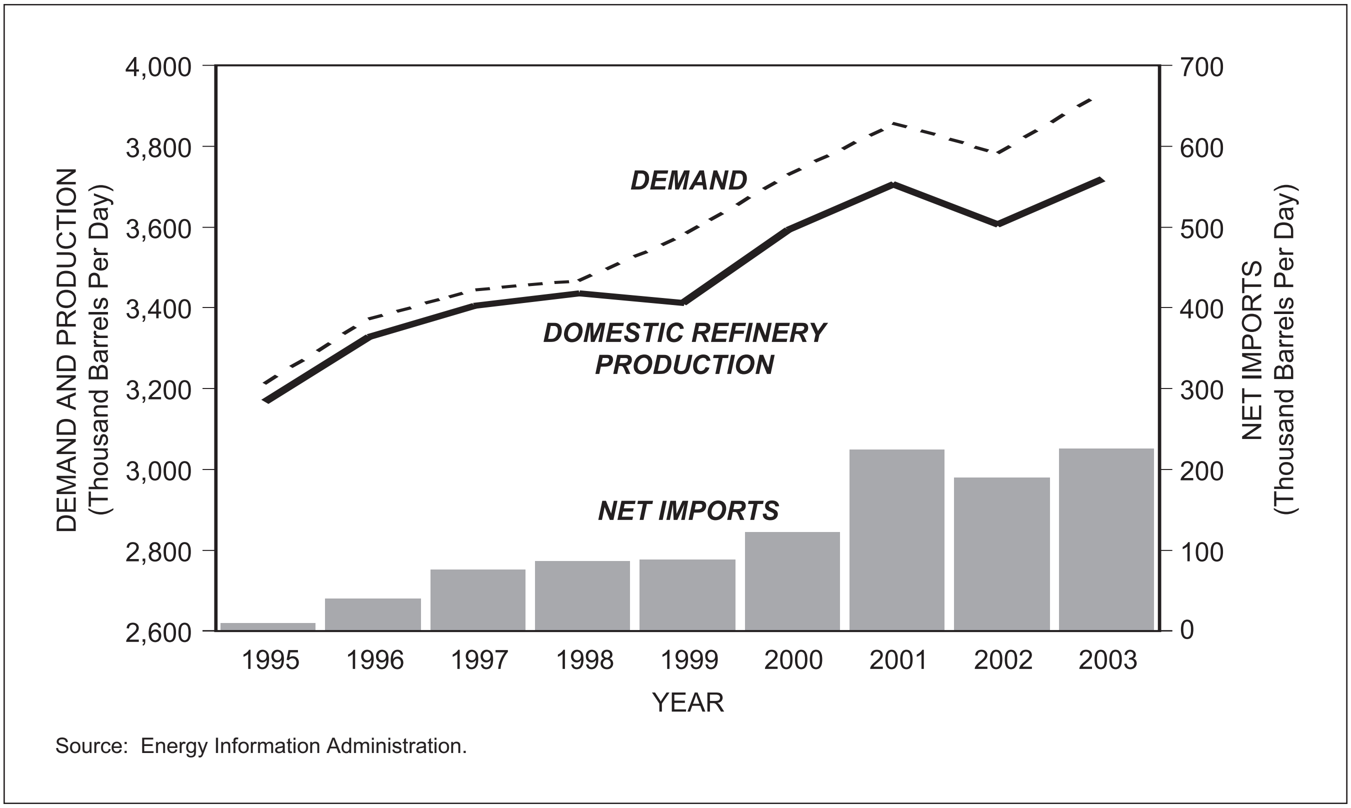


Figure I-8. U.S. Distillate Production, Demand, and Net Imports

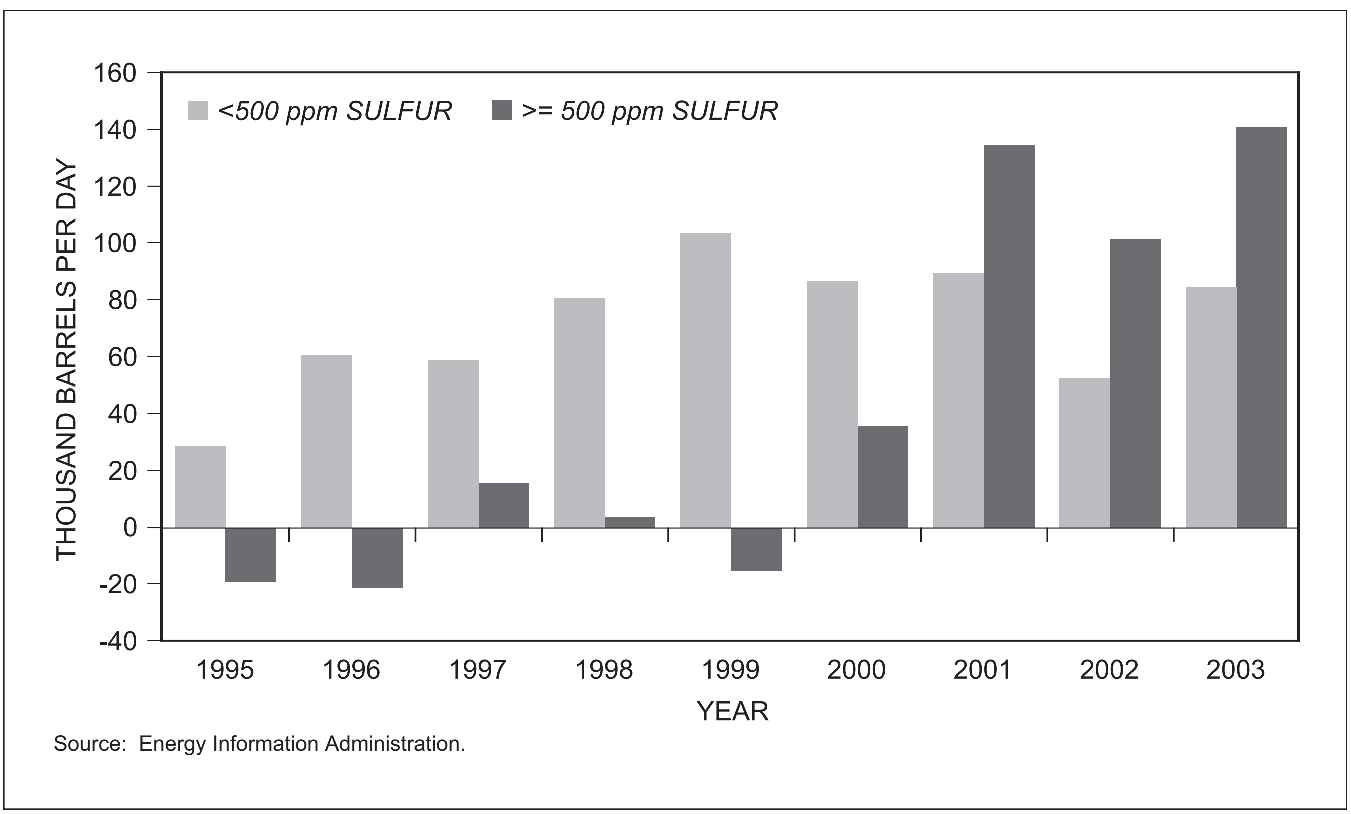


Figure I-9. U.S. Net Imports of Low Sulfur Diesel and High Sulfur Distillate

80 to 100 thousand barrels per day since 1998. In general, distillates in this sulfur range appear in the marketplace as highway diesel fuel. Imports of higher sulfur distillates, which are normally sold as heating oil or non-road diesel, have increased since 2000. This increase has been primarily from Canada into PADD I. This observation is consistent with a major expansion to a Maritime Provinces Canadian refinery and appears to result from a logistics advantage of this supply source to Northeast markets.

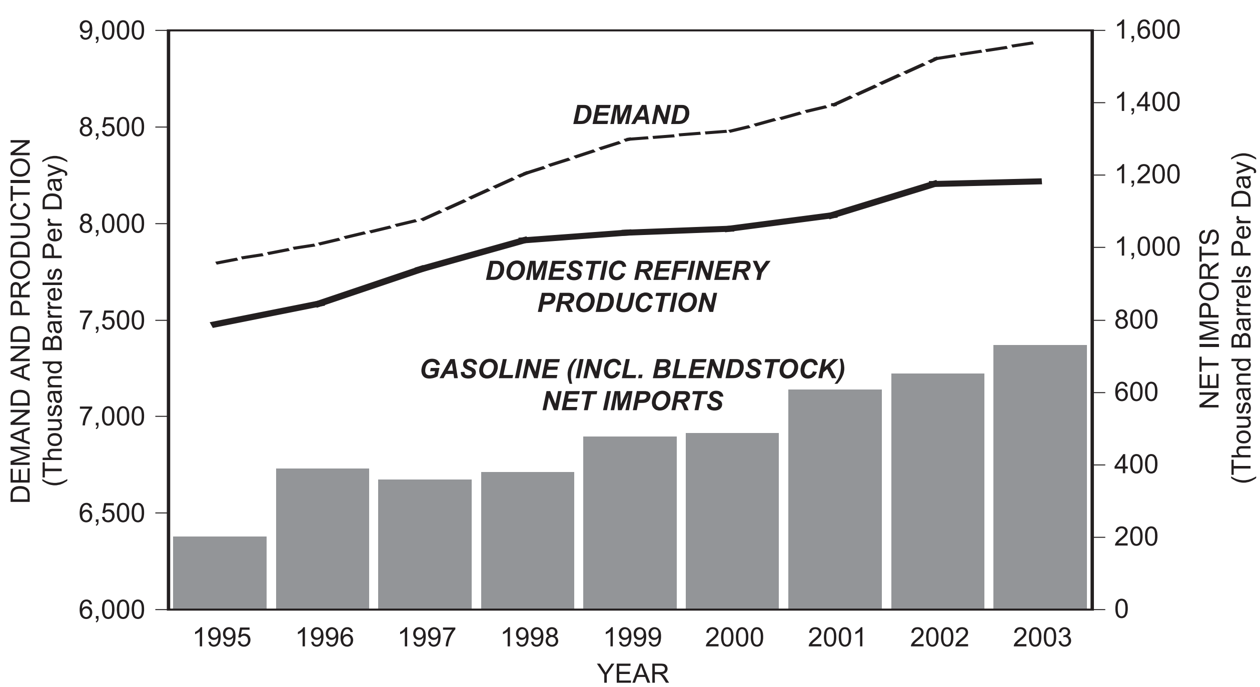
Gasoline Imports from Europe Increasing

Net gasoline imports including blendstocks have steadily increased, reaching 730 thousand barrels per day in 2003, as shown in Figure I-10. Gasoline imports, the largest product import volume into the U.S., have grown steadily. In 2002 and 2003, domestic production of gasoline leveled off at about 8.2 million barrels per day while gasoline demand continued to grow.

The majority of the U.S. gasoline imports, about 87% in 2003, are received into PADD I (Figure I-11). Overall they account for about 25% of the gasoline supply into this area (Figure I-12).

Between 1999 and 2003, net gasoline imports grew from about 6% to about 8% of domestic product demand. As shown in Figure I-13, the majority of gasoline imports are from the Atlantic Basin, with Canada, the Virgin Islands, and Western Europe accounting for about two-thirds of the volume. The remaining imports come primarily from Latin America and Eastern Europe, with some gasoline being imported to the West Coast from the Asia Pacific area. Since 2000, imports from Venezuela have declined. Venezuela reported a major maintenance period in 2002 and a strike in 2003. Imports from other Latin American countries such as Brazil and Argentina increased. There was also a significant increase in gasoline imports from Canada beginning in 2000 as a result of the Eastern Canadian refinery expansion mentioned earlier.

A major growing supply source for gasoline imports into the United States is Western Europe. The Western European highway fuels market has been impacted by the dieselization of the region's vehicle fleet resulting from preferential taxation favoring diesel-fueled vehicles. Highway diesel demand has been steadily displacing gasoline demand in Western Europe, as shown in Figure I-14.



Source: Energy Information Administration.

Figure I-10. U.S. Gasoline Production, Demand, and Net Imports

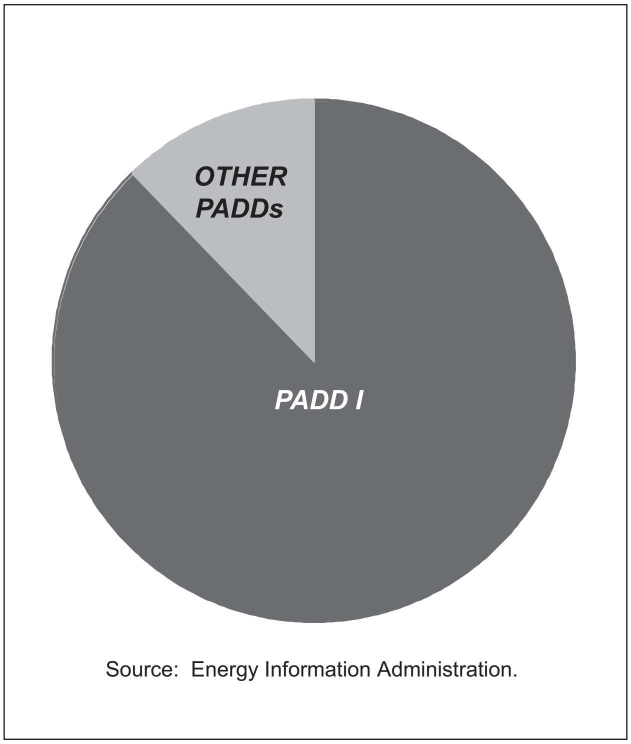


Figure I-11. U.S. Gasoline Import Distribution–
Year Average 2003

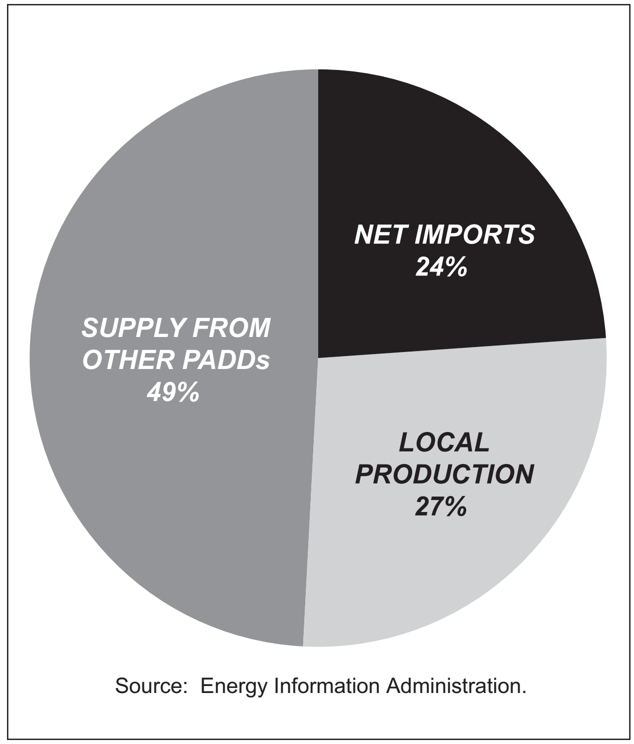


Figure I-12. PADD I Gasoline Supply

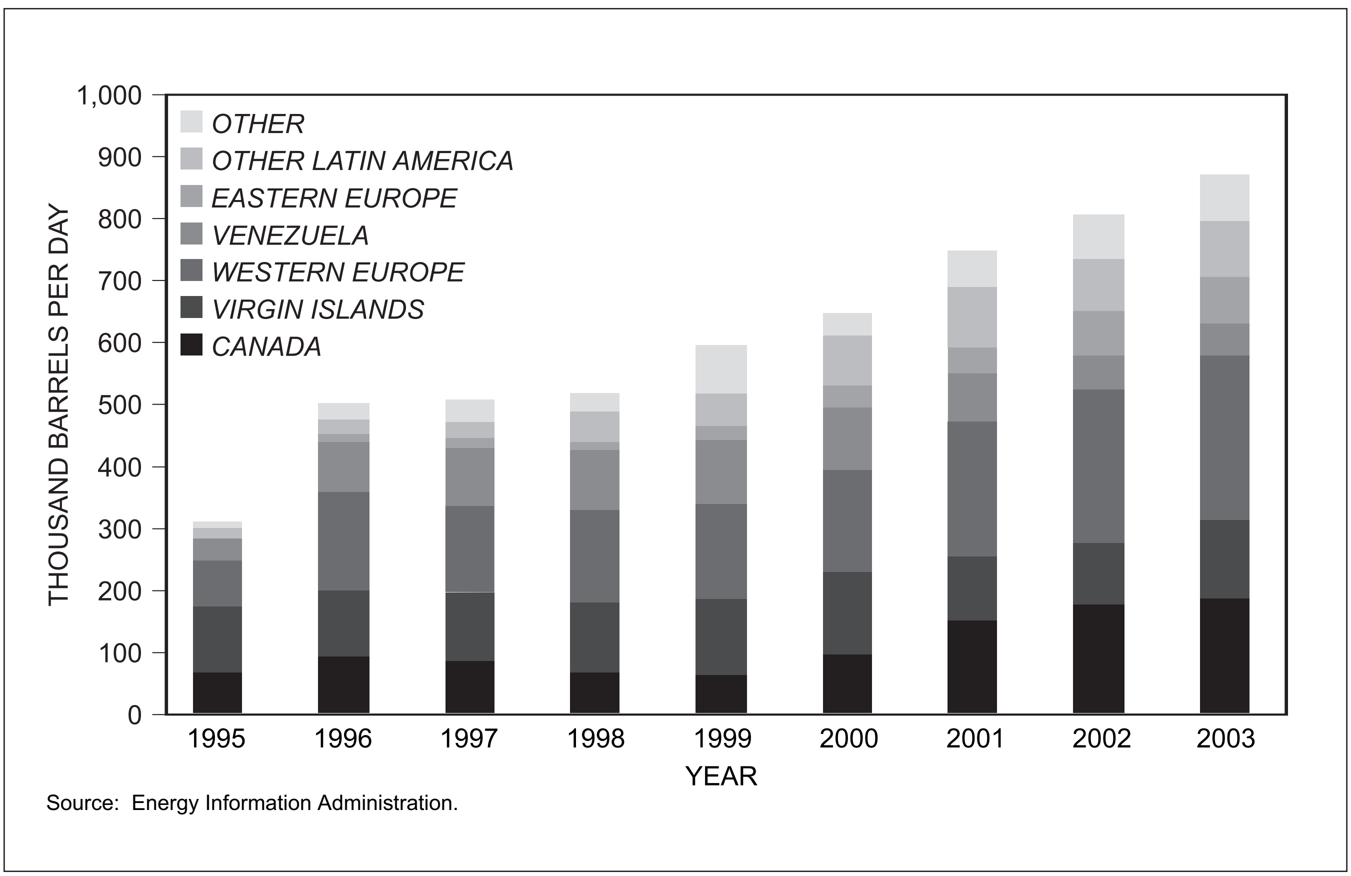


Figure I-13. U.S. Gasoline Imports by Country

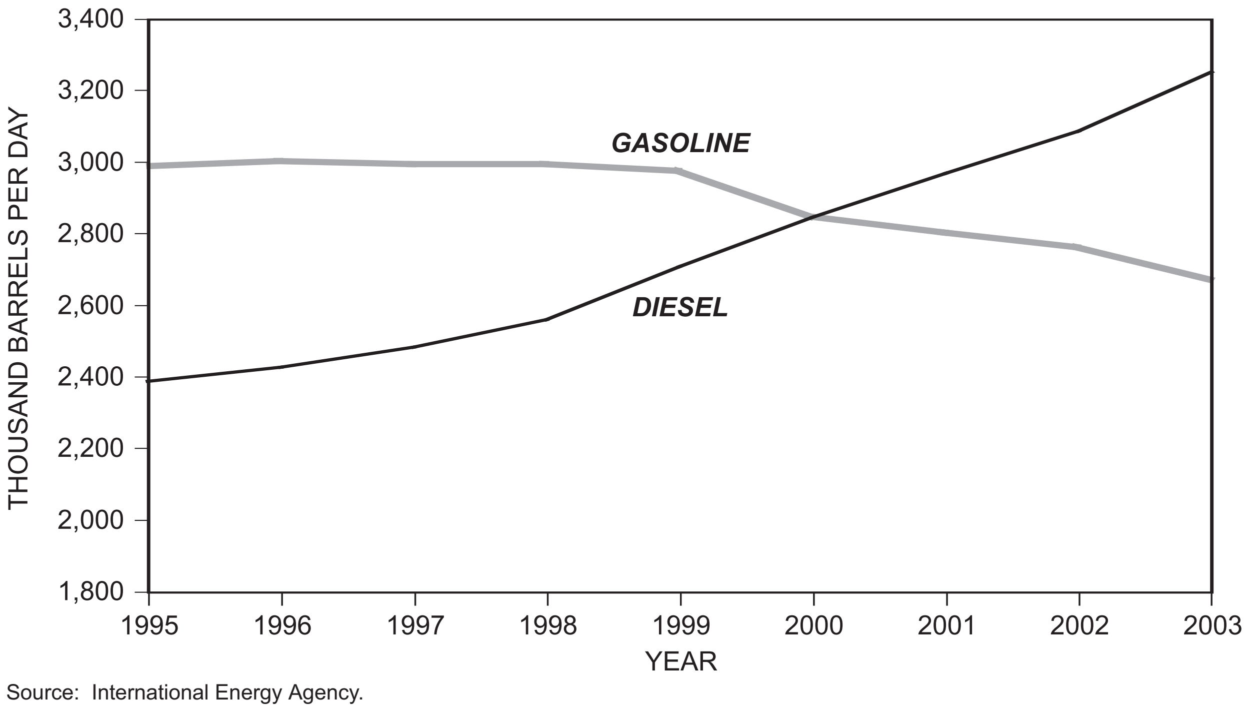


Figure I-14. Western European Gasoline and Diesel Demand

The diesel demand increase is being offset to some extent by a decrease in heating oil (gasoil) demand resulting from fuel switching, as indicated in Figure I-15.

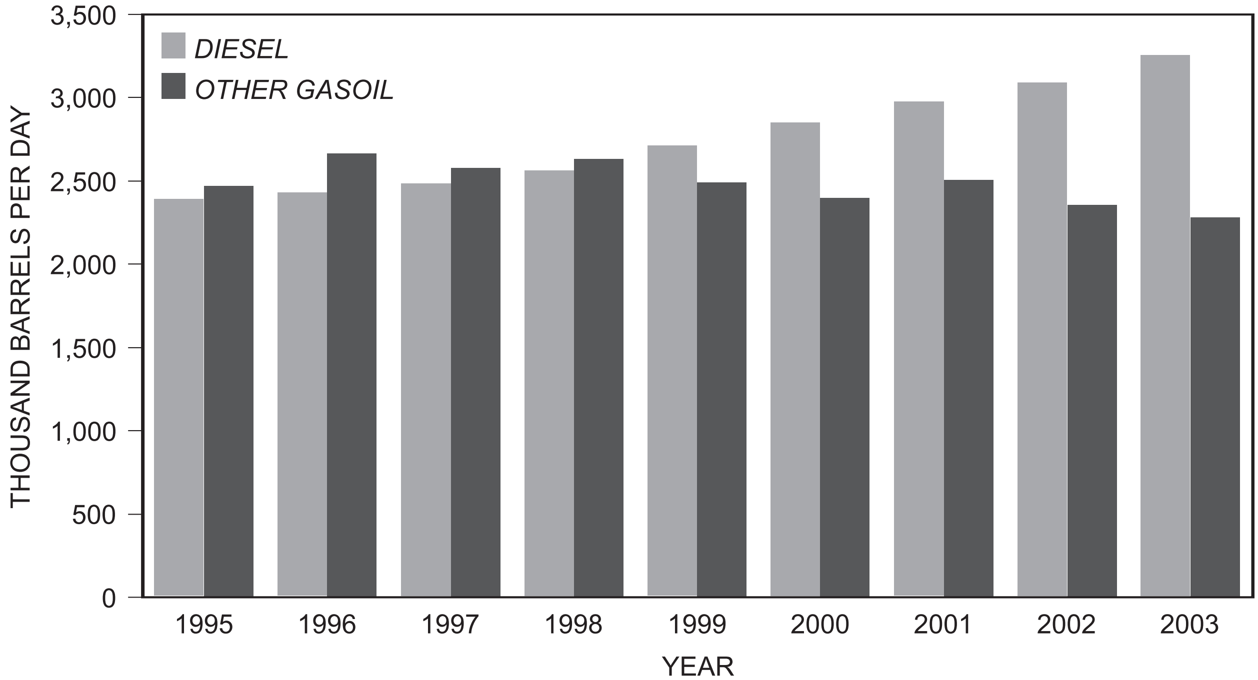
Although diesel demand has been increasing, gasoline values in western Europe are still above diesel. Hence, there have been few gasoline-to-distillate refinery conversion projects in European refineries. As gasoline demand in local markets declines, Western European refiners have the potential to produce more gasoline than needed locally.

Figure I-16 indicates that market behavior in the Mediterranean is consistent with the demand trends in Western Europe. Between 1996 and 1999, Mediterranean gasoline value versus distillate increased as specifications for gasoline were tightened significantly (lower vapor pressure, sulfur, benzene, and aromatics). Following 1999, the relative value of gasoline to diesel has declined as expected from the increase in diesel demand.

Contrary to Europe, in the United States both gasoline and distillate consumption have been increasing. Since 2000, the result of these differing market conditions has been a steady increase in the relative price of gasoline in New York Harbor versus Rotterdam, as indicated in Figure I-17.

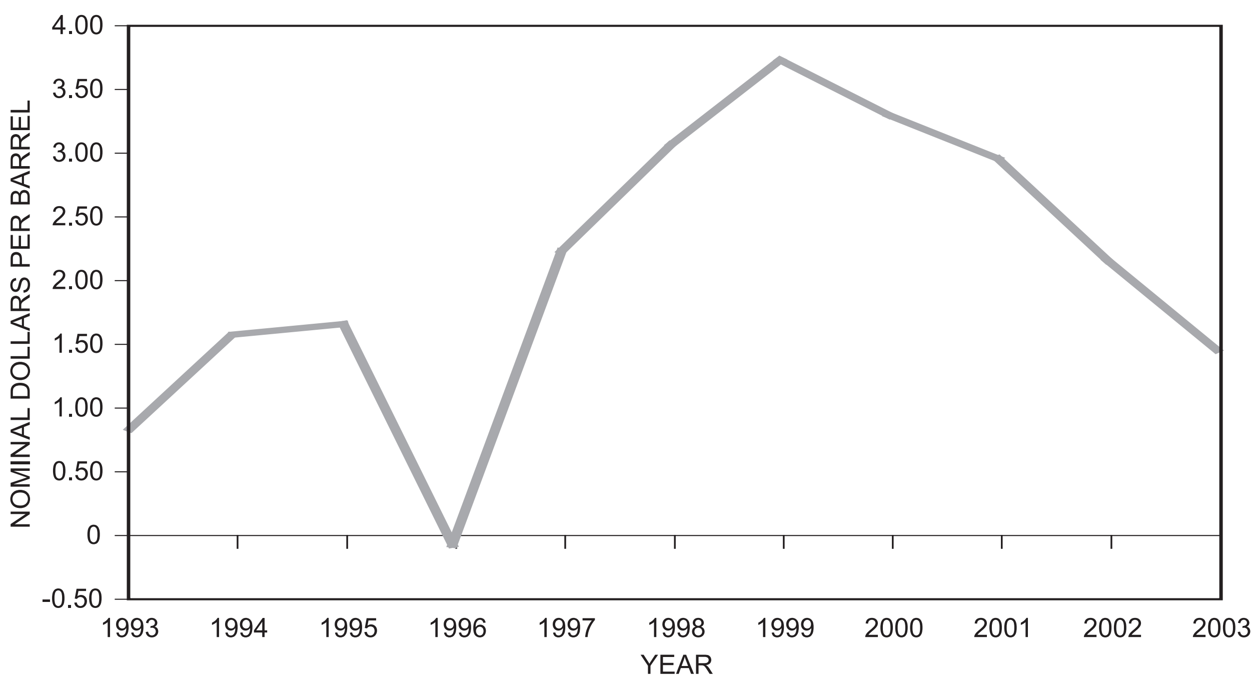
As shown in Figure I-18, the Rotterdam gasoline-distillate price differentials behaved similarly to the Mediterranean market until 2001. Since then, the differential has been increasing. This suggests that gasoline in Rotterdam is now being valued into New York Harbor as opposed to being valued into the local market. Historically, the Mediterranean market has been less impacted by conditions in U.S. markets than the Rotterdam market as a result of the difference in transportation costs to the U.S. East Coast from the two areas. This price trend in Rotterdam is consistent with the increase in Western European gasoline exports to the U.S.

