Independent Statistics & Analysis
U.S. Energy Information Administration

Refinery Outages: Fall 2016

November 2016

Independent Statistics & Analysis
www.eia.gov

U.S. Department of Energy
Washington, DC 20585

This report was prepared by the U.S. Energy Information Administration (EIA), the statistical and analytical agency within the U.S. Department of Energy. By law, EIA's data, analyses, and forecasts are independent of approval by any other officer or employee of the United States Government. The views in this report therefore should not be construed as representing those of the U.S. Department of Energy or other federal agencies.

Table of Contents

Tables

Figures

1. Preface

This report examines U.S. refinery outages planned for September 2016 through December 2016 and the implications for available refinery production capacity, petroleum product markets, and the supply of gasoline, diesel fuel, and jet fuel. Dissemination of such analyses can be beneficial to market participants who may otherwise be unable to access such information.

Refinery outages result from the planned shutdown of refinery units for maintenance and upgrades and from unplanned shutdowns from a variety of causes such as mechanical failure, bad weather, power failures, fire, and flooding. Planned maintenance is typically scheduled when refined petroleum product consumption is relatively low—in the fall and in the first quarter when there is less demand for transportation fuels.

This report analyzes the potential implications of planned shutdowns of various refinery units as reported by Industrial Info Resources (IIR) and uses individual refinery models from PRISM software developed by Baker & O'Brien, Inc. The IIR data used in this analysis are as of August 16, and have not changed significantly as of mid-October. The specific refinery units analyzed are the atmospheric crude distillation unit (ACDU), the fluidized catalytic cracking unit (FCCU), the catalytic reforming unit (CRU), the hydrocracking unit (HU), and the coking unit (CU). Definitions of these units can be found in the EIA glossary. A more detailed discussion of the methodology can be found in Section 3.

This report focuses on how planned refinery outages may affect the adequacy of regional gasoline, diesel fuel, and jet fuel, as defined by Petroleum Administration for Defense District (PADD) areas, and does not include a discussion of national-level balances.

National supply and demand balances have very limited implications for the regional adequacy of petroleum product supply because pipeline infrastructure, geography, and marine shipping regulations constrain the amount of product that can flow between the different regions of the United States. In most regions of the country, most petroleum products are primarily supplied by in-region refinery production.

Unplanned outages are by definition unexpected and vary widely. As a result, estimates of future unplanned outages based on historical averages are inherently problematic. This report does not attempt to estimate future unplanned outages.

2. Executive Summary

Planned refinery outages during the fall 2016 maintenance season (September through December) are not expected to adversely affect the supply of gasoline, jet fuel, and distillate fuel. The effect of refinery outages on product supplies depends on many factors, including petroleum product demand, the availability of product supplies from available refinery capacity, inventories, imports and redirected exports, as well as actual levels of both planned and unplanned refinery outages. Barring unusually high unplanned outages, planned outages that extend beyond the planned period, or higher-than-expected demand, the supply of gasoline, jet fuel, and distillate fuel should be adequate in all regions in 2016.

Fall planned maintenance along the East Coast (PADD 1) is expected to be very light for atmospheric crude distillation, fluidized catalytic cracking, and reforming capacity. The planned outages will result in estimated production loss in gasoline of 21,000 b/d and 44,000 b/d in September and October, respectively, and production loss in distillate fuel of 6,000 b/d and 11,000 b/d during the same periods. Planned outages are also expected to reduce gasoline supplies by 12,000 b/d in November. There are no outages planned for December. Total estimated production losses resulting from the expected outages account for only 3.5% of existing gasoline inventories and 1.0% of distillate inventories as of August 26, 2016. Therefore, the production loss in PADD 1 could be covered by existing product inventory.

Planned maintenance in the Midwest (PADD 2) is concentrated in September and October, though atmospheric crude distillation unit outages peak at 5% of supply, less than the historic average and only one-fourth of high 2015 maintenance levels. Planned maintenance of fluidized catalyst cracking capacity will be above the 10-year average from September through November, with 11% and 16% of capacity offline in September and October respectively, compared with an historical average of 5% and 10% during those months. The outages will result in moderate production loss of petroleum products, peaking at 130,000 b/d in October, including 65,000 b/d of gasoline, 43,000 b/d of diesel fuel, and 22,000 b/d of jet fuel. The total estimated production losses in gasoline, distillate fuel, and jet fuel account for 8%, 9%, and 20% of existing regional inventories as of August 26. Nevertheless, regional inventories will likely be sufficient to make up for lost in-region production and significant supplies are available in other regions, such as the Gulf Coast, to offset production shortfalls from planned outages as conditions warrant.

