U.S. Energy Information Administration

Market Assessment of Refinery Outages Planned for March 2011 through June 2011

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Preface and Contacts

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Summary

Section 804 of the Energy Independence and Security Act of 2007 (Pub. L. 110-140) requires the U.S. Energy Information Administration (EIA) to review and analyze planned refinery outages "not less frequently than twice each year." This report reviews the implications on supplies of gasoline and middle distillate fuel (diesel, jet fuel, and heating oil) from refinery outages planned for March through June 2011, which covers the seasonal increase in summer driving. Refinery outages are the result of both planned maintenance and unplanned unit shutdowns. Maintenance is usually scheduled during the times when consumption is lowest, i.e., in the first quarter and again in the fall. Unplanned outages can occur at any time and for any reason such as mechanical failure, fire, or flood.

EIA's analysis of current data for planned refinery outages, combined with the typical level of unplanned outages, indicates that available refinery capacity during the period from March through June 2011 is adequate to meet forecasts of U.S. gasoline and middle distillate consumption based on EIA's February 2011 *Short-Term Energy Outlook (STEO)*. However, Petroleum Administration for Defense District (PADD) 5 (see Appendix B) may experience tight markets and temporary price pressures in April or May.

EIA relies on commercial data, mainly that supplied by Industrial Info Resources, Inc. (IIR), to identify planned and unplanned outages. The production loss from these outages must be estimated to assess the potential impacts on markets. EIA estimates refinery production impacts of the outages using relationships between EIA historical refinery production and refinery unit input data. This report focuses on crude distillation and fluid catalytic cracking (FCC) unit capacities, since these are the refining units that have the most impact on production of distillate and gasoline, respectively.

Both gasoline and distillate inventories are at normal to high levels in most regions of the United States. Gasoline inventories, which had grown to very high levels earlier this year, fell sharply over the past month or so as stocks were used to help meet demand while some refineries underwent seasonal maintenance and as winter-grade gasoline was drawn down to make way for summer-grade product. With consumption projected to remain below levels seen in 2007, some surplus capacity is expected to be available to help meet unexpected demand changes despite refinery shutdowns during the past several years. U.S. refiners have increased gasoline and distillate exports and decreased imports of these products, resulting in more flexibility to reverse trade balances and accommodate domestic consumption should the need arise from refinery outages. For these reasons, the United States has sufficient capacity flexibility to absorb outages with little price impact. Crude oil prices, however, should continue to be a large factor affecting product prices.

Table 1 shows that, in aggregate and after both planned outages and typical levels of unplanned outages are taken into consideration, crude distillation unit capacity that remains operating should be more than adequate to meet EIA's *STEO* forecast for refining inputs needed to meet consumption. Table 2 shows similar findings for FCC capacity.

Even though aggregate U.S. capacity after outages appears adequate this spring, high outage levels in Petroleum Administration for Defense District (PADD) 5 during April and May could add some price pressure to that region. In spring and early summer 2010, PADD 5 experienced large unplanned outages with moderate gasoline price impacts. The planned outages expected in April and May 2011 are larger than the unplanned outages of 2010, but may have less impact since, with planned outages, refiners arrange for replacement supplies, including imports, in advance When this report was written, the impacts of the disastrous earthquake and tsunami in Japan on Pacific Basin product supply were not expected to have a significant effect on potential imports to PADD 5 from export areas like India, South Korea or Singapore.

In summary, as a result of modest demand levels and adequate capacity, including extra capacity that can be made available by shifting away from product exports towards domestic consumption should the need arise, most of the United States should not see product prices affected by refinery outages.

Table 1. U.S. Comparison of Maximum Crude Inputs from Crude Distillation Capacity Available After Outages with STEO-Forecast Crude Input Needs (Thousand Barrels Per Stream Day)

Month	Crude Inputs	Operable Distillation Capacity	Total Distillation Outages	Capacity Net of Outages	Potential Crude Inputs (Net Capacity x 0.907)	Surplus: Potential Inputs minus Actual or Projected Inputs
January 2011 Actual	14,390	18,393	845	17,548	15,916	1,526
February	14,270	18,393	1,346	17,047	15,461	1,191
March	14,340	18,393	906	17,487	15,861	1,521
April	14,830	18,393	832	17,561	15,928	1,098
May	15,250	18,393	742	17,651	16,009	759
June 2011	15,500	18,393	360	18,033	16,356	856

Note: January 2011 represents actual data. January 2011 crude inputs are based on weekly data through February 1. February through June 2011 data are *STEO*-forecast crude inputs. The potential crude inputs are estimated by applying a factor (0.907) that represents the average of the 10 highest utilization months from January 2002 through 2010, where utilization was estimated as crude inputs over distillation capacity net of outages. Sources: *February 2011 Short-Term Energy Outlook;* Industrial Info Resources (IIR), www.iirenergy.com, February 7, 2011 database.

Table 2. U.S. Comparison of Maximum FCC Inputs from FCC Capacity Available After Outages with Estimated STEO-Forecast FCC Input Needs (Thousand Barrels Per Stream Day)

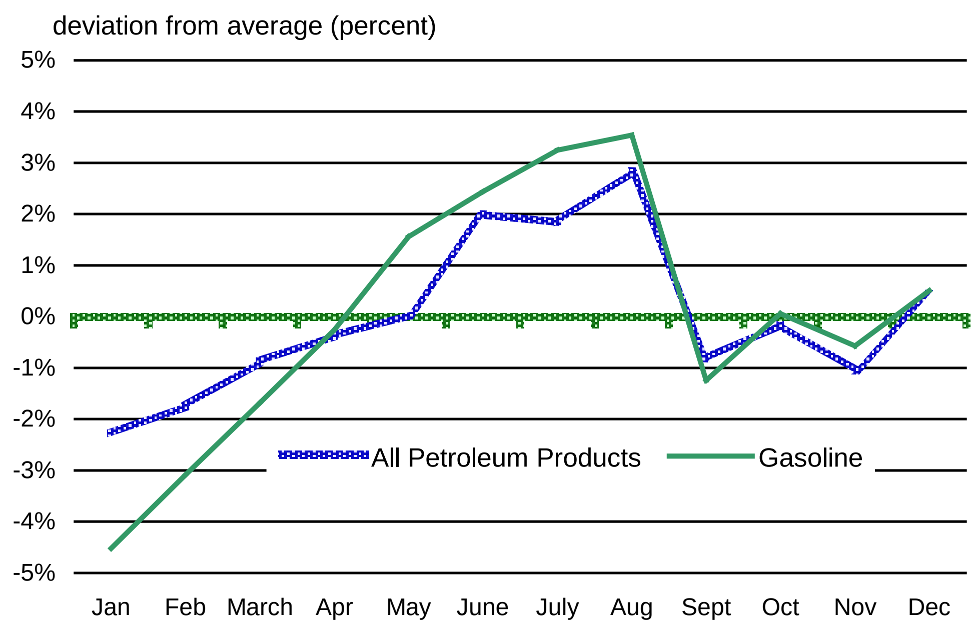
Month	Crude Inputs	Projected FCC Inputs (Pct Crude = .343)	Operable FCC Capacity	Total FCC Outages	Capacity Net of Outages	Potential FCC Inputs (Net Capacity x 0.942)	Surplus: Potential Inputs minus Projected Inputs
January 2011 Actual	14,390	4,936	6,119	378	5,741	5,408	472
February	14,270	4,895	6,119	621	5,498	5,179	285
March	14,340	4,919	6,119	556	5,563	5,240	321
April	14,830	5,087	6,119	333	5,786	5,450	363
May	15,250	5,231	6,119	125	5,994	5,646	415
June 2011	15,500	5,317	6,119	183	5,936	5,592	275

Note: January 2011 crude inputs based on weekly data. The projected FCC input volumes are estimated by multiplying crude inputs by a factor (0.343) that represents the average observed ratio between FCC and crude inputs for facilities experiencing no major outages. The potential FCC inputs are estimated by applying a factor (0.942) that represents the average observed difference between FCC input volumes and capacity in the United States for facilities experiencing no major outages and running at high input levels. Sources: *February 2011 Short-Term Energy Outlook*; Industrial Info Resource (IIR), www.iirenergy.com, February 7, 2011 database.

1. Introduction

As required under Section 804 of the Energy Independence and Security Act of 2007 (Pub. L. 110-140), this report reviews the supply implications of planned refinery outages for March 2011 through June 2011, which covers the seasonal increase in driving consumption. Refinery outages are the result of both planned maintenance and unplanned outages, the latter of which occur for many reasons, including mechanical failures, fires, and flooding.[1] Maintenance is usually scheduled during the times when consumption is lowest, i.e., in the first quarter and again in the fall. Figure 1 demonstrates these seasonal variations in consumption. Note that total petroleum consumption is driven mainly by gasoline consumption. Distillate consumption (which includes heating oil) moderates the petroleum consumption dip in the winter, but because distillate consumption is about half the size of gasoline, it does not substantially affect the total seasonal consumption variations.

Figure 1. Seasonal Variation in Petroleum Consumption around Annual Average (2002-2010)



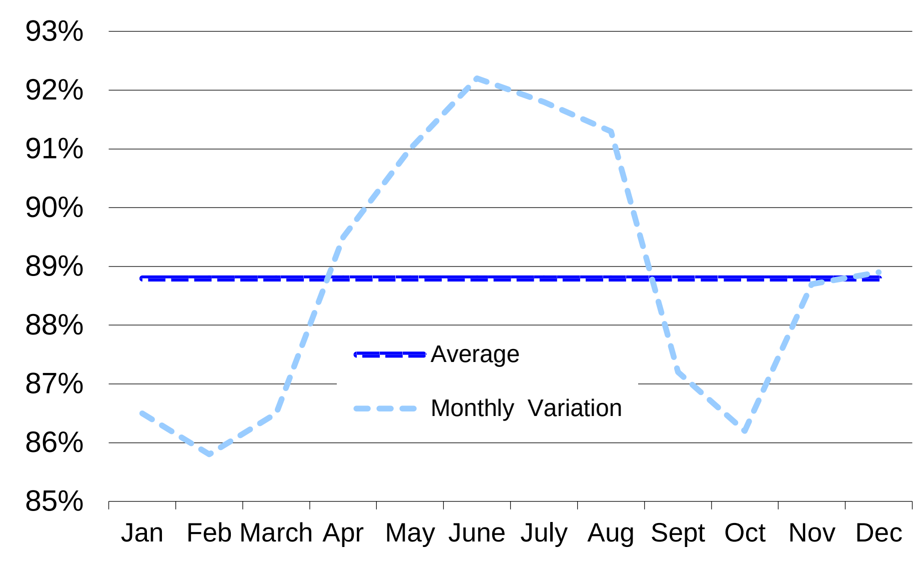
Source: EIA, *Petroleum Supply Monthly*

Refinery utilization reflects discretionary crude oil throughput changes that follow consumption as well as maintenance and unplanned outages. While utilization generally follows the seasonal consumption pattern, falling to its lowest during the first quarter and

[1] For more detail on refinery outages, see EIA, *Refinery Outages: Description and Potential Impact on Petroleum Product Prices*, March 2007, SR/OOG/2007-1. http://www.eia.doe.gov/oiaf/servicerpt/refinery_outages/SROOG200701.pdf.

dipping again in the fall (Figure 2), it does not distinguish between discretionary run decisions based on consumption and impacts due to outages.

Figure 2. Seasonal Variation in Refinery Utilization (Average 2002-2010)



Source: EIA, *Petroleum Supply Monthly*

Ultimately, changes in production impact price, so the impacts outages have on production must be determined. The relationship is not simple and can only be estimated. Outages may involve a number of different units and associated refinery equipment that will affect product output differently. Even refiners analyzing their own facilities will not have a definitive production impact number but will estimate the potential impact. For this report, EIA used statistical techniques based on historical data to produce aggregate outage impacts on production (Appendix A).

Middle distillate production (diesel, heating oil, jet fuel and kerosene) is mainly affected by outages of the crude distillation unit, while gasoline production is most strongly correlated with fluid catalytic cracking (FCC) unit outages.[2] As a result, this report focuses primarily on planned outages of crude distillation and FCC units. Outages for alkylation units, reformers, hydrotreaters (sulfur-removing units), hydrocrackers, and coking units can also impact volumes, but these units have not had the same degree of impact on gasoline and middle distillate production as the FCC and crude distillation units and therefore are not covered.

Crude distillation unit outages affect all product production, although refiners sometimes can use intermediate feedstocks to keep some downstream units, e.g., the FCC units, functioning. Conversely, if an FCC unit is offline, a refinery may not be able to store or

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[2] Ibid. Chapter 2.

move the FCC unit feedstock to another refinery; therefore, the crude oil distillation unit may need to run at lower rates to slow production of this feedstock.

The remainder of this report reviews the projected March 2011 through June 2011 outage situation. Chapter 2 begins with a review of the current market situation to provide the underlying setting for the outages. Chapter 3 looks specifically at projected outages and compares them with historical outages for that time of year. On a regional basis (i.e., Petroleum Administration for Defense District or PADD), very large deviations from typical levels are noted. Chapter 4 compares the ability of available capacity net of outages to meet EIA's *Short Term Energy Outlook* (*STEO*) consumption projections. Chapter 5 uses an EIA model to estimate the potential gasoline and middle distillate production that could come from refinery capacity available, net of outages. Chapter 6 ends the report with a summary conclusion on the impacts of outages on the market.

2. Recent Market Conditions and Outlook

The impact refinery outages may have on product prices depends both on the magnitude of the affected product output and on the market conditions in which the outages occur. For example, if consumption is low relative to available supply, even larger-than-normal refinery outages may not have much impact on prices.