The recent increase in gasoline imports from Europe reflects the changing economics of Atlantic Basin supply as refiners seek to move material to the highest value markets. Given the expected demand trends in Europe, European refiners are



Source: International Energy Agency.

Figure I-15. Western European Distillate Demand



Source: International Energy Agency.

Figure I-16. Mediterranean Gasoline to Gasoil Spreads

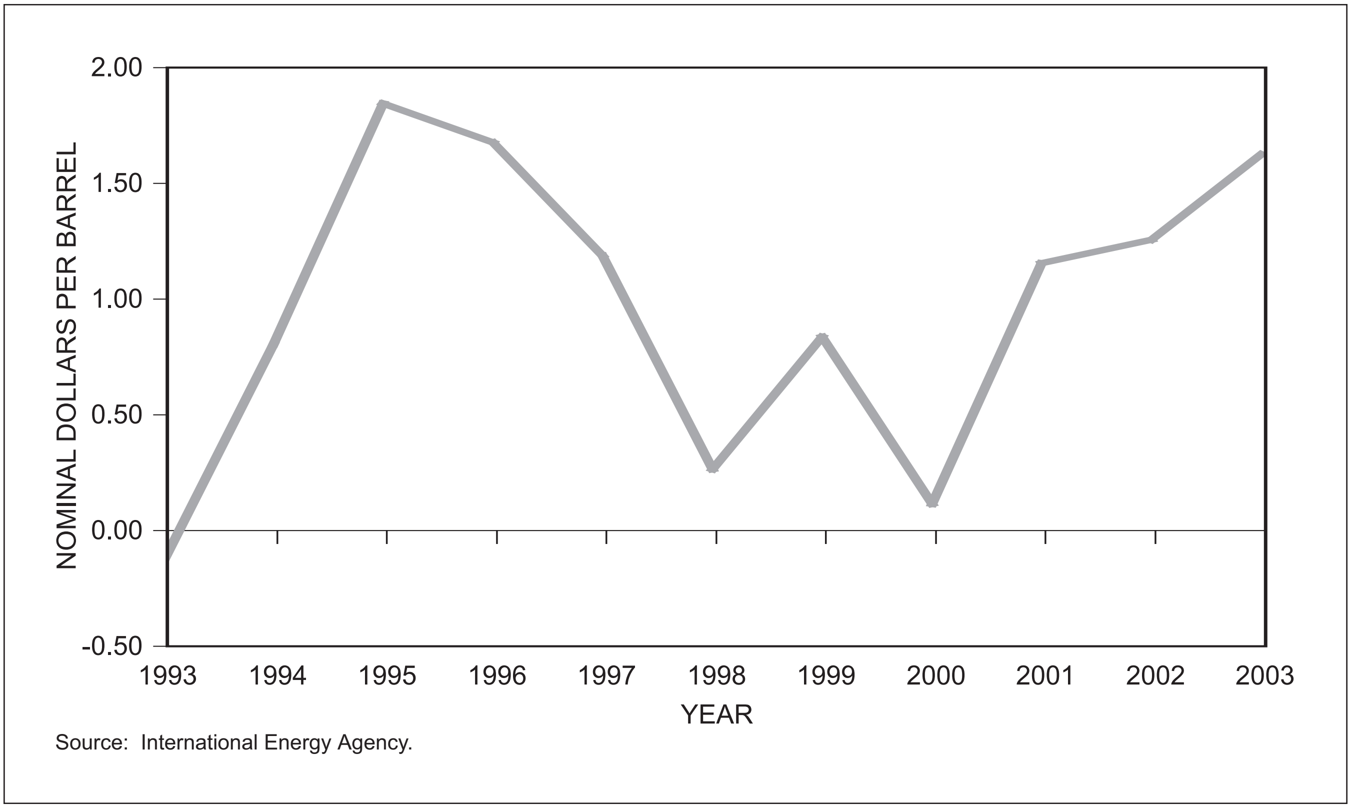


Figure I-17. Gasoline Differential – New York Harbor versus Rotterdam

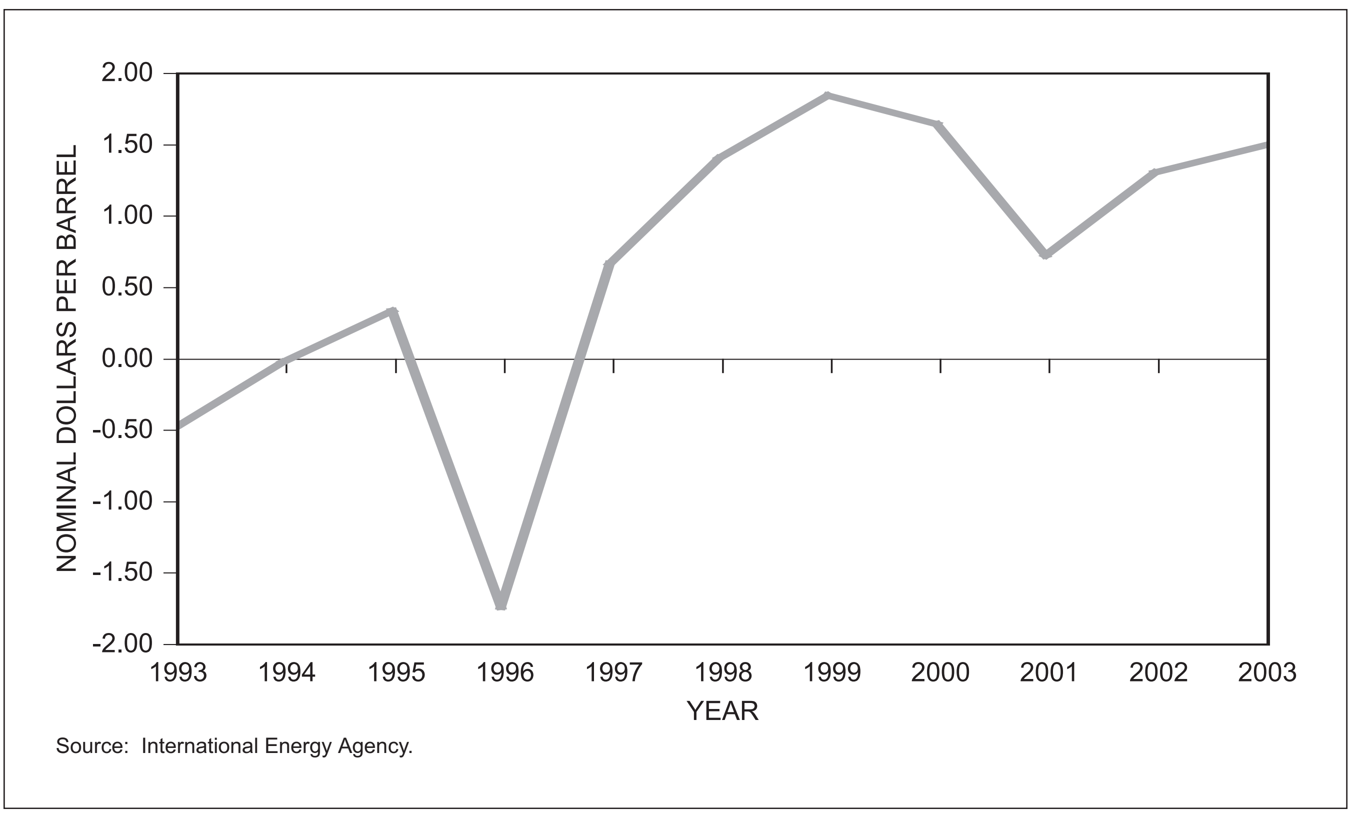


Figure I-18. Rotterdam Gasoline to Gasoil Spreads likely to be able to produce additional quantities of gasoline surplus to the local markets for several years. The U.S. East Coast is a logical outlet for these suppliers. The ultimate quantity that moves will be dependent on the relative cost of the imports compared with incremental domestic production, as well as the gasoline value in other potential markets.

New York and Connecticut MTBE Bans Illustrate the Market at Work

As of January 2004, the states of New York and Connecticut banned MTBE. MTBE is blended at refineries to meet the government-mandated oxygen content requirements of reformulated motor gasoline (RFG). The primary alternative to MTBE for meeting these requirements is ethanol. Unlike MTBE, ethanol must be blended in terminals because its affinity for water makes it impractical to move ethanol-blended gasoline in the petroleum product pipeline network. The hydrocarbon mixture that can be blended with ethanol to produce RFG is called "reformulated blendstock for oxygenate blending," or RBOB.

Venezuela has been a historical supplier of RFG to the East Coast. Initially in 2004, they reportedly experienced difficulty in producing RBOB, and their supplies to the U.S. declined. However, other supply sources such as Western Europe responded and there was no supply disruption observable to the consumer. Recently, imports from Venezuela have begun to increase, suggesting that their issues limiting RBOB production have been resolved and Venezuela is able to compete in the market. This observation indicates that Atlantic Basin suppliers of gasoline have the flexibility to respond to changing U.S. market requirements. It is also illustrative of market interactions and supply adjustments during periods of fuel specification transitions.

However, it is important to recognize that the MTBE bans in New York and Connecticut created a boutique fuel in that area, necessitating a new segregation in the distribution system and new sources of supply. While industry adapted and the new fuel has been delivered without disruption of supply, the potential for supply disruption and resulting price volatility has increased.

Factors That Potentially Impact the Growth in Domestic Product Producibility

Refining Industry Financial Performance

The petroleum industry is very competitive and the domestic downstream (refining and marketing) business has on average had financial results below both other segments of the oil business and other industries. The U.S. Energy Information Administration (EIA) collects financial and operating data from a sample of U.S. energy companies representative of the U.S. energy industry as a whole. The most recent report titled *Performance Profiles of Major Energy Producers 2002* was published in February 2004 and covered data through 2002. In 2002, the EIA's Financial Reporting System (FRS) data sample covered companies that accounted for over 80% of the refinery product output of all U.S. refining facilities. The data sample ranged over the entire spectrum of downstream companies. The FRS data are generally accepted as representative of results that would be expected from both the U.S. total and downstream petroleum industry.

Figure I-19 shows FRS petroleum industry return on equity compared with the average return on equity of the S&P 500 companies through 2002, the most recent data available from EIA.[4] While the data vary considerably from year to year, over the entire 1981-2002 period, the average for the FRS companies was slightly below the S&P 500 companies' average, at 11.3% and 12.2% respectively. Contrary to many perceptions, returns in the U.S. petroleum business are, on average, lower than those of other U.S. industries.

A historical perspective on U.S. downstream petroleum profitability can be seen on Figure I-20. Returns in this segment of the business are lower than the other segments of the oil business. Total petroleum industry return on capital employed averaged 7.7% across the entire period, with return on capital employed in the refining and marketing segment averaging only 5.3%. The same trend is evident in the more recent period (since 1990) as shown on the graph. The low returns in the refining

4 More recent data on refinery gasoline margins are presented in Figure I-25 later in this section.

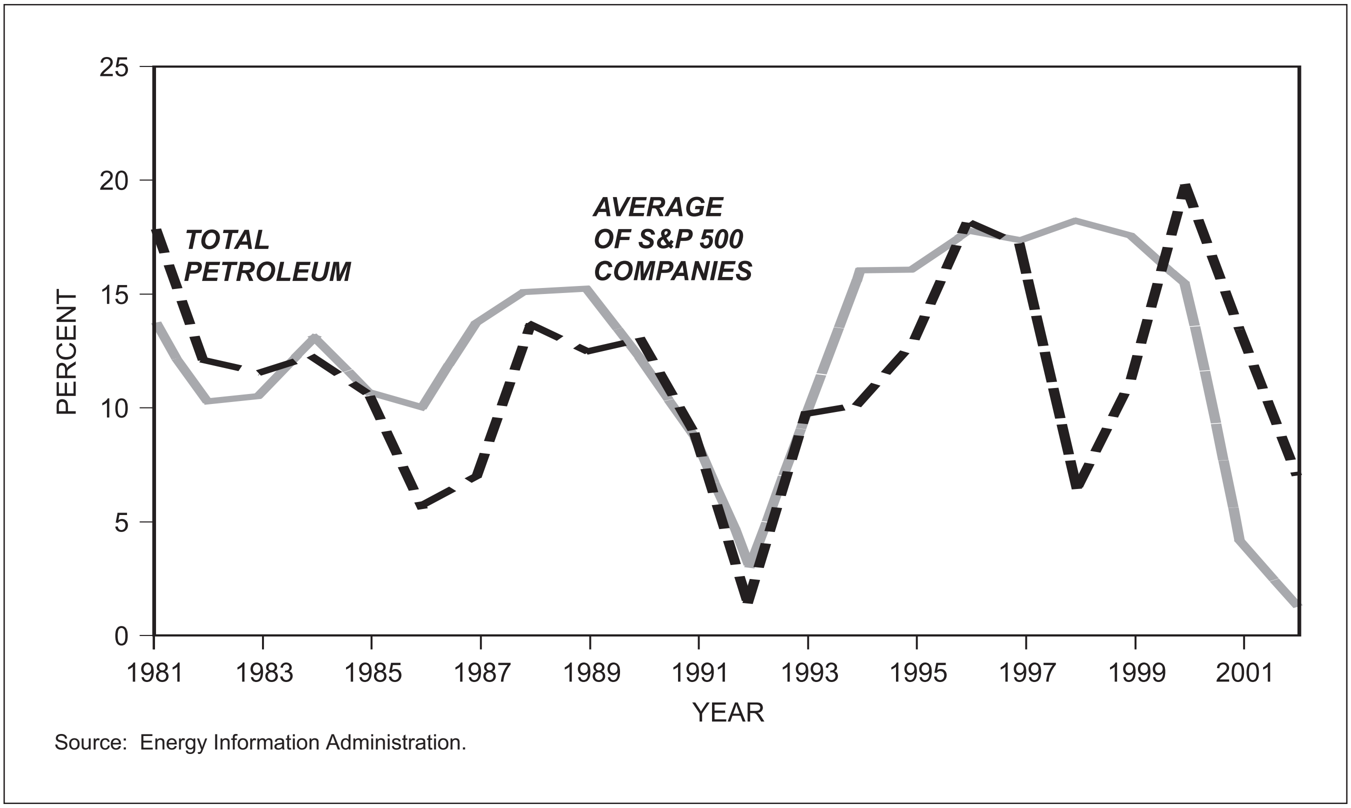


Figure I-19. Return on Equity for U.S. FRS Companies and the Average of S&P 500 Companies

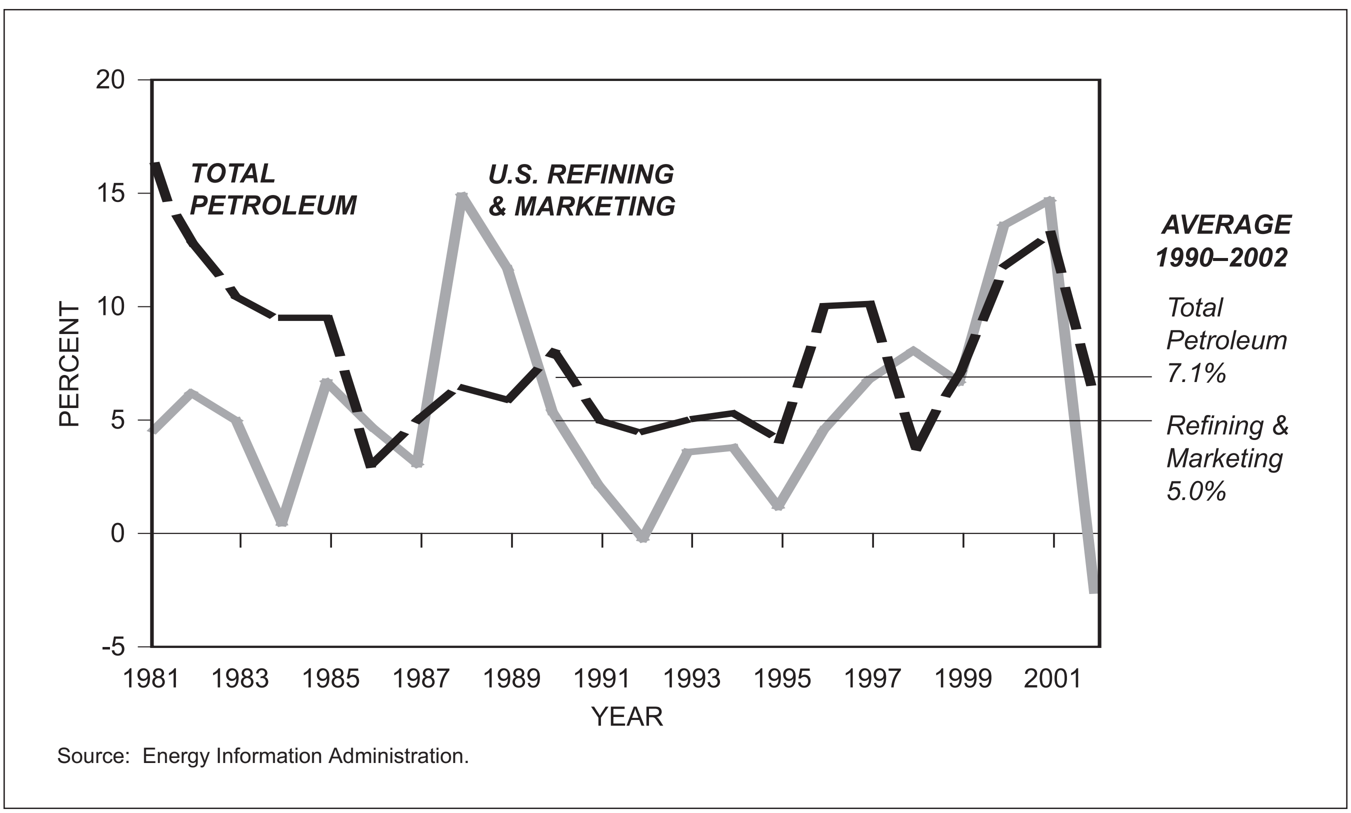


Figure I-20. U.S. Petroleum Industry Return on Capital Employed and marketing segment result from the highly competitive nature of the business as well as the significant amount of regulatory driven investments that tend to capture little to no return in the market.[5]

For FRS companies, operating costs have been generally declining since 1981, as seen in Figure I-21. Prior to 1981, the petroleum industry operated under federal price control regulation. Since the price regulation era, U.S. downstream operating costs have declined in response to competitive factors. Gross margins (product selling price minus crude oil price) closely followed the operating cost pattern over the time period. Net margins (gross margin minus operating cost) have exhibited a flat trend.

These data illustrate that the cost efficiencies (lower operating costs) captured as a result of competition within the industry have essentially all been passed to the market, as evidenced by the flat net margin trend. The significant savings realized over the past 20 years have been reflected in lower prices in the market rather than increased returns in the industry.

Decisions by individual refiners to invest in domestic refining capacity are complex and depend on expectations of return on investment. Refinery assets are long-lived as evidenced by the fact that all operating U.S. refineries are several decades old. For investment to occur, an individual refiner must reasonably expect investment in capacity to provide at least the same rate of return as other investment options over the life of the asset. While each company has its own perspective for future market conditions and will make its own independent decisions on investment and operation, the long-term history of below-average rates of returns remains a factor to be considered.

Capital and Other Resource Constraints

As they have done in the past, U.S. refining industry participants expect to continue to devote significant resources to environmental improvement,

5 In its estimates of low sulfur gasoline and ultra low sulfur diesel costs, EPA estimated a 7% before-tax capital amortization for investment costs, which provides an after-tax discounted cash flow return of 1-4% depending on the useful life assumption – below even the below-average return for petroleum refining and marketing assets per EIA's FRS (see 66 FR 5093 and 69 FR 39107).

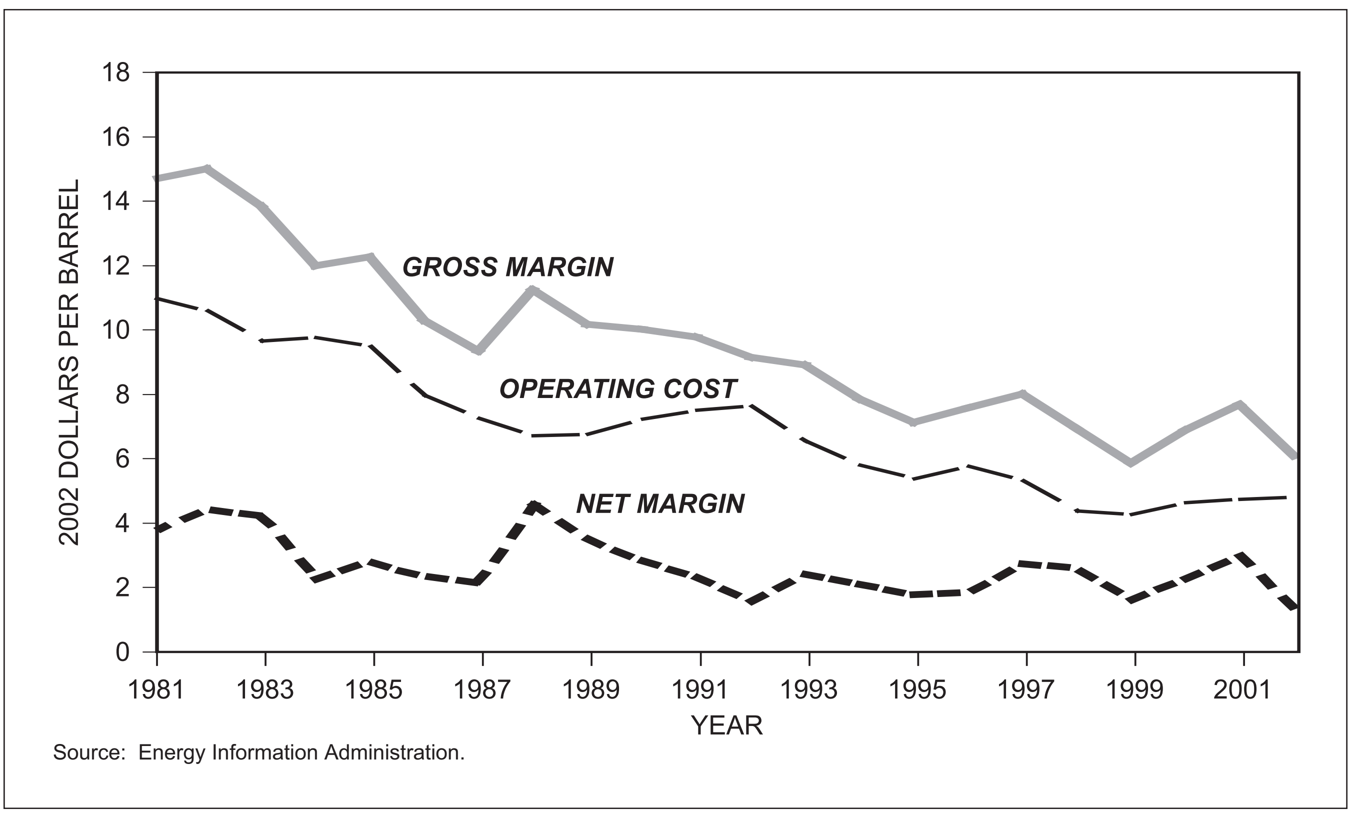


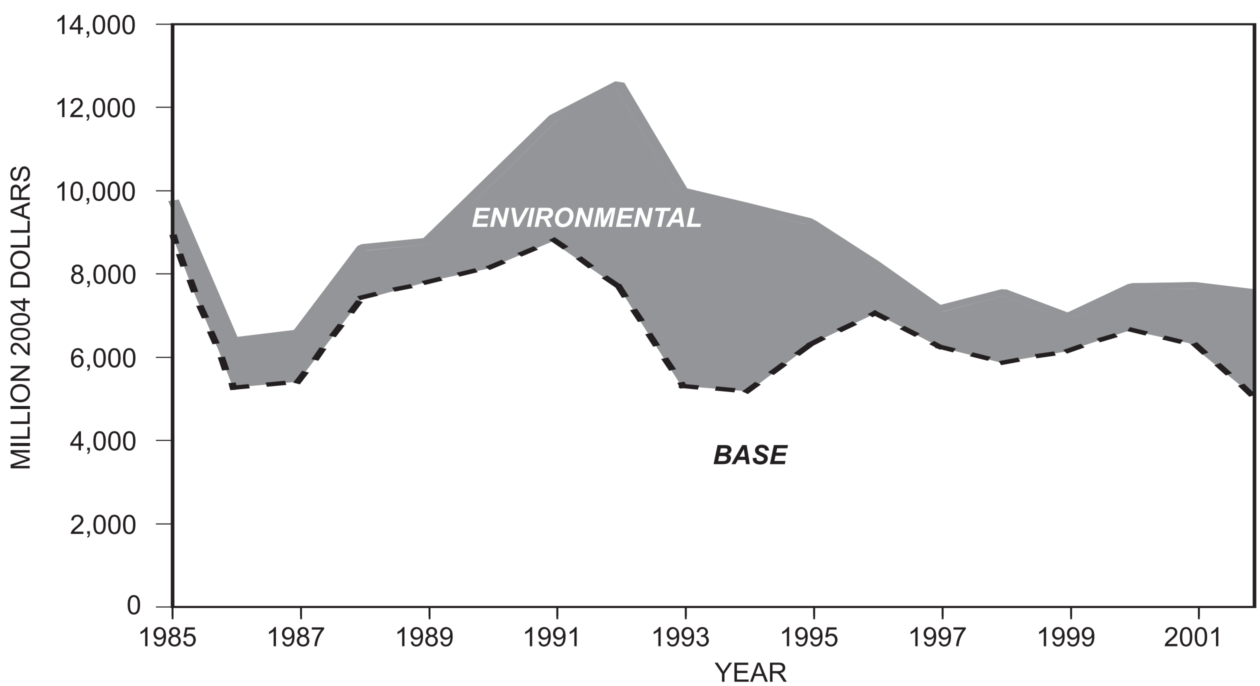
Figure I-21. U.S. Refining and Marketing Margins (Product Sold Basis) including cleaner fuels production and reduction of stationary emissions. Figure I-22 shows U.S. refining and marketing investments in total and for environmental compliance through 2002 in constant 2004 dollars. Data for total expenditures are reported by the *Oil & Gas Journal*, and environmental data by API.[6] Since 1999, overall expenditures have been slowly growing, reaching over $8 billion in 2003, the highest level since 1995. Expenditures in the "base," however, have been fairly flat over this time period, with environmental investments accounting for most of the increase.