Planned maintenance along the Gulf Coast (PADD 3) of fluidized catalytic cracking, reforming, hydrocracking, and coking units is above average this Fall, while planned atmospheric crude distillation unit maintenance is near or below the 10-year average. The outages will result in moderate production loss in petroleum products. During September and October, the expected average losses are 127,000 b/d in gasoline, 33,000 b/d in jet fuel, and 91,000 b/d in distillate fuel. As of August 26, Gulf Coast gasoline inventories are at their highest point in more than 10 years, and jet fuel and distillate fuel inventories are above the 10-year average. The total estimated production loss as a result of the planned outages accounts for 10% of existing gasoline inventories, 14% of jet fuel inventories, and 15% of distillate inventories. As a result, regional stocks are sufficient to offset lost production from the planned outages.

Planned outages in the Rocky Mountain region (PADD 4) this fall are limited to only fluidized catalytic cracking units during October and November, when 28,000 b/d (14% of regional capacity) and 6,000 b/d (3% of regional capacity) will be offline, respectively. During peak planned outages in October, maintenance is expected to reduce gasoline production by 21,000 b/d, jet fuel by 5,000 b/d, and distillate by more than 4,000 b/d. Total estimated production losses from planned outages in PADD 4 in October and November account for 12% of regional gasoline inventories, 26% of jet fuel inventories, and 5% of distillate inventories. Although October fluidized catalytic cracking maintenance is above average, the limited nature of maintenance, adequate product inventory levels that are close to the 10-year average, seasonally lower consumption, and above average inventories in neighboring regions should ensure that supplies are sufficient to offset planned production outages.

Along the West Coast (PADD 5), planned outages between October and November will be elevated compared with the 10-year average, and there is no maintenance planned for September or December. Maintenance is concentrated among atmospheric crude distillation units, with outages averaging 423,000 b/d (15% of regional capacity) in October and November, sharply higher than the 10-year average of 78,000 b/d (3% of regional capacity). Coking maintenance averages 50,000 b/d (9% of regional capacity) in October and November, above the 10-year average of 19,000 b/d (4%). Below average reforming maintenance only occurs in October, and there is no planned maintenance for fluidized catalytic cracking and hydrocracking units.

To mitigate the impact of higher-than-normal atmospheric crude distillation unit maintenance on downstream refinery units, refiners purchase gas oil from international and regional markets. As a result, the impact of planned maintenance on refinery production in PADD 5 is relatively reduced, averaging 117,000 b/d in October and November, including 31,000 b/d of gasoline, 64,000 b/d of jet fuel, and 41,000 b/d of distillate fuel. The total estimated reduction of petroleum products induced by the outages accounts for 4% of the existing gasoline inventory, 39% of jet fuel inventory, 16% of distillate fuel inventory. Overall, regional product inventories—supplemented with jet fuel imports—are sufficient to make up for the production loss from planned outages.

3. Methodology: Refinery Modeling and Base Cases

This report uses the methodology adopted in the March 2016 report to examine potential production implications of refinery unit outages. EIA subscribes to PRISM software, developed by Baker & O'Brien Inc., and uses this tool to simulate the shutdown of various refinery units and the subsequent potential impact on regional petroleum supply.

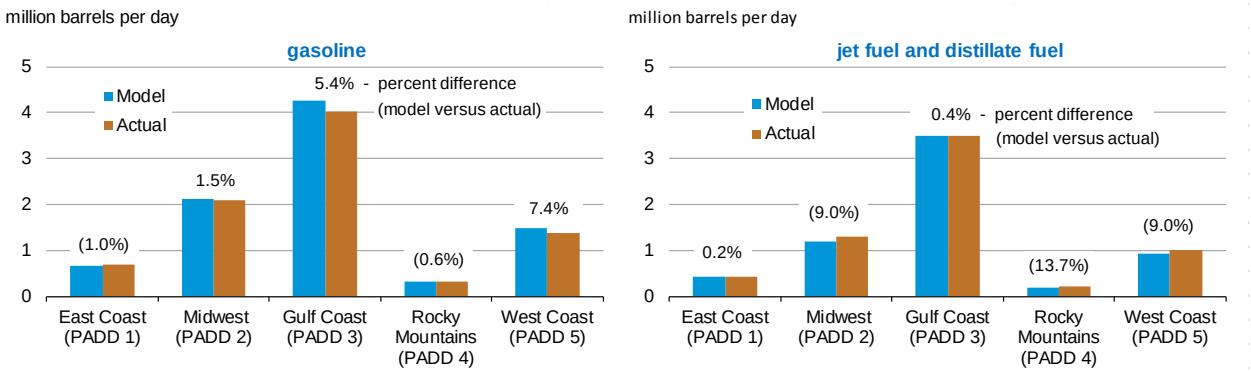
PRISM includes detailed computer models of 118 of the 137 operating U.S. refineries reported on by EIA. Each refinery model contains individual refinery unit simulations that can be manipulated to change unit operations, including a complete shutdown of the unit. The remaining refinery units can be operated through operational changes, by use of inventoried or purchased feedstocks, and by changes in refinery crude slates. The resulting petroleum product output with unit(s) down for planned maintenance can then be simulated. To assess production losses resulting from planned maintenance, however, these results must be compared with a more normal mode of refinery operations, thereby requiring the simulation of refinery base cases.

