United States Government Accountability Office

GAO

Report to Congressional Requesters

October 2008

ENERGY MARKETS

Refinery Outages Can Impact Petroleum Product Prices, but No Federal Requirements to Report Outages Exist

GAO-09-87

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GAO Accountability • Integrity • Reliability

Highlights

Highlights of GAO-09-87, a report to congressional requesters

Why GAO Did This Study

In recent years, global demand for petroleum products such as gasoline and diesel fuel has grown more quickly than the capacity to produce them, creating a tight market. U.S. refiners have been running near capacity, particularly during peak summer demand. In such conditions, unexpected refinery outages can result in price increases that adversely affect consumers. GAO was asked to evaluate (1) the trends in U.S. refinery outages over the last 5 years, in terms of reduced production capacity, frequency, and geographic location, and (2) the federal requirements for reporting outages at U.S. refineries. To evaluate these objectives, GAO obtained and analyzed Energy Information Administration (EIA) and commercial data, and obtained and analyzed federal legislation and policies, and interviewed federal agency, academic, and industry trade group officials.

What GAO Recommends

GAO is recommending that the Secretary of Energy direct the Administrator of EIA to (1) reevaluate its monthly refinery production survey and other data to determine whether those data allow EIA to adequately conduct future analyses of outage effects on petroleum product prices, and (2) report to the Congress on the costs and benefits of collecting any additional data on newer fuels. EIA officials provided verbal comments suggesting GAO distinguish between the types of outages and data collected, among other things, which we addressed as appropriate.

To view the full product, including the scope and methodology, click on GAO-09-87. For more information, contact Frank Rusco, (202) 512-3841 or ruscof@gao.gov.

What GAO Found

With the exception of impacts beginning in 2005 related to Hurricanes Katrina and Rita, GAO's analyses of commercial data on unplanned and planned refinery outages across the United States generally do not show discernible trends in reduced production capacity or in the frequency and location of outages from 2002 through 2007. GAO's analyses of commercial data from 2002 through 2007 indicate that the hurricanes resulted in two patterns of outages for refiners, depending on whether they were directly affected, specifically: (1) certain refiners that were forced to shut down due to the hurricanes opted to upgrade equipment and perform what maintenance they could during their unplanned outages, thus extending the length of time until the next round of planned outages for maintenance at these refineries; and (2) sometimes refiners not directly effected by the hurricanes deferred planned outages to continue to supply the market, thus partially increasing the need for planned outages in subsequent years as these refiners rescheduled their deferred outages. GAO's regional analyses showed few apparent trends, but some variation in reduced production capacity due to outages across regions, with the Gulf Coast region refineries experiencing a slightly higher rate of outages and related reductions in capacity than refineries in other regions, in part as a result of recurrent extreme weather events.

At present, there are no federal requirements for refiners to report planned or unplanned refinery outages, and available data may not allow EIA to adequately ascertain the effects of some outages on prices of petroleum products. EIA collects data on a monthly refinery survey and has used this data to estimate outages. However, GAO found estimating outages using this method has a number of limitations. Among other things, it does not identify whether the outage was planned or unplanned, and it is important to make this distinction because unplanned outages are likely to have a different impact on gasoline prices than planned outages. EIA is independently exploring whether to collect data directly on planned and unplanned outages from refiners, but has not established a time frame to determine if it will collect such data. In addition, in response to the Energy Independence and Security Act of 2007, EIA is preparing to enhance its monitoring of planned outages. EIA officials told GAO they plan to primarily rely on commercial data to perform the mandated semi-annual analyses. However, even if EIA collects or acquires reliable data on refinery outages, the agency lacks other data—such as data on special fuel blends—that could be important for the Department of Energy in meeting its obligations to conduct periodic analyses of the potential impacts of refinery outages on prices of petroleum products. While a full cost/benefit analysis of the merits of collecting additional data was outside the scope of this review, EIA has the authority and expertise to determine and suggest what other information for inclusion on the monthly refiner survey could be helpful in adequately evaluating the potential effects of both planned and unplanned outages on prices of petroleum products.

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Abbreviations

DOE	Department of Energy
EIA	Energy Information Administration
IIR	Industrial Information Resources, Inc.
PADD	Petroleum Administration for Defense Districts

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United States Government Accountability Office
Washington, DC 20548

October 7, 2008

Congressional Requesters

In recent years, global demand for crude oil and refined petroleum products such as gasoline, diesel fuel, and jet fuel has grown more quickly than available capacity of crude oil and refined petroleum products, creating a tight world marketplace. Globally, refineries have been running near their productive capacity in many recent years, which has contributed to higher prices of gasoline, diesel, jet fuel, and other petroleum products. In the United States, refiners have been running near capacity as well, particularly during the peak-demand summer months. In such conditions, unexpected refinery outages can result in rapid price increases that adversely affect consumers and businesses. The Federal Trade Commission has found that certain refinery outages have impacted petroleum product prices and supplies. Refineries may unexpectedly shut down due to fires, equipment malfunctions, chemical spills, or other causes, interrupting certain processing capabilities in what is known as an "unplanned outage." Recent refinery fires and other unplanned refinery outages have raised concerns about the stability of U.S. gasoline and other petroleum product supplies, especially given their current record high price levels.

In addition to unplanned outages, refineries must periodically shut down major pieces of equipment to perform maintenance, overhaul, and repair operations and to inspect, test and replace materials and equipment in what is known as a "planned outage." Such planned outages, including large planned outages known as "turnarounds," are necessary to ensure that refineries operate safely and efficiently. These large planned outages are typically scheduled at least a year or two in advance and can affect multiple pieces of equipment. Depending on the equipment and the amount of maintenance needed, a planned outage can take a refinery off-line from 1 to 4 weeks or more, according to the American Petroleum Institute. Although these planned outages are necessary, consumer groups and others have raised concerns that some refineries may plan outages at times that will lead to increases in the prices of petroleum products in

certain markets.[1] For the purposes of this report, we refer to an outage as the halting of production of any crude distillation unit or secondary processing equipment. In addition, in some cases outages may have little or no effect on production or prices, while in others, even a single large outage may have a significant effect.

The Department of Energy's (DOE) Energy Information Administration (EIA) is responsible for producing independent, unbiased research that helps the Congress, public, and international community better understand energy markets and promote sound policy-making. EIA has the authority to request information from entities engaged in energy supply or major energy consumption in the United States, including foreign companies operating in the United States.[2] EIA collects and analyzes these and other data on the supply, consumption, and prices of crude oil and petroleum products, including inventory levels, refining capacity and utilization rates, and product movements into and within the United States. EIA also collects and analyzes monthly data from refineries regarding the amounts of crude oil they receive and process, as well as the volumes of refined products they produce.[3] Such analyses allow policy makers to better understand the trends in petroleum product markets, including the extent of recent refinery outages and the effects of these outages on petroleum product prices. As part of this research, EIA issued an analysis of U.S. refinery outages in March 2007 that found that unexpected refinery outages can result in local supply disruptions that

[1]Analysts sometimes raise concerns that unplanned outages could affect prices differently than planned outages. On one hand, unplanned outages would generally be expected to be smaller than the large planned turnarounds, which would lower any potential impact on price relative to planned outages. However, unplanned outages may not allow for adequate time to arrange for additional supplies. If such outages occur during the peak summer demand season, when extra supply is not readily available, they could have a larger price impact on the margin than their size alone might imply. See Department of Energy, Energy Information Administration, *Refinery Outages: Description and Potential Impact on Petroleum Product Prices* (Washington, D.C.: March 2007).

[2]Federal Energy Administration Act of 1974, Pub. L. No. 93-275 (15 U.S.C. §772).

[3]The EIA–810 monthly refinery survey collects information regarding the balance between the supply (beginning stocks, receipts, and production) and disposition (inputs, shipments, fuel use and losses, and ending stocks) of crude oil and refined petroleum products located at refineries.

result in temporary price increases; however, refinery outages do not always affect prices.[4]

In this context, you asked us to study and evaluate (1) the trends in U.S. refinery outages over the last 5 years, including reduced production capacity, frequency, and geographic location, and (2) the federal requirements for reporting outages at U.S. refineries. As agreed with your staff, we will examine the potential effects of refinery outages on wholesale gasoline prices in a forthcoming report.