Figure 1-22 indicates that the refining and marketing industry has continued to invest in the base business in spite of the relatively low overall return data discussed previously. However, the figure also shows that investment in the base business can be reduced when expenditures for environmental facilities increase significantly. This is particularly evident during the early 1990s and in 2002 when significant expenditures for gasoline quality improvements occurred. This observation is likely a result of a combination of practical constraints on the ability to maintain base business investments when faced with a significant increase in investments to meet environmental standards. The domestic refining industry is comprised of many diverse companies and resource constraints are likely to vary widely among individual companies.

Capital needs in refining compete with capital needs in other petroleum segments as well as capital needs of other industries. Uncertainty around the current and future climate for the industry can not only impact internal capital allocation decisions, but can also affect external evaluations such as bond ratings. These external evaluations can significantly affect an individual company's access to capital. While no two industry participants are likely to access capital funding in exactly the same way, no participant has unlimited access to resources.[7] Thus, it should be expected that spending on

6 American Petroleum Institute, *U.S. Oil and Natural Gas Industry's Environmental Expenditures, 1993-2002,* January 28, 2004.

7 For additional discussion of the range of considerations for capital acquisition and allocation among companies, see the report *Refining Capacity – Challenges and Opportunities Facing the U.S. Industry* by Kummins, Yaccobucci, and Parker of the CRS, August 2004, pages 6-9 in particular. The NPC does not endorse the entire contents of this report.



Sources: *Oil & Gas Journal* and American Petroleum Institute.

Figure I-22. U.S. Refining and Marketing Investments mandatory environmental projects can detract from investments in the base business that provide capacity growth, yield flexibility and reliability improvements.

Large capital projects are typically designed and engineered by a combination of internal company resources and third-party companies. There are a number of these engineering companies, ranging in size from very small to those capable of handling projects of several billion dollars. This segment of the project business has in the past demonstrated the capability to expand with workload and has not been a constraint to domestic refining capital project implementation. However, before these entities are engaged, a development effort is required to determine what facilities should be built. While there are many different approaches to this phase of a capital project, the evaluation of the multitude of options with respect to costs, risks, impact on refinery operations, etc., is a very complex task. This phase of a project usually requires a significant amount of effort from highly skilled internal company individuals with detailed knowledge of the specific facility. These resources are not easily leveraged with additional resources when project workload is high. Thus, when environmental investment is high, the ability to develop projects that might lead to throughput or yield improvements can be limited by the availability of these internal company human resources.

Ever More Restrictive Product Quality Requirements

Each refinery is unique, with a collection of facilities that have evolved over the years in response to both market and regulatory changes. The operation of these facilities is routinely optimized in response to the market. As product specifications become more restrictive, the ability to utilize all the flexibility and volume capacity inherent in the refining system can be diminished. For example, regulations such as the gasoline vapor pressure restrictions in the summer mentioned previously reduce the ability of the industry to maximize volumetric output in response to market demands. While individually many of these impacts are small, collectively they can be significant, particularly during periods of high utilization. Although additional capital may be spent to recapture this lost capacity, it can be difficult to generate a return on an investment that only provides short-term or seasonal capacity since the time frame for capital recovery is limited.

Increasing Project Costs and Uncertainty from Environmental Regulations

Compliance with increasingly restrictive environmental regulations has been a way of life in the refining business for decades, and emissions reductions and an improved environment benefit society in many ways.[8] However, the magnitude of environmental requirements and the uncertainty around their enforcement can have a significant impact on refinery investment. If these costs and uncertainties are not faced to the same extent by foreign competitors, the domestic industry can become less competitive and capacity growth could be reduced.

A multitude of issues around environmental compliance, such as the history of reinterpretation of past environmental permit rulings led by EPA's NSR enforcement initiative, environmental justice litigation, the uncertainty of NSR reform, and NAAQs implementation schedules with questionable feasibility, has resulted in a very uncertain climate for the implementation of new refinery projects. A significant factor affecting investment decisions is the level of uncertainty about the future. While this uncertainty cannot be eliminated, it can be affected by government action or, in some cases, inaction.

For decisions requiring large amounts of capital, increased uncertainty tends to stop, minimize, or delay investment in order to reduce risk. The long-lived nature and high capital cost of refining assets result in a long payout period. Awaiting resolution of uncertainty by delaying investment and even taking a short-term economic loss may be a more attractive alternative than early investment in equipment that may prove not to be optimum for the long term. Uncertainty is increased when regulatory requirements are not based on sound science or thorough analysis of cost effectiveness. Such regulations face a higher likelihood of later challenge and change, increasing the uncertainty of the outcome and therefore increasing the risks associated with investment decisions. The recent confusion

8 Refer to Appendix D for a summary of recent and pending regulatory challenges facing the domestic refining industry.

about the status of RFG requirements for the Baton Rouge and Atlanta areas highlights the increased uncertainty of environmental requirements with questionable benefits.

Waivers Can Have a Negative Impact on the Investment for Clean Fuels

Another uncertainty in the market is the potential for waivers or enforcement relaxation of fuel specifications in response to political pressure during price events. As the risk of waivers increases, the potential incentive to invest to produce clean fuels will be reduced. States have sought and EPA has repeatedly considered and sometimes granted enforcement discretion, and this has increased market uncertainty. Use of exemptions, exceptions, and waivers should be limited to serious supply disruption situations that affect end-users' ability to obtain petroleum products, and the circumstances of their potential use should be clearly established in advance.

Environmental Operating Restrictions

Refineries today are subject to increasingly more stringent permit and public relations constraints. For example, it is no longer acceptable to flare for any significant length of time. New requirements continue to be imposed such as continuous emissions monitoring and the NOx ppm cap for FCC regenerators. In some areas, State Implementation Plans are more restrictive than federal requirements, further limiting operational flexibility. While industry participants will comply with these new requirements, as operations become more constrained both the effective capacity and the flexibility of existing facilities to respond to unexpected events can be reduced.

Facility Security Environment Could Potentially Impact Operations

Refining industry participants are committed to keeping their facilities secure from threats of violence or terrorism. Companies have been heavily engaged since before September 11, 2001 in maintaining and enhancing facility security. Through a public/private partnership approach, industry is working with many federal, state, and local agencies to address security issues. These agencies include the Department of Homeland Security (including U.S. Secret Service, Transportation Security Administration, and U.S. Coast Guard), the CIA, the FBI, the Department of Transportation, the Department of Energy, and the Department of Defense. Individual refineries also work closely with various state and local emergency response and law enforcement officers to ensure understanding and coordination of security plans.

Refiners have expended substantial resources, both human and financial, to enhance physical and cyber security. Expectations are that investments in facility security will continue to be necessary as potential threats are identified and assessed and as security regulations such as the U.S. Coast Guard regulations implementing the Maritime Transportation Security Act are promulgated. In addition, industry expects to continue to work with the Department of Homeland Security and the other agencies listed above in the public/private partnership to address security issues in the future. While resources have been consumed in implementing these changes, to-date security issues have had little, if any, detrimental impact on operations. However, there are proposals being discussed that include provisions for refining technology changes and criminal liability. In the opinion of the NPC, these proposals do not provide additional security benefits but could significantly reduce refinery production.

Grassroots Construction vs. Refinery Expansions

As discussed previously, domestic refinery capacity has continued to grow over time. However, as shown on Figure I-23, the number of refineries has continued to decline. No refinery capacity has been built on a new site (grassroots) in the U.S. since the mid-1970s.

The absence of grassroots domestic refinery construction indicates the relative attractiveness of expanding or acquiring existing refineries compared with building a new refinery. Refinery construction at a new site would require very long planning, site selection, permitting, financing, and construction lead times. Expansion, acquisition, and increased utilization of existing refineries are typically more feasible, quicker, and less costly options to increase light product production,

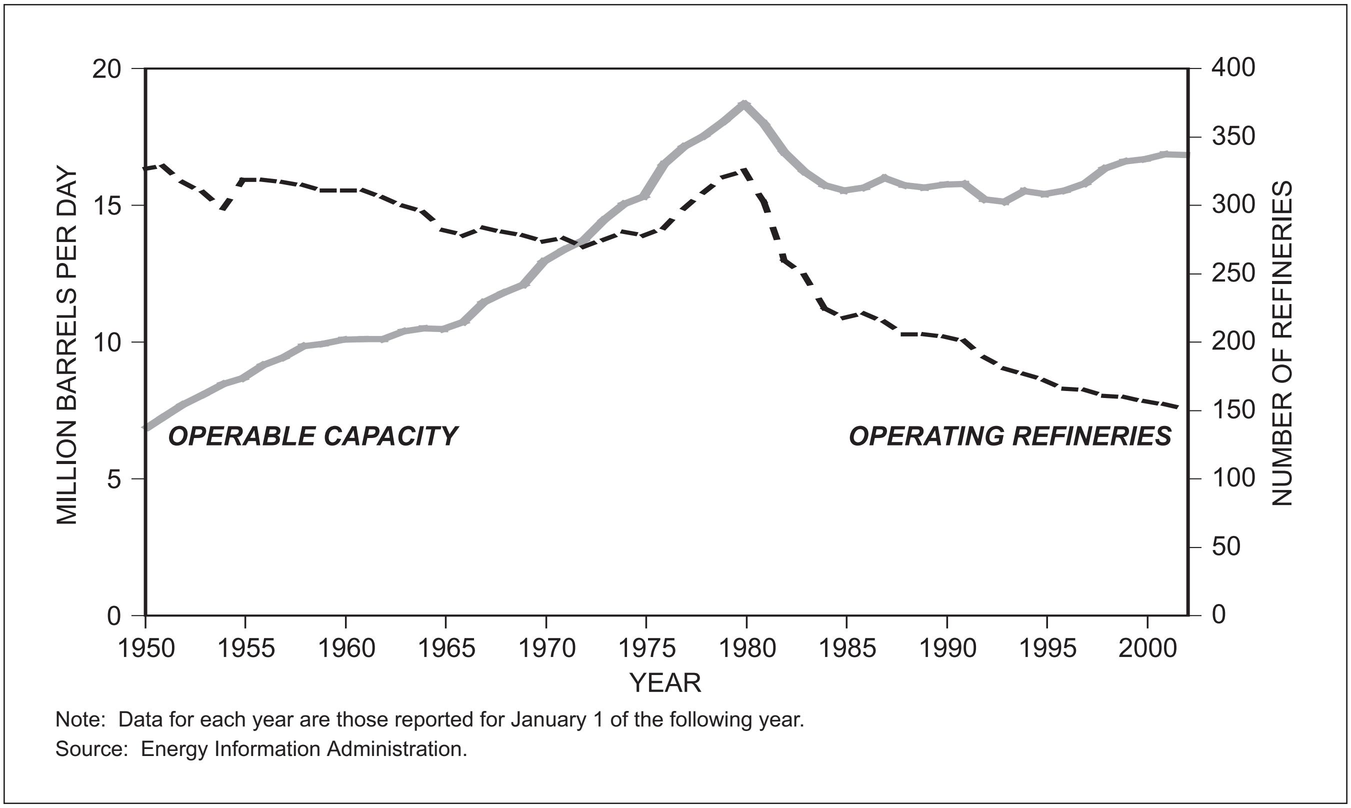


Figure I-23. U.S. Refining Capacity and Number of Refineries

although the lead times for modification of existing refineries can also be substantial.

The economics of constructing a grassroots refinery would be dependent on numerous factors including the location, size, crude oil source, and the product slate produced. For illustrative purposes, the following analysis provides a high level generic comparison derived from public data of the cost of grassroots construction compared with the cost of capacity additions through acquisitions.

Information published in the *Oil & Gas Journal* (March 19, 2001) by the consulting firm Turner, Mason & Company estimates the grassroots construction costs for a hypothetical large-scale, high-conversion refinery, designed to manufacture low sulfur fuels for the U.S. market. The refinery would be situated on the U.S. Gulf Coast, a location that has generally favorable construction costs relative to other domestic markets. The estimated construction cost for such a refinery is between $2.5 and $3.0 billion. Considering the additional hurdles beyond construction costs that a U.S. grassroots refinery project would face, such as obtaining site and environmental permits, the estimate appears to be somewhat low.

Equivalent Distillation Capacity (EDC) is a concept that is widely applied in the refining industry to perform comparisons between refineries of different scale and sophistication. Based on analysis of the Turner Mason estimate, the cost of the hypothetical Gulf Coast refinery would be within the range of $1,050/EDC to $1,275/EDC in 2004 dollars.

Refinery acquisition values can provide a measure of the value of domestic refining assets from both the buyer's and seller's perspective. The following data summarize refinery acquisition prices from all domestic refinery sales since 1998 that satisfied three conditions:

- Transaction price is public record
- Refining assets were primarily in the fuels business as opposed to asphalt or lubricants
- The primary assets included in the transaction were individual refineries, as opposed to company-

wide transactions or portfolios comprised of both refining and non-refining assets.

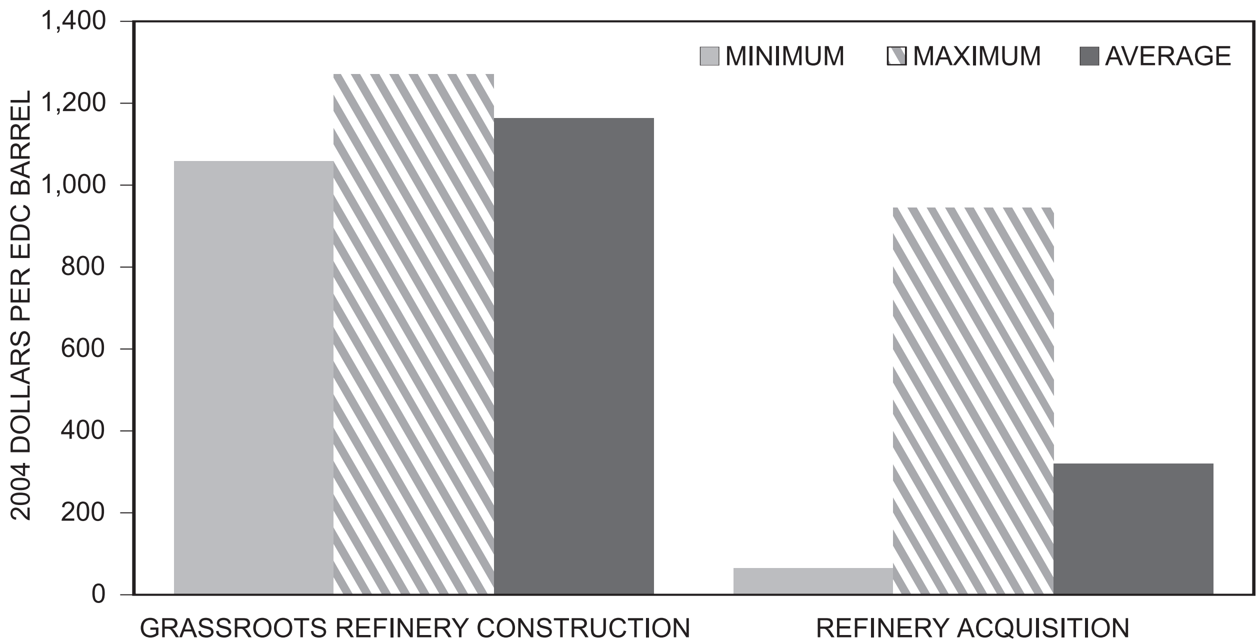
There were 25 transactions that met these conditions. In 2004 dollars on an EDC weighted basis, the average sales price was $320/EDC. A comparison of grassroots construction costs with refinery acquisition price is shown in Figure I-24.

This analysis suggests that current industry participants have valued U.S. refining assets at about one-fourth to one-third the cost of grassroots construction. This would appear to explain why some companies seeking to add domestic capacity have pursued acquisition rather than grassroots construction. The number of transactions in recent history indicates that a viable market for refining assets does exist.

As shown in Figure I-25, refinery gasoline margins have varied considerably over time. Margins for 2003 and 2004 to-date average about 25% above the average for the years 1998-2003. Assuming that the refinery sales history presented above has generally reflected margin expectations based on the longer-term averages, even the recent increase in margins would not appear to be sufficient to justify new grassroots refinery construction if translated into long-term future expectations.

The continuing expansion of existing refineries in this environment indicates that there have been refinery expansion opportunities available at lower cost than grassroots refinery construction. Capacity expansion projects can have more favorable economics than grassroots projects, because they can often use the existing refinery site, utility, and support units and can generally be implemented in a shorter time frame. Often, expansion projects can also be implemented with limited additional fixed operating costs in contrast with grassroots projects that bear a full fixed cost overhead.

The analysis above is a very generalized assessment. In reality, actual decisions about investing in a grassroots refinery, acquiring assets through acquisition, or expanding capacity at an existing site would be based on an individual company's assessment of the market and economics including the particulars of the investment being considered.



Note: EDC = Equivalent Distillation Capacity.
Source: Derived from public data as described in text.

Figure I-24. U.S. Grassroots Refinery Construction Costs vs. Refinery Acquisition Price

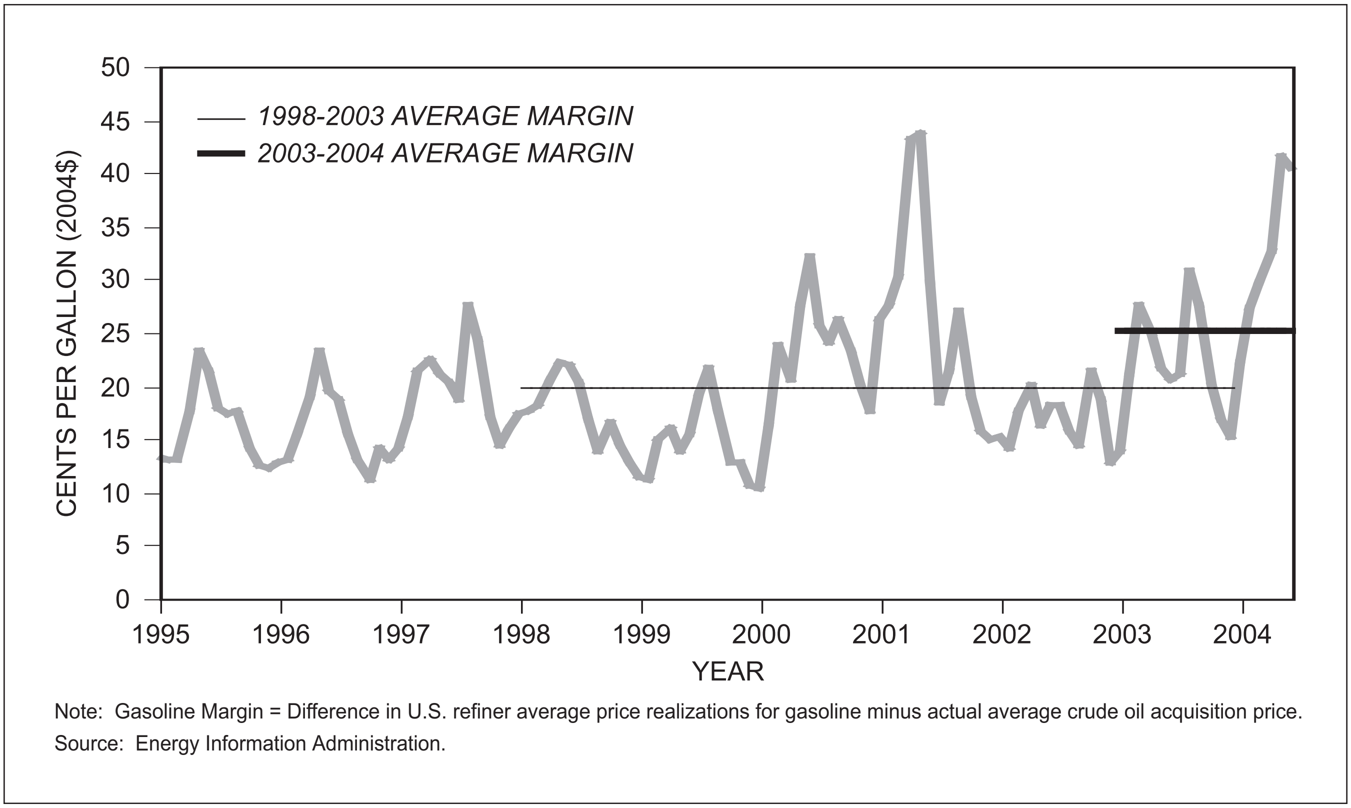


Figure I-25. U.S. Refinery Gasoline Margins

Near-Term Outlook

No Serious Supply Issues Anticipated with Low Sulfur Gasoline Implementation

The National Petroleum Council does not expect serious supply issues to arise associated with implementation of low sulfur gasoline through 2006. Individual companies have made independent decisions regarding investment in lower sulfur gasoline production, including timing, location, capacity, technology, and design assumptions for investments. No independent public source is available to provide aggregate data on these gasoline desulfurization investments, nor has EPA tracked the progress of refiners in achieving compliance with the new rules as it has done with the ULSD implementation. Therefore, the NPC must rely on general industry knowledge and limited public data to assess the likelihood that the demand for low sulfur gasoline will be met through implementation in 2006. Based on the information available, the NPC believes that current capacity for gasoline desulfurization along with announced additions of gasoline desulfurization capacity and the expected availability of imports will provide for continued domestic supply in the near term.

The NPC did not develop a demand forecast as part of this update activity. The NPC did review the most recent EIA demand forecast as part of this activity. The EIA forecast has domestic gasoline demand increasing about 2% per year in the near term.

Recent performance in meeting the early phase-in of the low sulfur gasoline rule can be used as a guide to expected future performance. In the 2000 NPC refining study, the average gasoline content was estimated at 340 ppm in the U.S. Beginning in January 2004, the cap on gasoline sulfur content was lowered to 300 ppm, with a corporate average of 120 ppm. Industry participants produced gasoline meeting these more stringent requirements at record total volumes for the first six months of 2004.

Further evidence of the ability to meet gasoline sulfur regulations in the near term is provided by reviewing imports and the availability of gasoline sulfur allotments, which allow for the production or importation of gasoline with higher sulfur than the corporate average but less than the 300 ppm cap. Allotments are generated by reducing the average sulfur content of gasoline below the prescribed corporate average of 120 ppm. In early 2004, EPA contemplated a relaxation of the average sulfur requirements for importers to allow additional imports after a small number of importers claimed they could not meet the average 120 ppm sulfur standard for 2004 because sulfur allotments were not available. Following a review, EPA determined that allotments were available to allow compliance and determined that such a relaxation was not warranted. Through the first six months of 2004, imports of gasoline were at record levels, and gasoline sulfur allotments remained available for purchase. While this does not provide definitive information on the flow of allotments or the absolute sulfur levels of domestic production or imports, it does indicate that current domestic production in combination with imports is capable of achieving market demand volumes while meeting specifications, and that some capacity exists to reduce sulfur below 2004 levels.

Gasoline imports are expected to continue to be an economic supply source for the U.S. in the near-term future. Primary sources of gasoline imports to the U.S. should be able to meet U.S. Tier 2 gasoline specifications. Canada and Western Europe both have mandated reductions in sulfur similar to those being mandated in the U.S. in approximately the same time frame. The Virgin Islands depends on the U.S. for the placement of its production and Venezuela has publicly stated it is investing in its refineries in order to continue to be a supplier of gasoline to the U.S. market. This being said, the U.S. may well lose some of its historical sources of supply including Eastern Europe and parts of Latin America. These supply sources will likely not be able to meet U.S. specifications without significant investment in the near term, and may choose not to invest to comply with U.S. specifications if other markets with growing demand are available as an economic outlet for their oil products.

The European Union has implemented regulations that are aimed at a reduction in emissions of global warming gases. Processing changes that may be required in European refineries to enable compliance with the global warming gas emissions regulations may cause an increase in the cost of producing oil products in European refineries relative to today. Depending upon market forces, this may result in upward pressure on the cost of imported gasoline from Europe to the United States.

The NPC is optimistic that gasoline supplies will be sustained through the implementation of the low sulfur gasoline rules in 2006. Some localized supply disruptions may occur due to operational difficulties, but these are not expected to be of significant duration.[9] There are a number of pending regulatory and legislative issues discussed in the Recommendations section of this report that if resolved would remove some uncertainty from the market and improve the climate for domestic refinery investment, further assuring this optimism.

Boutique Fuels Fragment Markets and Reduce Supply Efficiency

As boutique fuels proliferate, the marketplace becomes even more fragmented, increasing the potential for supply disruptions and price volatility. This occurs because boutique fuel requirements hinder the supply flexibility inherent in the complex petroleum product distribution system. Highly balkanized fuel requirements restrict potential alternative supply sources that can be used to balance demand. For example, when New York and Connecticut implemented MTBE bans effective January 1, 2004, they could no longer be supplied with MTBE-based RFG used throughout the rest of the Northeast. This required additional segregations and realignment of supplies. While industry responded successfully, preventing disruption of supplies to consumers, the system overall was and continues to be exposed to a higher probability of breakdown.

The NPC is not prepared to recommend changes in existing boutique fuel requirements; however, requests for additional specialty formulations, for example those under consideration in Detroit, should be approved only where necessary and cost effective relative to other emissions reduction options. The uncertainty generated by situations

9 Refer to the 2000 NPC refining study for a detailed discussion of the operational issues that may be associated with implementation of more restrictive product specifications.

such as RFG implementation issues in Baton Rouge and Atlanta further complicate supply planning and hinder efficient delivery of fuels to the market.

In addition to being a driver for boutique fuels, the proliferation of MTBE bans results in a net loss of domestic gasoline producibility. With the RFG oxygenate requirement in place, removing MTBE requires substitution of ethanol. Base gasoline volatility must be reduced to accommodate ethanol's higher blending volatility. This reduction is accomplished by removing light material from gasoline. As recommended in the 2000 NPC refining report, adequate lead time should be provided to allow all the activities necessary to enable refinery and distribution system modifications to respond to significant product quality changes such as MTBE bans.

Significant Supply Concerns Exist for Ultra Low Sulfur Highway Diesel Implementation

The NPC has significant concerns that the current Ultra Low Sulfur Highway Diesel (ULSD) regulations have the potential to result in serious and prolonged supply problems. The current regulations require earlier implementation and lower sulfur levels than those evaluated in the 2000 NPC refining study, raising additional supply concerns beyond those posed in that study. EPA regulations require ULSD in mid-2006, whereas the 2000 NPC refining study recommended implementation of ULSD in mid-2007 to avoid overlap with the Tier 2 sulfur gasoline investments. The ULSD rule also requires a 15 ppm sulfur cap for ULSD, rather than the 30 ppm sulfur refinery average evaluated in the 2000 NPC refining study. Further, EPA is requiring sulfur enforcement at retail, versus the refinery-gate enforcement strategy that was recommended in the 2000 NPC refining study and has been used successfully for the RFG and Tier 2 gasoline sulfur programs.