A base case for each refinery in the PRISM database was developed to represent high-utilization operations using nonconfidential data with the following assumptions:

- Input actual crude imports based on EIA's Company Level Import data identifies source country, API gravity level, and sulfur level. The data and are matched to crudes in the PRISM database.
- Assume 90% utilization on key units including crude distillation units, fluidized catalytic crackers, hydrocrackers, cokers, and reformers
- Input domestic crude slates per utilization assumption and local availability
- Buy intermediate feedstocks as necessary to fill conversion units
- Limit production of unfinished products

The results of these base case simulations were combined at the PADD level and compared with actual production levels reported by EIA in 2014, a year of very high refinery utilizations. For gasoline and middle distillate (including jet fuel, diesel, and heating oil) production, the model results are close to the 2014 actuals and can therefore provide a reasonable approximation of refinery production capability.

Figure 1. U.S. refinery production base-case results vs. 2014 actual



Source: U.S. Energy Information Administration

4. Recent Market Conditions

As of November 7, the price of North Sea Brent crude oil was $42.83 per barrel (b). In the November *Short-Term Energy Outlook* (STEO), EIA forecasted that Brent will average $43/b for all of 2016, $9/b lower than the 2015 average. The lower price reflects the continued global oversupply of crude oil and has been characterized by elevated volatility.

Global crude oil supplies have risen sharply over the past few years, primarily because of rapid and sustained growth in production in North America and, more recently, from the Organization of the Petroleum Exporting Countries. Although lower crude prices have led to declines in U.S. oil production, the November STEO estimated that U.S. crude production for 2016 will average 8.8 million barrels per day (b/d), which is 3.8 million b/d above 2008 levels. U.S. crude oil production is forecast to average 8.7 million b/d in 2017.

Global consumption of petroleum and other liquid fuels is estimated to have grown by 1.5 million b/d in 2015. EIA expects global consumption to increase by 1.3 million b/d in 2016 and by 1.5 million b/d in 2017, mostly driven by growth in countries outside of the Organization for Economic Cooperation and Development (OECD). Non-OECD consumption growth was 0.9 million b/d in 2015, and it is expected to be 1.2 million b/d in 2016 and 1.3 million b/d in 2017. India and China are expected to be the largest contributors to non-OECD petroleum consumption growth, with each country's consumption forecast to increase between 0.3 million and 0.4 million b/d annually in both 2016 and 2017.

With continued access to price-advantaged crude oil and natural gas, sophisticated upgrading equipment, and a strategic location compared with demand centers in Latin America, U.S. refineries have been running at or near record-high levels. Through June 2016, gross refinery inputs averaged 16.4 million b/d, tying last year's level as the highest annual average since EIA began collecting data in 1985. Since the start of last year, gross inputs to U.S. refineries have exceeded 17 million b/d in 13 separate weeks, a level that had previously not been reached since EIA began publishing the data in 1990. Refinery production of gasoline and distillate has increased to supply growing demand in global markets, contributing to a widening U.S. petroleum product trade surplus.

Refinery wholesale gasoline margins (the difference between the wholesale price of gasoline and the price of Brent crude oil) averaged 42 cents/gal in August. This level was lower than the 73 cents/gal average in August 2015, but similar to the previous five-year average for August. Higher U.S. gasoline production and inventory levels in 2016 have contributed to lower gasoline margins than in 2015. Margins have been lower despite gasoline consumption being 2.3% higher through the first eight months of 2016 compared with the same period in 2015.

Record-high U.S. refinery runs in 2016 contributed to high U.S. gasoline, distillate (diesel fuel and heating oil), and jet fuel inventories. Gasoline inventories in all regions of the nation were above their respective five-year averages for the week ending September 23. PADD 2 and PADD 3 gasoline inventories have been above than the five-year range for all but two weeks so far this year. Distillate inventories in all regions of the country were also at or above their five-year averages for the week ending September 23 and have been persistently high so far this year. Inventories of kerosene-type jet fuel are within or above the five-year ranges for all regions except the East Coast.