To evaluate trends in refinery outages we obtained and analyzed data from EIA's monthly refinery production survey form, EIA-810, from 1986 through 2006, and purchased data that included detailed information on refinery outages between 2002 and 2007 from Industrial Information Resources, Inc. (IIR), a private company that provides research and forecasts for various large industries. We determined that these data were sufficiently reliable for the purposes of this report. To evaluate the federal requirements for reporting outages at U.S. refineries, we obtained and analyzed federal legislation, policy, and guidance regarding requirements to report outage information or refinery production information, and interviewed federal agency, academic, and industry trade group officials to obtain more information about the purpose and utility of such requirements.

We conducted our work from August 2007 through September 2008 in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives.

Results in Brief

With the exception of effects beginning in 2005 related to hurricanes Katrina and Rita, our analyses of commercial data on unplanned and planned refinery outages across the United States generally do not show discernible trends in reduced production capacity or in the frequency and

[4]Department of Energy, Energy Information Administration, *Refinery Outages: Description and Potential Impact on Petroleum Product Prices* (Washington, D.C.: March 2007).

location of outages from 2002 through 2007. At the time of hurricanes Katrina and Rita, reduced production capacity spiked as a result of unplanned outages when refiners in or near the path of the storms were forced to close down multiple facilities. Our analyses of commercial data from 2002 through 2007 indicate that the effect of the hurricanes resulted in two patterns of outages for refiners, depending on whether they were directly affected by the hurricanes, specifically: (1) certain refiners that were forced to shut down due to the hurricanes opted to upgrade equipment and perform what maintenance they could during their unplanned outages, thus extending the length of time until the next round of planned outages for maintenance at these refineries; and (2) in some cases, refiners not directly affected by the hurricanes deferred planned outages to continue to supply the market, thus partially increasing the need in subsequent years for turnarounds and other planned outages for those refineries. Our regional analyses showed few apparent trends but some variation in reduced production capacity across regions, with the Gulf Coast region refineries experiencing greater reductions in capacity than refineries in other regions in part as a result of recurrent extreme weather events.

At present, there are no federal requirements for refiners to report planned or unplanned refinery outages, and available data may not allow EIA to adequately ascertain the effect, in some cases, of outages on prices of petroleum products. As recently as July 1, 2008, DOE noted that information on refinery disruptions and their possible effects on petroleum product supplies "are essential" to the mission of the Department of Energy and EIA in particular; however, EIA does not directly collect data on refinery outages. Through its monthly refinery survey, EIA collects data regarding the amounts of crude oil refineries receive and process, as well as volumes of some of the petroleum products these refineries produce, and has used the data to estimate outages indirectly. However, we found estimating outages using this method has a number of limitations; among other things, it does not identify whether the outage was planned or unplanned, and it is important to make this distinction because unplanned outages are likely to have a different impact on gasoline prices than planned outages. EIA is independently exploring whether to collect data directly on planned and unplanned outages from refiners, which might provide more comprehensive and detailed information, but has not established a timeframe to determine if it will collect such data. In addition, in response to the Energy Independence and Security Act of 2007, which requires EIA to review commercially available information on planned refinery outages and report semi-annually on their potential effects on prices of petroleum products, EIA is

preparing to enhance its monitoring of planned and unplanned outages. However, even if EIA collects or acquires reliable data on refinery outages, the agency lacks other data that could be important for DOE in meeting its obligations to conduct periodic analyses of the potential effects of refinery outages on prices of petroleum products. For example, these current and proposed data do not track the production of a number of special fuel blends and biofuel blendstocks that are designed to meet some environmental or engine performance standards. While a full cost/benefit analysis of the merits of collecting such data was largely outside the scope of this review, EIA has the authority and expertise to determine and suggest what other information for inclusion on the monthly refiner survey could be helpful in adequately evaluating the potential effects of both planned and unplanned outages on prices of petroleum products.

To meet its obligations to periodically report on the potential effects of planned outages and fulfill its federal role in providing timely and accurate data to explain trends in energy markets, we recommend that the Secretary of Energy direct the Administrator of EIA to (1) reevaluate its EIA-810 monthly refinery production survey and commercially available data, to determine whether those data sufficiently reflect changes over time in various blends of fuels refiners produce to allow EIA to adequately conduct future analyses of outage effects on prices of petroleum products and (2) report to the Congress on the cost and benefits of collecting any additional, more discrete data on newer fuels, including special fuel blends and biofuel blendstocks that may be produced by a limited number of refineries or used in a limited market that could be disproportionately affected by outages. DOE chose not to provide written comments on the report. However, we received verbal comments from EIA officials, which we addressed as appropriate. Specifically, EIA officials' comments related primarily to the report's adequacy in distinguishing between (1) the need for additional data and better analytical approaches, (2) historical and future data collection for analyses of outages, and (3) planned and unplanned outages. These officials also provided other clarifying and technical changes, which we included as appropriate.

Background

Refineries process crude oil into petroleum products through a combination of distillation and other processes. A single barrel of crude oil produces a varying amount of gasoline, diesel, jet fuel, and other products depending on the configuration—or complexity—of the refinery and the type of crude oil being refined. The first step in the refining process feeds the crude oil through a distillation unit that separates the oil into different

components.[5] As crude oil passes through the distillation unit and is heated, it is separated into different streams from heavy to light. In most cases, the separated crude oil then flows through other specialized refining equipment, collectively known as secondary processing units, which allow refineries to produce more technical fuel blends and process different grades of crude oil. The addition of such secondary processing units typically enable refiners to produce a greater proportion of products in high demand in the United States, such as gasoline, diesel, and jet fuel, and a lower proportion of products in lower demand, such as heavy residual fuel oil.

Secondary processing units installed at refineries to enhance their capabilities include:

- hydrocrackers, which enable refiners to convert heavy oils into lighter, more valuable fuel products such as gasoline, jet fuel, and /or high grade fuel oil;
- fluid catalytic crackers, which allow refiners to maximize the production of gasoline;
- cokers, which allow refiners to process heavier crude oils;
- hydrotreaters, which improve the quality of the product stream by removing contaminants;
- desulfurization units, which remove sulfur to produce low-sulfur fuels required to meet national environmental standards; and
- reformers, which convert certain low-octane gasoline material from the distillation unit into petrochemical feedstocks and higher-octane products suitable for blending into finished gasoline.

In recent years, global demand for refined products has grown significantly and exceeded refinery capacity growth, causing refineries worldwide to run closer to their maximum production capacity, and contributing to recent increases in petroleum product prices and refining profits. In the United States, average annual refinery utilization rates—a measure of how intensely a refinery is performing, with a theoretical