The EPA Highway Diesel Fuel 2003 Pre-Compliance Reports survey suggested that refiners' plans should provide sufficient production capacity of diesel at or under 15 ppm sulfur to meet demand, provided the 80/20 phase-in option works and downgrade of ULSD in the distribution system is minimal. The results of the 2004 EPA pre-compliance reports were released just at the time this report was drafted, and they indicated a very slight reduction in the anticipated production of 15 ppm maximum sulfur highway diesel versus the 2003 report. In the 2004 report, EPA summarizes: "Hence, it appears that the refining industry as a whole is adequately planning for projected highway diesel demand through 2010."[10]

The NPC has serious concerns about the feasibility of ULSD movement through the distribution system of pipelines, vessels, terminals, and trucks that will still move substantial volumes of higher sulfur jet fuel, non-road diesel, and heating oil. Significant losses and downgrades during delivery from refineries to the final consumer could result in apparently adequate supplies at refineries being unable to meet demand at retail. Trial pipeline shipments of ULSD suggest the potential for significant volume loss of on-specification ULSD, potentially in excess of 10% in each transportation segment, during distribution even allowing for a significant sulfur increase. Quantitative data were just becoming available at the time of this update.

The ULSD regulation provides for sale of limited volumes of ULSD with sulfur greater than 15 ppm at retail (but less than 500 ppm), provided it is segregated separately from sales of under-15 ppm sulfur ULSD. EPA is relying on this provision ("80/20 phase-in") to conclude that refineries will produce adequate ULSD to meet demand in 2006. However, there are no public evidence or announcements of distribution system preparation for segregation of an additional diesel product required to utilize the 80/20 phase-in option and to sell volumes of ULSD with sulfur slightly above 15 ppm. The combination of a short four-year window for the 80/20 phase-in and the small 20% volume offers little or no opportunity to payout any new facilities to segregate an additional diesel product. Without advance preparation in the distribution and retail system, downgraded ULSD cannot be sold to highway diesel customers. Further challenging ULSD distribution is the fact that EPA's testing tolerance is inconsistent with the sulfur test precision. EPA regulations allow only a 2 ppm tolerance for testing variability at retail whereas the best current sulfur test methods exhibit reproducibility in the 4 to 8 ppm range.

[10] U.S. Environmental Protection Agency, *Summary and Analysis of the Highway Diesel Fuel 2004 Pre-Compliance Reports.*

Enforcement of the retail cap without an adequate tolerance for test reproducibility could result in large quantities of diesel being disqualified as ULSD for supply to consumers. Alternatively, distribution companies could use the current sulfur test statistical reproducibility and the potential for downstream contamination to establish a refinery gate sulfur specification below 10 ppm. This is particularly true for long and complex distribution movements, such as those from the Gulf Coast to the East Coast and Midwest. Some pipelines are reportedly considering very stringent refinery gate requirements; numbers as low as 5 ppm sulfur have been mentioned. Design should have been completed and construction should be underway for most refinery projects to produce ULSD to meet the 2006 implementation date. While no public information exists on design targets for desulfurization projects, the NPC has concerns that actual release specifications may be significantly more restrictive than refinery project design. If this is the case and desulfurization projects are forced to operate at lower sulfur levels than design, then actual ULSD production could be substantially below design rates.

The NPC believes that it is unlikely that imports will be available to balance any significant domestic production and delivery shortfall that could occur when ULSD is implemented. As discussed earlier, the U.S. has not historically imported significant volumes of low sulfur highway diesel (less than 100 thousand barrels per day). While Canada and the Virgin Islands will likely maintain their historical volumes of highway diesel imports to the U.S. for the same reasons driving gasoline imports, it is unlikely that there will be any other reliable source of ULSD imports to the U.S. As mentioned previously, Western Europe diesel demand continues to increase and acquiring diesel from Europe could be problematic. In fact, Europe might compete with domestic markets for ULSD, though higher European cetane requirements could be a barrier. In addition, ultra low sulfur specifications are not scheduled to be fully implemented in Western Europe until 2009.

Although the timing and specification level of the ULSD regulations do not follow the NPC's 2000 refining study recommendations, the timing requirement has been finalized and should not be changed this close to the implementation date, because refiners are already making investments to comply.

However, EPA's current testing tolerance for ULSD should be adjusted to reflect the reproducibility of the tests that will be available for regulatory compliance. Otherwise, some on-specification batches of ULSD may be ruled non-compliant solely as a result of testing inaccuracy. This has the potential to significantly reduce ULSD supplies, particularly in the transition period.

EPA should work with DOE and the various fuel supply industries to consider emerging information about the behavior of ULSD moving through the entire distribution system and to consider how to achieve the goals of the program while recognizing distribution system behavior. A phased-in distribution tolerance could ease the transition supply concern.

In addition to the concerns with the implementation of ULSD, other potential diesel supply issues exist. Reducing sulfur to very low levels reduces diesel lubricity, and ASTM has adopted a diesel lubricity specification for highway diesel as of January 1, 2005. However, recently concerns have arisen with lubricity additive trailback into subsequent products in pipelines, particularly jet fuel, if the additive is injected at the refinery. Various pipelines have proposed conflicting refinery gate lubricity additive requirements, and provision for terminal addition of lubricity additive may be problematic for the January 1 timing. Industry participants are actively working this problem, but if successful resolution is not promptly achieved, localized supply issues with jet fuel or highway diesel may occur in early 2005. Another issue is the availability of additized 15 ppm sulfur No. 1 diesel to blend into the diesel pool to meet cold flow properties in the winter. This issue is unresolved and warrants further study.

Recommendations

The NPC provides the following recommendations to help ensure a reliable supply of light petroleum products to the U.S. consumer. These recommendations are aimed at avoiding hindrance of capacity expansion, improving the environment for investment in domestic refining and logistics capability, and allowing the current supply system to continue to operate efficiently. Allowing the market to work efficiently will benefit the customer as the market provides the fastest and most efficient response to supply disturbances.

The recommendations of the 2000 NPC refining study remain applicable and should be implemented. A summary of those recommendations and the current status is included in Appendix C.

New Source Review

Immediate implementation of comprehensive NSR reform is a very important policy step needed to improve the climate for investment in domestic refinery expansion. The reforms promulgated by the Bush Administration, including the Equipment Replacement Rule currently under judicial review, should be implemented as soon as possible. Attempts to delay or overturn the reforms should be vigorously opposed. Additional reform proposals regarding de-bottlenecking and project aggregation should be issued and finalized. Additional background on NSR is included in Appendix E.

National Ambient Air Quality Standards

EPA should revise the NAAQS compliance deadlines and procedures to take full advantage of emissions reduction benefits from current regulatory programs such as cleaner fuels/engines and reduction of regional emissions transport. As currently structured, attainment deadlines precede the benefits that will be achieved from emissions reductions already planned. Thus even though programs are already being implemented to provide emissions benefits, states with non-attainment areas will be required to pursue additional costly controls that might otherwise not be needed and might not be deliverable in the time frame currently required.

The current deadlines could result in:

- Requirements for additional emissions offsets for any refinery modifications, reducing the economic attractiveness of investment in refinery capacity expansion
- Additional investment in stationary source controls at refineries, reducing the overall profitability and viability of domestic refining versus imports
- Additional requirements for boutique fuels, reducing the efficiency of the distribution system and increasing the potential for supply disruptions.

These requirements would be disincentives to expansion of domestic refining capacity. If the states were given sufficient time to allow emissions benefits of clean fuels/engine programs and regional transport regulations to be considered in attainment demonstrations, the adverse impact of these regulations on domestic refining capacity would be greatly reduced.

Implementation of Ultra Low Sulfur Diesel Regulations

Although the timing and specification level of the ULSD regulations do not follow NPC's 2000 recommendations, the timing requirement has been finalized and should not be changed this close to the implementation date, because refiners are already making investments to comply.

To reduce the potential for supply disruptions, EPA should work with DOE and the various fuel supply industries to consider emerging information about the behavior of ULSD moving through the entire distribution system and to consider how to achieve the goals of the program while recognizing distribution system realities. EPA sponsored a workshop on this subject in November 2004.

EPA's current testing tolerance for ULSD should be adjusted to reflect the reproducibility of the tests that will be available for regulatory compliance; otherwise, enforcement actions based on testing inaccuracy may result in disruption to the supply system.

National Energy Legislation

The NPC recommends passage of national energy legislation as embodied in the 108th Congress conference report on HR.6 as the vehicle with the highest probability of obtaining prompt action on the RFG oxygenate, oxygenate liability, and boutique fuel issues. While clearly a compromise, the package will help remove some of the uncertainty around the future of the domestic refining industry.

- ***Oxygenate Liability.*** Congress should approve limited liability protections for defective product claims involving MTBE and other federally required additives. This action would eliminate only defective product claims that penalize fuel manufacturers for meeting the Clean Air Act requirements. Negligence and other traditional causes of action for MTBE cleanup would be unaffected.

- ***Boutique Fuels.*** Requests for specialty fuels formulations, whether driven by NAAQS or otherwise, should be approved only where such programs are necessary and cost-effective relative to other emissions reduction options. Proliferation of boutique fuels has fragmented the market, increasing the potential for supply disruptions and price volatility. While the industry has been able to adapt to the current slate of boutique fuels without significant supply disruptions, continued proliferation will substantially increase the risk of supply disruption and price volatility. Implementation of state and local fuels programs, including any actions on MTBE, should be coordinated to avoid hindering operation of the distribution system, and should provide sufficient lead time to implement any necessary refining and distribution changes.

  DOE and EPA should conduct a joint study of the boutique fuel issue, with participation by all stakeholders. This study should provide important information on the impact of boutique fuels on fuel production and distribution.

Sound Science, Cost Effectiveness, and Energy Analysis

The 2000 NPC refining report recommended that: *"Regulations should be based on sound science and thorough analysis of cost effectiveness."*

Executive Order 13211, signed by President Bush in 2001, requires agencies to prepare a "Statement of Energy Effects" including impacts on energy supply, distribution, and use, when undertaking regulatory actions. The NPC recommends that Executive Order 13211 be made law and strictly enforced.

The NPC is not suggesting elimination or rollback of environmental requirements, but rather that the cost analysis of proposed regulations should include a thorough analysis of energy supply effects from production to end-use. Examples of regulations that the NPC does not believe reflect a thorough analysis of the energy supply effects include off-road ULSD and NAAQS regulations. As a result, implementation of these regulations may impose unintended costs without commensurate benefit.

Regulatory cost/benefit analysis should also be performed on an incremental basis, to ensure that each required increment is cost justified. Using a total and average analysis may result in adopting emissions reduction increments that are not cost effective.

Permitting

Streamlining the permitting process would help improve the environment for domestic refining capacity investment. Some activities are currently underway to review processes and identify streamlining opportunities; these activities should include industry and other stakeholders. Streamlining should provide for expeditious overall review and have a clearly defined process for obtaining a permit, with agency roles and responsibilities well-defined and specific deadlines for making permit decisions.

While the permitting process can be time consuming and burdensome, it is not the only hindrance to additional domestic refining capacity expansion. Streamlining the permitting process alone may not result in a significant increase in the rate of domestic capacity expansion.

The 2000 NPC refining report identified environmental justice challenges to permit requests as a potential issue and recommended that EPA define a clear process for dealing with these challenges. While environmental justice challenges have not been widespread since the 2000 report, there have been a few instances where environmental justice challenges resulted in abandoning projects. The potential for more widespread challenges remain, and the NPC reaffirms its 2000 recommendation that EPA define a clear procedure for dealing with environmental justice challenges.

Depreciation Schedule Adjustment

Adjusting the depreciation schedule for all refining equipment to five years from the current ten years, consistent with the treatment of similar process equipment in other manufacturing industries, would have a positive impact on expansion investment economics. This action would reduce the capital recovery period for investment in refining equipment, helping to offset the historically low returns in the refining/marketing business that have hindered investment in capacity expansion. Depending on the specifics of the project, this depreciation change should increase the return on investment by about one percentage point.

The depreciation adjustment should be applied to all new domestic refining investment. Attempts to apply revised treatment to some small sub-segment of investment may have the perverse effect of reducing the incentive for more significant additions in base capacity. The depreciation schedules for petroleum pipelines and for storage facilities should be similarly reduced.

Fuel Waivers and Enforcement Discretion

Use of exemptions, exceptions, and waivers should be limited to serious supply disruption situations that affect end-users' ability to obtain petroleum products. States have sought and EPA has repeatedly considered and/or granted enforcement discretion, and this has increased market uncertainty. EPA should issue a definitive variance procedure for allowing non-complying fuel to be sold in the marketplace. Proposed guidance on waivers has been recently released by EPA as a first step in this process.

Alternative Fuels

Mandates or subsidies for alternative fuels increase the uncertainty and reduce the incentive for investment in additional domestic petroleum refining capacity. Therefore, these subsidies may not reduce petroleum product imports as intended and could increase the cost to consumers.

Distillation and Driveability Index

The 2000 NPC refining report recommended that the Driveability Index not be changed without thorough additional analysis. To date, EPA has resisted automakers' calls for a reduction in Driveability Index, or a change to Distillation Index (Driveability Index plus an ethanol adjustment). EPA should continue this position. A reduction in Driveability or a change to Distillation Index could result in a significant reduction in domestic refinery gasoline producibility.

Site Security

Site security enhancement should remain an industry responsibility with ongoing risk assessment coordinated with the Department of Homeland Security, which should retain the lead federal coordination role. Refining industry participants are committed to keeping their facilities secure from threats of violence and terrorism. Refiners have expended substantial resources to enhance security and expect to continue to do so. There are proposals being discussed that include provisions for refining technology changes and criminal liability. In the opinion of the NPC, these provisions do not provide an additional security benefit but have the potential to negatively impact light product production capability.

Reducing Distribution Incidents Would Improve Supply Reliability

The "one call" system to avoid digging incidents should be made national and aggressively promoted and enforced. Damage to underground pipelines by third-party digging has been a source of distribution disruption. Broadening the one-call system to include government entities and strictly enforcing its use will help reduce the potential for these incidents.

Access to Ports

Efficient access to ports is necessary for receipt of both imported crude oil and petroleum products. Sufficient funding should be provided to increase or maintain existing depth in waterways serving key crude oil and light product import facilities. The dredging permit process for individual terminal sites should be streamlined and adequate designated disposal sites should be provided for the dredging materials that are removed during the dredging process.

During periods of significant supply issues, increased waterborne movements of petroleum may be desirable. The current process for obtaining a waiver of the Jones Act should be evaluated and clarified so that definitive rules are in place should this need occur.

2005 Domestic Capacity

These recommendations are aimed at avoiding hindrance of capacity expansion, improving the environment for investment in domestic refining and logistics capability, and allowing the current supply system to continue to operate efficiently. These recommendations should be implemented as soon as practical to begin taking effect.

Major refinery modifications can take four or more years lead time for all the activities necessary for implementation. Due to this lead time, the capacity that will be available in 2005 is the result of regulatory actions and investment decisions over the last several years. The NPC has not identified any government actions that could significantly increase domestic refining capacity available for 2005.

Longer-Term (to 2010) Observations

Historically, large petroleum markets have been primarily served by refineries with a logistical advantage to the market. This occurs as a result of the relative cost advantage of transporting crude oil long distances as opposed to transporting a multitude of products. While worldwide refining capacity has historically been available to meet product demand, products flow to and from different demand areas as the market and refining capability changes in response to economic realities. Worldwide product demand growth is expected to be greatest in the developing countries of the Far East such as China and India. It is possible that refining capacity growth in those areas may not keep pace with demand and that some of the sources of current U.S. oil product imports will find it more attractive to serve markets other than the United States. Potentially this could alter U.S. refinery expansion economics such that domestic refining capability will grow to economically replace imports. Conversely, there might be over-expansion of refining capacity in growth markets in other parts of the world that could provide economic oil import supplies for the U.S. marketplace. Barring any artificial barriers to world trade in oil products, market economics and local construction and operating costs will dictate the economic location for new refinery capability.

It is still too early to determine how the reduction in non-road diesel sulfur in 2007 and 2010 will proceed. Any problems that do arise related to the implementation of 15 ppm non-road diesel sulfur would likely overlap into the highway ULSD supply. Each individual refiner will continue to independently evaluate when to upgrade/invest for additional diesel desulfurization capacity to meet the 500 ppm non-road diesel rule in 2007 and the total diesel sulfur pool at 15 ppm in 2010. Incremental 15 ppm diesel production costs are likely to rise as desulfurization of increasingly more difficult streams is required.

While there is uncertainty surrounding the impacts of implementation of the various diesel sulfur rules, heating oil supplies should not be negatively impacted. However, a potential wildcard contributing to the uncertainty in the heating oil supply outlook is whether individual states will impose lower heating oil sulfur requirements in this time frame.

PART II

OBSERVATIONS ON U.S. PETROLEUM INVENTORIES

Role of Inventory

This supplemental report focuses on major light petroleum products and crude oil inventories in the United States, but it is important to understand these inventories and their relationship to the light petroleum product market in the context of the larger global petroleum market. Production and delivery of petroleum products involves at least 14 separate activities, as shown in Figure II-1. This figure illustrates the various components of the global petroleum supply chain, and the points at which inventories occur. Many unique competitors participate in this supply chain. Some are integrated throughout the chain while others only specialize in certain segments. Competition in the global marketplace drives adoption of the most efficient strategies, including those related to inventory management.

Inventory is held at many points in the global supply chain and plays several roles. The focal point of this study is based on data collected from the EIA – major light petroleum products and crude oil in the primary system in the United States. The primary system is one component of global inventories and contains about half of the total U.S. inventory of major light petroleum products. Although movement and processing of a specific crude oil can take months due to the geography and complexity of the supply chain, in reality products are continuously being shipped from over 140 U.S. refineries and arriving at more than 1,500 points of terminal distribution. This continuous process allows prompt reallocation of products to meet fluctuations in local or regional needs.

Products move from primary storage into secondary storage, which includes distributor, retail station, and industrial and commercial inventories. Product from secondary storage is transferred to the consumer or end-user, making up the third inventory category called tertiary storage.

In facilitating the operation of this supply chain, inventory plays several roles: operational necessity, component of supply, financial opportunity, and protection against a worldwide emergency. While inventories are a requirement for reliable supply, they also represent a cost of doing business.

Inventory as an Operational Necessity

The flow of crude oil and products around the world is not always constant, homogenous, or uninterrupted, due in part to the batch nature of movements in ships, barges, pipelines, railcars, and trucks, as well as the real world variability associated with these transportation modes.

Delivery of crude oil and products to the customer is a complex process. The movement of crude oil from its reservoir through the supply chain to become a finished product can take months due to the vast distances in which crude oil and products normally travel. Crude oil reserves are generally not located near refineries, and refineries can be far removed from consumers. Significant quantities of crude oil and petroleum products are moved in large ships (some of which hold the equivalent of one-quarter of the U.S. daily gasoline consumption) at speeds around 15 miles per hour. Pipelines flow at the pace of a fast walk, 3 to 6 miles per hour. Even inside the United States, crude oil produced in Texas requires over two months before arriving as product on the U.S. East Coast. In addition to the relatively slow

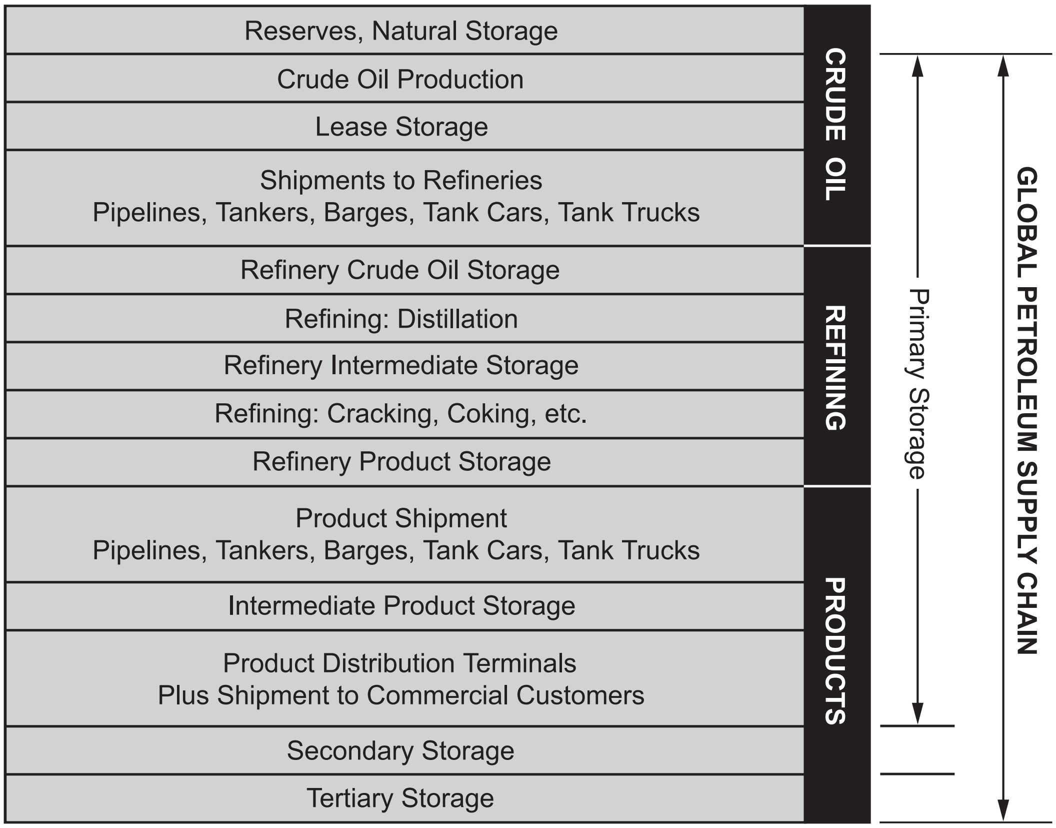


Figure II-1. Global Petroleum Supply Chain

movement of oil, the batched nature of oil movements (crude oils from the well to the refinery and the myriad of products from the refinery to terminals and ultimately to the consumer) creates additional logistical complexity.

Inventory used as an operational necessity includes tank bottoms, pipeline fill, in-transit inventory, and working inventory. Pipelines must be full in order to push crude oil and products to their delivery points. Many tanks must have a certain amount of crude oil or products always in their bottom in order to receive or deliver. This inventory is normally not available to meet demand because it is required to maintain a steady operation and it provides an interface between each segment of the industry's supply chain – production, transportation, refining, product distribution, and marketing. This allows the different rates of flow in different parts of the supply system to be balanced.

As the industry has achieved higher throughput rates while adding limited new inventory capacity, the improved operational efficiency is reflected in the reduction in the "days of supply of inventory." While a reduction in this number is reflective of improvements in efficiency, it does not reflect a lower level of supply reliability.

Inventory as a Component of Supply

Another role of inventory is that of a component of supply. This inventory is produced and stored in order to meet expected future demand. Product demand has seasonal and regionally specific characteristics. Off-season storage of inventory may serve as an economic method of supplying future demand versus a more timely purchase or production increase. In the United States, heating oil is the product that has historically seen the largest seasonal inventory builds to supply periods of peak demand. Even though U.S. refinery capacity is more than adequate to meet peak demand for heating oil and other distillate products, differing seasonal production economics have encouraged seasonal inventory builds. These seasonal builds have been diminishing in recent years, while demand has been met by higher and more flexible refinery output, and increased imports. Companies also build inventories in preparation for planned maintenance in the production, refining, and logistical systems. To ensure that customer needs are met, additional inventories are normally held as protection against variability in the elements of the supply chain as well as in customer demand. The quantity and use of these inventories vary and are subject to individual company operating philosophies.

Inventory as a Financial Opportunity

Changes in industry aggregate inventories cannot be interpreted as changes in the adequacy of supply. Physical inventories can also be used to improve economic performance. Inventory held for this purpose is referred to as "discretionary" because it is in excess of the level necessary for operational efficiency. This capability is, to varying degrees, available in all segments of the supply chain: production, refining, terminaling, commercial end-use, and consumers. In the primary sector, these inventories appear predominantly in terminals. Most companies actively manage their physical product inventory in response to economic incentives. Companies may manage their individual level of discretionary inventories based on their assessment of future market conditions. There may also be incentives based on the futures market that influence the level of discretionary inventories. For example, if futures prices for delivery in coming months are higher than the price today, an incentive may exist to build inventory because it may be worth sufficiently more later to cover the carrying cost and financial risks. Under this scenario, the market is said to be in contango. Conversely, if the futures prices for delivery in coming months are lower than the price today, companies may have an incentive to draw discretionary stocks and keep them low while maximizing sales. Under this scenario, the market is said to be backwardated. Regardless of these financial drivers, companies strive to hold sufficient inventories to operate reliably and meet customer demand.

Inventory as a Cost of Doing Business

The industry is very competitive, which drives each company to continually strive to financially optimize operations while providing adequate supply to meet expected customer demand. Achieving both these aims continually and successfully is a complex planning task for an operating company, requiring continuous coordination between the various segments of the supply chain – crude oil supply, refining, transportation, and final product delivery. Crude oil has to be supplied in adequate volumes and in a reliable and timely manner for refineries to process it into finished products. Refineries then have to run reliably to process the crude oil to meet local or regional product demand and the distribution systems need to have the capability to deliver product to market. Failure to plan for adequate inventories to meet an individual company's requirements results in a competitive disadvantage through the eventual loss of product sales and margins that could have been gained from those sales.

Inventory is considered working capital and, as such, is a cost of doing business. Carrying more inventory than required to operate the system may increase costs unnecessarily, unless there is a financial incentive to do so. Conversely, carrying too little inventory increases the risk that the system may not be able to meet customers' demand, resulting in a lost competitive advantage. The competitive nature of the industry is such that companies try to minimize working capital (or costs) consistent with operating reliable supply systems. Ultimately, customers benefit from efforts to reduce petroleum supply costs, as evidenced in Figure I-21.

Inventory as Protection Against a Worldwide Emergency

The United States' Strategic Petroleum Reserve is the largest government crude oil stockpile in the world. It was started in 1975 as part of the Energy Policy and Conservation Act. The Strategic Petroleum Reserve currently contains around 670 million barrels of crude oil (August 2004), accounting for about 40 percent of the primary U.S. petroleum inventory. The NPC remains strongly supportive of holding these inventories for use only during significant crude oil supply disruptions that threaten the system's ability to meet domestic demand.

Although there is a strategic heating oil reserve in the Northeast, the concept of a products strategic reserve was discussed as part of this update and the NPC does not believe such reserves are appropriate for the United States. There isn't the same necessity of a products reserve as there is for the crude oil reserve given that light product imports represent only 7% of light product demand, while crude oil imports represent about 60% of U.S. crude oil supplies. There are a number of factors that make the holding and management of a strategic products reserve complex and impractical. For example, the very large number of boutique gasoline formulations would likely require strategic storage at multiple regional, state, and/or local locations. This concept is further complicated by the requirement of seasonal inventory turnovers to meet gasoline specifications and product degradation experienced when held in storage for a lengthy period. It is also unlikely that there would be sufficient product of the right specification in the right location to be helpful during a supply disruption. Additionally, in the face of a supply/demand disruption, the presence of a products reserve could create uncertainty about when or whether it would be drawn down. These uncertainties would dampen the market response to correct the supply/demand imbalance.