Falling crude oil prices, coupled with increased refinery production of gasoline and distillate (diesel fuel and heating oil), have led to declines in gasoline and distillate prices. After averaging $2.43 per gallon (gal) in 2015, the U.S. average retail price for regular gasoline is forecast to average $2.13/gal in 2016, which would be the lowest annual average since 2004. The U.S. average retail price for ultra-low sulfur diesel (ULSD) is expected to average $2.32/gal in 2016, also the lowest annual average since 2004.

EIA estimates that U.S. gasoline consumption increased by 240,000 b/d (2.7%) in 2015. At 9.2 million b/d, U.S. gasoline consumption in 2015 was the highest level since the peak of 9.3 million b/d in 2007. Although total nonfarm employment and total vehicle-miles traveled have increased by 2.9% and 3.7%, respectively, since 2007, improving vehicle fuel economy has steadily contributed to lower gasoline consumption. In 2016, gasoline consumption is forecast to increase by 1.5% to 9.32 million b/d, which would be the highest annual average gasoline consumption on record, surpassing the previous record

set in 2007. The increase in gasoline consumption reflects a forecast 2.3% increase in highway travel (because of employment growth and lower retail gasoline prices) that is partially offset by increases in vehicle fleet fuel economy.

Distillate consumption is expected to fall by 150,000 b/d in 2016, after falling by 40,000 b/d in 2015. Falling distillate consumption in 2016 is the result of relatively warm winter temperatures, reduced oil and natural gas drilling (which uses diesel fuel in its operations), and declining coal production, which has reduced diesel use in rail shipments of coal. Stronger expected economic growth in 2017 contributes to forecast distillate fuel consumption growth of 70,000 b/d.

U.S. participation in the global petroleum products markets has increased steadily in the past several years. Total U.S. product exports averaged 4.3 million b/d in 2015, up 2.3 million b/d from 2009. Exports generally act as a stabilizer in U.S. product markets, similar to inventories, as this supply can be diverted to domestic markets if product balances tighten, depending on the structure of sales contracts. Supplying overseas markets with product from economically-efficient U.S. refineries also helps balance global product supply and demand, which in turn helps U.S. regions that rely on imports. In 2015, the U.S. East Coast imported an average of 0.9 million b/d of gasoline and distillate.

5. East Coast (PADD 1) Regional Outage Review

The East Coast region, which includes all states in New England, the Central Atlantic, and the Lower Atlantic, has 9 operating refineries with 1.3 million barrels per stream day[1] (b/sd) of atmospheric crude distillation capacity, 0.5 million b/sd of fluidized catalytic cracking capacity, 0.2 million b/sd of catalytic reforming capacity, 42,000 b/sd of hydrocracking capacity, and 75,000 b/sd of coking capacity.

Because the East Coast is structurally short of refinery capacity—meaning that regional consumption is higher than regional production—the region relies on transfers of petroleum products from other regions, primarily from the Gulf Coast, and on imports from the actively-traded Atlantic Basin market. As a result, refinery outages in other parts of the country and in the countries from which gasoline and distillate are imported can affect East Coast supply. Planned maintenance at refineries on the Gulf Coast is not expected to adversely affect supply of gasoline and distillate to the East Coast, as some of the substantial volumes of gasoline and distillate typically exported from the Gulf Coast can be diverted to domestic markets if product balances tighten.

Planned refinery maintenance in the East Coast was minimal in September and is expected to be very light in the fourth quarter of 2016. Planned atmospheric crude distillation capacity maintenance is expected to average 23,000 b/d, or 2% of regional capacity, in December. Planned fluidized catalytic cracking capacity maintenance averaged 25,000 b/d, or 5% of regional capacity, in September and is expected to average 29,000 b/d, or 6% of regional capacity, in October. Planned outage rates of crude distillation and fluidized catalytic cracking capacities in other months are expected to be negligible. Planned outage rates of reforming, hydrocracking, and coking capacities are negligible for September through December 2016 (Table 1 and Figure 2).

Table 1. East Coast (PADD 1) planned refinery capacity outages

Atmospheric crude distillation

Month	thousand barrels per day			as percentage of capacity	
	2016 planned outages	2015 planned outages	2006–15 average planned outages	2016 planned outages	2015 planned outages
September	0	134	59	0%	11%
October	1	23	69	0%	2%
November	0	0	61	0%	0%
December	23	64	27	2%	5%

[1] Stream day capacity is the maximum number of barrels of input that a distillation facility can process within a 24-hour period when running at full capacity under optimal crude and product slate conditions with no allowance for downtime. Barrels per calendar day is a measure of the amount of input that a distillation unit can process in a 24-hour period under usual operating conditions. It takes into account both planned and unplanned maintenance. Stream day capacity is typically about 6% higher than calendar day capacity.