In 2011, prices for petroleum products have been affected mainly by rising crude oil prices. West Texas Intermediate and Brent crude oil prices spiked in 2008 to over $140 per barrel in July, but fell in the second half as a world recession reduced petroleum consumption. By the end of 2008, crude prices were under $40 per barrel. World markets began to tighten again with continued relatively strong consumption growth in developing countries and more gradual recovery in the developed areas. By June 2009, crude oil prices were back over $70 per barrel and soon began fluctuating between $70 and $85 per barrel, but by the beginning of 2011, Brent crude oil was at $95 per barrel. Recent instability in the Middle East and North Africa added further to the price pressures, pushing and keeping crude oil prices well over $100 per barrel.

As a result of the recession and high petroleum prices in 2008, petroleum consumption in the United States fell, bottoming out in 2009 at more than 1.9 million barrels per day (9 percent) less than in 2007, the last year before the recession affected consumption (Table 3). Petroleum consumption has resumed growing, but is still projected to be about 1.4 million barrels per day less than it was in 2007.

Table 3. U.S. Consumption (Million Barrels Per Day)

	Historical				Projected	Growth
	2007	2008	2009	2010	2011	2010-2011
Gasoline	9.29	8.99	9.00	9.05	9.12	0.8%
Distillate and Jet Fuel	5.82	5.48	5.02	5.20	5.28	1.5%
Total Petroleum Consumption	20.68	19.50	18.77	19.13	19.28	0.8%

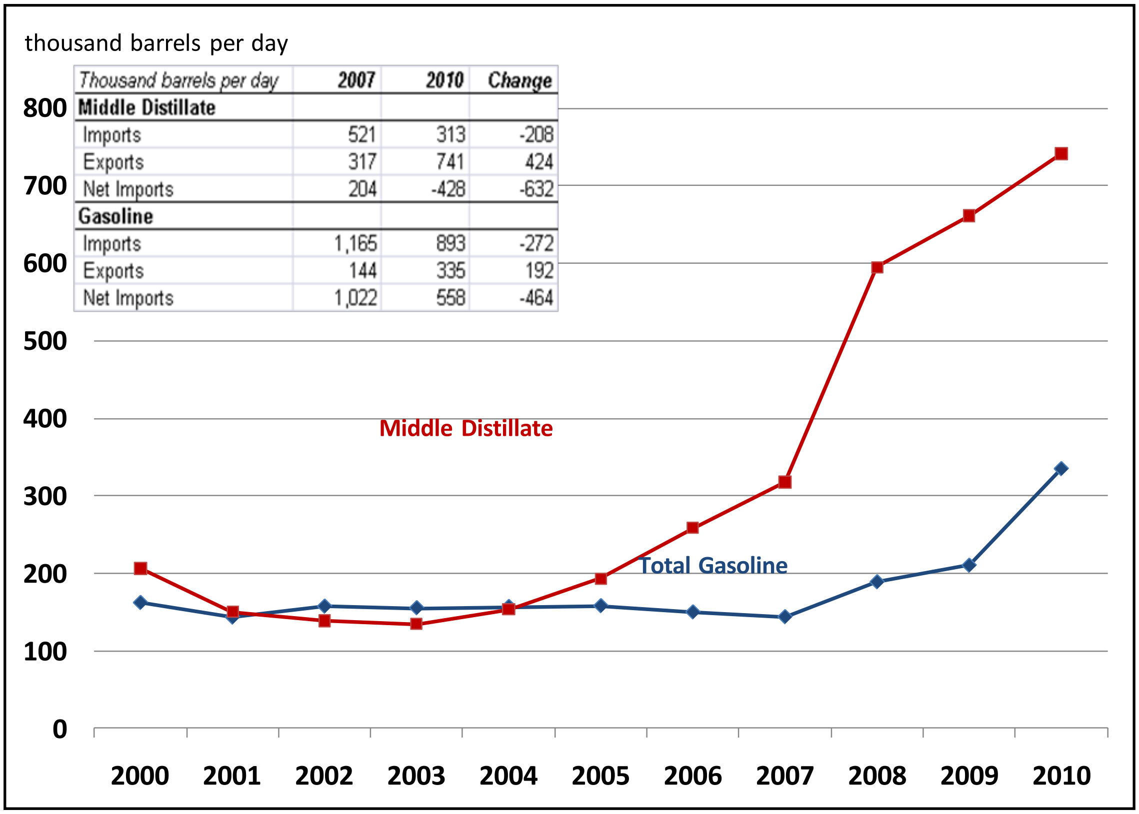
Note: Gasoline consumption includes ethanol.
Source: 2007-2010, EIA *Petroleum Supply Monthly;* 2011, February 2011 *Short Term Energy Outlook*

Gasoline consumption is sensitive to changes in personal income, which fared relatively better than overall economic activity during the downturn. Gasoline consumption fell 0.3 million barrels per day (3 percent) from 2007 to 2009, but is expected to grow 0.8 percent from 2010 to 2011, with second quarter growth year-over-year at only 0.4 percent.

Middle distillates consumption fell much more than gasoline, dropping 0.8 million barrels per day (14 percent), as the falling economy affected heavy duty trucking consumption and air travel. In 2011, middle distillate fuel use is expected to grow 1.5 percent, with second quarter growth averaging about 2.3 percent.

On the supply side, U.S. refiners continue to be cushioned somewhat from the consumption decline by increased exports of middle distillate fuels and gasoline as shown in Figure 3. Most gasoline imports come into PADD 1, while most gasoline and middle distillate exports leave from PADD 3.

Figure 3. Annual Middle Distillate & Gasoline Exports



Gasoline exports increased each year since 2007, going mainly to Mexico and other Latin American countries. At the same time, gasoline imports declined about 270 thousand barrels per day.

World consumption for distillate fuels has grown faster than for gasoline, providing more economic opportunities for exports. As with gasoline, U.S. distillate imports declined from 2007 through 2010. With distillate margins rising in international markets in 2008, middle distillate exports increased significantly, and the United States became a net exporter of middle distillate fuel that year. Distillate exports in 2010 were more than twice gasoline exports.

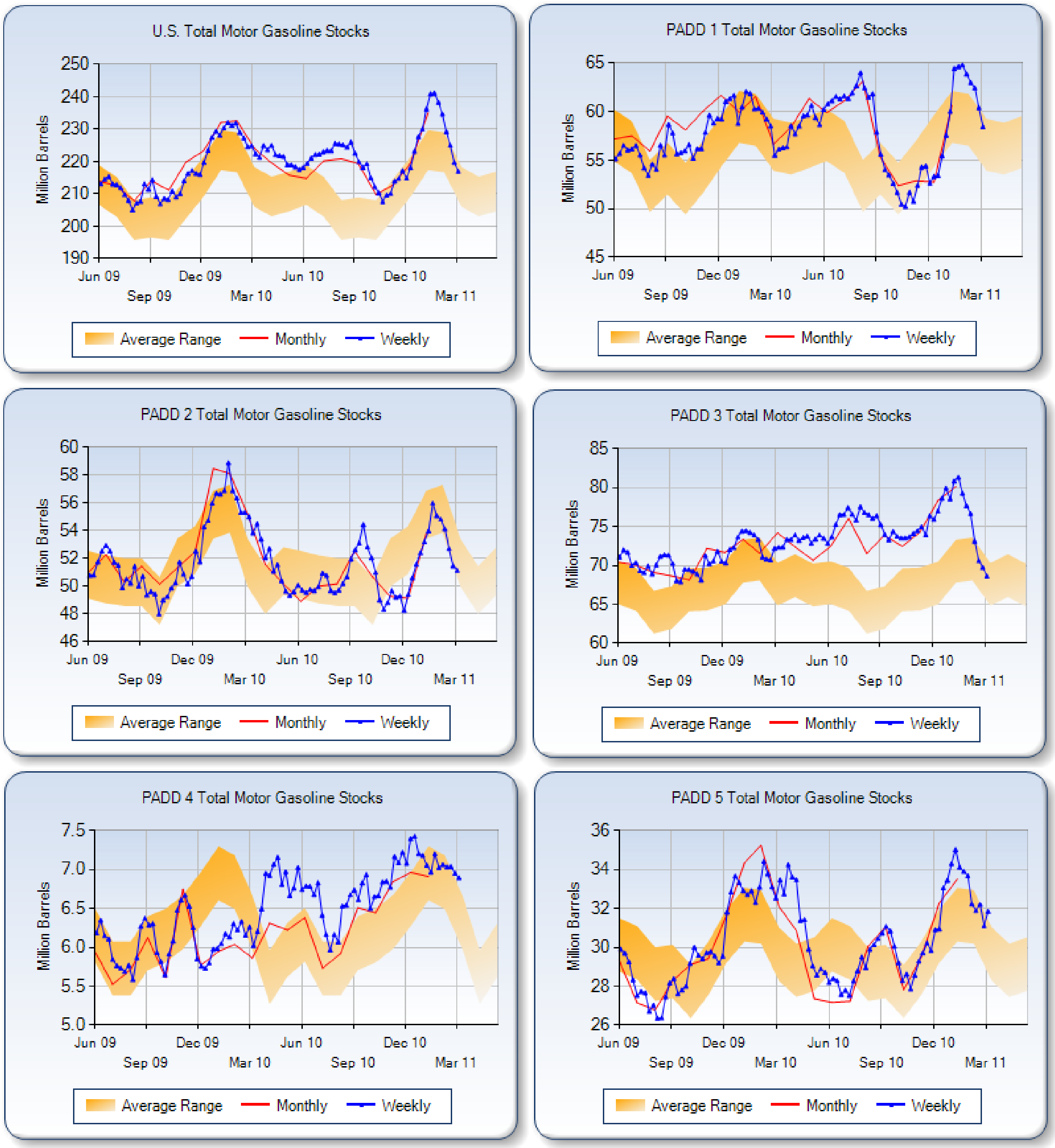
Even with increased gasoline and distillate exports and the decline in imports, refinery runs have been relatively low. In 2010, gross inputs to refineries were still 0.3 million barrels per day or almost 2 percent lower than in 2007, even though they were almost 3 percent higher than 2009. Similarly, operable utilization in 2010 at 86 percent was more than 2 percent lower than in 2007, and utilization for the first quarter 2011 at 84 percent, was about 3 percent lower than first quarter 2007.

Both gasoline and distillate inventories are at normal to high in most regions as shown in Figures 4 and 5. Most recently, the supply-demand balances for gasoline have been tightening during February and March as evidenced by declines in inventories, which typically fall this time of year when they help to meet demand during refinery maintenance. This year, gasoline stocks in most regions were well above typical levels before the declines began. Some of the stock draw may also be due to the need to remove winter-grade inventory in order to make room for summer-grade product. Gasoline inventories in PADD 2 have dropped to the low end of the typical band, but planned refinery maintenance in that region is light. Refineries in PADD 3 are currently experiencing a fairly heavy outage period, which helps to explain some of the extra inventory build earlier in 2011 and the current draw down.

PADD 5 is planned to experience a heavy refinery maintenance schedule in April and May. With gasoline inventories drawing down into the typical range over the past several weeks, the region bears watching. Although this region receives some imports from Asia, we are not expecting any significant price impacts due to the loss of supply in Japan. About half of PADD 5's gasoline imports come from Asia, mainly South Korea. As of the end of March, adequate refining capacity is expected to be restored in Japan to supply their internal needs. In the short run, consumption in Japan may be down as well. The situation is still evolving, but as of this report, we would not expect PADD 5 consumers to be affected much from the region's gasoline product trade with Asia. PADD 5 has about an equal amount of imports and exports of gasoline, each of which is around 2.5 percent of the consumption. In 2010, the region became a net exporter of gasoline for the first time, albeit only by a small amount – about 4 thousand barrels per day, implying some additional capacity is available to meet domestic needs if necessary.