Supply/Demand Imbalances

Imbalances Sometimes Coincide with Industry Maintenance

As part of good operating practices, companies periodically shut down facilities for planned maintenance. Planning for major maintenance activities is a lengthy (typically in excess of 12 months) and complex task, which requires significant planning and lead time to establish required activities, acquire resources and equipment to carry out those activities, and secure alternate product supply to cover customer demand, including adequate inventory. Planned maintenance is necessary for a variety of reasons, such as equipment inspection, repair, and improvements, equipment replacement when required, and ultimately safe operation. As shutdown activities are typically high cost and result in lost production, the industry has a strong financial incentive to extend periods between maintenance and expedite shutdown activities as quickly as possible, consistent with safe operating practice. However, planned maintenance almost always has lower costs than emergency maintenance, so refiners have a practical limit on how long they can operate between planned maintenance periods.

Maintenance activities on large assets, such as refineries, is typically planned for either early spring or late fall. There are primarily two reasons why the industry selects these periods. Firstly, typical weather patterns during these periods are less likely to interrupt (and hence extend) maintenance activities and secondly, historical demand and margins are typically lower outside of the summer driving season (minimizing the operating and financial impact of the maintenance activities).

The nature of planned maintenance is such that it is extremely costly to make anything but a minor change in the start date. This is because commitments for manpower and materials have been made well in advance. As a result of committing to shutdown dates, industry maintenance activities sometimes coincide with periods when there are significant unplanned supply and demand disturbances.

Unanticipated Events

Even with the best planning around maintenance activities, factors outside the control of operating companies may lead to disturbances in the supply/demand balance. Market dynamics and customer demand are unknown. If local or regional product demand increases unexpectedly when an operating company is committed to perform maintenance activities, there may be a resultant temporary imbalance in supply and demand. Similarly, there are times when unplanned events occur that cause a temporary disturbance to supply. While the public may be aware of a few major unplanned events each year, such as refinery fires, pipeline breaks, etc., there are in fact many events that the industry successfully responds to. Most of these disturbances are minor or moderate in nature but if multiple events occur simultaneously, a larger supply disturbance can result.

Petroleum markets respond to supply/demand changes with price movements that provide the incentive to increase or decrease supply to correct any imbalance. This is an integral part of normal and effective market operation. Through the individual response of various companies to these price movements, the petroleum industry as a whole reacts quickly and effectively to maintain the supply/demand balance in response to changes in local, regional, or global market conditions. Although the U.S. supply system is very complex, it is robust and has demonstrated flexibility to adjust to significant supply disturbances. Even during major supply disturbances, the supply/demand balance is typically restored within a short period of time. Given this capability, the fastest and most efficient response to supply disturbances is via market mechanisms described above.

Changes in Fuels Quality Specifications Can Impact Inventories

The promulgation of federal and state mandated changes to fuel specifications is having an impact on inventories. Examples are:

- **Lower inventory levels during spring gasoline vapor pressure transition.** Federal fuels regulations require that gasoline have reduced vapor pressure in summer. The industry strives to make the seasonal (winter to summer) transition, from high to low vapor pressure gasoline production, at as low a cost as possible. High Reid Vapor Pressure (RVP) gasoline inventories are reduced, to remove as much of the winter season gasoline stocks as possible, and then re-built with product that meets the lower summer vapor pressure requirements. During the period of reduced inventory, the system is at increased risk of not being able to respond as quickly if there is any event that causes a supply and demand imbalance.

- **Boutique fuels.** Fuels specifications established independently by states and municipalities result in the need to produce, transport, store, and deliver to consumers an increasing number of "boutique" fuels. In addition, the new gasoline formulation can disrupt normal supply processes because of reduced product fungibility. One example of this is the MTBE ban imposed by the states of New York, Connecticut, and California in 2004.

- **Ultra Low Sulfur Diesel.** Beginning in June 2006, highway diesel sulfur specifications are required to be lowered from 500 ppm to 15 ppm. The inventory-related impact of this specification change is not well understood at this time. The reduced diesel sulfur specification will result in more complex handling issues in the product distribution system to deal with the potential for more off-specification product.

Inventory Trends and Lower Operational Inventory

As discussed in the 1998 NPC Inventory Dynamics study, U.S. petroleum inventories respond to both market and infrastructure changes in the supply system. This section reviews crude oil and petroleum product inventory data since the 1998 study and evaluates the lower operational inventory (LOI) levels defined by the NPC in the 1998 study. The LOI, as defined in the 1998 study, is the lower end of the demonstrated operating inventory range updated for known and definable changes in the petroleum delivery system. While generally not used by industry, the NPC recognizes the LOI as a gauge to help the government assess current inventory levels. Several factors impact the LOI level of crude oil and petroleum products. Factors that act to decrease LOI are improved efficiency of the delivery systems and reduced domestic production. Increased demand and product specification changes may act to increase the LOI.

Based on the observed crude oil inventory trends, the NPC concludes that crude oil LOI should be a range of 260 to 270 million barrels, compared to the 1998 study conclusion of 270 million barrels. Since the 1998 study, crude oil inventory has been as low as 260 million barrels a few times with no impact on crude oil supply to U.S. refiners. However, in September 2004, Hurricane Ivan had a significant impact on offshore oil platforms and pipeline movements. This created localized supply disruptions at a few refineries even though crude oil inventories were slightly above 270 million barrels. There were no supply issues prior to Hurricane Ivan. Hurricane Ivan substantially reduced crude oil imports and shut in Gulf of Mexico production simultaneously. Peak disruption resulted in a reduction of about 60% of the Gulf Region crude oil supply, and as of early October, around 30% of Gulf Coast crude oil production remained shut in. As a result, a few refiners requested crude oil loans from the Strategic Petroleum Reserve to support crude oil runs at their Gulf Coast refineries. All of these refineries needed low sulfur crude oil, which has been in tight supply globally. The supply disruption is a reflection of a few refineries in the region being impacted by an extreme disruption to local low sulfur crude oil supplies and their lack of ability to substitute lower quality, higher sulfur crude oils. A crude oil LOI range is recommended, rather than a single value, to better represent the degree of accuracy associated with the LOI methodology. Delivery system efficiency improvements and declining domestic crude oil production have resulted in reduced crude oil inventory levels. Continued improvements to pipeline and other infrastructure, and technological improvements are likely to continue the trend towards lower operating inventory in the future.

The situation brought about by Hurricane Ivan is only one example of many different situations that could impact the LOI for crude oil. Using a single number or even a range for LOI is not likely to cover all situations where apparent shortages of crude oil may result. Since crude oil quality varies significantly from one supply point to another and refineries are designed to operate using crude oil of given qualities, sudden changes in crude oil supply could cause a reduction in refinery throughput even though there appears to be ample volumes of crude oil available. The same situation could occur with products because broad product categories like gasoline and distillate include a number of specific product types, all of which are not produced at every refinery. It is possible to have a product inventory above its LOI and experience an apparent shortage in a given location because product of a specific quality is not available.

Review of petroleum product inventory data since the 1998 study suggests that no appreciable change has occurred in the overall gasoline and distillate (heating oil and diesel) inventory levels. The NPC believes that inventory changes from improvements in system efficiency have been offset by increases in product demand and the number of different fuel specifications. Therefore, product LOIs were not studied in detail and no change is recommended at this time in the LOIs for those products. It may be appropriate to have an LOI range for both gasoline and distillate. However, this was not analyzed as part of this update given that there is no recommended change to the LOIs. Similar to crude oil, it would be expected that lower operational inventories would continue to decline as the product supply system evolves. Given the short time frame of this study, the potential impact of impending regulatory changes in diesel sulfur content on distillate inventory was not studied.

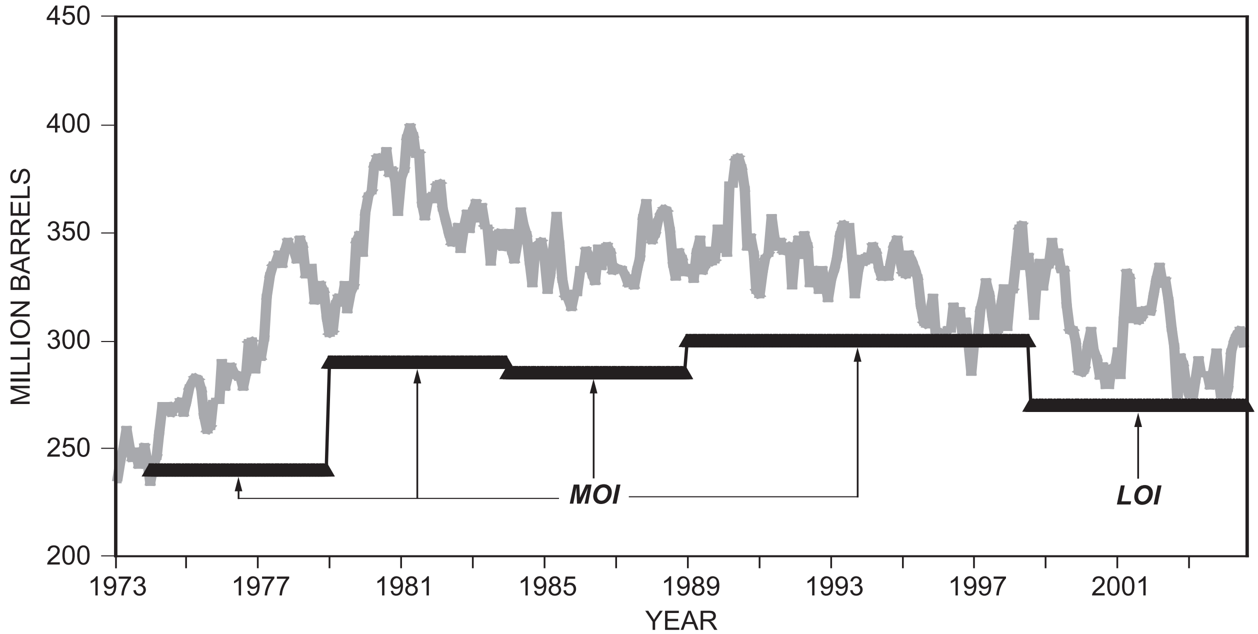
Crude Oil

Figure II-2 shows the monthly closing inventory levels of crude oil from 1973 to July 2004. Data available for the 1998 study ended at mid-year 1998. New data and the LOI inventory level developed during that study are shown on the right hand side of the figure. Crude oil inventory has continued its slow downward trend and has reached new lows since the 1998 study. The prior lowest observed crude oil level was 284 million barrels in December 1996. Since then, month-end crude oil inventory has been around the 270 million barrel range several times, with the lowest observed value of 268 million barrels in December 2003. In addition, weekly data (which are based on surveys and are not as accurate as monthly data) approached the 260 million barrel level several times in early 2004. No crude oil shortfalls or supply issues were observed with inventory in this range.

The crude oil delivery system and its inventory requirement is fundamentally different than for finished products as a result of the difference in the nature of the end-users. The product delivery system has been built up over a number of years to provide relatively small amounts of product to millions of customers in thousands of locations. Over time, the evolution of the product delivery system has largely been focused on efficient delivery of increasing amounts of product to an expanding customer base. Crude oil, however, flows to relatively few refiners that have been decreasing in number over time. In addition, as domestic production declines and imports grow, an increasing amount of crude oil inventory is in transit, which is not captured in the inventory data. The very competitive nature of the petroleum business coupled with continued efficiency improvements and crude oil increasingly supplied from offshore sources will likely drive domestic crude oil inventories lower over time.

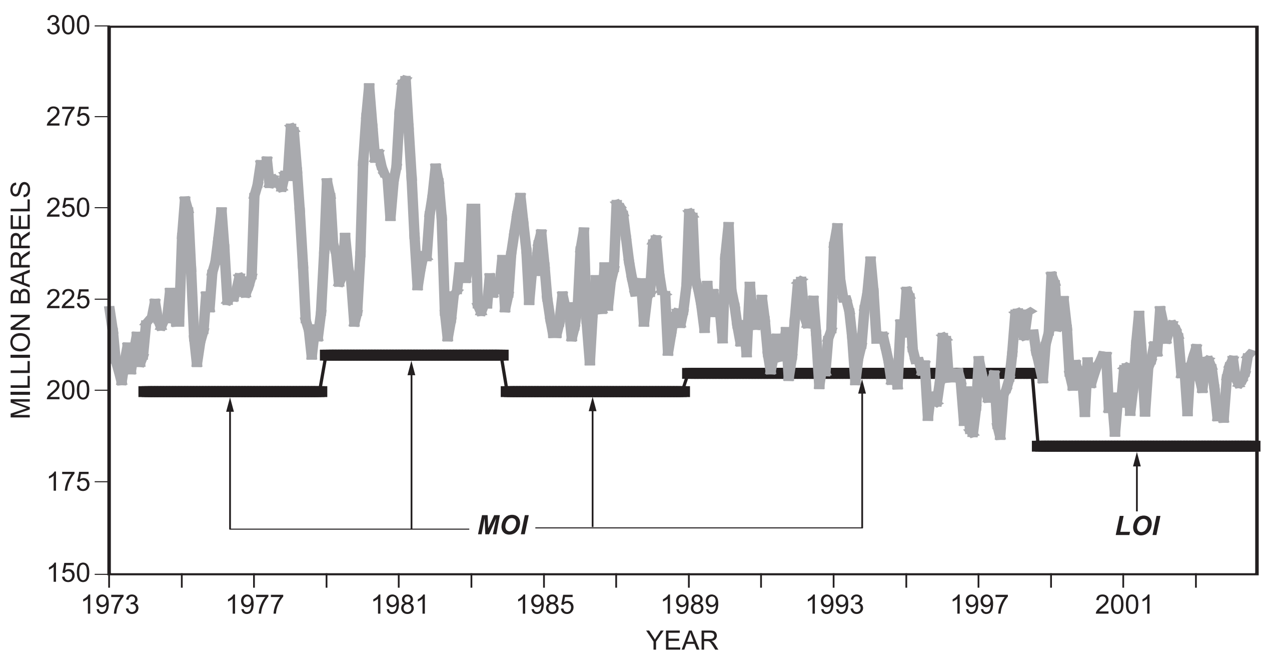
Motor Gasoline

Figure II-3 shows the monthly closing inventory of total U.S. motor gasoline over the same period as for crude oil. The long, slow decline of gasoline inventory primarily associated with finished gasoline



Notes: Excludes inventories in the Strategic Petroleum Reserve. Minimum Operating Inventories estimated in previous NPC studies.
Source of Data: Energy Information Administration and National Petroleum Council.

Figure II-2. U.S. Commercial Crude Oil Inventory Profile



Note: Minimum Operating Inventories estimated in previous NPC studies.
Source of Data: Energy Information Administration and National Petroleum Council.

Figure II-3. U.S. Gasoline Inventory Profile inventory at terminals that was observed in the 1998 inventory study is no longer apparent. The NPC believes that while additional system efficiencies have occurred, including those related to mergers and acquisitions, they have been offset by increases in product demand and the number of different fuel specifications.

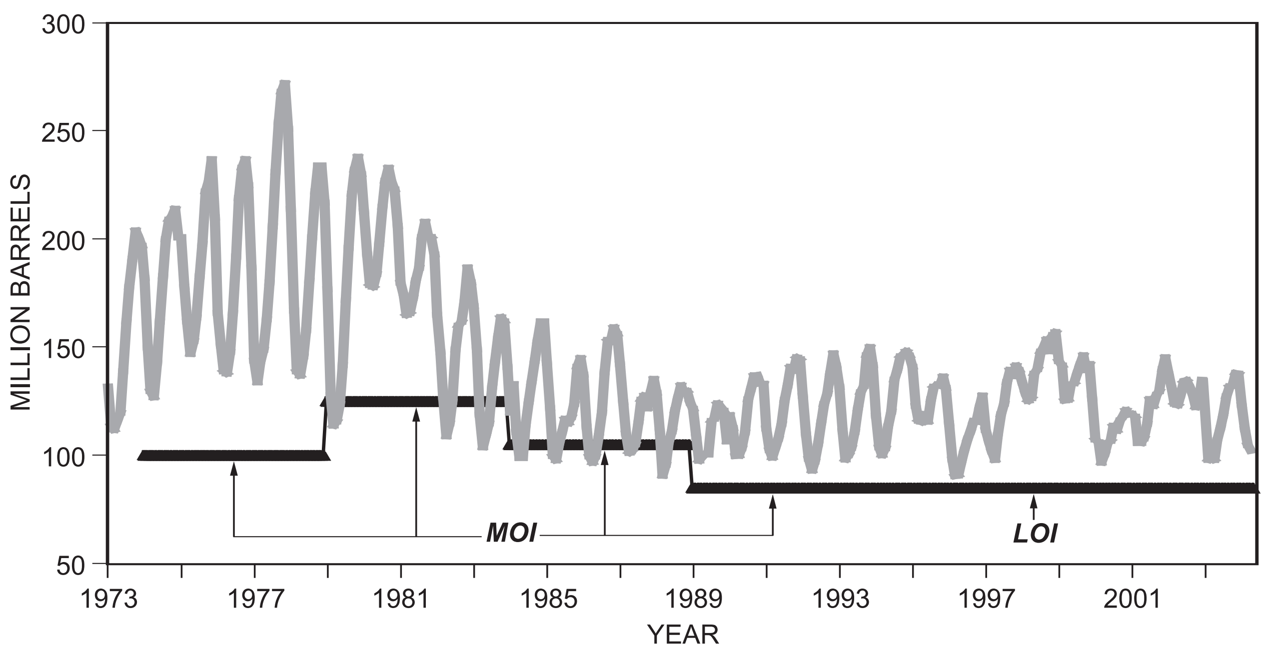
While inventories continue to fluctuate seasonally, the average level has remained flat since the last study. In addition, the low inventory level reached during the mid-1998 to 2004 time period was no lower than the minimum reached during the previous study's time period (1992 to mid-1998). Since the last study, inventories approached the LOI only once, reaching 188 million barrels at the end of October 2000. This was essentially the same as the prior minimum level observed in August 1997.

As discussed in the 1998 study, oxygenates are an important part of the U.S. motor gasoline supply system and should be considered when evaluating the capability of the supply system to respond to market forces. Since the 1998 study, the role of oxygenates has become more complex with MTBE bans in several states and the continued oxygenate requirement in reformulated gasoline. As a result, ethanol markets have expanded beyond the Midwest and ethanol is now used for gasoline production in both the Northeast and California. The transportation and inventory management systems for ethanol are largely out of the control of petroleum industry companies and the ethanol industry's capability to meet demand is beyond the scope of this study.

Distillate

Figure II-4 shows the monthly closing inventories of distillate since 1973. Distilllate inventory has remained essentially flat, albeit with seasonal fluctuations, through both the previous and current study periods. The lowest observed monthly closing inventory of about 90 million barrels occurred in March 1996. Since that time, distillate inventories have been in the 95 to 100 million barrels range a few times but have not approached the prior low.

The distillate market is approaching a period of significant change as new highway and off-highway diesel sulfur regulations begin to impact the market. The industry is addressing issues around the transportation and delivery, such as quality control



Note: Minimum Operating Inventories estimated in previous NPC studies.
Source of Data: Energy Information Administration and National Petroleum Council.

Figure II-4. U.S. Distillate Inventory Profile and product batch interface containment, of these lower sulfur products. At this time it is not clear what impact, if any, these regulations will have on distillate inventories.

Lower Operational Inventory

Prior Studies Have Been Unable to Define an Inventory Level Where Supply Problems Begin

It is widely understood that a significant part of reported petroleum inventories are required to operate the product and crude oil supply systems and are not readily available to meet demand. These inventories were identified as "operational" inventories in the 1998 study. The NPC has performed several studies since the early 1970s to define these inventory levels, originally defined as "minimum operating inventory" and subsequently modified as "lower operational inventory" in the 1998 inventory study. The redefinition was developed to move away from the concept that there is some definable inventory level where supply system reliability becomes of greater concern. While these levels have been reviewed several times, in retrospect, the "minimum" operating inventory levels identified have been broached several times with no visible impact on available supplies.

LOI – One of Many Measures for Assessing Inventory Adequacy

LOI is a measure defined to indicate there may be diminished inventory-related supply flexibility, and it is developed from observed inventory levels. However, the LOI definition specifically highlights that the supply system is not necessarily approaching problems when inventories are at low levels and that many other considerations need to be taken into account.

Although the NPC has studied and defined lower operational inventories a number of times, in practice these data are not used by individual companies when making supply decisions. Reliable product supply to U.S. consumers requires delivery of about 20 million barrels per day of a variety of petroleum products to thousands of locations. Over time, the system has evolved to a complex, interrelated delivery system comprised of ships, barges, rail, refineries, pipelines, terminals, and local outlets. This delivery system, from crude oil to end-user, has proven numerous times that it has the inherent flexibility to respond to day-to-day market fluctuations as well as significant one time events. While there is some apparent comfort when inventories are perceived to be high, in reality these inventories are seldom in the right place, at the right time, or of the right quality, when problems occur. Similarly, when inventories approach low levels relative to an historical perspective, the supply system is not approaching some failure point. Rather, the inventory level is reflective of an overall supply/demand balance where supply has been lagging demand.

Crude Oil LOI Recommended to be a Range of 260-270 Million Barrels

As previously mentioned, crude oil inventory has been below the LOI of 270 million barrels defined in the 1998 NPC study a few times with no impact on crude oil supply to U.S. refineries. A brief analysis of the minimum observed inventory in each of the reported crude oil inventory categories along with the observed simultaneous minimums suggests that PADD V in-transit inventory is about 5 million barrels below the level used in determining the prior crude oil LOI. This reduction is a direct result of the decline in Alaskan crude oil production. The data also indicate that the observed lower inventory level in pipelines and terminals in PADDs I - IV is about 10 million barrels below the data used in the 1998 study offset by about a 5 million barrel increase in the minimum observed level at PADD I - IV refineries. No attempt was made to analyze the apparent causes of these changes given the study's time constraints but they are consistent with the trend towards increased offshore crude oil supply coupled with continued efficiency improvements in the crude oil logistics system.

The NPC recommends that the LOI for crude oil be reduced to a range of 260 to 270 million barrels, supported by the following factors: the observed crude oil inventory has been as low as 260 million barrels, apparent regional structural change has reduced inventory by 10 million barrels, and the expectation that there will be continued cost pressure to reduce operational inventories. A crude oil LOI range is recommended, rather than a single value, to better represent the degree of accuracy associated with the LOI methodology.

Data Suggest the 1998 Analysis of Product LOI is Still Valid

Given the short time available for this supplemental report, a detailed assessment of all the various segments of reported product inventory data was not possible. For gasoline, the overall data suggest that no significant changes have occurred since 1998 and the NPC recommends no change to the 185 million barrels LOI. For distillate, given the lack of apparent trend since the last study, the NPC recommends no change to the 85 million barrels LOI. As with crude oil, it may be appropriate to have an LOI range for both gasoline and distillates. However, this was not analyzed as part of this update. Market pressures for continued efficiency will likely continue to drive operating inventories to lower levels. It should be expected that lower operational inventories may continue to decline as the product supply system evolves, unless offset by other structural changes. Also, given the short time frame of this study, the potential impact of impending regulatory changes in diesel sulfur content on distillate inventory was not studied.

The Importance of High Quality Inventory Data

The U.S. government maintains a system within the Energy Information Administration for gathering and disseminating information on U.S. petroleum industry statistics. Petroleum data and information are also available from the American Petroleum Institute and other private organizations. These data and information are important for industry in making business decisions and for government in making informed policy decisions affecting the U.S. petroleum industry. U.S. petroleum information is generally considered to be among the best in the world. In order to be useful, petroleum data must be timely, accurate, and relevant.

Every effort should be made by the EIA, working with industry, to ensure that the data are accurate, timely, relevant, and meet the highest quality standards. Therefore, from time to time, the EIA and its U.S. petroleum industry counterparts should review the data that are collected and subsequently reported to be certain the data meet the current needs. The NPC recommends that appropriate resources be made available to the EIA to support continued efforts to work with industry to improve data quality.

Assessment of Product Price Volatility

The 1998 study on U.S. Petroleum Product Supply—Inventory Dynamics concluded that over the time period of 1998-2002, the petroleum supply system balancing mechanisms available to respond to market events would not appreciably change. Thus, the frequency or magnitude of significant (non-crude oil related) upwards retail price moves would not likely increase in the 1998-2002 time period. Additionally, the 1998 study concluded that significant price excursions of major light petroleum products in the United States would continue to be driven primarily by movements in the global price of crude oil.

Data analysis for this update, covering the 1998-2004 time period, supports most but not all of the conclusions of the 1998 study and also offers additional insights. Many of the primary conclusions of the 1998 study remain valid:

- Global crude oil prices continue to be the primary driver of product price levels. Even though the number and magnitude of product price up-ticks (increases of greater than 10% or more versus prior year period) has increased since 1997, most of these events are driven by events in the global crude oil market.
- Retail price changes continue to lag behind spot price changes, which has the effect of dampening and delaying price swings at the retail level.

However, product and crude oil price levels and volatility have increased since the previous study, which focused on a time period of relative calm in oil markets (1992-1997). In the 1998-2004 time period, crude oil price volatility peaked in 1998, while gasoline price volatility peaked in early 2002. Market prices since 2002 reflect an upward movement in product prices in line with an upward movement in global crude oil prices. Retail gasoline prices, however, have been observed to be less volatile than crude oil prices, as identified in the last study.

These conclusions are based on analysis of national data. Consumers at a local level may be subject to more or less volatility than the national average as a result of local factors that are not captured by this analysis. This study primarily focused on gasoline price volatility because it is the product with the largest domestic demand and it is of the greatest national concern. The study also focused on the U.S. market, while crude oil markets, and to some extent product markets, are global, and as such are influenced by global fundamentals.