Fluidized catalytic cracking

Month	thousand barrels per day			as percentage of capacity	
	2016 planned outages	2015 planned outages	2006–15 average planned outages	2016 planned outages	2015 planned outages
September	29	0	0	6%	0%
October	25	32	36	5%	7%
November	0	12	27	0%	2%
December	0	0	7	0%	0%

Reforming

Month	thousand barrels per day			as percentage of capacity	
	2016 planned outages	2015 planned outages	2006–15 average planned outages	2016 planned outages	2015 planned outages
September	0	26	23	0%	11%
October	5	0	5	2%	0%
November	0	0	12	0%	0%
December	0	35	13	0%	14%

Hydrocracking

Month	thousand barrels per day			as percentage of capacity	
	2016 planned outages	2015 planned outages	2006–15 average planned outages	2016 planned outages	2015 planned outages
September	0	0	0	0%	0%
October	0	0	6	0%	0%
November	0	0	1	0%	0%
December	0	0	0	0%	0%

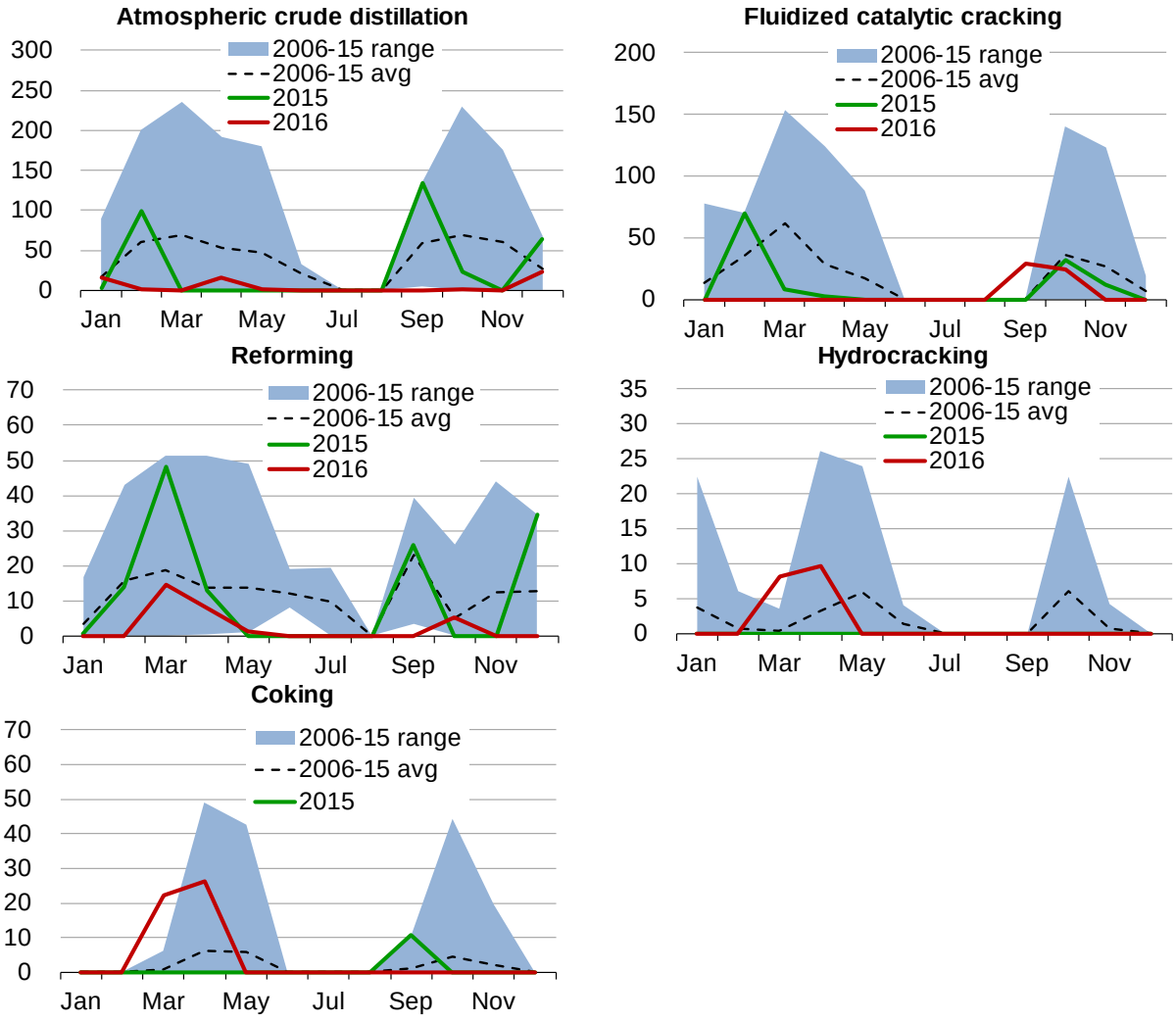
Coking