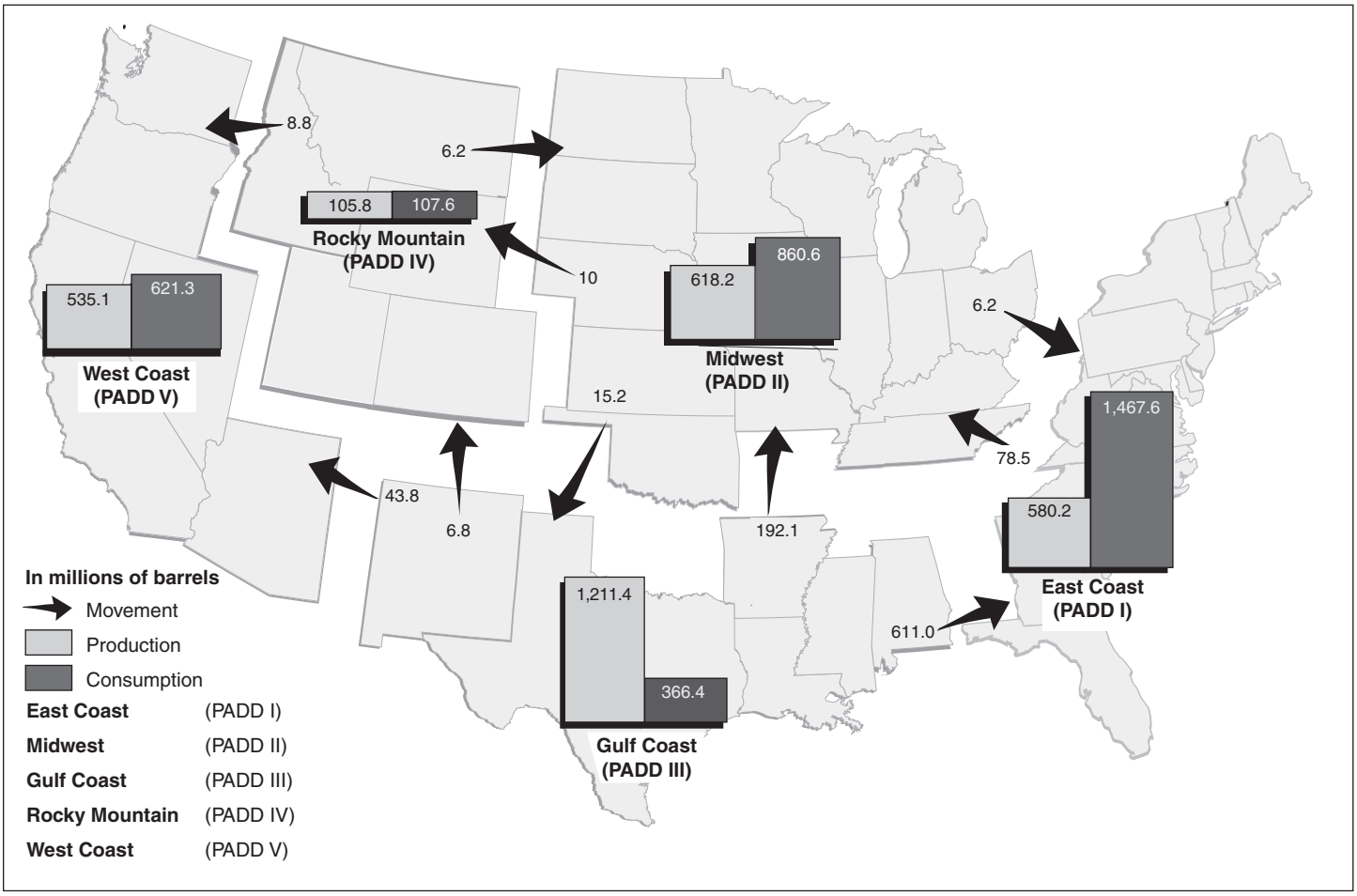
[5]Two of the nation's 150 operable refineries specialize in the production of asphalt, which typically relies on a distillation process only, with no other processing through other specialized processing equipment.

maximum rate of 100 percent[6]—rose steadily from 1985 to a first peak in 1998. Then these rates declined and rose to another peak in 2004, from which they have subsequently declined. U.S. refining capacity is heavily concentrated around the Gulf Coast—56 of the 150 operable U.S. refineries and almost half of the nation's operable refining capacity are located in this region. Gulf Coast refiners provide a natural option to resupply other markets, since they have ready access to imported crude oil supplies, numerous options for shipping product to the rest of the United States by pipeline and waterways, and a concentration of highly skilled workers.

Figure 1 illustrates how the United States is divided into five geographic regions—East Coast, Midwest, Gulf Coast, Rocky Mountain, and West Coast—called Petroleum Administration for Defense Districts (PADD). PADDs were created during World War II to help organize the allocation of petroleum products. Following this approach, many petroleum data collection organizations use the PADD regions to organize their petroleum data sets for analytical purposes. While some PADD regions need to import gasoline to meet consumer demand, such as the East Coast (PADD I) or Midwest (PADD II) regions, other regions, such as the Gulf Coast (PADD III), are large exporters to other areas of the United States. Figure 1 also depicts the movements of gasoline among the PADD regions in the United States.

[6]A refinery's utilization rate is calculated as the rate at which crude oil is fed into the distillation unit divided by the operable refining capacity of the unit. The utilization rates for secondary processing units, such as cokers or fluid catalytic crackers, can also be calculated by using a similar approach that compares the inputted volume to the unit's capacity.

Figure 1: Refined Product Flows in the United States by PADD, 2007



Source: GAO analysis of EIA data.

Note: A PADD's production is the amount produced within that PADD. A PADD's consumption is the sum of production within that PADD, net foreign imports, and net movement of product from other PADDs.

The supply infrastructure is a critical component of the nation's refined product markets in that it facilitates the flows of crude oil and refined products from one PADD or geographic region to another. From refineries, petroleum products are distributed through an extensive supply infrastructure composed of pipelines, barges, tanker vessels, marine terminals, railroads, trucks, and storage tanks. Crude oil pipelines connect several large refining centers to crude oil sources, and petroleum product pipelines connect these refineries to population centers all over the country. Thus, a disruption in one geographic region can affect the supply

and prices in another geographic region, and areas with fewer infrastructure options, such as the Rocky Mountains and the West Coast, may experience more significant price spikes and volatility due to a disruption. To help mitigate the effects of potential supply disruptions and facilitate smooth supply operations, refiners, distributors, and marketers of petroleum products maintain inventories of crude oil and petroleum products. Inventories represent the most accessible and available source of supply in the event of a production shortfall, such as one caused by a refinery outage, or increase in demand. However, long-term trends in inventories when measured as average days of consumption of petroleum products and crude oil in the United States indicate a general decline over the past 20 years and gasoline and crude oil inventories in many industrialized countries elsewhere have generally fallen over the same period.[7]

The increasing use of special fuel blends—refined petroleum products that are formulated to meet local, state, and federal environmental requirements of reducing harmful emissions from vehicles—has the potential to stress the gasoline supply system and raise costs, affecting operations at refineries, pipelines, and storage terminals.[8] Once produced, the various blends of refined products must be kept separate throughout shipping and delivery, effectively reducing the capacity of pipelines and storage terminal facilities and raising the costs of transporting petroleum products. Moreover, in the past, local supply disruptions could be addressed more quickly because additional fuel of the same formulation was readily available, but with the proliferation of special fuel blends, replacement supplies of a special blend may not be readily available, and refineries with the capability to produce them might be hundreds of miles away.

[7]Specifically, we recently reported that inventories of gasoline and crude oil in Organisation for Economic Co-operation and Development Countries—a group of 30 mainly industrialized nations with market economies—have generally fallen over the past 20 years. See, *Energy Markets: Increasing Globalization of Petroleum Products Markets, Tightening Refining Demand and Supply Balance, and Other Trends Have Implication for U.S. Energy Supply, Prices, and Price Volatility*, GAO-08-14 (Washington, D.C.: December 2007) for more information.

[8]These concerns were highlighted in a recent GAO report, *Gasoline Markets: Special Gasoline Blends Reduce Emissions and Improve Air Quality, but Complicate Supply and Contribute to Higher Prices*, GAO-05-421 (Washington, D.C.: June 2005).