Increase in Global Crude Oil Price Level

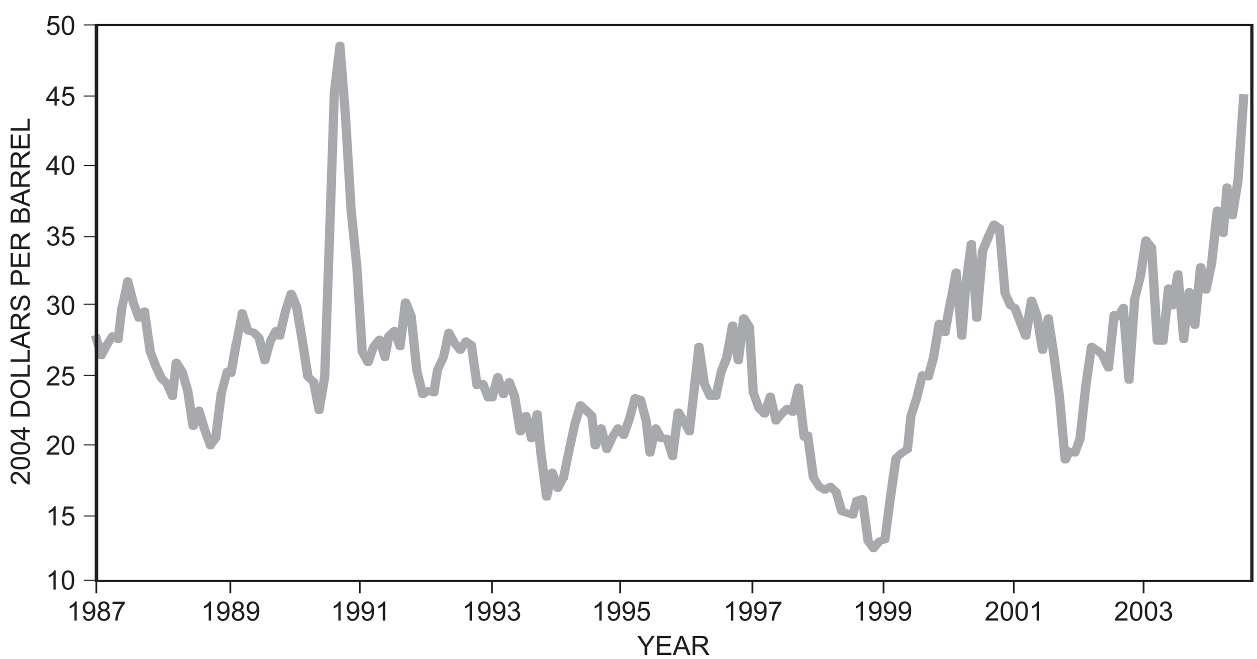
Since the previous study was completed in 1998, there has been a significant increase in global crude oil price levels, which has impacted prices across the value chain. As shown in Figure II-5, the global crude oil price collapsed (as evidenced by West Texas Intermediate) from an average price of over $20 per barrel to a low of $12 per barrel in February 1999, and over the course of the following five years rose to the level of about $45 per barrel in August 2004.

In 2004, crude oil prices were driven by robust global oil demand growth, resulting from the global and U.S. economic recovery and strong growth in China. Global oil demand growth this year was high relative to the weak growth rates experienced in three of the last four years. This strong demand growth is occurring at a time when OPEC has little spare oil production capacity. The resulting very tight supply/demand balance has been exacerbated by market concerns about increased geopolitical risk in a number of oil-producing countries.

Increase in Overall Retail Gasoline Price Level

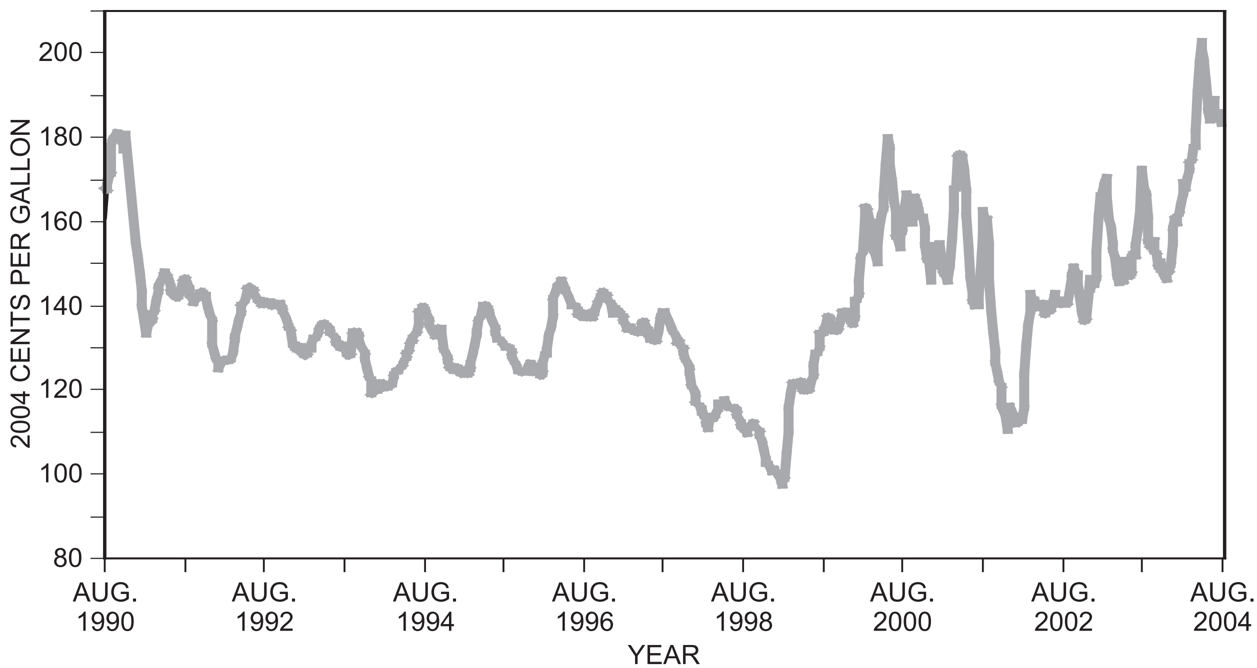
As shown in Figure II-6, U.S. retail average gasoline prices have also increased since 1998, following crude oil prices. Retail gasoline prices were particularly strong in the first half of 2004 due to an elevated spot gasoline-to-crude oil price spread, which added to the crude oil price increase. Figure II-7 shows that the spot gasoline-to-crude oil price spread was elevated earlier this year, but by August 2004 it had retreated to significantly lower levels.

There were some exceptional factors in the first half of 2004 that were responsible for the temporary up-tick in the gasoline-to-crude oil price spread. After several years of weak growth, U.S. oil demand in the first half of 2004 grew at a rate of 2.3% versus the first half of 2003 due to strong economic growth, as shown in Figure II-8. Temporary supply constraints associated with product specification changes also contributed to the up-tick in the gasoline-to-crude oil spread in the first half of 2004. Required and extended refinery turnarounds in 2004 in preparation for



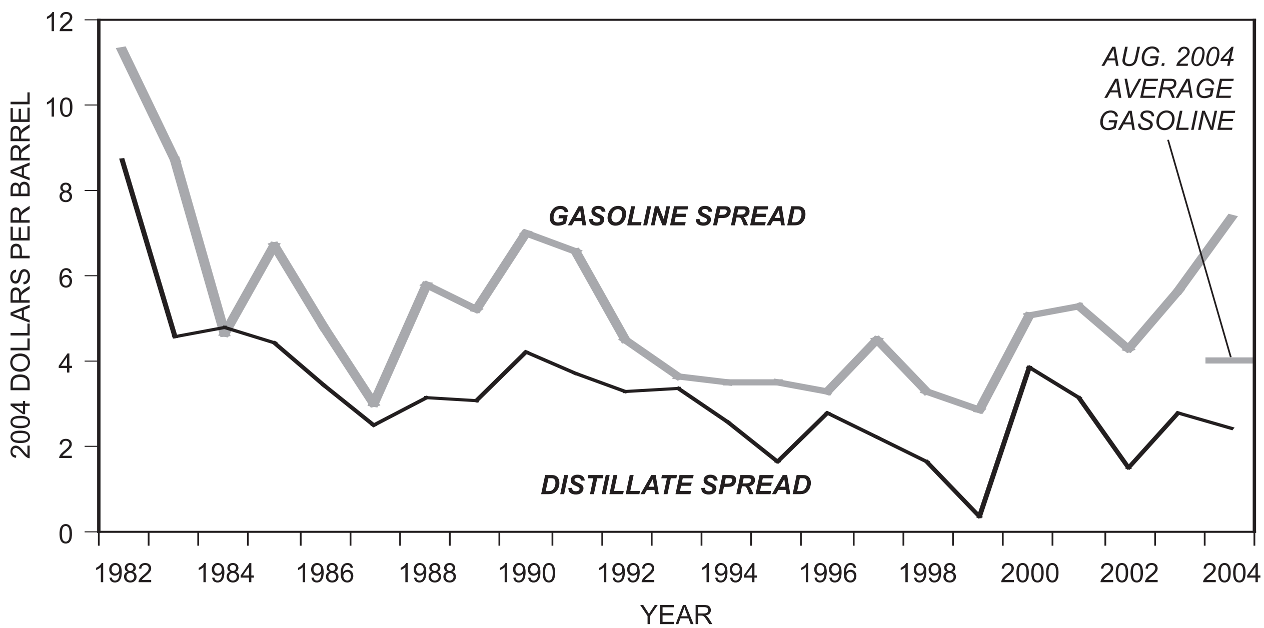
Note: Monthly averages from daily data.
Sources: Energy Information Administration (WTI, Spot Price (FOB) @ Cushing, OK ($/bbl)).

Figure II-5. West Texas Intermediate Crude Oil Price



Source: Energy Information Administration.

Figure II-6. Weekly Regular Conventional Retail Gasoline Price (including taxes)



Source: Platts Mid pipeline for products, WTI @ Cushing; 1982-84, WTI estimated from DOE Texas price.
2004 = year-to-date average through August.

Figure II-7. U.S. Gulf Coast Gasoline and Distillate Spreads vs. West Texas Intermediate Crude Oil

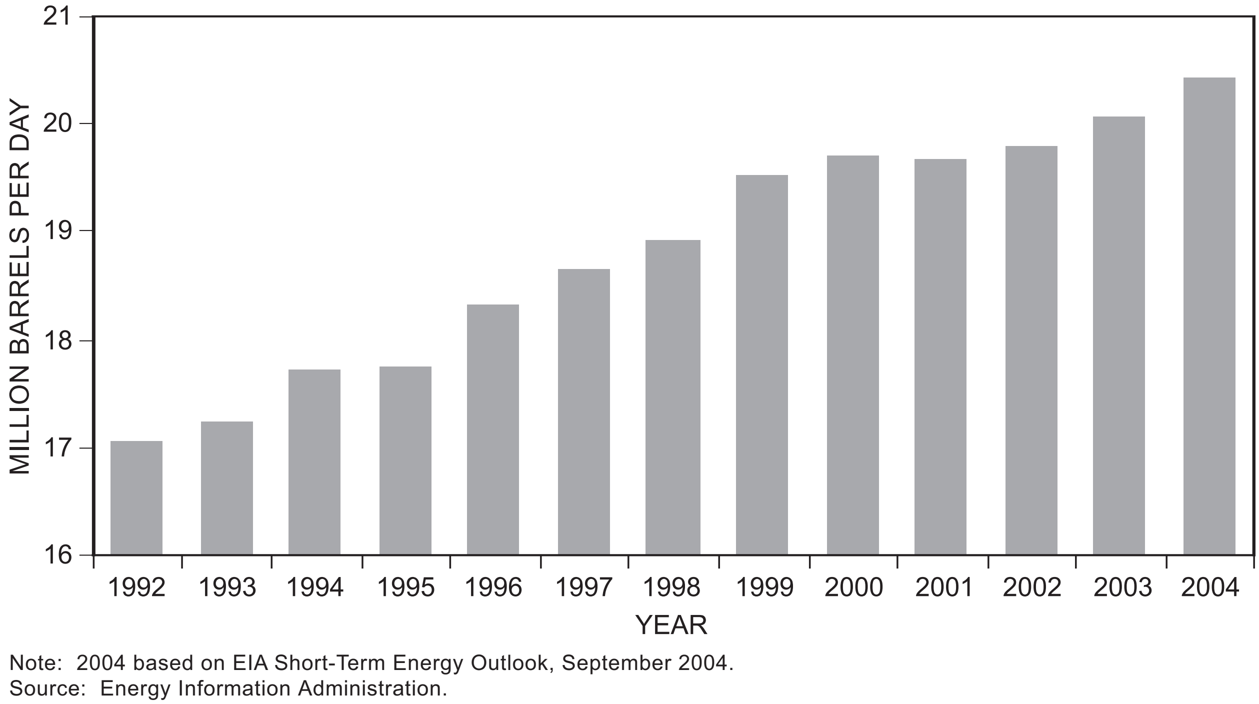


Figure II-8. U.S. Total Product Demand

the next phase of tighter gasoline sulfur specifications may also have contributed to tightness in gasoline supplies.

Occasionally there are instances when product supply/demand fundamentals influence the global crude oil market. There may have been such an instance in the first half of 2004, when it appeared that the tighter U.S. gasoline balance was contributing to the strength in the global crude oil price. However, other factors were primarily responsible for higher crude oil prices during this time period, such as strong global oil demand and geopolitical supply risk. Strong U.S. gasoline prices in the first half of 2004, and the need for additional gasoline supplies, may have contributed to the widening of the differential in the price of light, low sulfur crude oils that maximize gasoline yield, like West Texas Intermediate, and the price of heavier, higher sulfur crude oils that have a lower gasoline yield. This type of incident tends to equilibrate over time as the supply/demand balance in product markets is restored.

Crude Oil Prices are Still the Main Driver of Product Prices

Crude oil prices continue to be the main driver of product prices, as was concluded in the previous study. A recent report by the Federal Trade Commission indicated that changes in crude oil prices have accounted for approximately 85% of the increases and decreases in U.S. motor gasoline prices over the past two decades.[1] A major reason for this is that the cost of crude oil represents a substantial portion of retail product prices. In July 2004, the U.S. Department of Energy estimated that crude oil price represented nearly 60% of U.S. retail gasoline prices, excluding taxes.

This sub-section examines the relationships of crude oil and spot product prices, and of spot and retail prices.

1 Federal Trade Commission Bureau of Economics, "The Petroleum Industry: Mergers, Structural Change, and Antitrust Enforcement," August 2004, page 1.

Relationship of Crude Oil to Spot Product Prices

Figure II-9 demonstrates that gasoline and distillate spot product prices tend to track crude oil prices. There are a number of publicly available price quotes for the various crude oil and product prices that provide a framework for all transactions. Spot prices are wholesale prices for physical delivery of the crude or product set at a limited number of industry transfer points, such as a location on a pipeline or at a harbor.

Spot product prices tend to follow crude oil prices since the cost of crude oil is a large part of the cost of products, and both crude oil and products are driven by the same global market fundamentals. There is little to no lag in the response of spot product prices to crude oil price movements, as product markets have become more global and commoditized and more responsive to national and global fundamentals.

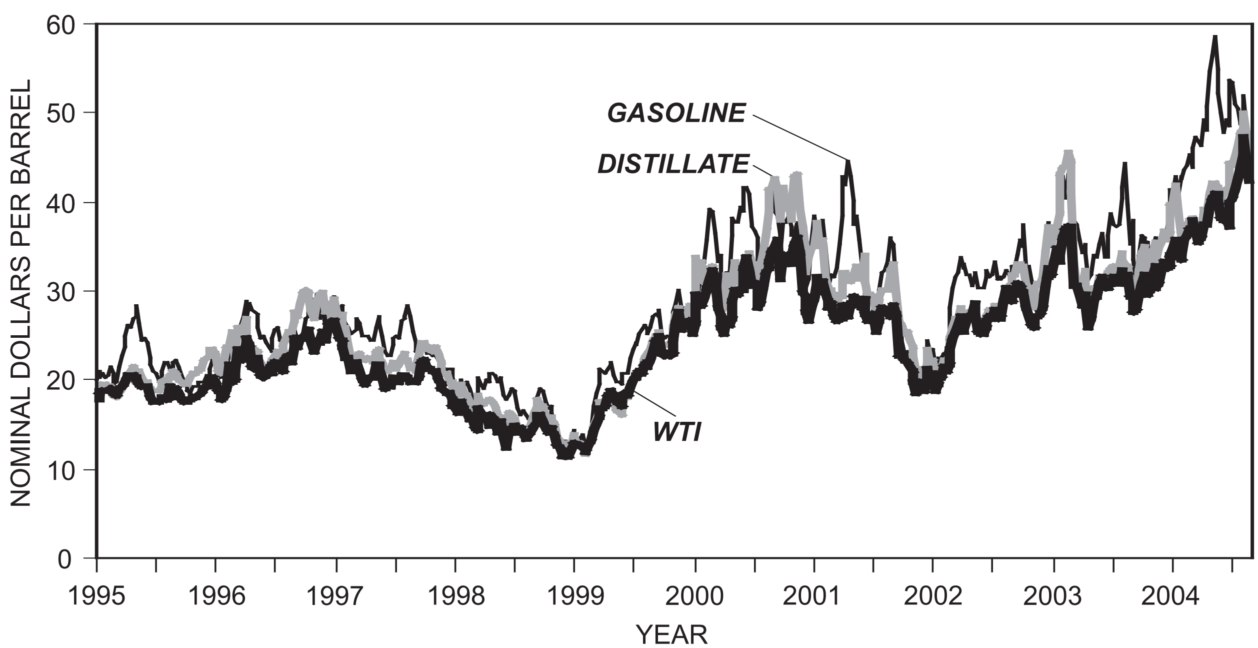
There are still a number of factors that may result in periodic dislocations between crude oil and product prices, such as seasonal demand, a tight product supply/demand balance, and product specification changes. As previously described, there were a number of exceptional factors (e.g., strong demand growth, product specification changes, etc.) in the first half of 2004 that resulted in an up-tick in the gasoline-to-crude oil price spread. However, the spread had fallen off substantially by the latter half of the year.

Relationship of Spot to Retail Product Prices

Retail prices typically lag spot prices in part because some product goes through a succession of resales by any combination of traders, jobbers, lessee dealers, or independent marketers. Figure II-10 shows that retail prices lag spot gasoline prices on the East Coast of the United States.

A U.S. Department of Energy study[2] on gasoline price pass-through from the spot to retail level last year determined that significant changes in spot prices appear to show up in retail prices with some time delay, and somewhat dampened. The study estimated that 50% of the price pass-through from the spot to the retail market on a

2 U.S. Department of Energy, Energy Information Administration, Michael Burdette and John Zyren, "Gasoline Price Pass-through," January 2003.



Source: Energy Information Administration (USGC for products, Cushing for WTI, daily data averaged weekly 1995-present).

Figure II-9. Relationship Between West Texas Intermediate Crude Oil Prices and Spot Gasoline and Distillate Prices

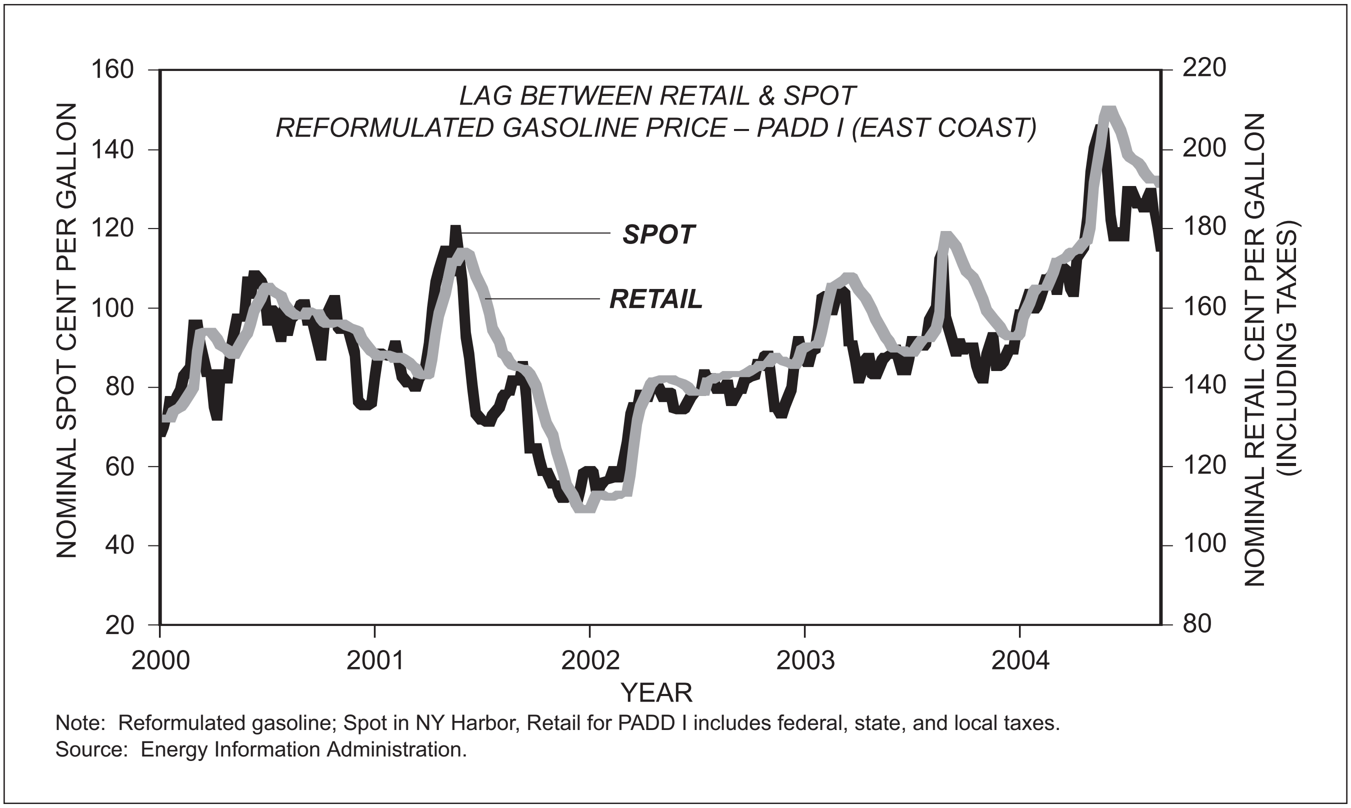


Figure II-10. Retail Prices Lag Spot Gasoline Prices

U.S. average basis occurs within two weeks and 80% within four weeks.

Product Price Volatility

Price Events

As a means to evaluate retail price movement, the previous study focused on upside price events of significant magnitude to have generated public concern in the past. The study identified monthly price increases in crude oil, retail gasoline, and retail distillate prices in excess of 10% above the prior year.

Figure II-11 shows the instances of price increases in excess of 10% above the prior year for crude oil, retail gasoline, and retail distillate. Non-crude oil related upward retail price movements tend to be driven by an infrequent large event or a confluence of smaller events in the same direction. This figure shows that the number and magnitude of product price up-ticks has increased since 1997, and that they are mostly driven by events in the global crude oil market.

Volatility

Price changes play an important role in markets, providing incentives to producers and consumers to adjust supply and demand and keep the market in balance. However, when prices rise rapidly, whatever the starting point, it is recognized that consumers of gasoline and home heating oil can be concerned. This update is focused on the petroleum supply system and does not address the implications of price volatility to consumers.

The standard statistical definition of volatility is deviation around a mean. This study analyzed volatility based on a 52-week moving average. Using a 52-week moving average reduces the impact of seasonality and is more indicative of a longer-term trend. Comparing daily percentage changes to the average percentage change over the period attempts to isolate true volatility from the underlying upwards trend in price.

Figure II-12 shows that both crude oil and gasoline price volatilities increased in the period from 1998 to 2004 relative to the period of focus for the

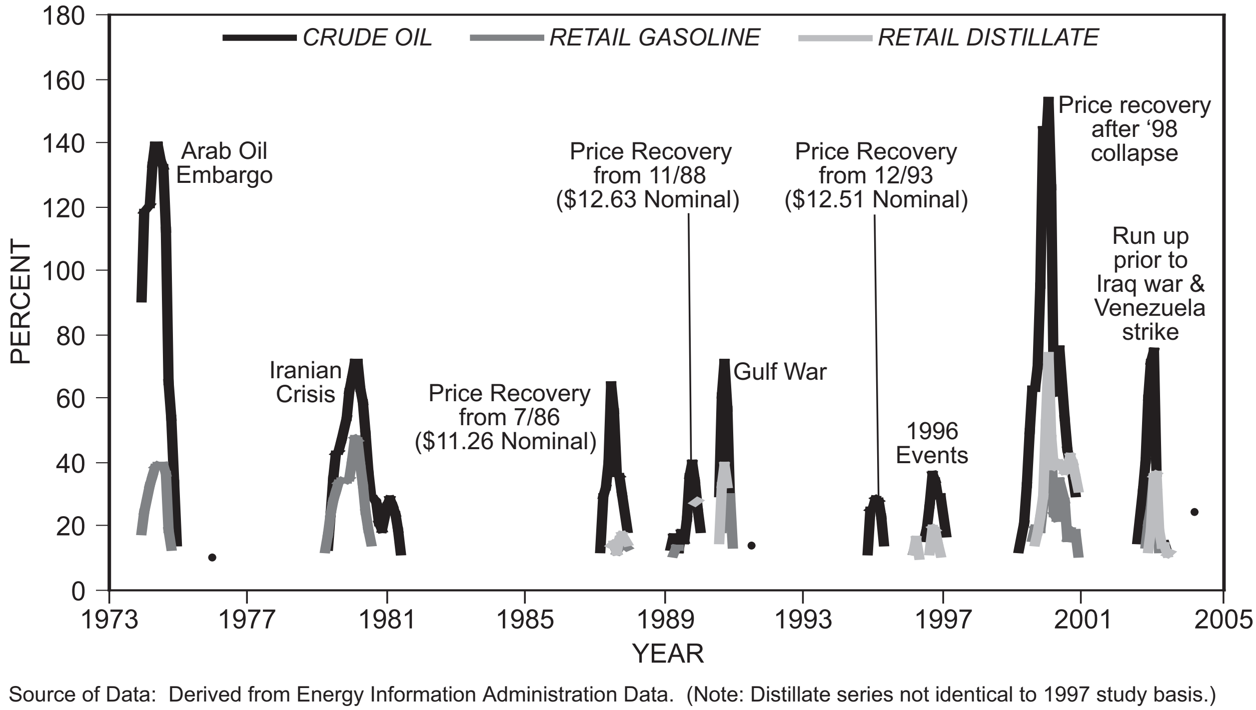


Figure II-11. Instances of >10% Change in Price vs. Prior Year – Crude Oil and Products

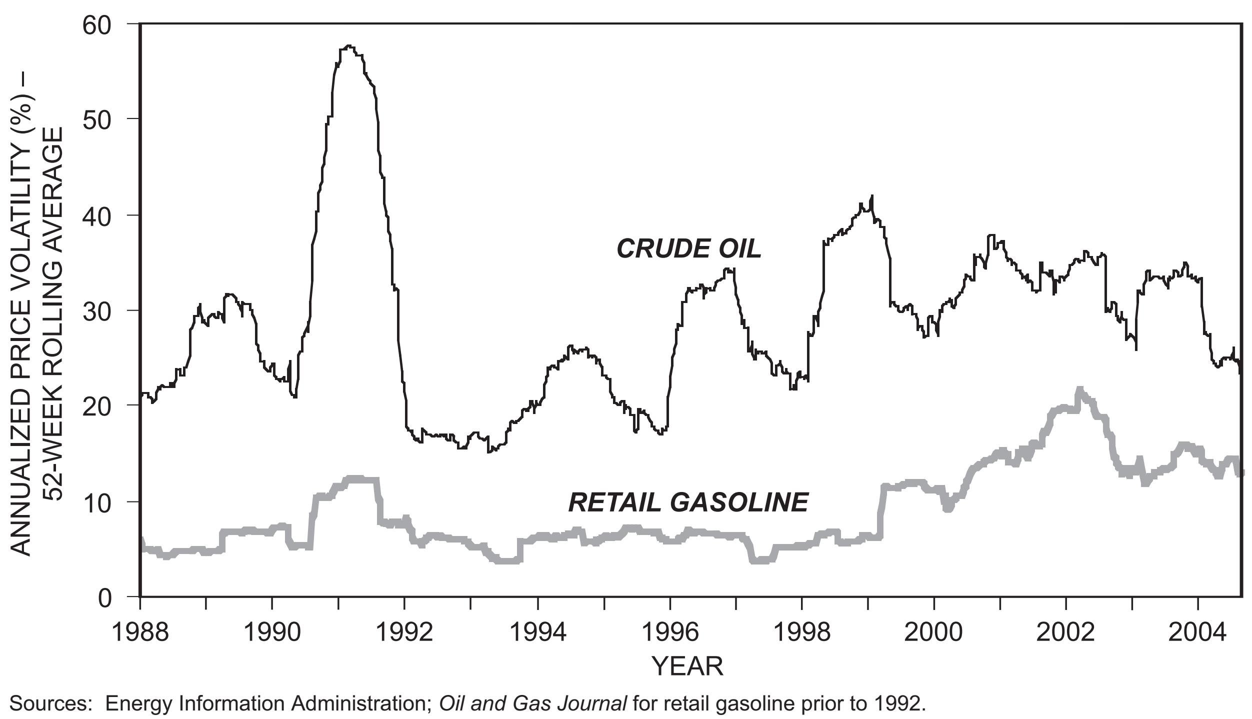


Figure II-12. Retail Gasoline and West Texas Intermediate Crude Oil Price Volatility previous study (1992-1997), which was one of relative market calm. Crude oil price volatility peaked in 1998, while gasoline price volatility peaked in early 2002. What has probably occurred since 2002 is an upward movement in product prices in line with an upward movement in global crude oil prices. Retail gasoline prices are also shown to be less volatile than crude oil prices.