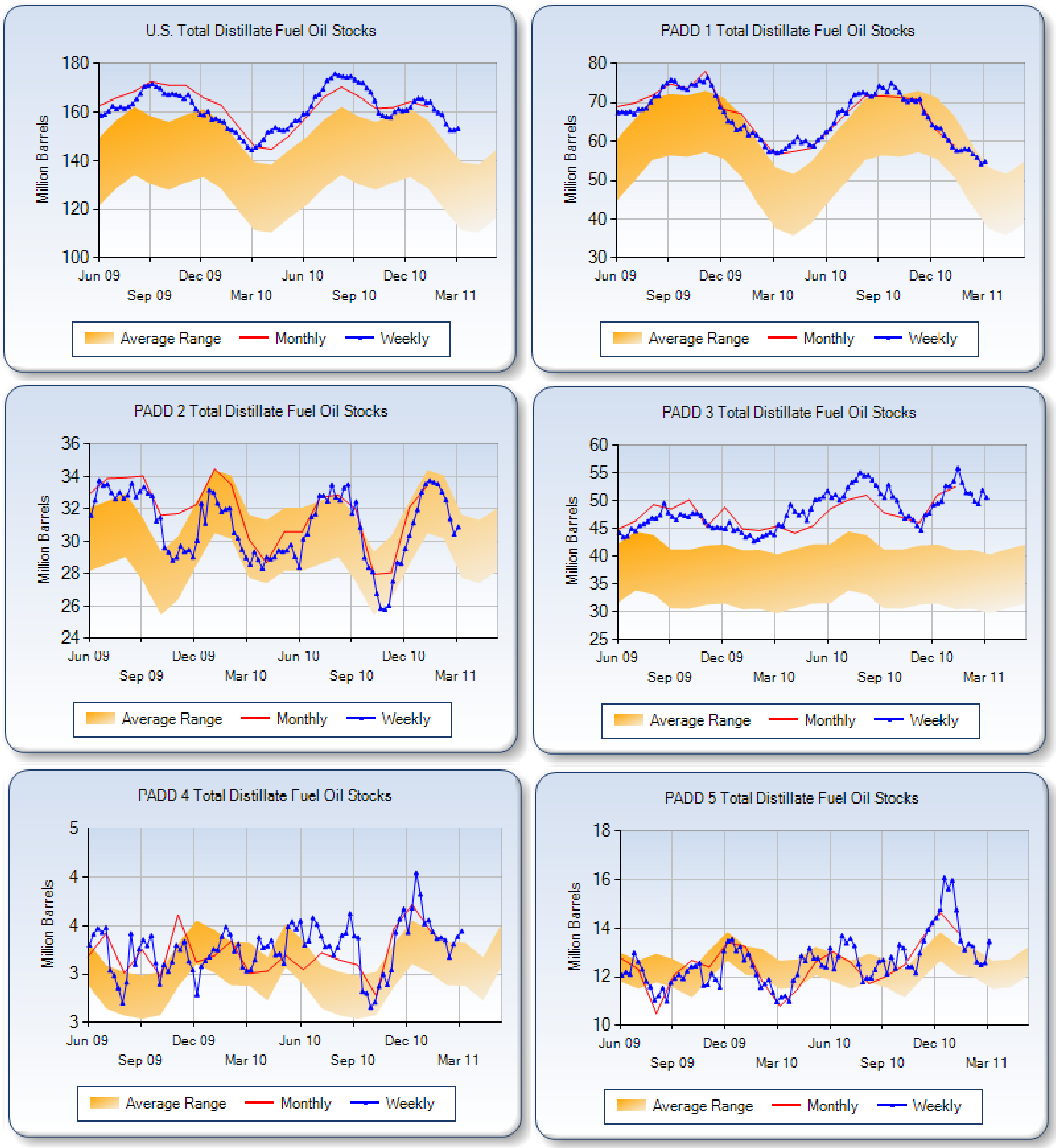
In summary, while gasoline and distillate inventories have been dropping, levels are still normal to high in most regions. EIA projects gasoline and distillate fuel consumption to grow in 2011, but we still expect annual average levels to remain under those in 2007. As discussed in the last Market Assessment report, in spite of a net loss of refinery capacity due to shutdowns, utilizations still indicate some surplus to deal with unexpected events. U.S. refiners have increased gasoline and distillate exports and decreased imports of these products, resulting in more flexibility to reverse trade balances and accommodate domestic consumption, should the need arise from refinery outages. Because of lower consumption than in 2007 and an ability to shift trade balances, the United States has additional capacity flexibility to absorb outages with little price impact. Crude oil prices, however, should continue to be a large factor affecting product prices.

Figure 4. Gasoline Inventories Week Ending March 26



Source: EIA *Weekly Petroleum Status Report*

Figure 5. Distillate Inventories Week Ending March 26



Source: EIA *Weekly Petroleum Status Report*

3. Capacity Outage Review

This chapter looks at projected outages for March 2011 through June 2011 and compares them with historical outage patterns. The chapter describes past planned and unplanned outages for both crude distillation and FCC units, which are the units that have the most impact on distillate and gasoline production respectively. Other unit outages, such as hydrocrackers, are inspected as well, but not summarized in these chapters for disclosure purposes.

Over the March 2011 through June 2011 period, the major areas of concern for planned outages are in (a) March-to-May for crude and FCC outages PADD 4; (b) April-May for crude outages in PADD 5 and (c) February-March for FCC outages in PADD 3.

Section 3.1 describes the data used in this report. Sections 3.2, 3.3, and 3.4 address capacity outages at the U.S. level, followed by regional reviews.

3.1 Data

EIA does not collect outage data directly. However, commercial data are available with enough detail to analyze potential impacts of planned outages on supply and thus on price. The main commercial data source used in this report is a database assembled by Industrial Info Resources (IIR), a firm that provides market intelligence in a range of areas including planned and unplanned refinery outages. Because outages are likely to be the primary cause of any substantial drops in inputs to refinery units, EIA compares total planned and unplanned IIR outages to the unit input data collected on Form EIA-810 (Monthly Refinery Report). In addition to IIR planned outage data, EIA gathers planned outage information from trade press and other public sources to compare with IIR's information.

3.2 United States Outages

Section 3.2 covers the U.S. aggregate crude distillation outages first, followed by U.S. FCC unit outages.

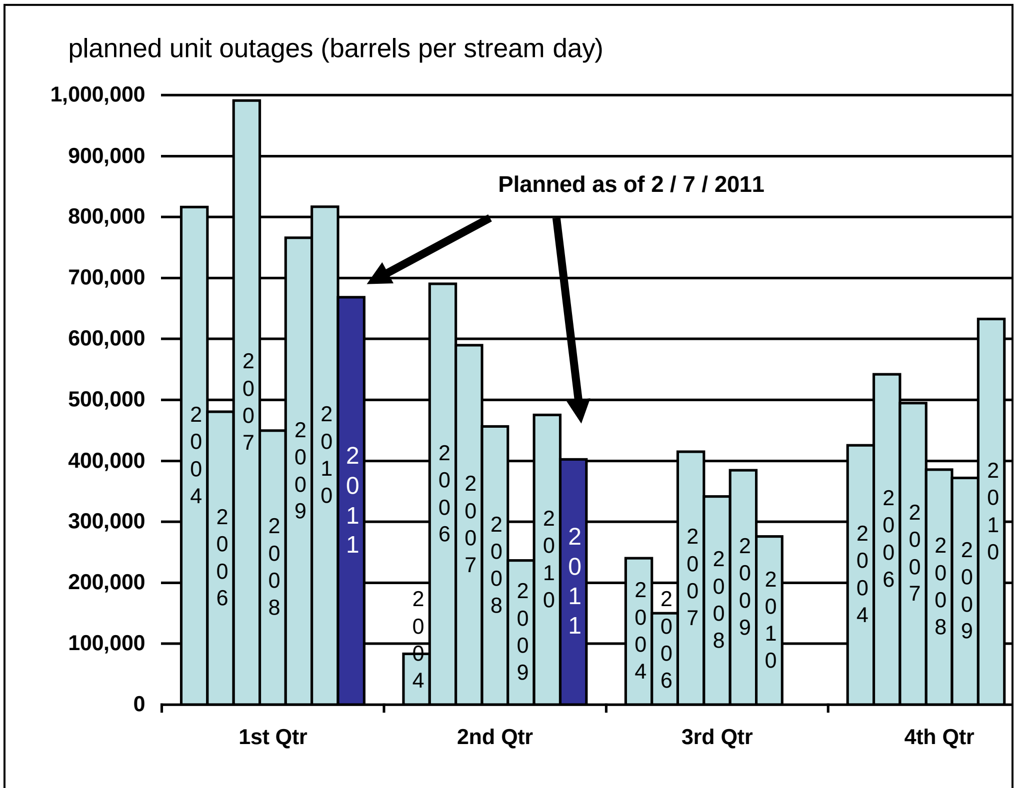
3.2.1 Crude Distillation Unit Outages

While crude distillation unit outages impact production of all products, these outages have a particularly strong correlation with distillate production. Section 3.2.1 looks at both planned and unplanned outages for crude distillation units.

<u>Planned Crude Distillation Unit Outages</u>

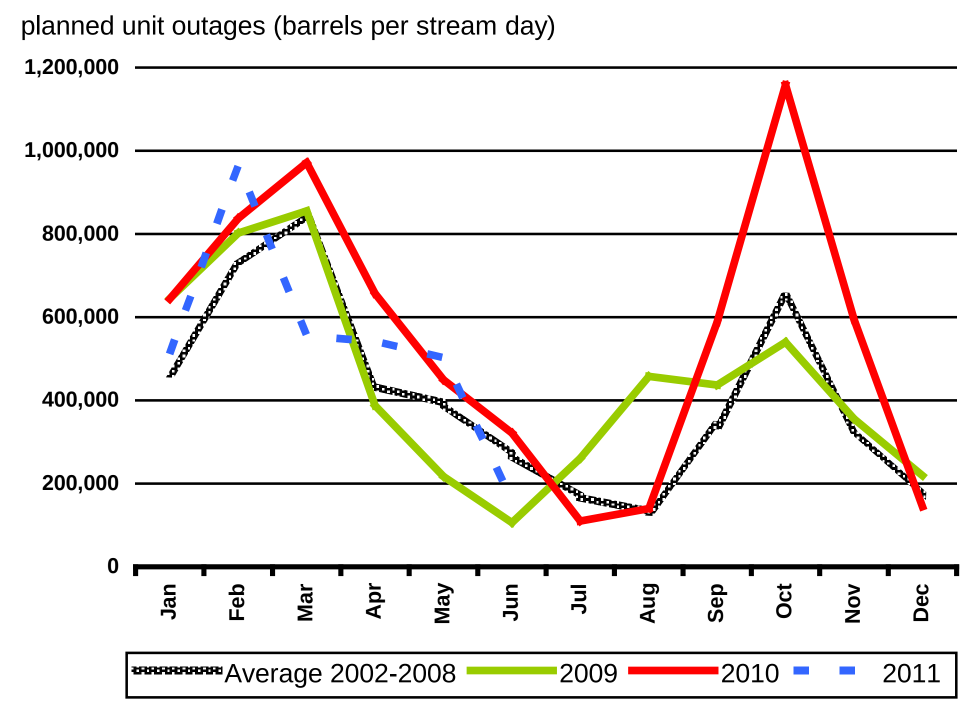
The quarterly crude unit outages shown in Figure 6 indicate that, for the United States in total, planned outages the first and second quarters 2011 are at a slightly-above average level for crude units. Figure 7 shows planned U.S. outages by month, since quarterly averages can mask potential high-outage months that could impact prices. The months of February and May are above average, but surrounded by months of average or below-average planned outage levels.

Figure 6. Quarterly U.S. Planned Crude Distillation Unit Outages, 2004-June 2011 (Barrels per Stream Day)



Source: Industrial Info Resources (IIR), www.iirenergy.com, September 9, 2010 database;

Figure 7. Monthly U.S. Planned Crude Distillation Unit Outages, 2002-June 2011 (Barrels per Stream Day)



Source: Industrial Info Resources (IIR), www.iirenergy.com, September 9, 2010 database; excludes PADD 1 and PADD 5 asphalt refineries.

Unplanned Crude Distillation Unit Outages

In addition to planned outages, unplanned outages also occur. While unplanned outages are often of short duration (e.g., a shutdown caused by loss of electricity), they can continue over longer periods if significant equipment damage occurs or severe weather keeps staff from returning a refinery to operation. Unplanned outage estimates are based on average historical unplanned outages since 2002, excluding the 2005, 2006, and 2008 hurricane impacts. Unplanned outages for July through December 2010 were slightly below average for US crude units, but January and February 2011 have had a number of unplanned events that drove unplanned outage to 50 percent above the historical average. As persistent high stock levels during 2009 and 2010 (and into early 2011) have illustrated, such deviations from historical unplanned outage levels have not significantly reduced supply relative to consumption, implying adequate compensating supply has been available to meet consumption.

Total Planned and Unplanned Crude Distillation Unit Outage Assessment

Actual total U.S. crude distillation unit refinery outages for April 2010 through January 2011 and expected outages for February 2011 through June 2011 are summarized in Table 1. Total expected outage levels for February 2011 through June 2011 represent planned outages plus typical (historical) unplanned outages.

As shown in Figure 7 and Table 4, total outages for the United States were consistently above average in the September through November of 2010. The crude unit outage projection for first half of 2010 is above average in February, April and May, but below average in March and June. However, as detailed in Section 3.3, individual PADDs may have crude distillation outage levels and monthly patterns which deviate above or below these average total U.S. levels.

Table 4. U.S. Crude Distillation Unit Outages (Barrels per Stream Day)

Month (April 2010 Through June 2011)	Planned	Unplanned	Total Outage Level	Typical Historical Total Outage Level
Apr 2010 Actual	656,701	143,066	799,767	730,000
May Actual	449,005	287,550	736,555	610,000
June Actual	321,500	359,800	681,300	430,000
July Actual	109,968	160,936	270,904	460,000
Aug Actual	139,855	277,161	417,016	400,000
Sept Actual	588,383	262,417	850,800	640,000
Oct Actual	1,158,166	199,968	1,358,134	890,000
Nov Actual	593,716	144,000	737,716	490,000
Dec Actual	181,580	121,854	303,435	380,000
January 2011 Actual	511,676	333,714	845,390	820,000
February	966,285	*380,000*	1,346,285	1,100,000
March	555,532	*350,000*	905,532	1,200,000
April	541,783	*290,000*	831,783	740,000
May	502,420	*240,000*	742,420	620,000
June 2011	160,200	*200,000*	360,200	450,000

Unplanned-outage values for February through June 2011 are historical average values for 2002-2010 excluding months in 2005, 2006, and 2008 affected by hurricanes & refinery closures. Similarly, typical historical values are average planned outages 2002-2010 plus average unplanned outages 2002-2010 excluding 2005, 2006 and 2008 hurricane impacts & refinery closures. Source: Industrial Info Resources (IIR), www.iirenergy.com, February 7, 2011 database; excludes PADD 1 and PADD 5 asphalt refineries.