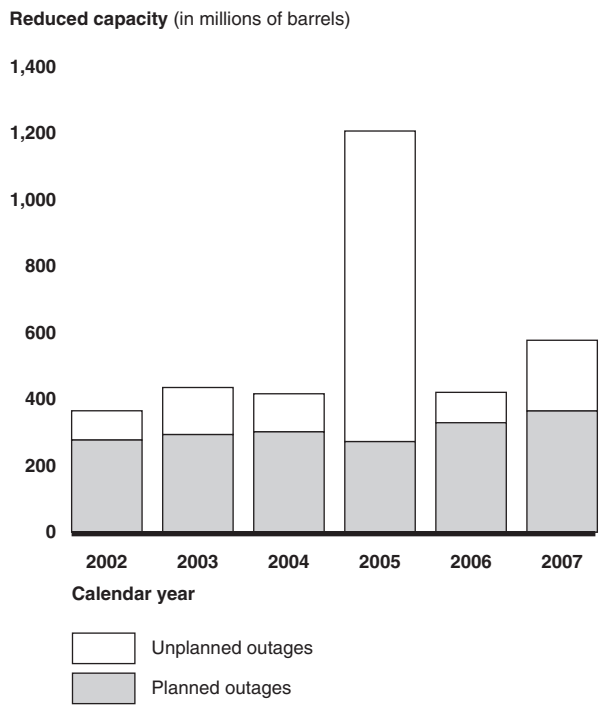
EIA analyzes supply and consumption trends across energy markets. To that end, EIA collects monthly data from refiners regarding the amounts of crude oil they receive and process and the volumes of refined products they produce. The EIA collects this data via the monthly refinery production survey known as the EIA-810 form, which is part of the EIA Monthly Petroleum Supply Reporting System, a survey of refiners and refined product marketers. EIA began the EIA-810 and the Monthly Petroleum Supply Reporting System in January 1983 to integrate the collection and processing of petroleum supply data that had been collected on other survey forms. The EIA-810 is for internal use and the limited use of certain statistical agencies. The annual EIA-820 refinery survey is a compendium of capacity and fuel utilization data from all operating and idle refineries, located in the 50 states, District of Columbia, Puerto Rico, U.S. Virgin Islands, Guam, and other U.S. possessions. EIA uses these data to perform periodic analyses of refined product markets.[9]

With the Exception of Hurricane Effects, There Are No Discernible Trends in Reduced Production Capacity as a Result of Outages from 2002 through 2007

With the exception of effects beginning in 2005 related to hurricanes Katrina and Rita, our analyses of commercial data on unplanned and planned refinery outages across the United States generally do not show discernible trends in reduced production capacity or in the frequency and location of outages from 2002 through 2007. Figure 2 shows that reduced production capacity as a result of unplanned and planned refinery outages was relatively constant over the period with the exception of 2005 when hurricanes Katrina and Rita caused refinery production capacity to be significantly reduced as a result of unplanned outages when refiners in or near the path of the storms were forced to close down multiple facilities.

[9]The Form EIA-820 is used to collect data on fuels consumed for all purposes at the refinery during the preceding year; refinery receipts of crude oil by method of transportation during the preceding year; current and next year projections for operable atmospheric crude oil distillation capacity; and current year working and shell storage capacity for crude oil and petroleum products at the refinery.

Figure 2: Reduced Capacity in the United States as a Result of Refinery Outages, 2002 through 2007



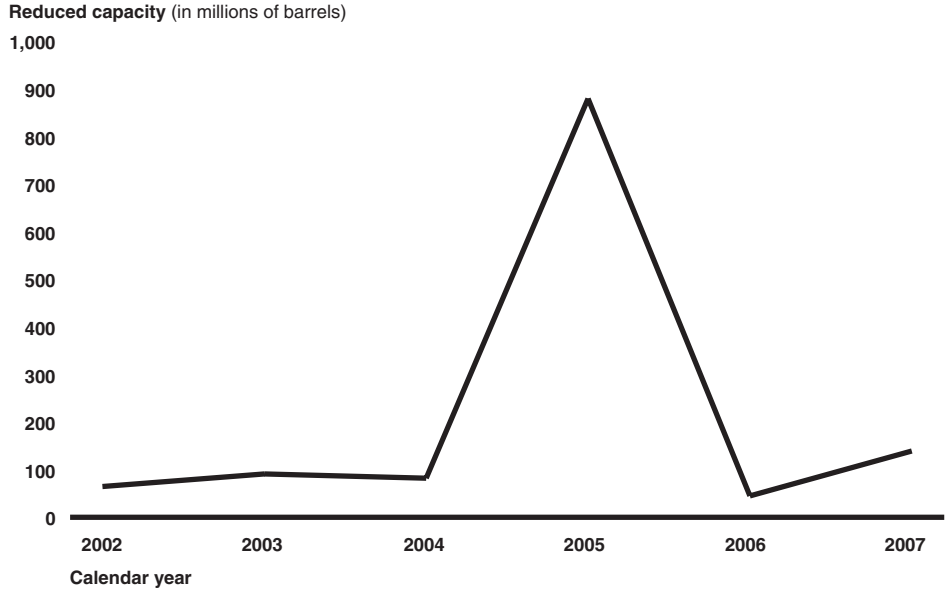
Source: GAO analysis of IIR data.

Note: While IIR data collects information on outages by 12 different secondary processing units, not all outages lead to similar volumes of capacity offline. For example, outages due to breakdowns or maintenance on four types of processing units (atmospheric distillation units, delayed cokers, fluid catalytic crackers, and cyclic reformers) accounted for approximately 83 percent of all outages and 88 percent of reduced capacity due to outages between 2002 and 2007. Breakdowns or maintenance of atmospheric distillation units accounted for 49.7 percent of reduced capacity as a result of outages during that same time period.

Our analyses of commercial data from 2002 through 2007 indicate that the impact of the hurricanes resulted in two patterns of outages for refiners, depending on whether they were directly affected by the hurricanes, specifically: (1) certain refiners that were forced to shut down due to the hurricanes opted to perform maintenance or upgrade and improve equipment where feasible during their unplanned outages, thus extending the length of time until the next expected round of planned outages for maintenance; and (2) in some cases, refiners not directly impacted by the hurricanes deferred planned outages to continue to supply the market, thus partially increasing the need in subsequent years for turnarounds and other planned outages for these refineries.

Industry representatives said and our analysis of commercial data corroborates, that some U.S. Gulf Coast refiners—those most directly affected by the hurricanes in 2005—chose to perform what maintenance and equipment upgrading projects they could during their hurricane-related outages, thus reducing their need for large maintenance projects in 2006. Figure 3 shows the trend in capacity lost as a result of unplanned outages experienced by refiners in the U.S. Gulf Coast states of Alabama, Louisiana, Mississippi, and Texas. Specifically, the reduced capacity attributable to unplanned outages at Gulf Coast refineries increased from approximately 82 million barrels in 2004 to approximately 880 million barrels in 2005 before decreasing to approximately 45 million barrels in 2006.

Figure 3: Reduced Capacity in U.S. Gulf Coast States of Alabama, Louisiana, Mississippi, and Texas as a Result of Unplanned Refinery Outages, 2002 through 2007

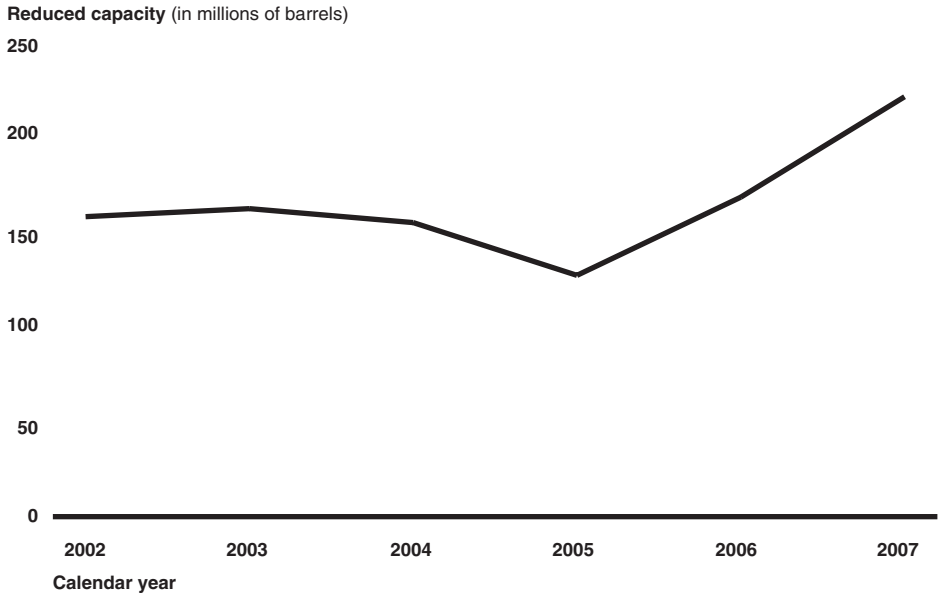


Source: GAO analysis of IIR data.