Future Product Price Volatility

It was beyond the scope of this report to develop a new supply/demand forecast or provide a forecast of future product price volatility. Furthermore, future product price volatility is inherently unknown since it is dependent upon future events that impact the global crude oil market. Some of the factors that could increase or decrease product price volatility in the future are identified below.

Factors That Potentially Increase Volatility

- Political events causing disruptions in oil-producing countries.
- Greater proportion of global demand coming from developing countries with more volatile economies than OECD countries.
- Oil demand becoming more inelastic as oil is backed out of the power and industrial sectors (elastic sectors), and income levels support greater use of oil in the transportation sector (inelastic sector).
- Lengthening and greater complexity of supply chains, including the possible diversion of imports to other countries if they are short product and have higher prices than the U.S.
- Refining investments have long lead times. Uncertainty over regulations can delay investment decisions and permitting processes can add to investment lead times. Both of these factors will slow the industry's response to bringing additional supplies to the market.
- Continued specification changes, with higher volatility during transition periods.[3]
- Boutique fuels within the U.S. reduce the fungibility of products.[4] This phenomenon is complicated by international fuel specifications not keeping pace with changes in the U.S.

Factors That Potentially Decrease Volatility

- Common fuel specifications, increasing fungibility of products
  - Regions and states within the U.S. standardizing specifications
  - Non-OECD countries increasing stringency of specifications to be closer to OECD country specifications
- Removal of government barriers to industry responsiveness
  - Removal of barriers to permitting refinery expansions, pipelines, and storage facilities
  - Adjusting the depreciation schedule for equipment so that it is consistent with the treatment in other manufacturing industries
  - Allowing for adequate lead times in regulatory changes
  - Providing certainty about regulations, without rule changes midstream
- Improvements in industry response time
  - Greater percentage of inventory on the water allows greater mobility and flexibility for the product to go where it is most needed, although product on the water could be diverted to other countries as previously specified.

Assessment of Inventories and Price

As addressed in the previous NPC inventory study, the expectation that inventories influence prices is based on the economic assumption that prices reflect the current supply/demand balance and that inventories provide a measure, however imperfect, of the changing balance between supply and demand. Inventories are a result of supply and demand fundamentals. Any factor that serves as a measure of the short-term supply/demand balance would be expected to influence prices.

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[3] Office of Oil and Gas, Energy Information Administration, U.S. Department of Energy, *2003 California Gasoline Price Study: Preliminary Findings,* May 2003.

[4] Office of Oil and Gas, Energy Information Administration, U.S. Department of Energy, *Gasoline Type Proliferation and Price Volatility,* September 2002.

However, statistical analysis of the simple relationship between inventories and prices or inventory changes and price changes finds only a modest correlation. This conclusion is indicative of the fact that the interaction of inventories and prices is complex. Inventories are an imperfect measure of the supply/demand balance, and prices for crude oil and petroleum products are influenced by many factors in addition to inventories.

When petroleum inventory data are made public, they can potentially have a short-lived effect on petroleum prices, including futures prices. This appears particularly true when the inventory data deviate from market expectations, in which case the market reacts by bidding prices up or down on the basis of the new information.

The previous NPC study also discussed the role of forward markets and time spreads in inventory decisions. Inventory levels may influence the shape of the forward price curve. As inventory levels rise, the spot price tends to fall relative to futures prices due to perceptions of an oversupply. Conversely, as inventory levels fall, the spot price tends to rise relative to the futures prices due to perceptions of current market tightness. In addition, the forward price curve can provide economic incentive or disincentive to companies to hold discretionary inventory, as the forward price curve represents future price expectations. However, regardless of these factors, individual companies strive to hold sufficient operational inventory to meet customer demand.

These conclusions are based on national indicators. The NPC recognizes that consumers at a local level may be subject to different forces and volatility as a result of local conditions that are not captured by this analysis.

Inventories, Prices, and Rational Market Behavior

The policy community's interest in inventory levels may stem from the expectation that when petroleum inventory data is made public, it can potentially have a short-lived effect on petroleum prices, including futures prices. If inventory reports deviate significantly from market expectations, the market typically responds as expected by bidding prices up or down on the basis of the new information conveyed in the inventory data. Market participants react to inventory signals because they are perceived as a measure of the short-term balance between supply and demand.

If product inventories are significantly below expectations, this signal of tightness in the balance may lead participants to bid spot prices higher. An increase in prices should spur incremental production by progressively exceeding the economic thresholds required to deliver incremental supplies. These new supplies may come from incremental product imports or increased output from domestic refineries, as progressively higher-cost marginal production steps are implemented. These new supplies serve to restore the supply/demand balance and ultimately cause prices to decline.

In a similar fashion, a report of higher-than-expected inventory levels would typically be interpreted as a signal of looseness, which may cause prices to decline. As prices decline, marginal supply sources become increasingly uneconomic, and marginal production increases are eventually reversed. With supply reduced, excess inventories decline, and supply and demand are brought back into balance.

Relationship between Inventories and Prices

The NPC found only a modest correlation in the simple relationship between current inventory levels and prices. It must also be understood that correlations do not necessarily imply causality. In addition, this correlation was not sufficient by itself to use as a predictive tool. This modest relationship indicates that current inventories are only an imperfect measure of the supply/demand balance, and that many other factors impact prices. The U.S. Department of Energy found a slightly stronger relationship between inventories and crude oil price when they included total crude oil and product OECD inventories (not just U.S.), used relative inventories as measured by actual inventories versus "normal" inventories defined by historical seasonal movements and general trends, and included recent inventory trends (not just the current level).[5]

As shown in Figure II-13, prices and inventories only loosely track each other, reflecting the weak

5 Michael Ye, John Zyren, and Joanne Shore, "A Forecasting Model for Monthly Crude Oil Spot Prices," U.S. Department of Energy, July 15, 2003.

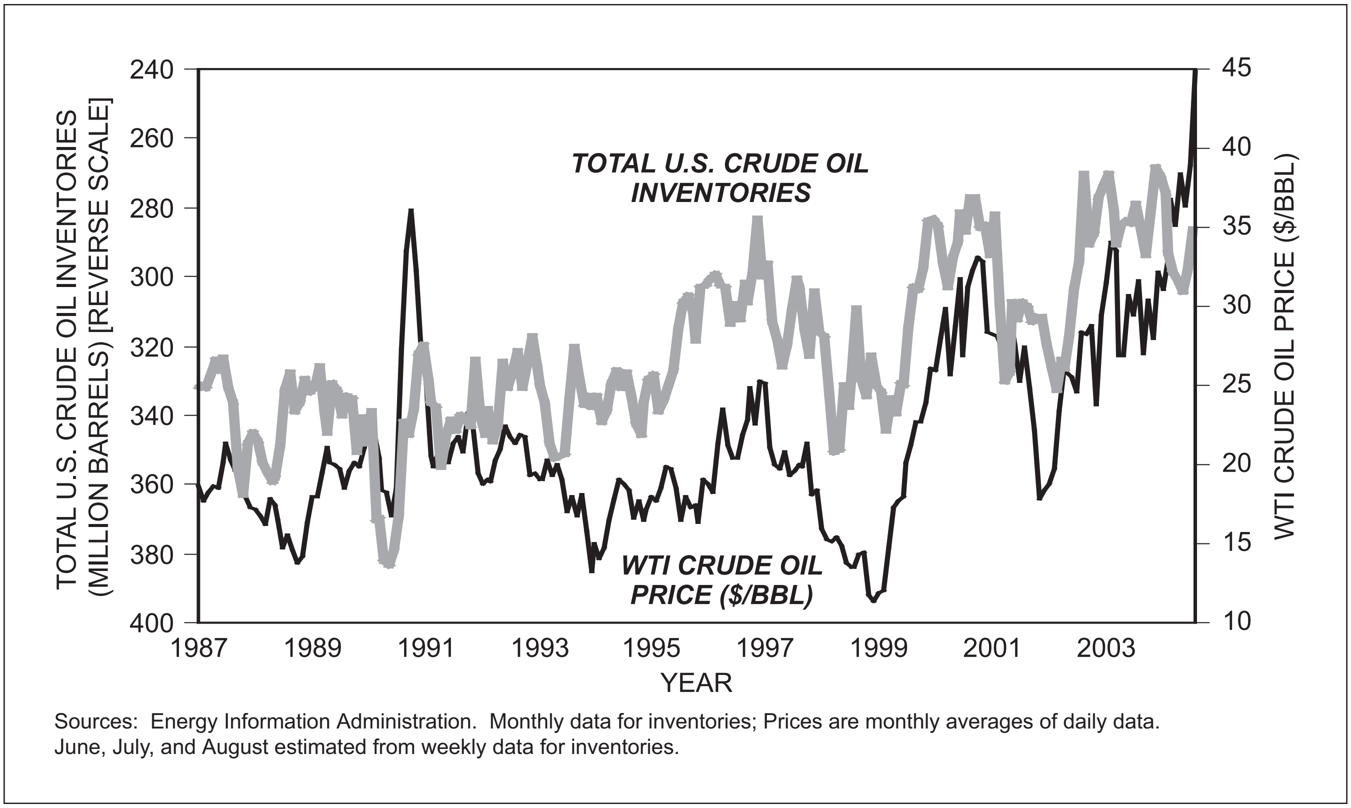

Figure II-13. Total U.S. Crude Oil Inventories (excluding SPR) vs. West Texas Intermediate Crude Oil Price

correlation. However, as indicated by the Department of Energy's work, the relationship between inventories and prices is complex.

Gasoline Inventories and Gasoline Price Spreads

Gasoline inventories are weakly related, if at all, to gasoline-to-crude oil price spreads (spot gasoline price minus crude oil price). Various analysts have compared gasoline inventory levels versus a "normal" level (defined as previous five-year average) to the gasoline-to-crude oil price spread. The theory is that when gasoline inventories are in surplus, the gasoline-to-crude oil price spread will be low, and when gasoline inventories are lower than normal or in deficit, the gasoline-to-crude oil price spread will be high. That is because inventories are a yardstick for the short-term gasoline supply/demand balance. However, as shown in Figure II-14, the correlation between inventories and the price spread is weak.

This is not intended to imply that gasoline inventory levels relative to "normal" levels (previous five-year average) have no influence on gasoline-to-crude oil price spreads, but rather that there are other factors that overwhelm the influence of inventories – whether inventories are measured in absolute terms or relative to "normal levels." Prices ultimately reflect the combined influences of all available market information, including inventory levels, but also many other market factors, such as expectations of future supply and demand.

Inventory Levels and Future Price Spreads

While inventories are weakly correlated to current prices, they may influence the shape of the futures price curve or the spread between futures prices and current prices. Futures markets, like the New York Mercantile Exchange, allow buyers and sellers to conduct transactions for a limited number of crude oil and petroleum products for delivery at a specified time in the future at a specific location and price. At any given time, prices are established by this open and continuous auction for current and future trading months. This "strip" of future prices is referred to as the forward price curve. The shape of the forward price curve refers to the relationship between outer month futures prices and the current month price.

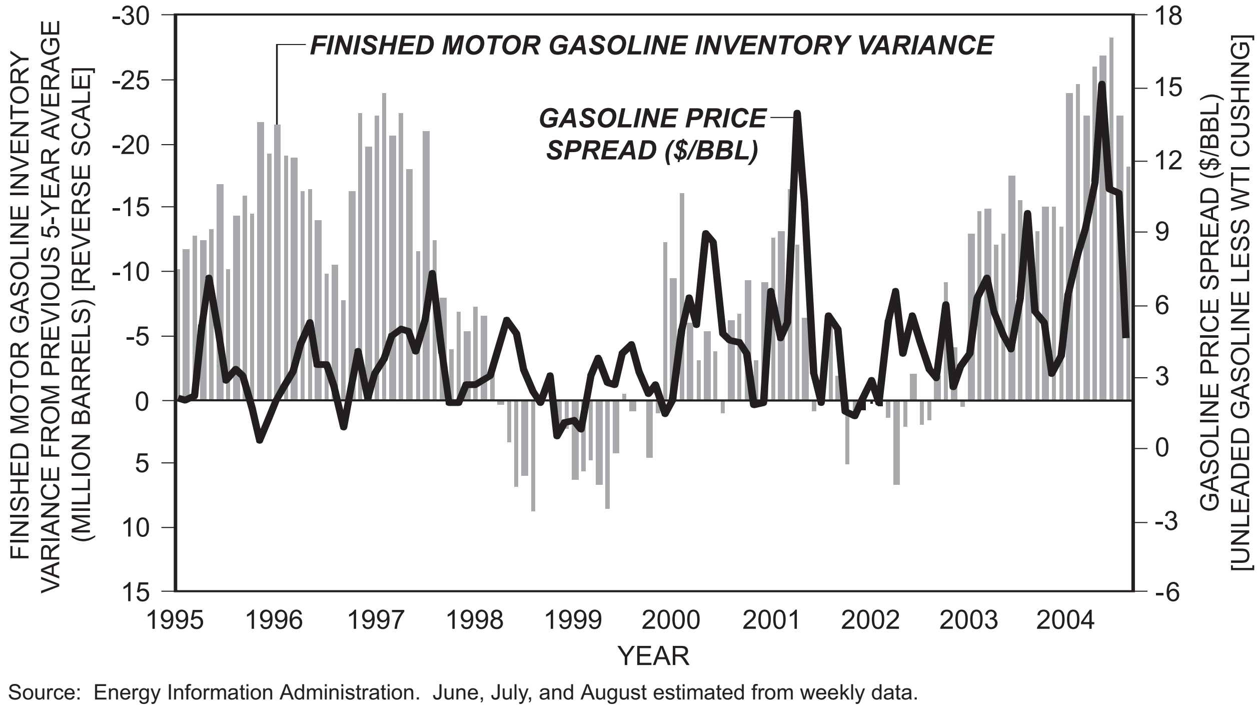

Figure II-14. Inventory Variance from Five-Year Average vs. Gasoline Price Spread

Figure II-15 shows the nature of the relationship between inventories and the forward price spread, defined as a futures price minus the current price. Inventory, as it reflects the supply/ demand balance, is one of the factors that can influence the forward price spread. In addition, the forward price spread, which represents future price expectations, may also influence company inventory-holding behavior.

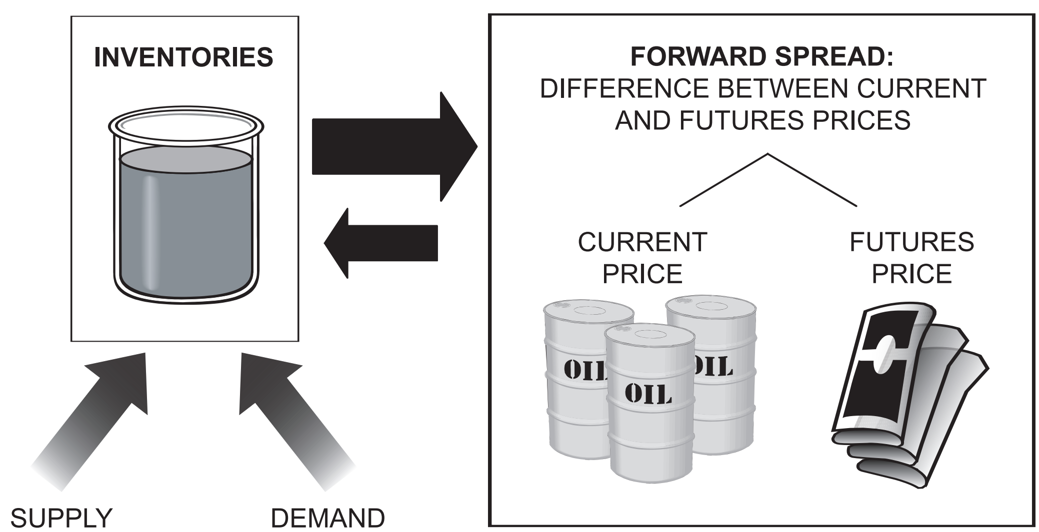

Figure II-15. Interplay between Inventories and Futures Markets

Inventory Levels Influence the Forward Price Spread

The relationship between commodity inventories and commodity price spreads has often been described in the economic literature.[6] The empirical work demonstrates that there is a relationship between inventories and the shape of the forward price curve. Inventories are positively correlated with the forward price spread.

When futures prices are higher than current spot prices, the market is said to be in contango. Conversely, when prices for future delivery are lower than spot prices for current delivery, the market is said to be in backwardation. Figures II-16 and II-17 clarify the features of a contango and backwardated market.

As shown in Figure II-18, low crude oil inventories tend to be associated with a backwardated forward price (futures price below current price) and high inventories tend to be associated with contango in forward markets (futures price above current price).

Low inventories tend to be associated with backwardated futures prices because they may be indicating present market tightness, which causes current spot prices to rise relative to future prices. Conversely, high inventories may be indicating an oversupplied market, causing current spot prices to fall relative to future prices.

Price Expectations Influence Inventories

As explained in the previous NPC study, future price expectations can affect company decisions regarding inventories. If the contango in the forward curve (futures price above current spot price) is sufficient to cover the storage costs and financial risk associated with holding inventory, there is an economic incentive to build stocks. Conversely, backwardated prices (futures prices below current spot price) may provide an economic disincentive to hold inventories greater than those needed to meet supply requirements. Backwardation in the forward price curve indicates that prices are expected to fall and that the inventories will be worth less in the future. Regardless of these factors, individual companies strive to hold sufficient operational inventory to meet customer demand.

6 Jeffrey C. Williams, "The Economic Function of Futures Markets," Cambridge, England: Cambridge University Press, 1986. Michael J. Brennan, "The Supply of Storage," American Economic Review 57, No. 1 (1958), pp. 50-72. Holbert Working, "The Theory of the Price of Storage," American Economic Review 48 (1949), pp. 1254-1262.

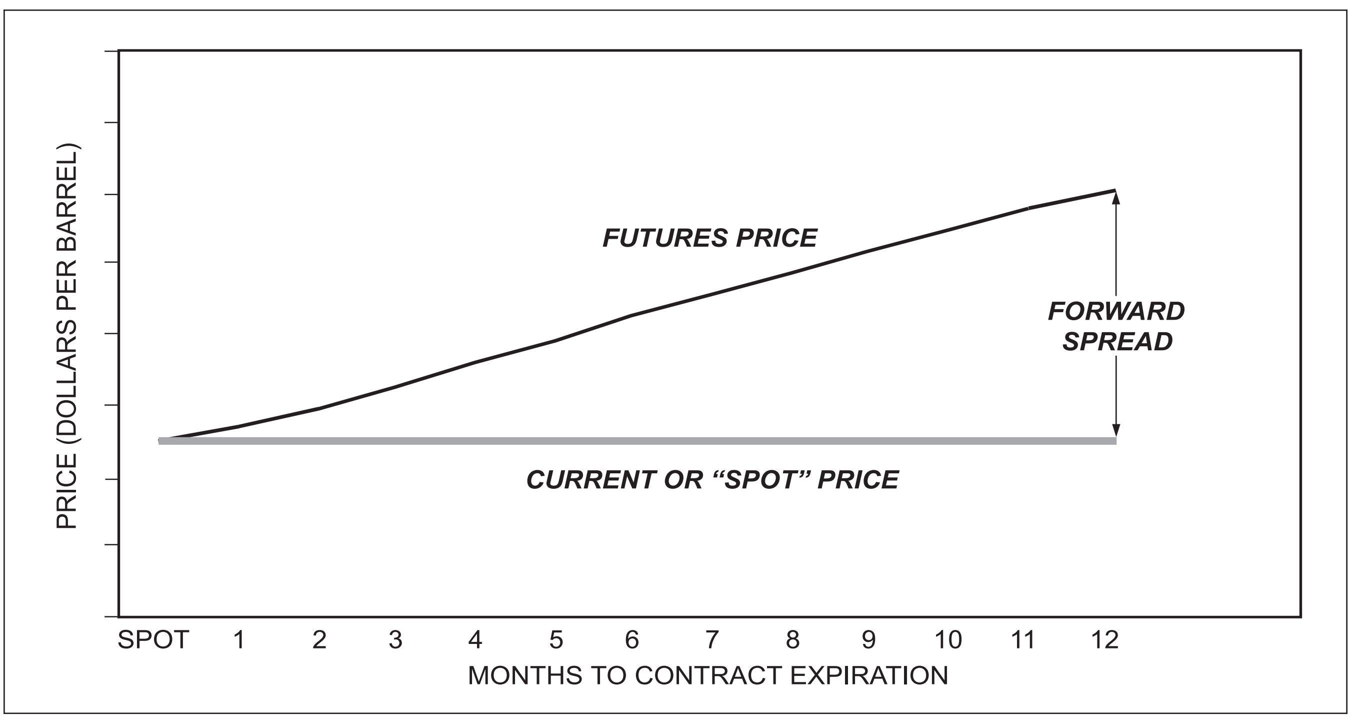

Figure II-16. Contango Market – A market condition in which a futures price is higher in the more distant delivery months than in the near delivery months.

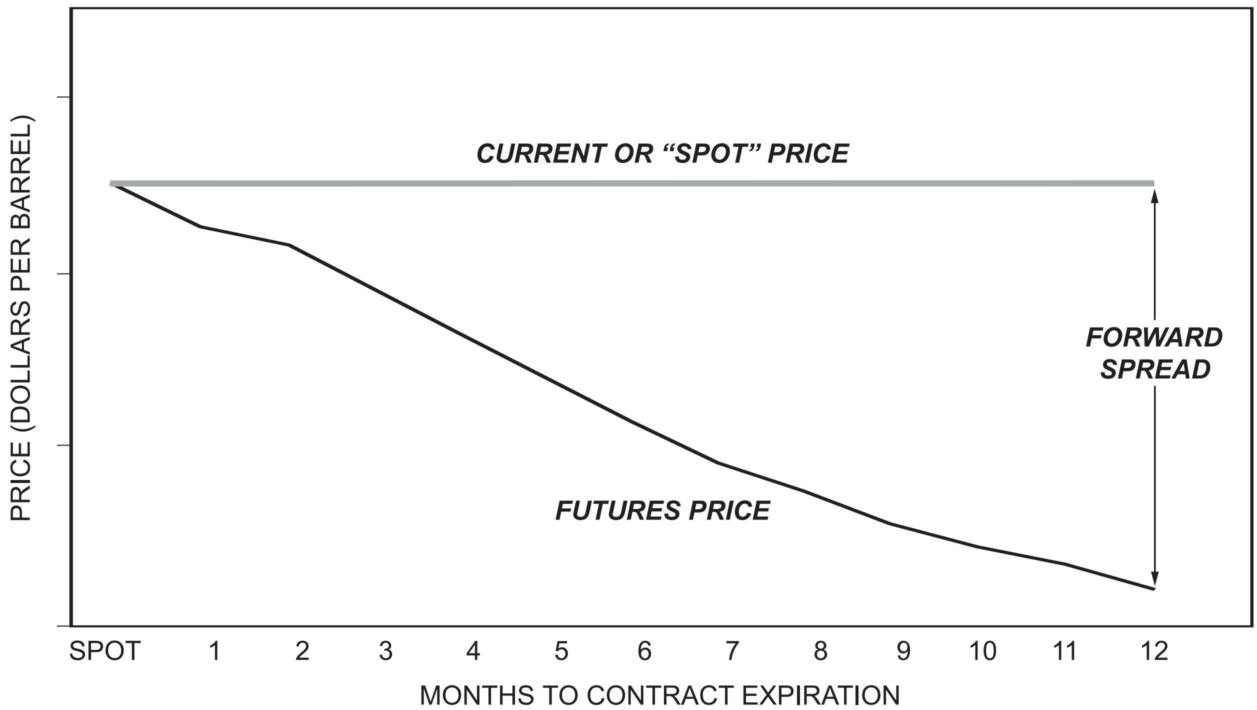

Figure II-17. Backwardated Market – A market condition in which a futures price is lower in the more distant delivery months than in the near delivery months.