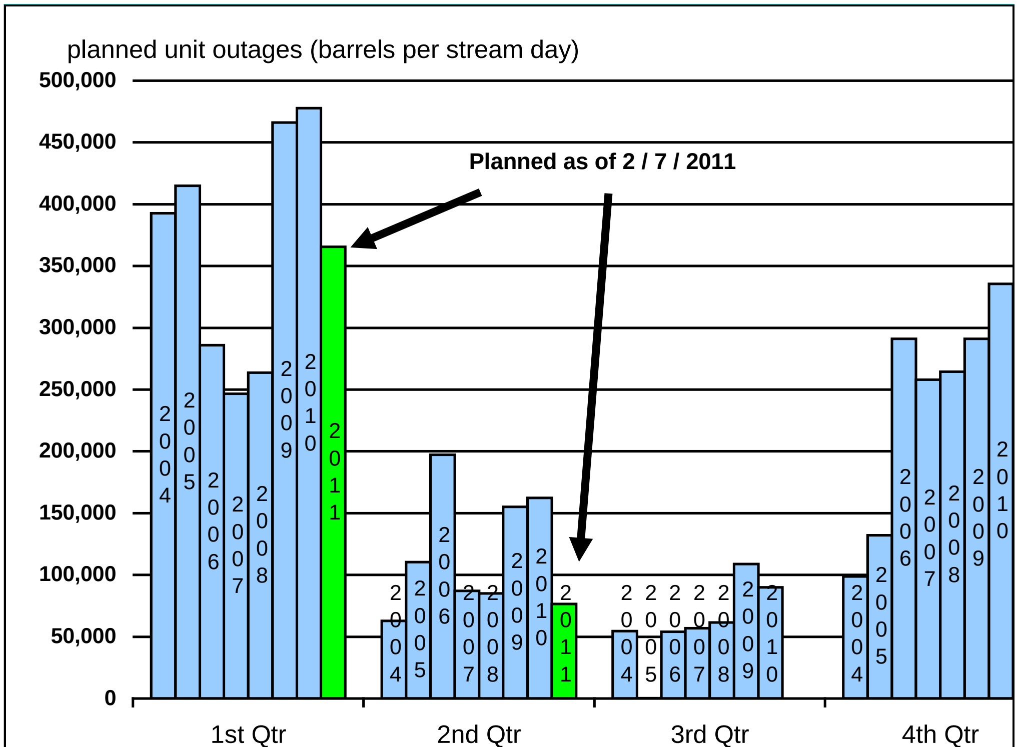
3.2.2 FCC Outages

FCC unit outages usually have a significant impact on gasoline production, although they can affect crude throughput as well. The large volume of material that goes from the crude unit to the FCC unit may require more storage than is available while an FCC unit is down. If a refinery does not have a means of moving that FCC feed volume to another facility, the refinery may have to reduce its crude runs to reduce the generation of FCC feedstock. Also, in periods when consumption is low and margins are weak, refiners may reduce refinery inputs when there is a planned or unplanned outage on a key downstream unit such as the FCC unit.

Planned FCC Unit Outages

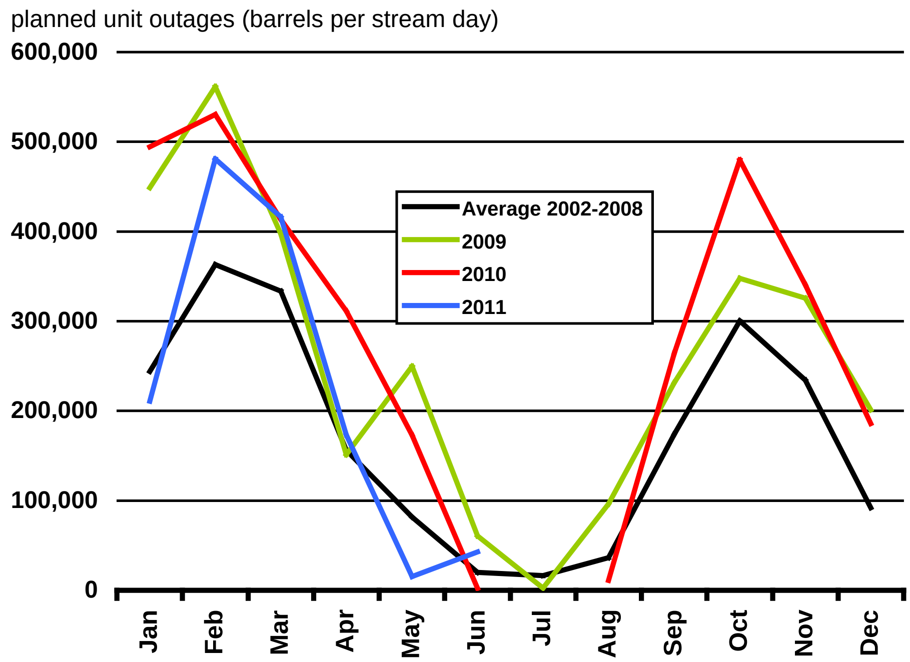
For this forecast period, total U.S. FCC planned outages follow a pattern similar to crude distillation unit outages. The quarterly FCC unit outages, for the United States in total, shown in Figure 8 indicate that, planned outages for the third and fourth quarters of 2010 were significantly above average; thus, followed by a more average planned outage outlook for first half of 2011. Figure 9 shows planned U.S. outages by month, since quarterly averages can mask potential high-outage months that could impact prices. The high September to November 2010 outage levels for FCC units are now followed by the average outage levels for first half of 2011, in contrast to the high outages in the same periods in 2009 and 2010.

Figure 8. Quarterly U.S. Planned Fluid Catalytic Cracking Unit Outages, 2004-2010 (Barrels per Stream Day)



Source: Industrial Info Resources (IIR), www.iirenergy.com, September 9, 2010 database; excludes PADD 1 and PADD 5 asphalt refineries.

Figure 9. Monthly U.S. Planned FCC Unit Outages, 2002 -2010 (Barrels per Stream Day)



Source: Industrial Info Resources (IIR), www.iirenergy.com, September 9, 2010 database; excludes PADD 1 and PADD 5 asphalt refineries.

Unplanned FCC Unit Outages

For the second half of 2010, unplanned outages were above average. A number of these events have led to planned FCC outages during the first half of 2011.

Total Planned and Unplanned FCC Unit Outage Assessment

Table 5 summarizes both planned and unplanned U.S. outages by month. Total FCC outage levels were significantly above average in September through December 2010; while the forecast for first half 2011 is for average total levels of outages for U.S. FCC units.. However, as will be discussed in Section 3.3, individual PADDs have FCC outage levels that are not at typical levels.

Table 5. U.S. FCC Unit Outages (Barrels Per Stream Day)

Month (April 2010 Through June 2011)	Planned	Unplanned	Total Outage Level	Typical Historical Total Outage Level
Apr 2010 Actual	314,999	60,666	375,665	320,000
May Actual	176,016	135,549	311,565	210,000
June Actual	2,167	141,200	143,367	160,000
July Actual	-	81,225	81,225	150,000
Aug Actual	11,226	171,097	182,323	200,000
Sept Actual	264,380	187,465	451,845	310,000
Oct Actual	479,951	194,806	674,757	420,000
Nov Actual	340,826	142,266	483,092	320,000
Dec Actual	185,783	127,620	313,403	210,000
January 2011 Actual	210,936	166,937	377,873	440,000
February	480,820	140,000	620,820	550,000
March	416,356	140,000	556,356	490,000
April	173,401	160,000	333,401	330,000
May	15,483	110,000	125,483	230,000
June 2011	42,933	140,000	182,933	160,000

Unplanned-outage values for February through June 2011 are historical average values for 2002-2010 excluding months in 2005, 2006, and 2008 affected by hurricanes & refinery closures. Similarly, typical historical values are average planned outages 2002-2010 plus average unplanned outages 2002-2010 excluding 2005, 2006 and 2008 hurricane impacts & refinery closures. Source: Industrial Info Resources (IIR), www.iirenergy.com, February 7, 2011 database; excludes PADD 1 and PADD 5 asphalt refineries.

3.3 Regional Outages of Interest for Potential Price Impacts

3.3.1 PADD 1 Outages

Outages in PADD 1 during 2010 do not include the now-closed or idled Yorktown, Delaware City, and Eagle Point refineries. Historical averages are also calculated without these refinery histories.

As shown in Table 6, PADD 1 had some large planned crude unit outages in October and November 2010 and large unplanned crude unit outages stretching from August through February 2011. However, the projected crude unit outage levels for March through June are below average historical levels. Table 7 shows a similar pattern with large unplanned FCC outages, often associated with a refinery's crude unit outages in August through February 2011. The projected outage levels for March through June are at or slightly below average historical levels.

Table 6. PADD 1 Crude Distillation Unit Outages (Barrels per Stream Day)

Month (April 2010 Through June 2011)	Planned	Unplanned	Total Outage Level	Typical Historical Total Outage Level
Apr 2010 Actual	9,333	-	9,333	62,000
May Actual	10,323	-	10,323	50,000
June Actual	33,000	-	33,000	9,700
July Actual	-	-	-	20,000
Aug Actual	-	63,226	63,226	11,000
Sept Actual	38,333	70,000	108,333	25,000
Oct Actual	230,000	70,000	300,000	54,000
Nov Actual	130,333	70,000	200,333	24,000
Dec Actual	-	75,548	75,548	680
January 2011 Actual	-	36,935	36,935	2,500
February	-	112,571	112,571	35,000
March	45,161	7,100	52,261	72,000
April	7,667	15,000	22,667	56,000
May	-	18,000	18,000	46,000
June 2011	-	5,100	5,100	12,000

Unplanned-outage values for March through June 2011 are historical average values for 2002-2010 excluding months in 2005, 2006, and 2008 affected by hurricanes & refinery closures; February 2011 is large, known value. Similarly, typical historical values are average planned outages 2002-2010 plus average unplanned outages 2002-2010 excluding 2005, 2006 and 2008 hurricane impacts & refinery closures. Source: Industrial Info Resources (IIR), www.iirenergy.com, February 7, 2011 database; excludes asphalt refineries.

Table 7. PADD 1 FCC Unit Outages (Barrels Per Stream Day)

Month **(April 2010 Through June 2011)**	Planned	Unplanned	Total Outage Level	Typical Historical Total Outage Level
Apr 2010 Actual	61,833	5,667	67,500	42,000
May Actual	42,903	-	42,903	30,000
June Actual	-	-	-	10,000
July Actual	-	12,903	12,903	6,000
Aug Actual	-	9,484	9,484	29,000
Sept Actual	-	10,500	10,500	40,000
Oct Actual	21,000	29,032	50,032	20,000
Nov Actual	2,800	41,767	44,567	19,000
Dec Actual	-	6,097	6,097	13,000
January 2011 Actual	-	21,250	21,250	24,000
February	-	48,571	48,571	24,000
March	46,581	3,500	50,081	71,000
April	34,400	14,000	48,400	45,000
May	-	17,000	17,000	31,000
June 2011	-	8,900	8,900	8,900

Unplanned-outage values for March through June 2011 are historical average values for 2002-2010 excluding months in 2005, 2006, and 2008 affected by hurricanes & refinery closures; February 2011 is large, known value. Similarly, typical historical values are average planned outages 2002-2010 plus average unplanned outages 2002-2010 excluding 2005, 2006 and 2008 hurricane impacts & refinery closures. Source: Industrial Info Resources (IIR), www.iirenergy.com, February 7, 2011 database.

3.3.2 PADD 2 Outages

Table 8 shows that after a high level of unplanned outages in January 2011, PADD 2 crude distillation unit outages are projected to be below average in March through June 2011. As shown in Table 9, PADD 2 FCC units had a high level of total outages in 4th Qt 2010. In March through June 2011, PADD 2 FCC outages are projected to be below average.

Table 8. PADD 2 Crude Distillation Unit Outages (Barrels Per Stream Day)

Month **(April 2010 Through June 2011)**	Planned	Unplanned	Total Outage Level	Typical Historical Total Outage Level
Apr 2010 Actual	466,834	17,833	484,667	180,000
May Actual	143,693	-	143,693	110,000
June Actual	75,000	-	75,000	54,000
July Actual	-	1,129	1,129	120,000
Aug Actual	-	19,742	19,742	80,000
Sept Actual	46,534	5,667	52,201	160,000
Oct Actual	244,678	13,065	257,743	240,000
Nov Actual	111,067	15,000	126,067	99,000
Dec Actual	20,968	42,306	63,274	72,000
January 2011 Actual	-	145,287	145,287	61,000
February	5,893	44,636	50,529	100,000
March	146,097	48,000	194,097	360,000
April	86,333	56,000	142,333	210,000
May	-	44,000	44,000	120,000
June 2011	-	25,000	25,000	56,000

Unplanned-outage values for March through June 2011 are historical average values for 2002-2010 excluding months in 2005, 2006, and 2008 affected by hurricanes & refinery closures; February 2011 is large, known value. Similarly, typical historical values are average planned outages 2002-2010 plus average unplanned outages 2002-2010 excluding 2005, 2006 and 2008 hurricane impacts & refinery closures. Source: Industrial Info Resources (IIR), www.iirenergy.com, February 7, 2011 database.

Table 9. PADD 2 FCC Unit Outages (Barrels Per Stream Day)

Month (April 2010 Through **June 2011)**	Planned	Unplanned	Total Outage Level	Typical Historical Total Outage Level
Apr 2010 Actual	104,133	19,566	123,699	52,000
May Actual	32,226	3,033	35,259	49,000
June Actual	-	5,033	5,033	17,000
July Actual	-	6,032	6,032	32,000
Aug Actual	-	30,581	30,581	45,000
Sept Actual	99,880	-	99,880	77,000
Oct Actual	249,096	-	249,096	100,000
Nov Actual	182,017	41,733	223,750	59,000
Dec Actual	38,194	40,065	78,259	45,000
January 2011 Actual	6,194	27,290	33,484	22,000
February	-	18,000	18,000	43,000
March	40,903	12,000	52,903	98,000
April	29,800	13,000	42,800	60,000
May	-	17,000	17,000	47,000
June 2011	-	7,400	7,400	16,000

Unplanned-outage values for February through June 2011 are historical average values for 2002-2010 excluding months in 2005, 2006, and 2008 affected by hurricanes & refinery closures. Similarly, typical historical values are average planned outages 2002-2010 plus average unplanned outages 2002-2010 excluding 2005, 2006 and 2008 hurricane impacts & refinery closures. Source: Industrial Info Resources (IIR), www.iirenergy.com, February 7, 2011 database.