While unplanned outages due to the hurricanes significantly reduced refinery capacity on the Gulf Coast in 2005, we found that the reduced capacity as a result of planned outages at refineries in states not directly impacted by hurricanes decreased in 2005. Industry representatives, including officials from the National Petrochemical Refiners Association, told us that these refiners may have deferred some planned outages—provided it was safe to do so—so that they could continue to supply the

market during the aftermath of the hurricanes. Subsequently, relatively high volumes of refinery capacity were disrupted due to planned outages in 2006 and 2007 in non-Gulf refineries, indicating that maintenance activities were more intensive possibly because of maintenance deferred in 2005 (see fig. 4).[10] Specifically, the reduced capacity attributable to planned outages increased from approximately 130 million barrels in 2005 to approximately 170 million barrels in 2006 and approximately 222 million barrels in 2007 for these non-Gulf refiners.

Figure 4: Reduced Capacity Resulting from Planned Outages for U.S. Refiners Excluding Alabama, Louisiana, Mississippi, and Texas [Non-U.S. Gulf Refiners], 2002 through 2007



Source: GAO analysis of IIR data.

As part of our analysis, we analyzed refineries in certain clusters of states not directly impacted by the hurricanes and found that refiners appeared to defer their planned outages in 2005. Specifically, we found that refineries in the Northeastern states of Delaware, New Jersey, and Pennsylvania, and the Midwestern states of Illinois, Indiana, Minnesota,

[10]Other factors could have been responsible for some of this increase in planned outages. For example, PADD II (Midwest) refineries in 2007 could have scheduled large planned outages to perform equipment upgrades to handle new Canadian crude streams coming online.

and Ohio had the fewest planned outages and smaller effects on their production capacity in 2005 than any other year between 2002 and 2007. In the Midwestern states, the number of planned outages decreased from 35 in 2004 to 14 in 2005, and then increased to 24 in 2006 and 20 in 2007. Subsequently, the loss of refinery capacity as a result of planned outages in those states decreased from approximately 37 million barrels in 2004 to approximately 23 million barrels in 2005, and then increased to approximately 29 million barrels in 2006 and 56 million barrels in 2007. Similarly, planned outages in Northeastern refineries decreased from 19 in 2004 to 10 in 2005 and then increased to 16 in 2006 and 15 in 2007. Lost refinery capacity as a result of planned outages in the Northeastern states decreased from approximately 30 million barrels in 2004 to approximately 12 million barrels in 2005, and then increased to approximately 52 million barrels in 2006 and 29 million barrels in 2007. Our analysis corroborates what industry officials told us and underscores the interconnected nature of the U.S. petroleum product market, where a refinery in one geographic region may react to the economic signals and product needs of another region.

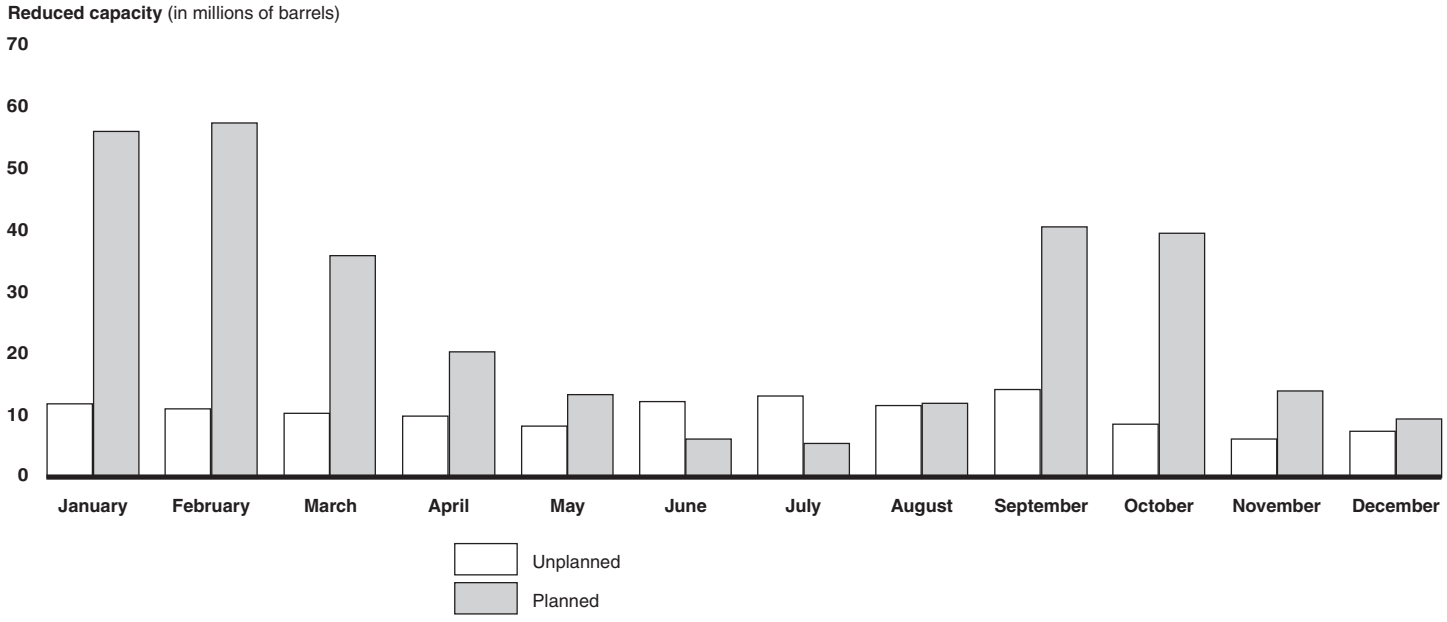
Although our analyses indicate, and our interviews with industry observers corroborated, that some deferrals of planned outages are possible and may be desirable under certain circumstances, in general, delaying planned maintenance is highly unusual.[11] Large planned outages are typically scheduled during periods of less demand and interspersed among refiners and refineries. For example, by scheduling large planned outages during periods of relatively low refined product demand, refineries can purchase additional supplies of refined products to fill orders with those customers with whom they have long-term contracts for refined products at a cost less than would be required in an emergency or unplanned situation. In addition, refineries have the ability to produce at the highest possible rate during summer and winter, when gasoline and heating oil demand, respectively, is peaking. Refiners also told us they generally have little flexibility to defer maintenance, as the equipment and labor for such an endeavor must be booked months—or even years—in advance. Because there are a limited number of qualified technical staff to perform the work—up to 2,000 additional technical staff from a contracting firm can be involved in completing a major turnaround—such

[11]In some circumstances, economic considerations, including unusually high demand for refined products and/or unusually high refining margins, may warrant the deferral of a planned outage, if safety concerns are not affected.

labor may only be available to a limited number of refineries at one time, and consequently refiners have little opportunity to complete turnarounds at many refineries simultaneously.

Planned refinery outages in the aggregate are somewhat predictable and exhibit seasonal patterns. Figure 5 shows the seasonal nature of reduced capacity as a result of planned outages, as shown by an analysis of IIR data.

Figure 5: Reduced Capacity Due to Outages by Month in Which Outage Began, United States, 2002 through 2007



Source: GAO analysis of IIR data.

Note: Analysis excluded the months of July, August, and September 2005 in order to eliminate distortions due to the effects of the 2005 hurricanes.