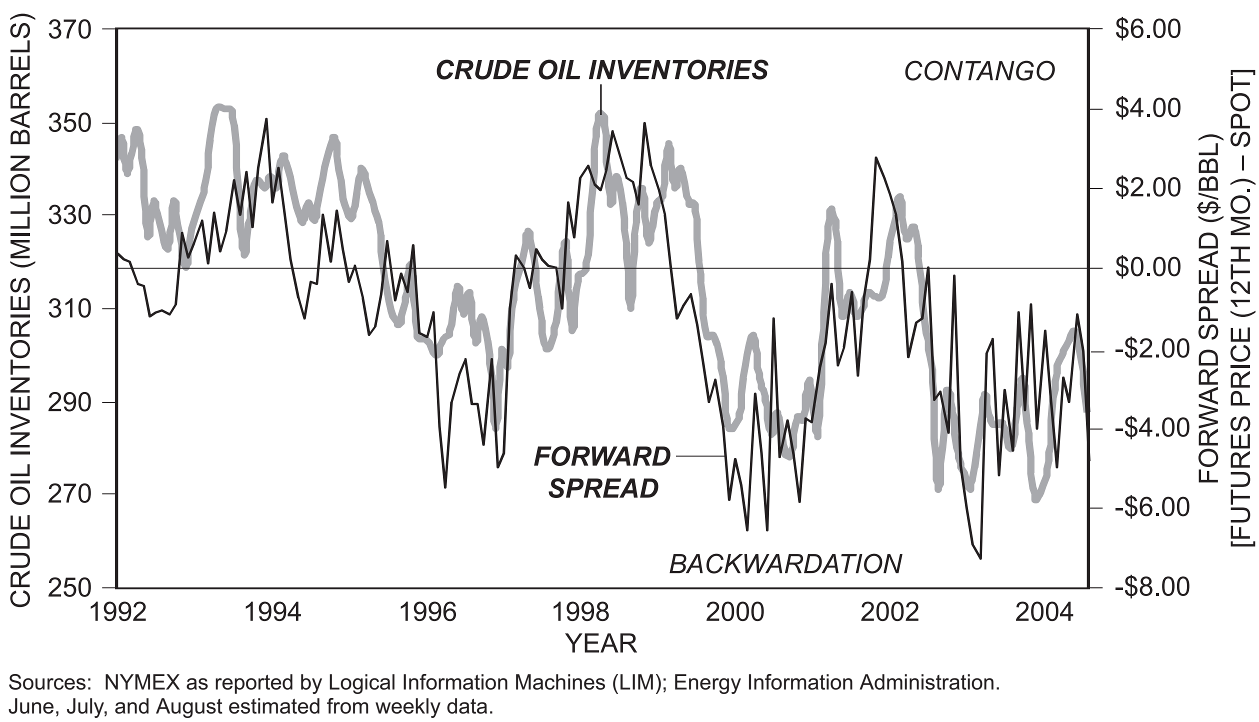

Figure II-18. U.S. Crude Oil Inventories and Forward Price Spreads

APPENDICES

The Secretary of Energy
Washington, DC 20585

July 16, 2004

Mr. Bobby S. Shackouls
Chairman
National Petroleum Council
1625 K Street, N.W.
Washington, DC 20006

Dear Chairman Shackouls:

The National Petroleum Council periodically advises the Secretary of Energy, at his request, on issues related to petroleum refining and refined product distribution. This advice has proven invaluable to both the Department of Energy and the Congress throughout the process of developing and evaluating public policy options.

The Council's most recent refining report, *U.S. Petroleum Refining -- Assuring the Adequacy and Affordability of Cleaner Fuels*, completed in June 2000, concluded that the refining and distribution industries would be significantly challenged to meet increasing domestic light product demand with the substantial changes in fuel specifications then promulgated or proposed. That report provided key insights to help ensure a reliable supply of light petroleum products to consumers.

Similarly, the Council's December 1998 report, *U.S. Petroleum Product Supply -- Inventory Dynamics*, provided important advice on the interrelationships between product inventories and retail prices. That report also defined lower operating inventory levels for crude oil, gasoline, distillate, and kerosene jet fuel.

Considerable change has occurred in the world and domestic petroleum markets since these reports were completed. In the United States, tight product supply and demand conditions have combined with rising crude oil prices to fuel substantial increases in gasoline, diesel, and heating oil prices. Our continued push for cleaner fuels, while necessary to protect the health of our citizens and environment, layers further challenges on an already strained system. And while increases in refinery production have been substantial, constraints on refinery expansion coupled with an effective moratorium on new construction since 1976 have resulted in our dependence on a system running at an average 96 percent utilization for the summer of 2004. This level of utilization is unsustainable over the long term, and provides little system capability to manage unexpected outages.

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By 2025, the Energy Information Administration projects consumer demand for refined products will be 28 million barrels per day, while domestic production of finished product to be only 24 million barrels per day. As the gap between domestic supply and demand increases, domestic markets will become increasingly reliant on imports. And as the global economy recovers, the United States faces increasing competition for supply from beyond our borders—supply that is obviously less certain than that produced by our domestic system.

The American people need to be confident that the challenges related to petroleum refining and product supply in the United States are being addressed. Accordingly, I request that the National Petroleum Council identify the factors that will impact the refining and distribution industry's ability to meet future product demand, and report on potential near-term options to meet demand for transportation fuels and heating oil over the next year. Additionally, I ask that the Council reexamine its 1998 advice on lower operational inventory levels for crude oil and petroleum products.

Items to consider should include the current and future demand for refined products, domestic capacity to meet this demand, potential barriers to efficient markets, the influence of petroleum product supply on price, industry actions to meet environmental requirements, and the capital investment and other factors that will drive supply growth. Additionally, I would appreciate the Council's insights on how refining capacity, inventories, and demand patterns outside the United States may impact meeting the consumer demand for refined petroleum domestically.

I request that you complete this study as timely as practicable. I have designated Mr. David K. Garman, Acting Under Secretary for Energy, Science, and Environment, and Mr. Mark R. Maddox, Acting Assistant Secretary for Fossil Energy, to represent me in the conduct of this important study.

Sincerely,

Spencer Abraham

BACKGROUND INFORMATION ON THE NATIONAL PETROLEUM COUNCIL

In May 1946, the President stated in a letter to the Secretary of the Interior that he had been impressed by the contribution made through government/industry cooperation to the success of the World War II petroleum program. He felt that it would be beneficial if this close relationship were to be continued and suggested that the Secretary of the Interior establish an industry organization to advise the Secretary on oil and natural gas matters.

Pursuant to this request, Interior Secretary J. A. Krug established the National Petroleum Council (NPC) on June 18, 1946. In October 1977, the Department of Energy was established and the Council was transferred to the new department.

The purpose of the NPC is solely to advise, inform, and make recommendations to the Secretary of Energy on any matter requested by the Secretary, relating to oil and natural gas or the oil and gas industries. Matters that the Secretary would like to have considered by the Council are submitted in the form of a letter outlining the nature and scope of the study. The Council reserves the right to decide whether it will consider any matter referred to it.

Examples of studies undertaken by the NPC at the request of the Secretary include:

- U.S. Arctic Oil & Gas (198l)
- Environmental Conservation – The Oil & Gas Industries (1982)
- Third World Petroleum Development: A Statement of Principles (1982)
- Petroleum Inventories and Storage Capacity (1983, 1984)
- Enhanced Oil Recovery (1984)
- The Strategic Petroleum Reserve (1984)
- U.S. Petroleum Refining (1986)
- Factors Affecting U.S. Oil & Gas Outlook (1987)
- Integrating R&D Efforts (1988)
- Petroleum Storage & Transportation (1989)
- Industry Assistance to Government – Methods for Providing Petroleum Industry Expertise During Emergencies (1991)
- Short-Term Petroleum Outlook – An Examination of Issues and Projections (1991)
- Petroleum Refining in the 1990s – Meeting the Challenges of the Clean Air Act (1991)
- The Potential for Natural Gas in the United States (1992)
- U.S. Petroleum Refining – Meeting Requirements for Cleaner Fuels and Refineries (1993)
- The Oil Pollution Act of 1990: Issues and Solutions (1994)
- Marginal Wells (1994)
- Research, Development, and Demonstration Needs of the Oil and Gas Industry (1995)
- Future Issues – A View of U.S. Oil & Natural Gas to 2020 (1995)
- Issues for Interagency Consideration – A Supplement to the NPC's Report: Future Issues – A View of U.S. Oil & Natural Gas to 2020 (1996)
- U.S. Petroleum Product Supply – Inventory Dynamics (1998)
- Meeting the Challenges of the Nation's Growing Natural Gas Demand (1999)
- U.S. Petroleum Refining – Assuring the Adequacy and Affordability of Cleaner Fuels (2000)
- Securing Oil and Natural Gas Infrastructures in the New Economy (2001)
- Balancing Natural Gas Policy – Fueling the Demands of a Growing Economy (2003).

The NPC does not concern itself with trade practices, nor does it engage in any of the usual trade association activities. The Council is subject to the provisions of the Federal Advisory Committee Act of 1972.

Members of the National Petroleum Council are appointed by the Secretary of Energy and represent all segments of the oil and gas industries and related interests. The NPC is headed by a Chair and a Vice Chair, who are elected by the Council. The Council is supported entirely by voluntary contributions from its members.

NATIONAL PETROLEUM COUNCIL

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APPENDIX C

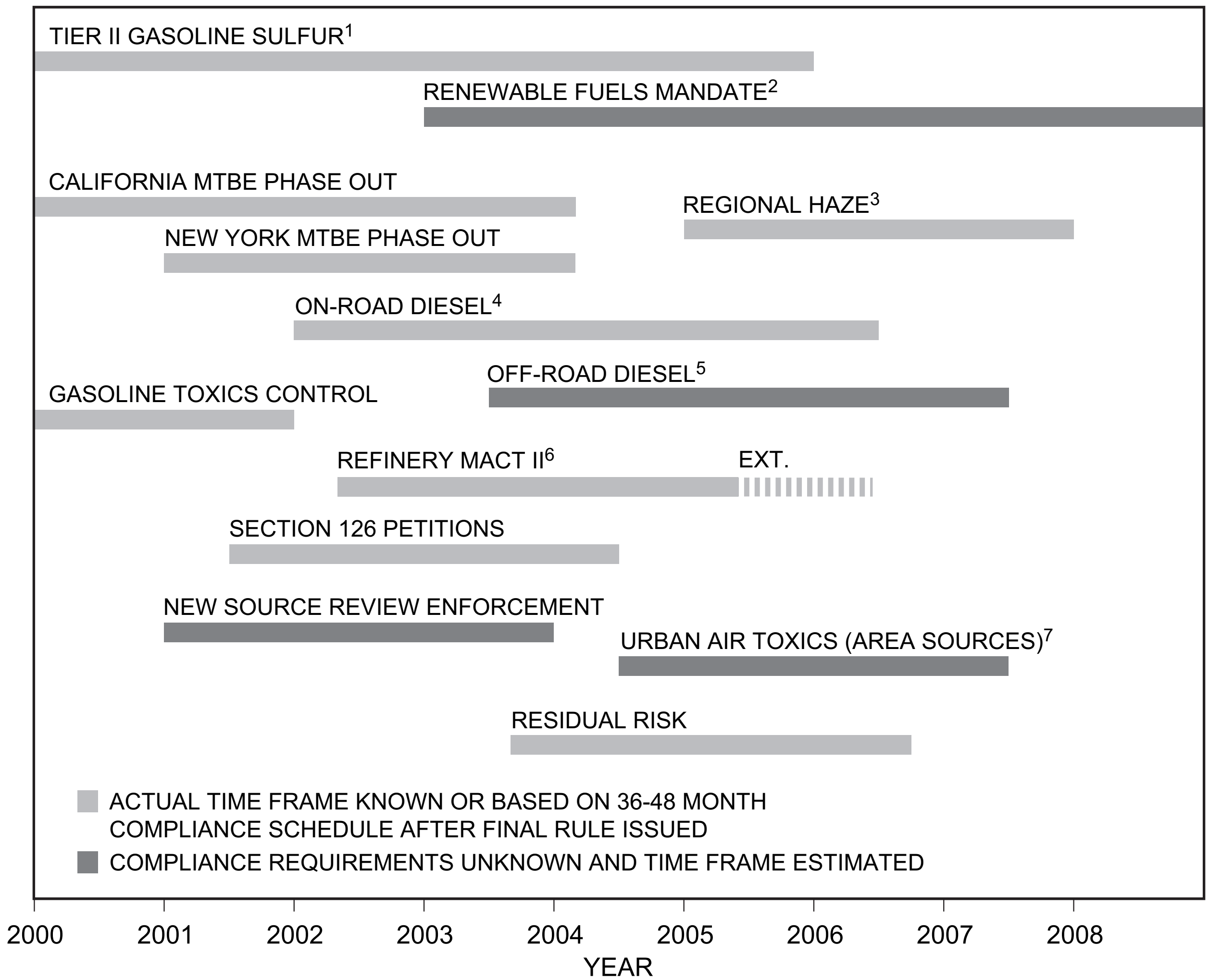
2000 REFINING STUDY RECOMMENDATIONS AND STATUS

Report Recommendation	Subsequent Action
• Regulations should be based on sound science, thorough analysis of cost effectiveness, and commercially proven technology.	• The ULSD regulation of a 15 ppm cap at retail was implemented as a technology forcing regulation. While some technology development has occurred, enforcement tolerances and downgrades in the distribution system raise serious questions about the ability to comply with the rule. Commercially proven light duty engine and after treatment technology did not and does not exist to use 15 ppm diesel to comply with NOx emissions specifications. The NPC questions the adequacy of the non-road diesel cost-effectiveness analysis.
• The NPC proposed that fuel quality changes have minimum overlap to prevent resource constraints (financial and human); ULSD was recommended no sooner than 2007. EPA should finalize timing and specifications for off-highway diesel sulfur reduction and national MTBE use in a timely manner.	• The timing for ULSD was set in mid-2006, earlier than the 2007 recommendation. The non-road diesel rules were finalized in 2004 for a mid-2007 implementation. Regulations for MTBE continue to be a patchwork by individual states.
• Regulations should be defined with certainty in scope, timing, and requirements to allow the refining industry to make effective investments decisions. Allow at least four years time from adoption to implementation.	• EPA has not provided clarity to state fuel requirements including oxygen waivers and NAAQS. The lead time of four years has only been partially recognized. NSR reforms necessary to improve regulatory certainty have been promulgated but are under litigation.
• Policy makers should recognize that policies or regulations favoring or promoting renewable or alternative fueling tends to discourage refinery investment.	• Considerable uncertainty exists surrounding a possible Renewable Fuels Standard. National energy legislation continues to be debated but legislation has yet to be passed.

Report Recommendation	Subsequent Action
• Reducing gasoline or on-highway diesel below 30 ppm average should not be imposed until a basis for sound conclusions about the cost, benefit, producibility, and deliverability of products is established.	• EPA established a 30 ppm standard for gasoline at the refinery gate. EPA did not follow this recommendation for diesel, imposing a 15 ppm standard at retail. Light duty engine technology remains unproven and deliverability remains in question.
• Changing the DI specification should not occur until further analysis of the cost effectiveness and potential supply impacts is identified.	• As recommended, no DI specification has been imposed by EPA. However, states (California and Michigan) are beginning to discuss including a DI specification as part of state fuel requirements.
• Provide a streamlined permitting process and allocate necessary resources to support state and local agencies.	• A limited amount of streamlining has occurred.
• Allow a portion of the emissions reduction resulting from the use of lower sulfur fuels to offset the stationary source emissions resulting from new facilities required in their manufacture.	• No low sulfur fuel offsets have been allowed in the permitting of new facilities to produce low sulfur fuels.
• Requirements for the new source review should not be retroactively reinterpreted.	• NSR reform is under litigation. However, no enforcement relief of reinterpretation of past NSR actions has been implemented.
• States and localities considering localized restrictive fuel requirements should recognize associated increased costs and reduced reliability of supply.	• States and localities continue to impose restrictive fuel requirements resulting in boutique fuels. Connecticut did revise the timing of their MTBE ban to align with New York when advised of potential supply impacts.
• Enforcement requirements for compliance should maintain the flexibility and capability of distribution system, i.e. primary enforcement at the refinery gate, point of production, or import.	• Enforcement of Tier 2 gasoline sulfur does maintain distribution flexibility with primary refinery gate enforcement. Enforcement of ULSD at retail introduces substantial issues for the supply and distribution of ULSD starting in mid-2006.

APPENDIX D

CUMULATIVE REGULATORY IMPACTS ON REFINERIES, 2000-2008



1. Longer compliance time for refineries in Alaska and Rocky Mountain states and small refineries covered by Small Business Regulatory Enforcement and Flexibility Act (SBREFA). Additional compliance time is available for these refineries if they produce ultra low sulfur highway diesel beginning in 2006.

2. Senate Energy bill (S. 517) proposes an ethanol mandate of 2.3 billion gallons in 2004 whichincreases to 5 billion gallons in 2012.

3. Regional Haze State Implementation Plans (SIPs) due 2005-2007. Earliest compliance date. Schedule may be impacted by National Ambient Air Quality Standard (NAAQS) litigation.

4. Longer compliance time for small refiners covered by SBREFA.

5. Estimated effective date based on proposed heavy duty vehicle standards.

6. Compliance date may be harmonized with Tier II schedule.

7. Urban Air Toxics Strategy includes potential controls of gasoline loading facilities at refineries. Estimated compliance schedule.

Source: National Petrochemical & Refiners Association, March 2002.

APPENDIX E

NEW SOURCE REVIEW (NSR) REFORM BACKGROUND

The NPC recommends: *"Immediate implementation of comprehensive NSR reform is a very important policy step needed to improve the climate for investment in domestic refinery expansion. The NSR reforms promulgated by the Administration, including the Equipment Replacement Rule currently under judicial review, should be implemented as soon as possible. Attempts to delay or overturn the reforms should be vigorously opposed. Additional NSR reform proposals regarding de-bottlenecking and project aggregation should be issued and finalized."*

This recommendation flows from several key observations and conclusions of the study group, as follows:

Lack of grassroots domestic refinery construction since the mid 70s reflects the historical profitability of the industry, more attractive opportunities for expansion of existing refineries and the economic availability of alternative supplies.

Expansion and increased utilization of existing refineries is typically more feasible, quicker, and less costly than grassroots refinery construction.

One of the significant factors affecting investment decisions is the amount of future uncertainty. While uncertainty cannot be eliminated, it can be exacerbated by certain government actions. Where decisions regarding large amounts of capital investment are involved, increasing uncertainty tends to result in minimization or delay of investment to reduce risk. This results from the long-lived nature of refining assets, where taking a short term economic loss to await resolution of uncertainty may be more attractive than investing earlier in equipment that is not optimum for the long term.

The NPC's strong support for NSR reform reflects the fact that the national interest requires that unnecessary, policy-based impediments to additional investment in domestic refinery capacity expansions be eliminated. No other federal policy has fostered as much uncertainty and discouragement of domestic refining investment as has EPA's past application and enforcement of the New Source Review program.

By the end of the last decade, NSR requirements were subject to a welter of conflicting interpretations and court decisions. A sweeping reinterpretation of the program at that time exacerbated this situation, and finally brought NSR-related problems to a head.

The Administration's 2001 National Energy Policy recommended that EPA review the potential impact of the NSR program on investment in new utility and refinery capacity, energy efficiency and environmental protection. As part of the public review process, the refining industry submitted evidence to EPA that the existing NSR program resulted in foregone opportunities for additional capacity increments, prevented increased production of cleaner fuels, and discouraged energy efficiency projects.

On June 13, 2002, EPA presented a report on NSR and recommendations for reform to the President. EPA found that the NSR program had impeded or resulted in the cancellation of projects that would maintain or improve reliability, efficiency or safety of existing power plants and refineries. EPA concluded that reforms to the NSR program would remove barriers to pollution prevention projects, energy efficiency improvements, and investments in new technologies and modernization of facilities.

EPA has taken three significant actions on NSR reform in the past two years, as follows:

- December 31, 2002: EPA issued the final rule on NSR commonly referred to as the NSR Improvement Rule
- December 31, 2002: EPA issued a proposed rule on NSR Routine Maintenance, Repair and Replacement (RMRR)
- October 27, 2003: EPA issued a final rule, known as the Equipment Replacement Provision, which addresses a part of the Routine Maintenance, Repair and Replacement exclusion.

New Source Review Improvement Rule

The December 31, 2002 NSR Improvement Rule was issued after more than a decade of rulemaking, including two proposed rules, one supplemental proposal, numerous public hearings, and consideration of over 130,000 comments. The rule made four important changes to the NSR program:

- **Calculating Emissions Increases and Establishing Emissions Baseline.** The new NSR improvement rule provides for an actual-to-projected actual test to calculate any projected actual increases in emissions due to a physical or operational change. Under the actual-to-potential test, EPA estimated post-change emissions based upon what a plant would theoretically emit if it operated at maximum rates 24 hours a day, year-round. This made it impossible to make certain modest changes in a facility without triggering NSR, even if those changes did not actually increase emissions. In the NSR improvement rule, a facility is to use, in its permitting analysis, the amount of emissions actually projected to occur after the proposed change instead.

  Also, to more accurately measure actual emissions, account for variations in business cycles, and clarify what may be a "more representative" period, the improvement rule allows facilities to use any consecutive 24-month period in the previous decade as a baseline for pre-change actual emissions, as long as all current control requirements are taken into account. The same 24-month period must be used for all pollutants.
- **Plantwide Applicability Limits.** A plantwide applicability limit (PAL) is an option that facilities may choose which allows greater operational flexibility to manage emissions on a plantwide basis. Under a PAL, a plant owner may decide to establish a plantwide emissions cap based on actual emissions (any 24-month period in the last 10 years). The plant owner may then make changes to the facility or individual units without triggering the NSR permitting process, as long as the facility's overall emissions remain below the plantwide cap.

  The PAL creates an emissions "bubble" in which emissions from the facility are treated as a whole, rather than on a unit-by-unit basis. A facility selecting this option is required to monitor emissions from all of its units.
- **Clean Unit Provision.** Under the improvement rule, plants that install "clean units" are allowed operational flexibility if they continue to operate within permitted limits. This is meant to encourage installation of state-of-the-art air emissions controls. Clean units must have an NSR permit or other regulatory limit that requires use of the best air pollution control technologies.
- **Pollution Control and Prevention Projects.** This new applicability test governs facilities that have gone through NSR review and have installed the required best available control technology (BACT) (in attainment areas) or met the lowest achievable emissions rate (LAER) (in non-attainment areas). Under the improvement rule, these facilities may make changes to the Clean Unit without triggering further NSR requirements, if the change does not require alterations to the emissions limitations or work practices requirements of their permit and the changes would not alter any physical or operational characteristics. Clean Unit status will last for up to 10 years. EPA intends this new applicability test to protect air quality, create incentives for sources to install state-of-the-art controls, provide flexibility, and promote administrative efficiency.

  EPA has listed environmentally beneficial technologies that qualify as pollution control projects.

An owner or operator installing a Pollution Control and Prevention Project (PCPP) listed by EPA automatically qualifies for the NSR exclusion if there are no adverse air quality impacts. A PCPP not listed may also qualify for the exclusion if the reviewing authority determines, on a case-specific basis, that the PCPP is environmentally beneficial when used in a particular application. In the future, EPA may add specific PCPPs to the list through rulemaking. EPA intends this exclusion to encourage the use of environmentally beneficial emissions controls and to offer operational flexibility.

The NSR reform rule has been challenged in court by environmental groups and others. The case is pending in the U.S. Court of Appeals for the D.C. Circuit, and is expected to be resolved sometime in 2005. In the meantime, the court has twice refused to stay implementation of the rule, and its provisions are currently in force in EPA direct implementation states and in states with EPA-approved programs that have incorporated the rule into their state programs. States have until January 2006 to incorporate the rule into their state programs. The current legal challenge to this rule has at least temporarily limited its anticipated positive impacts on domestic refining investment and operations.

Routine Maintenance, Repair and Replacement

When EPA published the NSR Improvement Rule on December 31, 2002, it simultaneously proposed reforms to the routine maintenance, repair and replacement (RMRR) exclusion. Conflicting interpretations of the RMRR exclusion from NSR have led to confusion as to whether basic repairs and other traditional operations at a facility might trigger NSR and lead to significantly higher expenditures than contemplated for the repairs or other routine actions. The refining industry has urged EPA to consider clarifications to RMRR as well as the broader reforms included in the NSR Improvement Rule. To date, however, EPA has finalized only the equipment replacement portion of its proposal to reform RMRR.

EPA clarified the RMRR exclusion rule "to increase environmental protection and promote the implementation of necessary repair and replacement projects." The agency explained that although NSR excludes repairs and maintenance activities that are "routine," a complex analysis had to be used to determine what repairs meet that standard.

The RMRR rule is intended to remove disincentives for owners and operators of refineries and other manufacturing facilities from undertaking RMRR activities that would improve the safety, reliability, and efficiency of their plants. It is especially important that refinery owners and operators have clarity on RMRR because these facilities run at very high rates of utilization (compared to other manufacturing plants) in order to provide sufficient supplies of petroleum products to meet consumer demand. Therefore, uncertainty in the application of the RMRR exclusion has the potential to interfere with the efficient operation of refineries and their ability to provide reliable supplies of petroleum products.

Equipment Replacement Provision

EPA published its Equipment Replacement Provision (ERP) rule on October 27, 2003. The rule is intended to provide greater regulatory certainty without sacrificing environmental protection and the benefits derived from the NSR program. The ERP provides an automatic exclusion from NSR requirements for equipment replacement meeting the following conditions:

- they involve replacement of any existing component(s) of a process unit with component(s) that are identical to or serve the same purpose as the replaced component(s);
- the fixed capital cost of the replaced component(s) plus the costs of any activities that are part of the replacement activity (e.g., labor, contract services, major equipment rental, and associated repair and maintenance activities) do not exceed 20% of the current replacement value of the process unit; and
- the replacements do not alter the basic design parameters of the process unit or cause the process unit to exceed any emission limitation or operational limitation that applies to any component of the process unit and is legally enforceable.

Like the NSR Improvement Rule, the equipment replacement provision was challenged by some environmental groups and others in the U.S. Court of Appeals for the District of Columbia. The rule has been stayed pending litigation and the lawsuit is expected to be decided in 2005. Pending resolution of the litigation, the positive impacts of this regulation on domestic refining investment and operations have been severely limited. In the meantime, EPA has allowed additional opportunity for public comment on certain issues raised in administrative petitions for reconsideration.

Additional NSR Reforms

EPA also made informal proposals addressing debottlenecking activities and clarifying project aggregation requirements. Both proposals would further the efficient operation of refineries and improve the prospect for increased production and capacity expansion through debottlenecking and similar projects.

Debottlenecking occurs when one part of a facility is modified in such a way that throughput in other parts of the facility increases. Under current rules, determining whether NSR applies to such complex projects is difficult and can be time consuming. EPA has proposed that sources should generally look only at the unit undergoing the change when calculating actual emissions associated with a project. Unless their permitted emissions limit is exceeded or increased, emissions from units upstream or downstream of the unit undergoing the change should not be considered.

Aggregation refers to the situation in the facility in which multiple projects are implemented in a short period of time. In such a case, a difficult and complex analysis must be performed to determine if the projects should be treated separately or together (i.e., aggregated) under NSR. EPA's proposal establishes two criteria that would guide this determination.

EPA has yet to finalize its debottlenecking and aggregation proposals, leaving significant uncertainty involving NSR application to multiple project undertakings and debottlenecking. The study group strongly recommends that EPA finalize these important proposals.

Response to Criticisms of the NSR Reform Proposals

There is much confusion about the purpose of the NSR program and the impact of the reform regulations. The program, initiated in 1974, requires preconstruction review of new and modified major stationary sources of air pollution that cause emissions increases. EPA's NSR webpage notes that "When Congress established the New Source Review Program, it did so with a goal of providing for economic growth while maintaining or improving air quality," and "Over time, the NSR program has become more complex and complicated, due to the evolving nature of industrial practices and changes in the regulations and EPA's interpretation of them. In response to concerns about this, EPA has worked for nearly 10 years to simplify the NSR program." [http://www.epa.gov/nsr/]

To quote EPA's Fact Sheet [http://www.epa.gov/nsr/facts.html], "NSR is one of the many tools to ensure the air quality goals are met. The key provisions of the Clean Air Act (CAA) include programs designed to protect human health and the environment from the harmful effects of air pollution. The final rule does not alter these protections. CAA programs such as the National Ambient Air Quality Standards (NAAQS), the Acid Rain program, and the NOx SIP Call will ensure that the nation's air quality will continue to improve." In short, EPA believes that NSR reform will not have a negative impact on air quality or lead to a significant increase in emissions.

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