3.3.3 PADD 3 Outages

As shown in Table 10, PADD 3 crude distillation units experienced above-average total outage levels in September through November 2010. After below average levels in December and January 2011, February is projected to have total outage levels about 40 percent above average. Then, the March through June 2011 crude distillation units' outages are projected to be slightly below average. For PADD 3 FCC outages, Table 11 shows above average outage levels in February and March 2011 that are followed by April through June at average outage levels.

Table 10. PADD 3 Crude Distillation Unit Outages (Barrels Per Stream Day)

Month **(April 2010 Through June 2011)**	Planned	Unplanned	Total Outage Level	Typical Historical Total Outage Level
Apr 2010 Actual	138,000	10,333	148,333	350,000
May Actual	136,661	84,017	220,678	320,000
June Actual	171,167	144,250	315,417	300,000
July Actual	55,000	45,097	100,097	260,000
Aug Actual	100,210	28,903	129,113	250,000
Sept Actual	464,883	78,000	542,883	380,000
Oct Actual	618,310	-	618,310	460,000
Nov Actual	319,583	-	319,583	290,000
Dec Actual	91,935	4,000	95,935	250,000
January 2011 Actual	301,870	125,356	427,226	630,000
February	833,535	280,000	1,113,535	760,000
March	271,677	250,000	521,677	570,000
April	160,000	180,000	340,000	330,000
May	78,710	130,000	208,710	310,000
June 2011	149,500	130,000	279,500	300,000
Unplanned-outage values for February through June 2011 are historical average values for 2002-2010 excluding months in 2005, 2006, and 2008 affected by hurricanes & refinery closures. Similarly, typical historical values are average planned outages 2002-2010 plus average unplanned outages 2002-2010 excluding 2005, 2006 and 2008 hurricane impacts & refinery closures. Source: Industrial Info Resources (IIR), www.iirenergy.com, February 7, 2011 database.				

Table 11. PADD 3 FCC Unit Outages (Barrels Per Stream Day)

Month **(April 2010 Through June 2011)**	Planned	Unplanned	Total Outage Level	Typical Historical Total Outage Level
Apr 2010 Actual	32,500	21,733	54,233	190,000
May Actual	30,403	9,032	39,435	120,000
June Actual	-	32,033	32,033	120,000
July Actual	-	19,516	19,516	110,000
Aug Actual	7,742	83,613	91,355	110,000
Sept Actual	139,500	132,099	271,599	170,000
Oct Actual	112,258	92,000	204,258	260,000
Nov Actual	67,875	12,267	80,142	180,000
Dec Actual	74,395	29,168	103,563	100,000
January 2011 Actual	127,742	106,235	233,977	300,000
February	445,070	110,000	555,070	380,000
March	309,581	100,000	409,581	240,000
April	67,734	120,000	187,734	180,000
May	-	64,000	64,000	110,000
June 2011	42,933	97,000	139,933	110,000

Unplanned-outage values for February through June 2011 are historical average values for 2002-2010 excluding months in 2005, 2006, and 2008 affected by hurricanes & refinery closures. Similarly, typical historical values are average planned outages 2002-2010 plus average unplanned outages 2002-2010 excluding 2005, 2006 and 2008 hurricane impacts & refinery closures. Source: Industrial Info Resources (IIR), www.iirenergy.com, February 7, 2011 database.

3.3.4 PADD 5 Outages

As detailed in Table 12, PADD 5 crude distillation units experienced larger than average unplanned outage levels in the last half of 2010, but few planned outages. In the first-half 2011, individual monthly forecasts vary widely from well-below average to well-above average. Especially noteworthy are April and May 2011, which are forecast to have crude total outages about 160 percent and 225 percent above average. As shown in Table 13, PADD 5 FCC units also experienced larger than average total outage levels in the last half of 2010. However, currently no planned outages are scheduled in March through June 2011.

Table 12. PADD 5 Crude Distillation Unit Outages (Barrels Per Stream Day)

Month **(April 2010 Through June 2011)**	Planned	Unplanned	Total Outage Level	Typical Historical Total Outage Level
Apr 2010 Actual	5,333	112,400	117,733	95,000
May Actual	126,613	200,710	327,323	100,000
June Actual	28,000	188,000	216,000	55,000
July Actual	45,968	108,000	153,968	54,000
Aug Actual	30,645	125,032	155,677	54,000
Sept Actual	27,300	108,000	135,300	62,000
Oct Actual	20,129	116,903	137,032	120,000
Nov Actual	20,400	59,000	79,400	66,000
Dec Actual	55,645	-	55,645	37,000
January 2011 Actual	200,806	9,032	209,839	110,000
February	117,857	39,000	156,857	220,000
March	51,000	43,000	94,000	170,000
April	218,733	35,000	253,733	98,000
May	377,452	46,000	423,452	130,000
June 2011	1,700	34,000	35,700	73,000
Unplanned-outage values for February through June 2011 are historical average values for 2002-2010 excluding months in 2005, 2006, and 2008 affected by hurricanes & refinery closures. Similarly, typical historical values are average planned outages 2002-2010 plus average unplanned outages 2002-2010 excluding 2005, 2006 and 2008 hurricane impacts & refinery closures. Source: Industrial Info Resources (IIR), www.iirenergy.com, February 7, 2011 database; excludes asphalt refineries.				

Table 13. PADD 5 FCC Unit Outages (Barrels Per Stream Day)

Month (April 2010 Through **June 2011)**	Planned	Unplanned	Total Outage Level	Typical Historical Total Outage Level
Apr 2010 Actual	100,000	12,600	112,600	17,000
May Actual	41,935	123,484	165,419	5,900
June Actual	-	100,467	100,467	18,000
July Actual	-	42,000	42,000	12,000
Aug Actual	-	42,000	42,000	8,800
Sept Actual	25,000	44,433	69,433	13,000
Oct Actual	93,871	66,548	160,419	32,000
Nov Actual	86,667	45,966	132,633	56,000
Dec Actual	73,194	52,290	125,484	45,000
January 2011 Actual	77,000	6,065	83,065	98,000
February	35,750	4,200	39,950	100,000
March	-	18,000	18,000	70,000
April	-	7,800	7,800	28,000
May	-	16,000	16,000	24,000
June 2011	-	26,000	26,000	27,000

Unplanned-outage values for February through June 2011 are historical average values for 2002-2010 excluding months in 2005, 2006, and 2008 affected by hurricanes & refinery closures. Similarly, typical historical values are average planned outages 2002-2010 plus average unplanned outages 2002-2010 excluding 2005, 2006 and 2008 hurricane impacts & refinery closures. Source: Industrial Info Resources (IIR), www.iirenergy.com, February 7, 2011 database.

3.4 Other Outages

Because PADD 4 includes sparsely populated areas, some of which are served by only one refinery, outages can create temporary price increases. Planned and extended unplanned crude unit outages at 10 percent are well above the 6-percent average for March and April 2011. FCC planned and extended unplanned outages for March and April 2011 are even larger with about 17 percent of FCC capacity being offline, while the average of total FCC outages is about 8 percent for these months. However, for PADD 4, such outage patterns have occurred during March and April in 2010, 2007 and 2002.

EIA has also reviewed the planned outages that affect the northern areas of PADD 2 and PADD 4, which sometimes experience supply problems as a result of limited supply alternatives. The primary refineries supplying the Magellan Pipeline, which moves product from the Gulf Coast and lower Midwest into the upper Midwest, planned significant crude and FCC outages (one-sixth of total system distillation and FCC capacity) in October 2010. After that month, November 2010 through June 2011 have been and are forecast to be below average historical levels of outages. Also, refineries in these northern areas are forecast to be at or below average historical levels of outages for February through June 2011.

4. Adequacy of Available Capacity after Outage Considerations

This chapter compares the maximum available capacity (i.e., total capacity minus capacity lost from outages) to the projected need for capacity to meet consumption for the period March 2011 through June 2011. The STEO is used as the benchmark to estimate the need for refining capacity to meet consumption. Chapter 3 indicated that, based on typical historical outage patterns, total U.S. crude distillation and FCC unit outages are projected to be at average to above-average levels in the first half of 2011, with some months significantly above average in certain PADDs. But EIA projects continued moderate consumption of liquid fuels through the first half of 2011, which should help diminish the potential for outage-related price impacts in the spring driving period of 2011.

PADD 3 FCC units are forecast to have February and March outages about 40 percent and 70 percent above average, returning to average levels in the second-quarter. Currently, PADD 3 stocks of gasoline and of distillate fuels are substantially above the average range for these products, which should help cushion the loss of supply..

PADD 4 has a high level of crude distillation and FCC outages in March through May, although the outages are distributed evenly among the states in this geographic area. Similar high levels of activity also occurred in 2010, 2007 and 2002..

Also, PADD 5 will experience planned crude distillation unit outages at 160 percent and 225 percent above historical averages in April and May respectively; yet, there are no planned outages for PADD 5 FCCs, the gasoline-generating units.

Unlike the high outage levels, pipeline interruptions and resultant supply tightness which impacted PADD 2 in fall 2010, outages at refineries supplying the Magellan pipeline are at below-average levels. Also, refineries in northern areas of Midwest and PADD 4 have below-average levels of planned outages. In this region, some winter unplanned outages are predicted to end in early March and refineries in this area should have above-average production levels for the spring driving season.

4.1 Adequacy of U.S. Capacity

This section compares the availability of refining capacity after outages to meet STEO's consumption projections. Looking at historical refinery crude distillation unit inputs for those refineries not experiencing outages and running at fairly high input levels, a maximum utilization factor was developed to estimate the potential or maximum crude inputs that could be achieved with available capacity, net of outages. These potential crude inputs are then compared to STEO's projected crude inputs. The difference, when positive, represents surplus capability to meet forecast consumption.

FCC unit information is handled differently. The STEO does not forecast FCC inputs. This outage report uses a historical relationship between distillation unit inputs (which STEO forecasts) and FCC inputs. The maximum available FCC input is compared with an estimate of projected FCC inputs, which is calculated as STEO crude distillation unit input times the historical ratio of FCC-to-distillation unit inputs.

Table 14 compares the STEO forecast of refinery crude inputs needed to meet total U.S. petroleum consumption with an estimate of potential inputs that could be run in available refinery capacity after outages (i.e., total capacity minus capacity lost to outages). While Chapter 3 showed higher than average crude distillation outage levels in February, April and May, crude distillation capacity exceeds that needed to meet consumption in all months, as the last column in Table 14 shows the surplus capability. The predicted surplus input capabilities of 0.8 to 1.5 million barrels per day represent a range of 5 to 11 percent over inputs needed to meet consumption for spring 2011.

Table 14. U.S. Comparison of Maximum Crude Inputs from Crude Distillation Capacity Available After Outages with STEO-Forecast Crude Input Needs

(Thousand Barrels Per Stream Day)

Month (April 2010 Through June 2011)	Crude Inputs	Operable Distillation Capacity	Total Distillation Outages	Capacity Net of Outages	Potential Crude Inputs (Net Capacity x 0.907)	Surplus: Potential Inputs minus Actual or Projected Inputs
Apr 2010 Actual	15,120	18,464	800	17,664	16,021	901
May Actual	15,220	18,464	737	17,727	16,079	859
June Actual	15,390	18,464	681	17,783	16,129	739
July Actual	15,520	18,464	271	18,193	16,501	981
Aug Actual	15,110	18,393	417	17,976	16,304	1,194
Sept Actual	14,740	18,393	851	17,542	15,911	1,171
Oct Actual	14,000	18,393	1,358	17,035	15,451	1,451
Nov Actual	14,630	18,393	738	17,655	16,013	1,383
Dec Actual	14,910	18,393	303	18,090	16,407	1,497
January 2011 Actual	14,390	18,393	845	17,548	15,916	1,526
February	14,270	18,393	1,346	17,047	15,461	1,191
March	14,340	18,393	906	17,487	15,861	1,521
April	14,830	18,393	832	17,561	15,928	1,098
May	15,250	18,393	742	17,651	16,009	759
June 2011	15,500	18,393	360	18,033	16,356	856

Note: Actual data April 2010 through January 2011. December 2010 and January 2011 crude inputs are based on weekly data through February 1. February through June 2011 data are *STEO*-forecast crude inputs. The potential crude inputs are estimated by applying a factor (0.907) that represents the average of the 10 highest utilization months from January 2002 through 2010, where utilization was estimated as crude inputs over distillation capacity net of outages. Sources: *February 2011 Short-Term Energy Outlook;* Industrial Info Resources (IIR), www.iirenergy.com, February 7, 2011 database.

With total U.S. FCC planned and estimated unplanned outages close to average, Table 15 illustrates that the available FCC capacity at the U.S. level should also be able to meet the total forecast gasoline consumption. Here again, the estimated surplus input capability of 0.3 to 0.4 million barrels per day represents a range of 5 to 8 percent surplus input capability for FCC units in spring 2011.