Month	thousand barrels per day			as percentage of capacity	
	2016 planned outages	2015 planned outages	2006–15 average planned outages	2016 planned outages	2015 planned outages
September	0	11	1	0%	14%
October	0	0	4	0%	0%
November	0	0	2	0%	0%
December	0	0	0	0%	0%

Source: U.S. Energy Information Administration, using IIR data as of August 16, 2016

Figure 2. East Coast (PADD 1) planned refinery capacity outages

thousand barrels per day

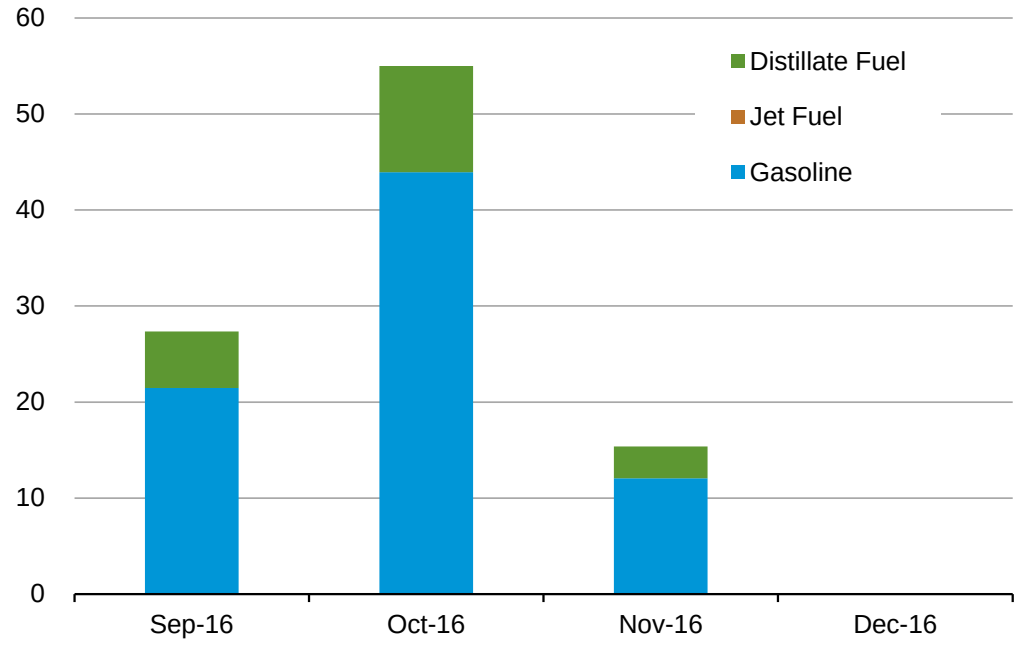


Source: U.S. Energy Information Administration, using IIR data as of August 16, 2016

The planned outages resulted in estimated production losses in gasoline and distillate of 21,000 b/d and of 6,000 b/d, respectively, in September. Estimated production losses in October are expected to be larger, at 44,000 b/d and 11,000 b/d of gasoline and distillate, respectively. Production losses trail off in November and will likely be negligible in December (Figure 3).