This figure also shows that, in recent years, reduced capacity as a result of unplanned outages has occurred most frequently in the summer months of June through September—peak summer driving season—and the time when refinery utilization is generally highest.[12] Therefore, if a refinery has an unplanned outage during this period of peak demand and profitability,

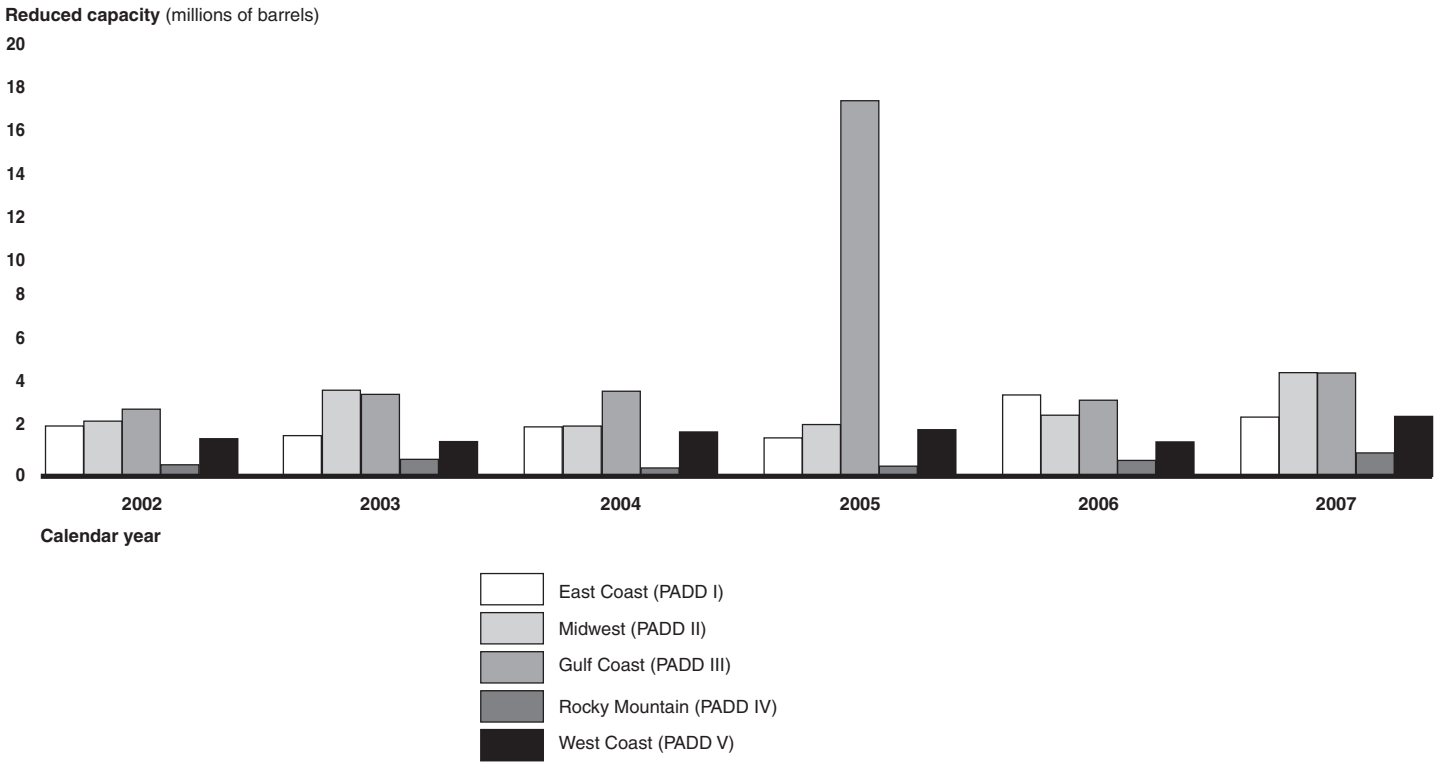
[12]Refining margins are defined as refined product revenues less raw material expense and product purchases divided by refined product sales volume.

it is of relatively higher economic consequence to both the refiner, who is not able to sell the product at the period of typically high margins and profits, and to consumers, since an outage in a relatively tight marketplace can trigger higher price increases, all else equal.

Industry experts told us they want to avoid unplanned outages for both safety and economic considerations. Unplanned outages can be much more expensive for refiners than planned outages. Typically, if refiners are unable to borrow the needed products from neighboring refineries to meet their contractual obligations to buyers or to keep those refining units that are not down for maintenance operating, they must purchase what they need from traders or on the spot market—perhaps at a significantly higher cost. In addition, labor is cheaper to book in advance of a planned outage; refiners pay relatively high costs for the specialized labor needed to fix the equipment if an unplanned outage occurs, and these specialized workers may be pulled off their other work. According to the American Petroleum Institute, delaying a turnaround can increase the cost of the turnaround by 20 to 50 percent or more.

With regard to overall regional variation in reduced production capacity, our analyses showed few apparent trends by region with the exception of the hurricane-related issues discussed previously. We did find some variation with regard to reduced capacity across regions, as shown in figure 6. Specifically, refineries in the PADD III Gulf Coast region experienced a slightly higher rate of outages than refineries in other PADDs.

Figure 6: Reduced Production Capacity Per Plant Due to Outages by PADD, United States, 2002 through 2007



Source: GAO analysis of IIR data.

Experts told us that a number of factors could be responsible for this, including the fact that Gulf Coast refineries are among the biggest in the world. To the extent that Gulf Coast refineries have a greater number of distillation and secondary processing units, they have a greater number of pieces of equipment for which periodical maintenance must be scheduled. In addition, as noted earlier, the Gulf Coast experiences seasonal weather disturbances such as hurricanes, where refineries may need to regularly shut down to avoid harm to processing equipment.

There Are No Federal Requirements to Report Refinery Outages, and Existing Data May Not Allow EIA to Adequately Ascertain Some Effects of Outages on Prices of Petroleum Products

At present, there are no federal requirements for refiners to report planned or unplanned refinery outages, and available data may not allow EIA to adequately ascertain the impact of outages on prices of petroleum products. As recently as July 1, 2008, DOE noted that information on refinery disruptions and their possible effects on petroleum product supplies "are essential" to the mission of the Department of Energy and EIA in particular;[13] however, EIA has not directly collected data on refinery outages because officials believe that they can indirectly estimate outages using existing EIA data as well as use available commercial data for their reporting purposes.

EIA collects some data—through the EIA-810 monthly refinery survey—regarding the amounts of crude oil refineries receive and process, as well as volumes of certain refined products they produce. Specifically, the EIA-810 collects information regarding the balance between the fuel supply (beginning inventory stocks, receipts, and production) and use (inputs, shipments, fuel use and losses, and ending inventory stocks) of crude oil and refined petroleum products located at refineries. However, the EIA-810 does not collect information on refinery outages directly and thus the information it currently collects can only be used to indirectly estimate outages. Specifically, to assess the likelihood that an outage occurred in a given month, EIA has evaluated the crude oil processed by certain processing units for that month, and compared those with historical volumes processed. If EIA determines that the monthly volume is significantly less than the maximum potential amount for that calendar year, EIA views this as a strong indication of an outage. Agency officials can also look at other information in the EIA-810 data to corroborate that an outage has occurred. While we found this method of analyzing the EIA-810 data useful for estimating gross trends in outages, it has a number of limitations:

- It cannot determine whether the outage was planned or unplanned, which, as discussed previously, may have different ramifications for the potential impact on product prices;
- EIA's methodology may be unable to identify some major outages because the information on the Form EIA-810 is monthly aggregate data. For example, if an outage were to straddle the end of 1 month and the

[13]Proposed Agency Information Collection, U.S. Department of Energy, 73 Fed. Reg. 37453, (2008).

beginning of the next, its observed impact on crude input would be diluted and it may be difficult to identify the outage and the corresponding reduction in refining capacity; and

- The exact date and length of an outage cannot be determined, only the months in which it occurred.

As a result, it is difficult to use EIA-810 data to determine whether a specific outage had a significant impact on the production of some petroleum products as well as market prices.

EIA is independently exploring whether to collect data directly on planned and unplanned outages from refiners, which might provide more comprehensive and detailed information on outages. On February 28, 2008, EIA issued a notice for public comment on a proposal to collect data from refiners on their planned and unplanned outages on the EIA-810 monthly survey. EIA's proposal would require refiners to report monthly to EIA all outages that lasted 5 days or more. The report would include whether the outage was planned or unplanned; the outage stop and start dates; the capacity affected; the type of processing unit that was affected; and the projected effects on the production of petroleum products including finished motor gasoline, motor gasoline blending components, jet fuel, kerosene, and other distillates.

In addition, EIA is preparing to enhance its monitoring of outages in response to the Energy Independence and Security Act of 2007,[14] which requires EIA to review commercially available information on planned refinery outages and report at least semi-annually on the potential effects of planned outages on petroleum markets. Among other provisions, the law calls for EIA to:

- analyze information to determine whether the scheduling of a refinery outage may substantially affect the price or supply of any refined petroleum product nationally or regionally by decreasing its production and causing or contributing to a retail or wholesale supply shortage or disruption;

- submit a report describing the results of the review at least twice a year; and

[14]Pub. L. No. 110-140 (2007).