Table 15. U.S. Comparison of Maximum FCC Inputs from FCC Capacity Available After Outages with Estimated STEO-Based FCC Input Needs

(Thousand Barrels Per Stream Day)

Month (April 2010 Through June 2011)	Crude Inputs	FCC Inputs (Projected FCC Pct Crude = .343)	Operable FCC Capacity	Total FCC Outages	Capacity Net of Outages	Potential FCC Inputs (Net Capacity x 0.942)	Surplus: Potential Inputs minus Actual or Projected Inputs
Apr 2010 Actual	15,120	4,953	6,147	376	5,771	5,437	484
May Actual	15,220	4,970	6,147	312	5,835	5,497	527
June Actual	15,390	5,247	6,147	143	6,004	5,655	408
July Actual	15,520	5,170	6,147	81	6,066	5,714	544
Aug Actual	15,110	5,021	6,119	182	5,937	5,592	571
Sept Actual	14,740	4,869	6,119	452	5,667	5,338	469
Oct Actual	14,000	4,559	6,119	675	5,444	5,128	569
Nov Actual	14,630	4,605	6,119	483	5,636	5,309	704
Dec Actual	14,910	5,114	6,119	313	5,806	5,469	355
January 2011 Actual	14,390	4,936	6,119	378	5,741	5,408	472
February	14,270	4,895	6,119	621	5,498	5,179	285
March	14,340	4,919	6,119	556	5,563	5,240	321
April	14,830	5,087	6,119	333	5,786	5,450	363
May	15,250	5,231	6,119	125	5,994	5,646	415
June 2011	15,500	5,317	6,119	183	5,936	5,592	275

Note: Actual data April 2010 through January 2011 except FCC inputs, which are actual through December 2010. The projected FCC input volumes are estimated by multiplying projected crude inputs by a factor (0.343) that represents the average observed ratio between FCC and crude inputs for facilities experiencing no major outages. The potential FCC inputs are estimated by applying a factor (0.942) that represents the average observed difference between FCC input volumes and capacity in the United States for facilities experiencing no major outages and running at high input levels. Sources: *February 2011 Short-Term Energy Outlook*; Industrial Info Resources (IIR), www.iirenergy.com, February 7, 2011 database.

4.2 Adequacy of Regional Capacity

While U.S. capacity in the aggregate shows adequate capability to meet expected consumption, individual PADDs and geographic areas may have market and supply issues due to local refinery outages and other issues as described in the following sections.

4.2.1 Adequacy of PADD 1 Capacity

As indicated in Table 16, PADD 1 refineries should have adequate crude unit distillation capacity to meet forecast regional consumption. With below average level of outages planned for spring 2011, surplus input capability for crude distillation units ranges from 15 to 20 percent in PADD 1.

Table 16. PADD 1 Comparison of Maximum Crude Inputs from Crude Distillation Capacity Available After Outages with *STEO*-Based Crude Input Needs

(Thousand Barrels Per Stream Day)

Month (April 2010 Through June 2011)	Crude Inputs	Operable Distillation Capacity	Total Distillation Outages	Capacity Net of Outages	Potential Crude Inputs (Net Capacity x 0.927)	Surplus: Potential Inputs minus Actual or Projected Inputs
Apr 2010 Actual	1,212	1,476	9	1,467	1,360	148
May Actual	1,260	1,476	10	1,466	1,359	99
June Actual	1,243	1,476	33	1,443	1,338	95
July Actual	1,241	1,476	-	1,476	1,368	127
Aug Actual	1,215	1,405	63	1,342	1,244	29
Sept Actual	1,093	1,405	108	1,297	1,202	109
Oct Actual	845	1,405	300	1,105	1,024	179
Nov Actual	941	1,405	200	1,205	1,117	176
Dec Actual	1,088	1,405	76	1,329	1,232	144
January 2011 Actual	1,050	1,405	37	1,368	1,268	218
February	1,042	1,405	113	1,292	1,198	156
March	1,047	1,405	52	1,353	1,254	207
April	1,083	1,405	23	1,382	1,281	199
May	1,113	1,405	18	1,387	1,286	172
June 2011	1,132	1,405	5	1,400	1,298	166

Note: Actual data April 2010 through January 2011. December 2010 and January 2011 crude inputs are based on weekly data through February 1. February through June 2011 data are *STEO*-forecast crude inputs. The potential crude inputs are estimated by applying a factor (0.927) that represents the average of the 10 highest PADD 1 utilization months from January 2002 through 2010, where utilization was estimated as crude inputs over distillation capacity net of outages. Sources: *February 2011 Short-Term Energy Outlook;* Industrial Info Resources (IIR), www.iirenergy.com, February 7, 2011 database.

Similar to crude units, moderate consumption forecasts and below-average planned FCC outage levels in Table 17 result in estimated surplus input capabilities from 12 to 16 percent in spring 2011. Besides local product production at refineries, PADD 1 relies on product imports to meet consumption. Unlike fall 2010 with significant outages and strikes in Atlantic Basin refineries affecting potential import supply, spring 2011 does not appear to have any significant supply issues and PADD 1 gasoline and distillate inventories are currently at above average and average levels.

Table 17. PADD 1 Comparison of Maximum FCC Inputs from FCC Capacity Available After Outages with Estimated STEO-Based FCC Input Needs

(Thousand Barrels Per Stream Day)

Month (April 2010 Through June 2011)	Crude Inputs	FCC Inputs (Projected FCC Pct Crude = .422)	Operable FCC Capacity	Total FCC Outages	Capacity Net of Outages	Potential FCC Inputs (Net Capacity x 0.949)	Surplus: Potential Inputs minus Actual or Projected Inputs
Apr 2010 Actual	1,212	499	617	68	550	521	22
May Actual	1,260	514	617	43	574	545	31
June Actual	1,243	542	617	-	617	586	44
July Actual	1,241	520	617	13	604	573	53
Aug Actual	1,215	533	589	9	580	550	17
Sept Actual	1,093	520	589	11	579	549	29
Oct Actual	845	449	589	50	539	511	62
Nov Actual	941	481	589	45	544	517	36
Dec Actual	1,088	459	589	6	583	553	94
January 2011 Actual	1,050	443	589	21	568	539	95
February	1,042	440	589	49	540	513	73
March	1,047	442	589	50	539	511	70
April	1,083	457	589	48	541	513	56
May	1,113	470	589	17	572	543	73
June 2011	1,132	477	589	9	580	551	73

Note: Actual data April 2010 through January 2011 except FCC inputs, which are actual through December 2010. The projected FCC input volumes are estimated by multiplying projected PADD 1 crude inputs by a factor (0.422) that represents the average observed ratio between FCC and crude inputs for facilities experiencing no major outages. The potential FCC inputs are estimated by applying a factor (0.949) that represents the average observed difference between FCC input volumes and capacity in the United States for PADD 1 facilities experiencing no major outages and running at high input levels. Sources: February 2011 Short-Term Energy Outlook; Industrial Info Resources (IIR), www.iirenergy.com, February 7, 2011 database.

4.2.2 Adequacy of PADD 2 Capacity

Below average PADD 2 crude distillation outages are forecast for spring 2011. For crude units (Table 18), projected surplus input capability ranges from 5 to 8 percent (0.2 to 0.3 million barrels per day) over that needed to meet consumption during this timeframe.

Table 18. PADD 2 Comparison of Maximum Crude Inputs from Crude Distillation Capacity Available After Outages with STEO-Based Crude Input Needs

(Thousand Barrels Per Stream Day)

Month (April 2010 Through June 2011)	Forecast Crude Inputs	Operable Distillation Capacity	Total Distillation Outages	Capacity Net of Outages	Potential Crude Inputs (Net Capacity x 0.932)	Surplus: Potential Inputs minus Actual or Projected Inputs
Apr 2010 Actual	3,133	3,953	485	3,468	3,232	99
May Actual	3,410	3,953	144	3,809	3,550	140
June Actual	3,442	3,953	75	3,878	3,614	172
July Actual	3,457	3,953	1	3,952	3,683	226
Aug Actual	3,434	3,953	20	3,933	3,666	232
Sept Actual	3,312	3,953	52	3,901	3,636	324
Oct Actual	3,063	3,953	258	3,695	3,444	381
Nov Actual	3,244	3,953	126	3,827	3,567	323
Dec Actual	3,355	3,953	63	3,890	3,625	270
January 2011 Actual	3,238	3,953	145	3,808	3,549	311
February	3,211	3,953	51	3,902	3,637	426
March	3,227	3,953	194	3,759	3,503	277
April	3,337	3,953	142	3,811	3,552	215
May	3,431	3,953	44	3,909	3,643	212
June 2011	3,488	3,953	25	3,928	3,661	173

Note: Actual data April 2010 through January 2011. December 2010 and January 2011 crude inputs are based on weekly data through February 1. February through June 2011 data are *STEO*-forecast crude inputs. The potential crude inputs are estimated by applying a factor (0.932) that represents the average of the 10 highest PADD 2 utilization months from January 2002 through 2010, where utilization was estimated as crude inputs over distillation capacity net of outages. Sources: *February 2011 Short-Term Energy Outlook;* Industrial Info Resources (IIR), www.iirenergy.com, February 7, 2011 database.

As shown in Table 19, PADD 2 FCC units also have below average planned outages in spring 2011. The projected FCC surplus input capability ranges from 8 to 12 percent (varying around 0.1 million barrels per day)

Table 19. PADD 2 Comparison of Maximum FCC Inputs from FCC Capacity Available After Outages with Estimated *STEO*-Based FCC Input Needs
(Thousand Barrels Per Stream Day)

Month (April 2010 Through June 2011)	Crude Inputs	FCC Inputs (Projected FCC Pct Crude = .326)	Operable FCC Capacity	Total FCC Outages	Capacity Net of Outages	Potential FCC Inputs (Net Capacity x 0.950)	Surplus: Potential Inputs minus Actual or Projected Inputs
Apr 2010 Actual	3,133	973	1,296	124	1,172	1,114	141
May Actual	3,410	1026	1,296	35	1,261	1,198	172
June Actual	3,442	1076	1,296	5	1,291	1,226	150
July Actual	3,457	1069	1,296	6	1,290	1,225	156
Aug Actual	3,434	1061	1,296	31	1,265	1,202	141
Sept Actual	3,312	993	1,296	100	1,196	1,136	143
Oct Actual	3,063	884	1,296	249	1,047	995	111
Nov Actual	3,244	928	1,296	224	1,072	1,019	91
Dec Actual	3,355	1094	1,296	78	1,218	1,157	63
January 2011 Actual	3,238	1056	1,296	33	1,263	1,199	144
February	3,211	1047	1,296	18	1,278	1,214	167
March	3,227	1052	1,296	53	1,243	1,181	129
April	3,337	1088	1,296	43	1,253	1,191	103
May	3,431	1119	1,296	17	1,279	1,215	96
June 2011	3,488	1137	1,296	7	1,289	1,224	87

Note: Actual data April 2010 through January 2011 except FCC inputs, which are actual through December 2010. The projected FCC input volumes are estimated by multiplying PADD 2 projected crude inputs by a factor (0.326) that represents the average observed ratio between FCC and crude inputs for facilities experiencing no major outages. The potential FCC inputs are estimated by applying a factor (0.950) that represents the average observed difference between FCC input volumes and capacity in the United States for PADD 2 facilities experiencing no major outages and running at high input levels. Sources: *February 2011 Short-Term Energy Outlook*; Industrial Info Resources (IIR), www.iirenergy.com, February 7, 2011 database.

4.2.3 Adequacy of PADD 3 Capacity

After some large planned outages in February, PADD 3 crude distillation units will experience average outage levels in March through June 2011. Surplus input capability to crude units of will range from 5 to 11 percent (0.4 to 0.8 million barrels per day) as shown in Table 20.

Table 20. PADD 3 Comparison of Maximum Crude Inputs from Crude Distillation Capacity Available After Outages with *STEO*-Based Crude Input Needs

(Thousand Barrels Per Stream Day)

Month (April 2010 Through June 2011)	Crude Inputs	Operable Distillation Capacity	Total Distillation Outages	Capacity Net of Outages	Potential Crude Inputs (Net Capacity x 0.934)	Surplus: Potential Inputs minus Actual or Projected Inputs
Apr 2010 Actual	7,809	9,075	148	8,927	8,338	529
May Actual	7,679	9,075	221	8,854	8,270	591
June Actual	7,709	9,075	315	8,760	8,181	472
July Actual	7,814	9,075	100	8,975	8,383	569
Aug Actual	7,593	9,075	129	8,946	8,355	762
Sept Actual	7,368	9,075	543	8,532	7,969	601
Oct Actual	7,224	9,075	618	8,457	7,899	675
Nov Actual	7,527	9,075	320	8,755	8,178	651
Dec Actual	7,500	9,075	96	8,979	8,386	887
January 2011 Actual	7,238	9,075	427	8,648	8,077	839
February	7,178	9,075	1,114	7,961	7,436	258
March	7,213	9,075	522	8,553	7,989	776
April	7,459	9,075	340	8,735	8,158	699
May	7,671	9,075	209	8,866	8,281	610
June 2011	7,797	9,075	280	8,796	8,215	418

Note: Actual data April 2010 through January 2011. December 2010 and January 2011 crude inputs. The potential crude inputs are estimated by applying a factor (0.934) that represents the average of the 10 highest PADD 3 utilization months from January 2002 through 2010, where utilization was estimated as crude inputs over distillation capacity net of outages. Sources: *February 2011 Short-Term Energy Outlook;* Industrial Info Resources (IIR), www.iirenergy.com, February 7, 2011 database.

A different scenario unfolds for PADD 3 FCC units than for its crude distillate capacity. February and March FCC total outage levels were about 40 percent and 70 percent above historical averages, but are projected to return to average levels during the second-quarter. Table 21 illustrates the tight balance that occurred in February and March as measured by using the STEO-based estimate of PADD 3 typical FCC input to meet product consumption. While inventories and imports can help to fill in for reduced capacity, refiners historically have adjusted several ways: by shifting actual FCC input during months like February and March to neighboring months; by using product or feedstock exchanges with other refiners; or by increasing refinery throughputs in PADD 1 and PADD 2, which normally receive product from PADD 3. PADD 3 refiners may also be able to reduce exports. If maintenance schedules are on target and no unplanned outages arise, the surplus input capability to PADD 3 FCC units will return to the positive range in April through June (0.2 to 0.3 million barrels per day) as detailed in Table 21.