Figure 3. East Coast (PADD 1) production losses as a result of planned outages

thousand barrels per day

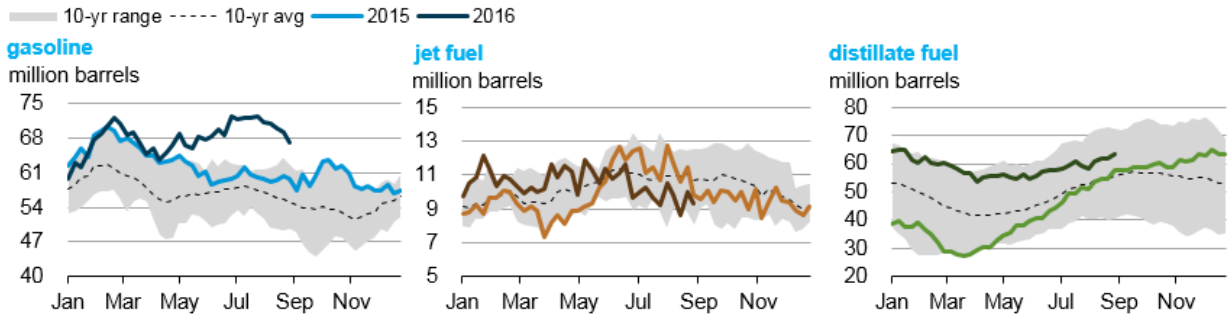


Source: U.S. Energy Information Administration

According to EIA's PADD-to-PADD movement of petroleum products, in 2015, the East Coast received, on average, 1.6 million b/d of gasoline blending components, 412,000 b/d of jet fuel, and 882,000 b/d of distillate fuel from the Gulf Coast. The production losses shown in Figure 3 are relatively small compared with the volume of products the region typically receives from the Gulf Coast and from imports.

The total estimated production losses resulting from the expected outages accounted for only 3.5% of existing gasoline inventories and 1.0% of distillate inventories as of August 26. Therefore, the production loss in PADD 1 could be covered by existing product inventory (Figure 4).

Figure 4. East Coast (PADD 1) petroleum product inventories, 2015–present



Source: U.S. Energy Information Administration

6. Midwest (PADD 2) Regional Outage Review

PADD 2 includes North Dakota, South Dakota, Nebraska, Kansas, Oklahoma, Missouri, Iowa, Minnesota, Wisconsin, Illinois, Indiana, Michigan, Ohio, Kentucky, and Tennessee. The region has 27 operating refineries with combined atmospheric crude distillation capacity of 4.0 million barrels per stream day[2] (b/sd), fluidized catalytic cracking capacity of 1.2 million b/sd, catalytic reforming capacity of 0.8 million b/sd, hydrocracking capacity of 0.3 million b/sd, and coking capacity of 0.5 million b/sd.

Midwest refineries produce most of the gasoline and distillate fuel consumed in the region, particularly during the winter months when gasoline demand is seasonally lower. The Midwest also receives supplies from other regions, primarily from the Gulf Coast. Planned Gulf Coast refinery maintenance is not expected to affect the supply of gasoline and distillate available to the Midwest.

Inventories can act as a source of supplemental supply during outages. Supplemental supply from the Gulf Coast should also be available if needed. However, the time required for resupply to reach the Midwest from the Gulf Coast does vary considerably across the region because of its size. Resupply can reach Oklahoma, Kansas, and Missouri from the Gulf Coast within 7–10 days, but may take close to 30 days to reach the northernmost states at the end of the supply line. As a result, unplanned outages in the northernmost states could lead to supply disruptions.

From September to December 2015, planned refinery outages in the Midwest were relatively high, and monthly maintenance on several units set ten-year record high levels. Conversely, planned outages this fall are mostly at or below the ten-year average levels (Table 2 and Figure 5).

Table 2. Midwest (PADD 2) planned refinery capacity outages

Atmospheric crude distillation

Month	thousand barrels per day			as percentage of capacity	
	2016 planned outages	2015 planned outages	2006–15 average planned outages	2016 planned outages	2015 planned outages
September	169	508	180	4%	13%
October	180	859	269	5%	22%
November	34	326	168	1%	8%
December	0	176	91	0%	4%

[2] Stream day capacity is the maximum number of barrels of input that a distillation facility can process within a 24-hour period when running at full capacity under optimal crude and product slate conditions with no allowance for downtime. Barrels per calendar day is a measure of the amount of input that a distillation unit can process in a 24-hour period under usual operating conditions. It takes into account both planned and unplanned maintenance. Stream day capacity is typically about 6% higher than calendar day capacity.

Fluidized catalytic cracking

Month	thousand barrels per day			as percentage of capacity	
	2016 planned outages	2015 planned outages	2006–15 average planned outages	2016 planned outages	2015 planned outages
September	131	21	59	11%	2%
October	198	55	129	16%	4%
November	73	19	64	6%	2%
December	0	0	12	0%	0%

Reforming

Month	thousand barrels per day			as percentage of capacity	
	2016 planned outages	2015 planned outages	2006–15 average planned outages	2016 planned outages	2015 planned outages
September	27	42	29	3%	5%
October	22	129	65	3%	16%
November	4	45	24	0%	5%
December	0	0	1	0%	0%