- alert the Secretary of Energy of any refinery outage that may nationally or regionally substantially affect the price or supply of a refined petroleum product.

If the Secretary of Energy deems that EIA's report indicates a certain outage may affect the price or supply of a certain refined petroleum product, the law states the Secretary "shall make available to refinery operators information on planned refinery outages to encourage reductions of the quantity of refinery capacity that is out of service at any time." EIA officials told us that at present they plan to primarily rely on the IIR data, but will supplement it with other commercial data to perform the mandated semi-annual analyses of planned outages. In general, EIA officials noted that the agency's approach to collecting and analyzing data on refinery outages is evolving.

We found the IIR data to be sufficient for our analyses of historical trends of reduced capacity and the frequency, magnitude, and geographic location of outages.[15] However, the IIR database is not designed to collect the type of data necessary to fully evaluate the effects of outages on prices of petroleum products. We've identified several reasons the data may not be comprehensive enough for EIA's semi-annual analyses. Specifically:

- The IIR data track production capacity offline due to planned or unplanned outages, and the type of unit that incurred the outage, but do not track the specific type of petroleum products disrupted. For example, they do not track whether the decline in production was a decline in gasoline, diesel fuel, or another refined petroleum product. EIA officials pointed out that capacity offline is not a sufficient measure of lost production because it may not accurately capture reduced production in the restart period after an outage. Therefore, EIA may need additional data to accurately estimate reduced production as a result of refinery outages and to evaluate the effects of outages on the prices of specific petroleum products.

- There are incentives for refiners to keep planned outages private, lest they be disadvantaged in the marketplace when attempting to book the labor,

[15]While there is no other comprehensive commercial or federal data on outages to benchmark the IIR data against, IIR strives to update its data with current information on planned and unplanned outages, including, if necessary, adjusting the dates of planned outages as they shift and updating on a daily basis its database of unplanned outages. According to EIA officials, their analysis confirms that IIR data is reliable for conducting retrospective analyses on planned and unplanned outages.

supplies, and other inputs needed to perform major turnarounds. This could limit the ability of IIR to know of and account for all planned outages in a timeframe consistent with EIA's needs. Specifically, it is uncertain whether future planned outages could be identified comprehensively at the time EIA needs the data to do its analyses without a requirement that refineries provide this information to EIA. EIA officials stated that EIA's review of IIR data indicated that the database captured most outages historically.

EIA's recently proposed requirement for the collection of outage data appears to be generally as comprehensive as the commercially available IIR data, in that it tracks almost all of the processing units that IIR tracks—and all the processing units that our analyses found to be significant sources of outages— and, in addition, tracks some other units that IIR does not track.[16] However, EIA is only planning to capture outages that last longer than 5 days, while IIR captures all outages of more than 10,000 barrels per day. While the data EIA proposes to collect has the potential to be at least as effective at capturing the broad historical record of outages in the United States as the existing IIR data, it is unclear whether it will be implemented. As of August 2008, EIA has not provided a time frame for finalizing the proposal and proceeding with collecting and reporting such data.[17]

In addition, EIA does not collect—and is not proposing to collect—other information that could be important for DOE in meeting its obligations to conduct periodic analyses of the potential effects of refinery outages on prices of petroleum products. Since the creation of the EIA-810 survey in 1983, the refining sector has changed; in particular, the increasingly stringent fuel blend specifications have necessitated the installation of

[16]Specifically, EIA's proposal would track alkylation, gasoline hydrotreating, and distillate hydrotreating units, which IIR does not currently track. In addition, IIR data tracks other processing units, which EIA's proposed enhanced survey would not track. Our analyses of outages on secondary processing units using IIR data show that EIA's proposal would track all units on which almost all outages, according to our analysis of IIR data, occur.

[17]In addition, on July 1, 2008, DOE issued a notice for public comment on a proposal to collect data on emergency shutdowns of refineries and major processing units or other systems with the potential to significantly disrupt production. The proposal would require refiners to report the date and time of the disruption or incident; its duration; the type of incident; the actions taken by the refinery, units, or processes affected; the estimated production impact; a narrative description of the disruption or incident; details on the impact to supplies and stocks; and storage or distribution problems. The closing for comments of this notice was September 2, 2008. 73 Fed. Reg. 37451 (2008).

complex equipment capable of refining such formulations. In addition, the recent proliferation of special fuel blends and introduction of several federally mandated changes to gasoline specifications—including the addition of biofuels—have changed the formulation of products refineries produce. In making adjustments for some of these changes EIA's survey was updated in 1987 to include additional types of refining processing units, and in 2004 to track addition types of fuels.[18] However, there are still a number of fuels that are not captured by the EIA-810 survey and would not be captured under EIA's current proposal to enhance the survey. In this regard, we identified some data that would allow EIA to more comprehensively analyze the potential impacts of refinery outages and are within EIA's purview to collect, including information on:

- Special fuel blends that may be produced by only a handful of refineries for a state or city with a particular fuel standard. Cities in states requiring these or other special blends of gasoline are particularly vulnerable to price spikes if a refinery outage occurs because it would take time for another refinery to make and transport these fuels in the event one of the few regular producers had an outage.

- Biofuel blendstocks with different proportions of biofuels such as ethanol, which are of increasing use due to federal, state, and local mandates. These blendstocks represent distinct fuels that must be segregated during transportation and storage, putting additional stress on the petroleum product infrastructure. Limited data are available on biofuel production, but they could be increasingly important to understanding price effects as the number of types of blendstocks increases to reflect varying federal, state and local requirements to blend biofuels with petroleum products.[19] EIA officials told us that they have the ability to request information from refineries regarding specific fuel blends and biofuel blendstocks on a case-by-case basis. However this information is not available in a comprehensive historical database, limiting potential EIA analyses to individual case studies. Further, some data are not available to other

[18]The 2004 update was the most recent update to the EIA-810 survey.

[19]The Form EIA-810 currently collects data on fuel ethanol and several gasoline blending components including reformulated blendstock for oxygenate blending (RBOB) for blending with alcohol and conventional blendstock for oxygenate blending (CBOB). According to EIA officials, EIA will begin collecting data on biodiesel in 2009. The Energy Policy Act of 2005 requires the Department of Energy to collect monthly data on the quantity of renewable fuels produced, blended, imported, and demanded on both the regional and national level.

government agencies or researchers for proprietary reasons, limiting the public understanding of how petroleum product markets function and specifically, how events such as outages affect consumer prices. While EIA officials stated that they believe special fuel blends and biofuel blendstocks have not contributed to higher gasoline prices except in a few isolated cases, they noted that the proliferation of these fuels could have significant price impacts in the future.

While a full cost/benefit analysis of the merits of collecting additional data such as special fuel blends and biofuel blendstocks was outside the scope of this review, EIA has the authority and expertise to determine and suggest what other information for inclusion on the EIA-810 monthly refiner survey could be helpful in adequately evaluating the potential effects of both planned and unplanned outages on prices of petroleum products.

Conclusions

Given the tight balance between supply and consumption of refined petroleum products, the critical role refining plays in providing fuels to consumers and industry, and the importance of petroleum products to the economy, it is essential for EIA to be adequately prepared to respond to questions by the Congress and others regarding the refining industry. In addition, EIA should ensure that the information collected adequately reflects industry trends over time, and when possible, predicts future trends. With EIA planning to meet its new reporting obligations under the Energy Independence and Security Act of 2007, and as it considers whether to begin collecting additional data from refiners, EIA is at a natural decision-making point regarding what refinery information it will need going forward. As it makes these decisions, it is important for EIA to ensure that data—from its monthly refiner survey and commercial sources—are sufficient to allow the federal government to comprehensively track and understand refinery outages and other market phenomena. Based on our work, we believe that there are important gaps in the data that are currently available and that some of these gaps would persist even if EIA's current proposal to collect outage data is adopted. Without formally collecting other data within EIA's purview to collect—including data on special fuel blends and biofuel blendstocks—EIA and others may not be able to adequately analyze and describe the effects of refinery outages on reduced production capacity and prices of petroleum products.