Table 21. PADD 3 Comparison of Maximum FCC Inputs from FCC Capacity Available After Outages with Estimated STEO-Based FCC Input Needs

(Thousand Barrels Per Stream Day)

Month (April 2010 Through June 2011)	Crude Inputs	FCC Inputs (Projected FCC Pct Crude = .365)	Operable FCC Capacity	Total FCC Outages	Capacity Net of Outages	Potential FCC Inputs (Net Capacity x 0.961)	Surplus: Potential Inputs minus Actual or Projected Inputs
Apr 2010 Actual	7,809	2700	3,128	54	3,074	2,954	254
May Actual	7,679	2681	3,128	39	3,089	2,968	287
June Actual	7,709	2782	3,128	32	3,096	2,975	193
July Actual	7,814	2731	3,128	20	3,108	2,987	256
Aug Actual	7,593	2571	3,128	91	3,037	2,918	347
Sept Actual	7,368	2438	3,128	272	2,856	2,745	307
Oct Actual	7,224	2444	3,128	204	2,924	2,810	366
Nov Actual	7,527	2449	3,128	80	3,048	2,929	480
Dec Actual	7,500	2737	3,128	104	3,024	2,906	169
January 2011 Actual	7,238	2642	3,128	234	2,894	2,781	139
February	7,178	2620	3,128	555	2,573	2,473	**(147)**
March	7,213	2633	3,128	410	2,718	2,612	**(20)**
April	7,459	2723	3,128	188	2,940	2,826	103
May	7,671	2800	3,128	64	3,064	2,945	145
June 2011	7,797	2846	3,128	140	2,988	2,872	26

Note: Actual data April 2010 through January 2011 except FCC inputs, which are actual through December 2010. The projected FCC input volumes are estimated by multiplying PADD 3 crude inputs by a factor (0.365) that represents the average observed ratio between FCC and crude inputs for facilities experiencing no major outages. The potential FCC inputs are estimated by applying a factor (0.961) that represents the average observed difference between FCC input volumes and capacity in the United States for PADD 3 facilities experiencing no major outages and running at high input levels.
Sources: *February 2011 Short-Term Energy Outlook*; Industrial Info Resources (IIR), www.iirenergy.com, February 7, 2011 database.

4.2.4 Adequacy of PADD 5 Capacity

As detailed in Chapter 3 (Table 12), PADD 5 crude distillation units experienced larger than average unplanned outage levels in the last half of 2010, but few planned outages. In the first-half 2011, a significant number of planned crude unit outages are now scheduled. Especially noteworthy are April and May 2011, which are forecast to have crude total outages about 160 percent and 225 percent above average. During the first quarter, PADD 5 is expected to have a surplus input capability of about 11 percent (Table 22). But with the large planned outages in April and May, the surplus input capability in

April will fall to 5 percent and May available capacity may fall short of meeting consumption (86 MB/D deficit). As in PADD 3, product and feedstock exchanges with other refiners or strategic scheduling of imports can be used in such scenarios along with use of inventories. With the restart of the PADD 5 crude units in June, about 7 percent surplus input capability is forecast.

Table 22. PADD 5 Comparison of Maximum Crude Inputs from Crude Distillation Capacity Available After Outages with STEO-Based Crude Input Needs

(Thousand Barrels Per Stream Day)

Month (April 2010 Through June 2011)	Crude Inputs	Operable Distillation Capacity	Total Distillation Outages	Capacity Net of Outages	Potential Crude Inputs (Net Capacity x 0.829)	Surplus: Potential Inputs minus Actual or Projected Inputs
Apr 2010 Actual	2,430	3,300	118	3,182	2,638	208
May Actual	2,342	3,300	327	2,973	2,464	122
June Actual	2,423	3,300	216	3,084	2,557	134
July Actual	2,435	3,300	154	3,146	2,608	173
Aug Actual	2,324	3,300	156	3,144	2,607	283
Sept Actual	2,373	3,300	135	3,165	2,624	251
Oct Actual	2,332	3,300	137	3,163	2,622	290
Nov Actual	2,370	3,300	79	3,221	2,670	300
Dec Actual	2,415	3,300	56	3,244	2,690	274
January 2011 Actual	2,331	3,300	210	3,090	2,562	231
February	2,312	3,300	157	3,143	2,606	294
March	2,323	3,300	94	3,206	2,658	335
April	2,402	3,300	254	3,046	2,525	123
May	2,471	3,300	423	2,877	2,385	**(86)**
June 2011	2,511	3,300	36	3,264	2,706	195

Note: Actual data April 2010 through January 2011. December 2010 and January 2011 crude inputs. The potential crude inputs are estimated by applying a factor (0.829) that represents the average of the 10 highest PADD 5 utilization months from January 2002 through 2010, where utilization was estimated as crude inputs over distillation capacity net of outages. Sources: *February 2011 Short-Term Energy Outlook;* Industrial Info Resources (IIR), www.iirenergy.com, February 7, 2011 database.

In contrast to the PADD 5 crude unit forecasts, Table 23 shows no FCC outages are planned for March through June 2011; thus surplus input capability is a fairly stable average of 15 to 20 percent in the first six months of 2011.

Table 23. PADD 5 Comparison of Maximum FCC Inputs from FCC Capacity Available After Outages with Estimated STEO-Based FCC Input Needs

(Thousand Barrels Per Stream Day)

Month (April 2010 Through June 2011)	Crude Inputs	FCC Inputs (Projected FCC Pct Crude = .283)	Operable FCC Capacity	Total FCC Outages	Capacity Net of Outages	Potential FCC Inputs (Net Capacity x 0.946)	Surplus: Potential Inputs minus Actual or Projected Inputs
Apr 2010 Actual	2,430	623	904	113	791	749	126
May Actual	2,342	606	904	165	739	699	93
June Actual	2,423	671	904	100	804	760	89
July Actual	2,435	673	904	42	862	815	142
Aug Actual	2,324	683	904	42	862	815	132
Sept Actual	2,373	742	904	69	835	790	48
Oct Actual	2,332	618	904	160	744	703	85
Nov Actual	2,370	585	904	133	771	730	145
Dec Actual	2,415	684	904	125	779	736	53
January 2011 Actual	2,331	660	904	83	821	777	117
February	2,312	654	904	40	864	817	163
March	2,323	657	904	18	886	838	181
April	2,402	680	904	8	896	848	168
May	2,471	699	904	16	888	840	141
June 2011	2,511	711	904	26	878	831	120

Note: Actual data April 2010 through January 2011 except FCC inputs, which are actual through December 2010. The projected FCC input volumes are estimated by multiplying PADD 5 crude inputs by a factor (0.283) that represents the average observed ratio between FCC and crude inputs for facilities experiencing no major outages. The potential FCC inputs are estimated by applying a factor (0.946) that represents the average observed difference between FCC input volumes and capacity in the United States for PADD 5 facilities experiencing no major outages and running at high input levels.
Sources: *February 2011 Short-Term Energy Outlook*; Industrial Info Resources (IIR), www.iirenergy.com, February 7, 2011 database.

5. Outage Impacts on Production

Chapter 4 indicated that outages in most regions should not prevent refiners from meeting EIA's *STEO*-forecast consumption through June 2011. This chapter focuses on the U.S. total gasoline and distillate production that available capacity (net of outages) might produce. That is, it focuses on production potential of available capacity.

Unit outages have varying impacts on production, but adequate statistical relationships exist to estimate production impacts. In particular, FCC unit outages better explain gasoline production than outages of crude distillate units. Crude distillation units, on the other hand, are a better indicator of distillate production. Distillate and gasoline wholesale margins, refinery capacity utilization, and time of year also help explain some of the production variations historically and are helpful in estimating future gasoline and distillate fuel production impacts consistent with prices seen in EIA's *STEO*. Models developed to capture these relationships are summarized in Appendix A.

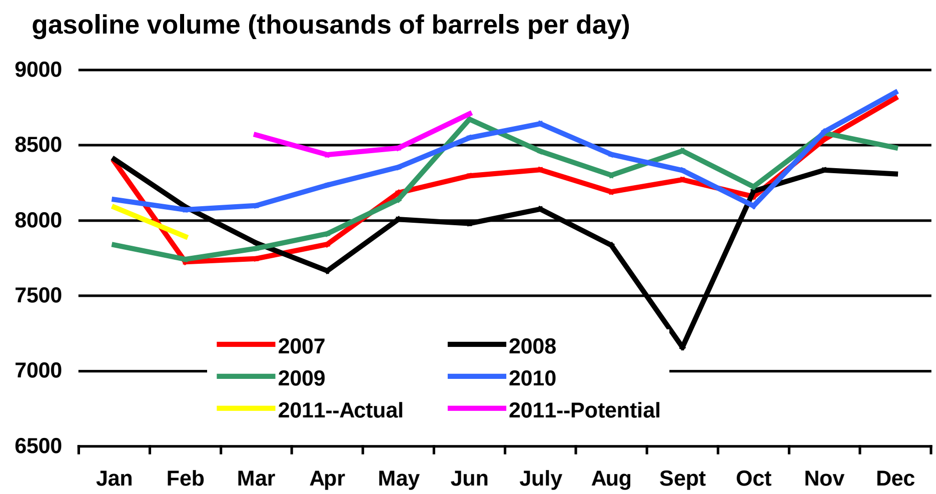
In any given region, the underlying assumption is that refiners with available capacity can increase their throughputs, and thus production, to help fill in for offline capacity. The dynamics of this process, however, are influenced by current market conditions. The price response is the signal to refiners to produce more supply. In weak markets, such as currently being experienced, refiners are unlikely to produce supply in advance of a potential supply problem. This means some price increase could occur before refiners increase production from available capacity.

As was the case in 2010, low petroleum consumption projected in 2011 means less refinery capacity is needed than before the recession-related reduction in consumption. In addition, more ethanol is being used to meet gasoline consumption than in prior years, further reducing the need for refinery capacity to produce that fuel.

Looking ahead to the summer driving season, Figure 10 and Figure 11 show U.S. actual gasoline and middle distillate production from 2007 through 2010, and potential production March 2011 through June 2011. Potential production is derived using the model in Appendix A, assuming maximum inputs of crude and unfinished oils to available capacity (net of outages).

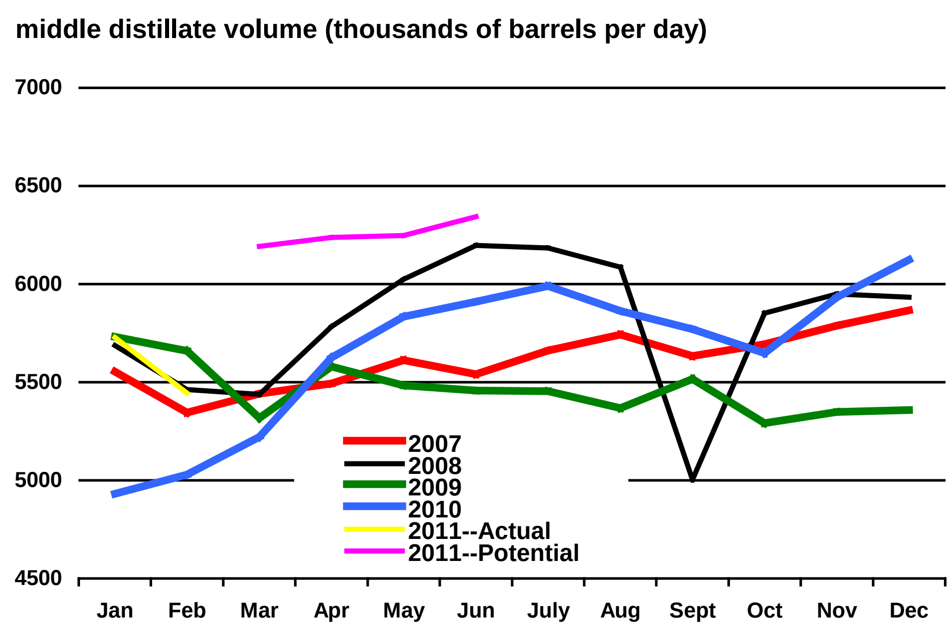
Figure 10 and Figure 11 show that potential production for gasoline and middle distillates is in excess of historical production. Estimated potential gasoline and distillate production from refineries including the subsequent addition of ethanol in gasoline, remains above prior year's actual production.

Figure 10. U.S. Monthly Gasoline Actual and Potential Production, 2007-June 2011 (Thousand Barrels per Day)



Note: Refinery gasoline production represents finished gasoline (including oxygenates added at terminals).
Sources: Actual: 2007 – February 2011. EIA *Petroleum Supply Monthly* and for February 2011, *Weekly Petroleum Supply Report*. Potential: March 2011-June 2011, EIA projections based on available capacity.

Figure 11. U.S. Monthly Middle Distillate Actual and Potential Production, 2007-June 2011 (Thousand Barrels per Day)



Sources: Actual: 2007 – Feb 2011, EIA *Petroleum Supply Monthly* and February 2011 *Weekly Petroleum Supply Report*. Potential: March 2011-June 2011, EIA projections based on available capacity.

6. Conclusion

At the U.S. level, available refinery capacity adjusted for outages is adequate to meet forecast consumption through June 2011. While gasoline and distillate inventories have been dropping, they are still at normal to high levels in most regions, providing some cushion for outages. EIA projects gasoline and distillate fuel consumption to grow in 2011, but we still expect annual average levels to remain under those in 2007. As discussed in the last Market Assessment report, in spite of a net loss of refinery capacity due to shutdowns, the extent of refinery utilization still indicates some surplus to deal with unexpected events. U.S. refiners have increased gasoline and distillate exports and decreased imports of these products, resulting in more flexibility to reverse trade balances and accommodate domestic consumption should the need arise from refinery outages. Because of lower consumption than in 2007 and an ability to shift trade balances, the United States has additional capacity flexibility to absorb outages with little price impact. Crude oil prices, however, should continue to be a large factor affecting product prices.