We recognize that, as EIA moves forward with its data considerations, it must strike a reasonable balance between meeting the needs of the

Congress and the public and not being overly burdensome on industry to provide and on EIA to collect and manage these data. However, without sufficient data to allow the federal government to comprehensively track refinery outages and understand their implications, EIA may miss an opportunity to provide meaningful information to policy makers and to address important questions about petroleum product prices, such as gasoline, that are key to public confidence in government.

Recommendations

To meet its obligations to periodically report on the potential effects of planned outages and fulfill its federal role in providing timely and accurate data to explain trends in energy markets, we recommend that the Secretary of Energy direct the Administrator of EIA to (1) reevaluate its EIA-810 monthly refinery production survey and commercially available data, to determine whether those data sufficiently reflect changes over time in various blends of fuels refiners produce to allow EIA to adequately conduct future analyses of outage effects on prices of petroleum products and (2) report to the Congress on the cost and benefits of collecting any additional, more discrete data on fuels not currently included in the EIA-810 survey, including special fuel blends and biofuel blendstocks that may be produced by a limited number of refineries or used in a limited market that could be disproportionately affected by outages.

Agency Comments and Our Evaluation

We provided a draft of this report to DOE and its Energy Information Administration (EIA) for review and comment, and met with officials from EIA's Office of Oil and Gas to obtain their verbal comments. EIA's comments and GAO's evaluation are summarized below. EIA provided other clarifying and technical comments that we incorporated as appropriate but EIA did not comment on the report's conclusions or recommendations.

EIA officials stated that the draft report did not distinguish sufficiently between the need for both data and analysis to effectively characterize the impacts of outages on the price of petroleum products. More specifically, they said that, in some cases, improved analytical approaches are more important to understanding these effects than additional or more comprehensive data. GAO agrees that there are analytical limitations to measuring the impacts of refinery outages on petroleum product prices that are difficult to resolve. However, we continue to believe that there are important gaps in the data that are currently available on the EIA Form 810 and from commercial data sources and that some of these gaps would persist even if EIA's current proposal to collect outage data is adopted.

Without these data—including data on special fuel blends and biofuel blendstocks--EIA and others may not be able to adequately analyze and describe for some markets the effects of refinery outages on reduced production capacity and prices of petroleum products.

EIA officials stated that the draft report did not distinguish between historical and future data and analyses on refinery outages. In this regard, they said that current data collected through the EIA-810 survey are sufficient to analyze or track historical impacts of refinery outages on the production of petroleum products. We believe the report does distinguish between historical and future data, as well as the potential and existing requirements for analyzing outages. For example, we note that there are no historical federal requirements to collect data on outages, and we also point out that EIA has a proposal to collect such information. Similarly, we note that EIA has completed a study of the impacts of refinery outages, and that there is a new federal mandate that requires EIA to conduct semi-annual prospective analyses of the potential price impacts of refinery outages. Again, however, we continue to believe that there are important gaps in the available data that would persist even if EIA's proposal is adopted and that EIA and others may not be able to adequately analyze and describe the effects of refinery outages without these data. Thus, we made no changes to the report in response to this comment.

EIA officials stated that the report did not discuss why it is important to distinguish between unplanned and planned refinery outages and how that distinction could be useful. We added language detailing why it is important to distinguish between planned and unplanned outages to the introduction of this report. Specifically, we noted that analysts sometimes raise concerns that unplanned outages could affect prices differently than planned outages.

EIA officials stated that the draft report does not recognize that EIA currently collects some data on ethanol and plans to begin collecting information on renewable fuels and biodiesel in 2009. We acknowledge that EIA collects some data on ethanol and plans to collect other data on renewable fuels and biodiesel. We have added language to the report to reflect these data collection efforts. However, the proliferation of biofuel blends, including various blends of ethanol in gasoline, will lead to a commensurate proliferation of biofuel blendstocks that have to be segregated during shipment, further stressing the pipeline and storage infrastructure. We believe that data on these blendstocks and other unique gasoline blends are necessary information to help EIA better understand the petroleum products market.

As agreed with your offices, unless you announce its contents earlier, we will not distribute this report until 30 days from its date. At that time we will send copies of this report to interested congressional committees, the Secretary of Energy, and other interested parties. We will also make copies available to others upon request. In addition, this report will be available at no charge on the GAO Web site at http://www.gao.gov.

If you or your staffs have any questions concerning this report, please contact me at (202) 512-3841 or ruscof@gao.gov. Contact points for our Offices of Congressional Relations and Public Affairs may be found on the last page of this report. Major contributors to this report are acknowledged in appendix II.

Frank Rusco
Acting Director, Natural Resources and Environment

List of Requesters

The Honorable Charles E. Schumer
Chairman
Joint Economic Committee
United States Senate

The Honorable Christopher J. Dodd
The Honorable Byron L. Dorgan
The Honorable Joseph I. Lieberman
United States Senate

The Honorable Joseph Courtney
The Honorable Rosa DeLauro
The Honorable John B. Larson
The Honorable Christopher S. Murphy
The Honorable Christopher Shays
House of Representatives

Appendix I: Scope and Methodology

We addressed the following questions during our review: (1) What are the trends in U.S. refinery outages over the last 5 years, in terms of reduced production capacity, frequency, and geographic location, and (2) What are the federal requirements for reporting outages at U.S. refineries. For the purposes of this report, we will define the various types of outages as follows:

- Planned outages are periodic shutdowns of one or more refinery processing units or possibly the entire refinery to perform maintenance, inspection, and repair of equipment or to replace process materials and equipment that have worn out or broken, in order to ensure safe and efficient operations.

- Unplanned outages are events where an entire unit or refinery must be brought down immediately and without advance notice and are caused by unplanned circumstances such as a fire or a power outage.

We also refer to an outage as the halting of production of any crude distillation unit or secondary processing equipment; thus, a refinery can have multiple outages simultaneously, and the number of outages being experienced at any given time can be greater than the number of refineries operating at that time. In addition, an outage is counted as a downtime of a unit by at least 1 day, but in practice, a unit experiencing an hours-long downtime would count as an outage of 1 day's duration. To determine trends in refinery outages over the last 5 years, we purchased data from Industrial Information Resources, Inc. (IIR) that contain detailed information on refinery outages, including the date of the outage, whether the outage was planned or unplanned, and the amount of reduced production capacity due to the outage. We evaluated the data and found they provide reliable estimates of all outages from 2002 onward.

To determine the requirements for reporting outages at U.S. refineries, we conducted a comprehensive literature review of economic, federal and state agency, and legislative material relevant to federal and state reporting requirements for refiners. In addition, we identified several states with a large number of refineries and approached the relevant state energy and environmental entities responsible for monitoring petroleum product markets. We conducted interviews with academic, industry trade group, and federal and state agency officials as well as members of the refining industry to gather information about federal and state reporting requirements. We obtained and analyzed federal and state legislation, policy, and guidance regarding legislated production requirements and interviewed federal agency and state officials to obtain more information

about the purpose and utility of such requirements. We obtained refinery production information from databases that track refinery outages or information from which outage information may be inferred, as well as data from OSHA and EPA from which outage information may be inferred. We obtained and analyzed EIA-810 monthly refinery production survey data from 1986 through 2006, and interviewed EIA and other officials regarding the purpose of the data and their ability to track outages and monitor petroleum product markets. We analyzed the EIA-810 to determine whether it was sufficient to perform analyses of the effects of planned outages on petroleum product markets, as mandated by law.

We conducted this performance audit from August 2007 through September 2008 in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives.

Appendix II: GAO Contact and Staff Acknowledgments

GAO Contact

Frank Rusco (202) 512-3841 or ruscof@gao.gov

Staff Acknowledgments

In addition to the individual named above, Dan Haas, Frank Cook, Michael Kendix, Christopher Klisch, Rob Marek, Micah McMillan, Michelle Munn, Alison O'Neill, Kimberly Perteet, Rebecca Sandulli, and Barbara Timmerman made key contributions to this report.