Even though aggregate U.S. refinery capacity after outages appears adequate this spring, high outage levels in PADD 5 during April and May could add some price pressure to that region. In spring and early summer 2010, PADD 5 experienced large unplanned outages with moderate gasoline price impacts. The planned outages expected in April and May are larger than the unplanned outages of 2010, but may have less impact since they are planned events and refiners arrange for replacement supplies in advance, including imports. When this report was written, the impacts of the disastrous earthquake and tsunami in Japan on Pacific Basin product supply were not expected to have a significant impact on potential imports to PADD 5 from export areas like India, South Korea or Singapore.

Appendix A. Forecast Models Used to Estimate Gasoline & Distillate Production from Available Capacity

As part of the outage study, an econometric analysis was made of refinery light product yields in order to explore whether forecasting models could be created for refinery output of finished gasoline and light oil products (LOP) given easily obtained unit input variables. This would allow us to explore the impact of outages, which reduce unit inputs, on production. In addition, market variables were explored that would also potentially impact production. To assist in this goal, an effort was made to model LOP yield and gasoline yield as a percentage of LOP yield for the United States, the estimation results for which are shown below.

Model estimates show that the refinery yield of LOP and finished gasoline vary seasonally and depends on FCC inputs, with product margins having small effects. Distillate output also varies seasonally and depends mainly on distillation capacity utilization with product margins. Both models include 0 / 1 indicator variables for onetime events: d_dec02 refers to market effects the Venezuelan strike on imports, and dh_sep05 refers to hurricanes Katrina / Rita. The data used in this study came from various sources, including EIA's *Petroleum Supply Monthly* and *Petroleum Marketing Monthly*. The methodology differs from that used in previous reports by the use of the U.S. Imported Refiner's Acquisition Cost (IRAC) crude oil price to calculate product margins rather than average WTI spot price. This change was needed due to the current price imbalance between WTI and other crude oils. The data used include:

- Refinery Light Oil Product production and production yields;
- Refinery gasoline production and production yield;
- Available refinery distillation capacity;
- Gasoline and diesel wholesale product margins were calculated using the price forecast in the EIA *Short-Term Energy Outlook* relative to the IRAC, in cents per gallon.

$$y_{L,t} = c + \alpha z_t + \sum_{i=1}^{11} \gamma_i m_i + \tau T + \varphi\, y_{L,t-1} + \delta_i D_i + \varepsilon_t \qquad \text{Eqn. 1.}$$

$$y_{G,t} = c' + \sum_{j=0}^{1} \beta'_j x_{G,t-j} + \beta'_2 x_{D,t-1} + \alpha' z_t + \sum_{i=1}^{11} \gamma'_i m_i + \tau' T + \varphi' y_{G,t-1} + \delta'_i D_i + \varepsilon'_t$$

Eqn. 2.

Where

$y_{L,t}$ refers to light oil product yield at time t;

$y_{G,t}$ refers to gasoline percent of LOP yield at time t;

$x_{G,t}$ refers to gasoline margin (cents per gallon) relative to IRAC at time t;

$x_{D,t}$ refers to diesel margin (cents per gallon) relative to IRAC at time t;

z_t refers to distillation capacity utilization at time t;

m_i refers to monthly 0 / 1 indicator variables, Feb, Mar, …, Dec ;

T refers to a linear time trend;

D_i refers to onetime event indicator variables;

ε_t refers to error term at time t.

$c, \alpha, \beta, \gamma, \tau, \delta, \varphi$ and $c', \alpha', \beta', \gamma', \tau', \delta', \varphi'$ are estimated parameters.

The LOP yield variable was calculated as a percent of crude oil and unfinished refinery inputs. The distillation capacity variable was calculated as total distillation capacity minus the capacity lost to outages. Gasoline production is total gasoline production less butanes, pentanes and oxygenates.

Both equations were estimated using data from January 2002 through November 2010. For the gasoline output yield model, one would expect the coefficient sign on the gasoline margin to be positive (more profit leading to higher yields), and a negative coefficient on distillate margins. The positive coefficient on the lagged dependent variable for both models indicates that the level of current yield depends on the previous month's output, the large (approximately 0.5) estimated coefficients indicating a large degree of inter- temporal inertia. The models are summarized in Tables A-1 and A-2.

The models fit historical data well, as demonstrated by the high R-square and the small regression error relative to the size of the dependent variable and providing good out-of-sample forecasts. A comparison of the goodness-of-fit to historical data can be seen in Figures A-1 and A-2.

Table A-1. Light Oil Product (LOP) Yield Model

Independent Variable: LOP Yield

Parameter	*Estimated Coefficient*	
C	36.34471	***
FEB	-0.47342	**
MAR	-1.20347	***
APR	-0.90989	***
MAY	-0.73025	**
JUN	-0.72374	**
JUL	-0.65115	*
AUG	-0.55863	
SEP	0.56844	
OCT	0.84676	***
NOV	1.07715	***
DEC	0.98675	***
Trend	0.01275	***
Distillation Capacity	-0.02959	
LOP Yield (-1)	0.59051	***
DH_SEP05 variable	1.43516	***
adj. R Squared	0.946	
std. error of reg.	0.422	
mean of dep. variable	82.99	
Note: *** indicates significance at the 1% level, ** indicates significance at the 5% level, and * indicates significance at the 10% level.		

Table A-2. Model for Gasoline Percent of LOP Yield

Independent Variable: Gasoline Pct. of LOP

Parameter	*Estimated Coefficient*	
C	38.3584	***
FEB	-0.61364	**
MAR	-0.75918	***
APR	-0.85621	***
MAY	-0.68590	**
JUN	-0.59283	**
JUL	-0.62386	**
AUG	-0.93982	***
SEP	-0.23007	
OCT	-0.72364	***
NOV	0.00761	
DEC	0.03226	
Trend	-0.01532	***
margin_gasoline	0.01652	**
margin_gasoline (-1)	0.01933	**
margin_diesel (-1)	-0.03191	***
Distillation Capacity	-0.06570	**
GASPctLOP (-1)	0.46553	***
D_DEC02 variable	-1.50707	***
DH_SEP05 variable	1.25482	**
adj. R Squared	0.899	
std. error of reg.	0.512	
mean of dep. variable	57.54	

Note: *** indicates significance at the 1% level, ** indicates significance at the 5% level, and * indicates significance at the 10% level.

Figure A-1. LOP yield model fit of historical data.

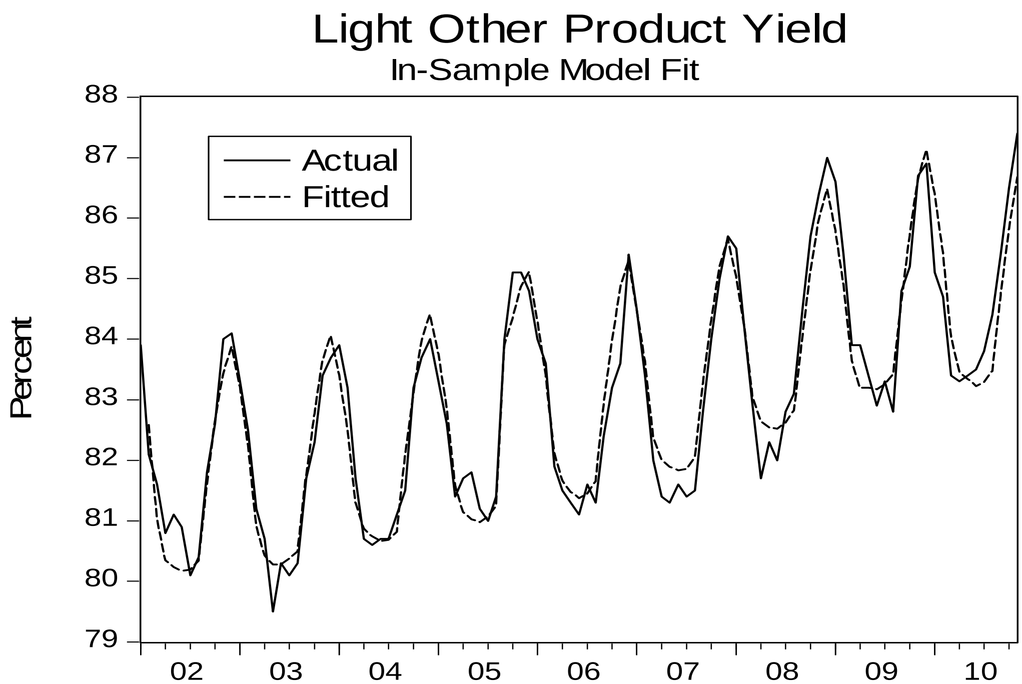
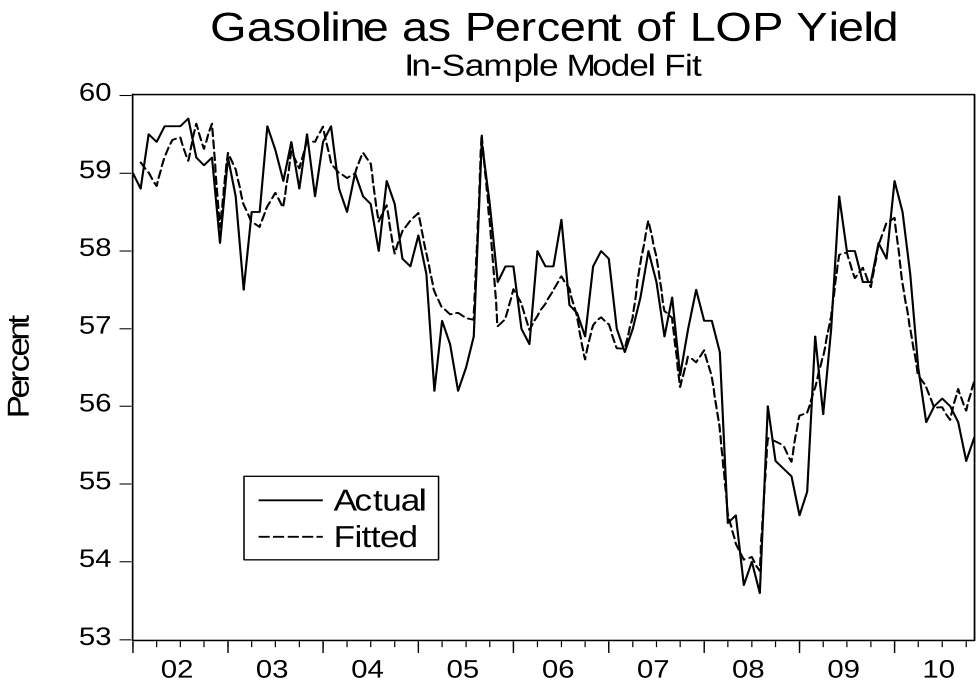
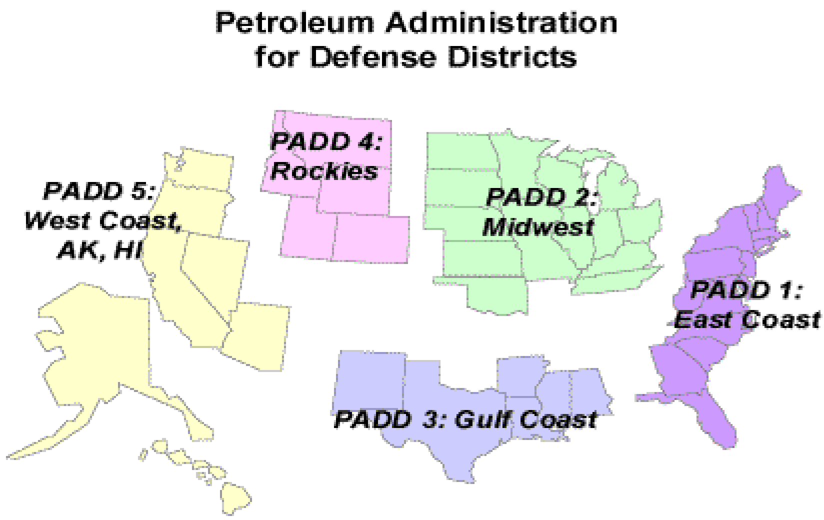


Figure A-2. Gasoline yield as percent of LOP yield model fit of historical data.



APPENDIX B. Petroleum Administration for Defense Districts (PADDs)



PADDs were delineated during World War II to facilitate oil allocation.

PADD 1 (East Coast) is composed of these three subdistricts:

Subdistrict 1A (New England): Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, Vermont.

Subdistrict 1B (Central Atlantic): Delaware, District of Columbia, Maryland, New Jersey, New York, Pennsylvania.

Subdistrict 1C (Lower Atlantic): Florida, Georgia, North Carolina, South Carolina, Virginia, West Virginia.

PADD 2 (Midwest): Illinois, Indiana, Iowa, Kansas, Kentucky, Michigan, Minnesota, Missouri, Nebraska, North Dakota, South Dakota, Ohio, Oklahoma, Tennessee, Wisconsin.

PADD 3 (Gulf Coast): Alabama, Arkansas, Louisiana, Mississippi, New Mexico, Texas.

PADD 4 (Rocky Mountain): Colorado, Idaho, Montana, Utah, Wyoming.

PADD 5 (West Coast): Alaska, Arizona, California, Hawaii, Nevada, Oregon, Washington