Hydrocracking

Month	thousand barrels per day			as percentage of capacity	
	2016 planned outages	2015 planned outages	2006–15 average planned outages	2016 planned outages	2015 planned outages
September	30	82	16	10%	28%
October	82	119	31	28%	41%
November	19	22	13	6%	8%
December	0	0	0	0%	0%

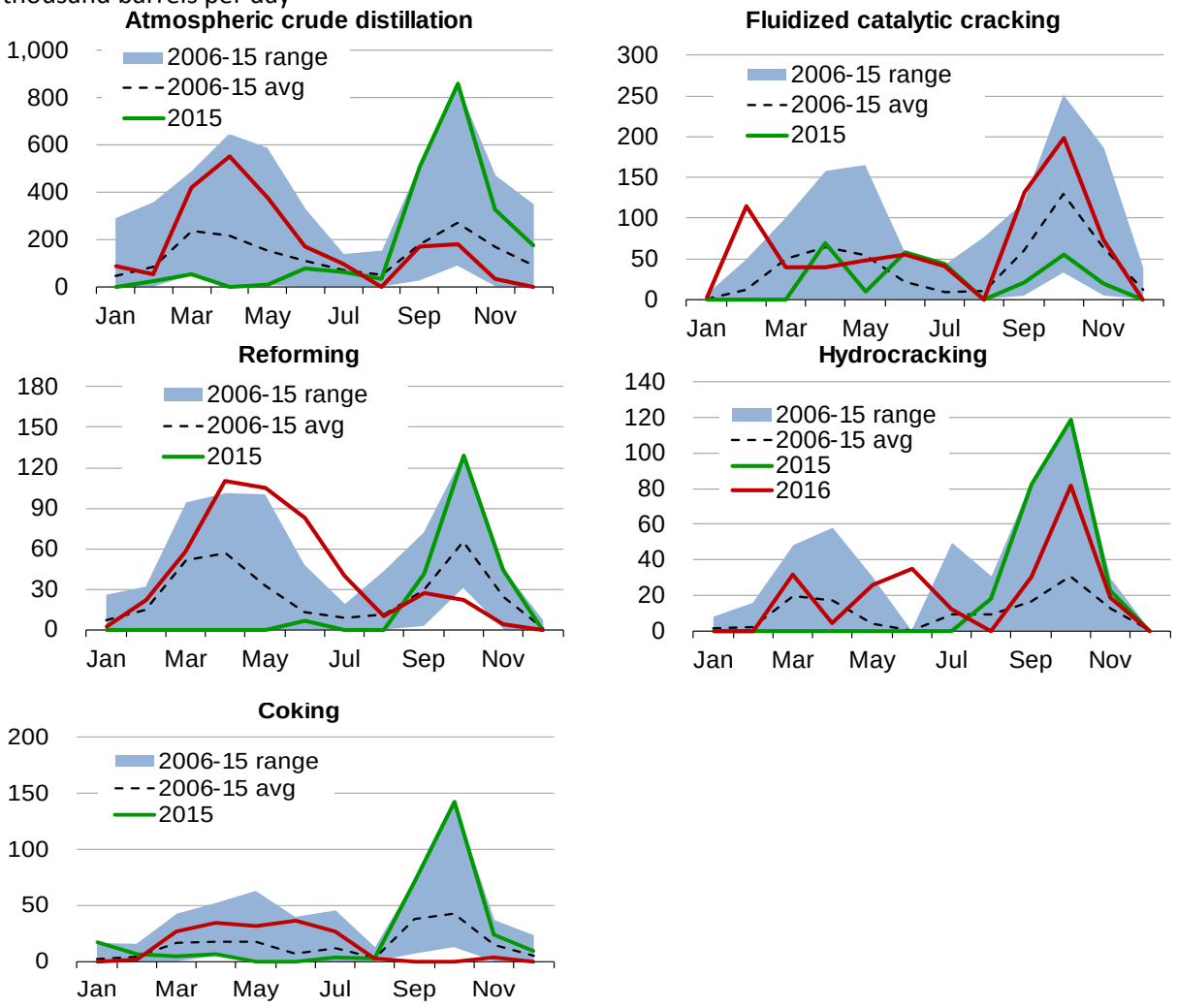
Coking

Month	thousand barrels per day			as percentage of capacity	
	2016 planned outages	2015 planned outages	2006–15 average planned outages	2016 planned outages	2015 planned outages
September	0	72	38	0%	14%
October	0	143	43	0%	27%
November	4	23	14	1%	4%
December	0	9	5	0%	2%

Source: U.S. Energy Information Administration, using IIR data as of August 16, 2016

Figure 5. Midwest (PADD 2) planned refinery capacity outages

thousand barrels per day

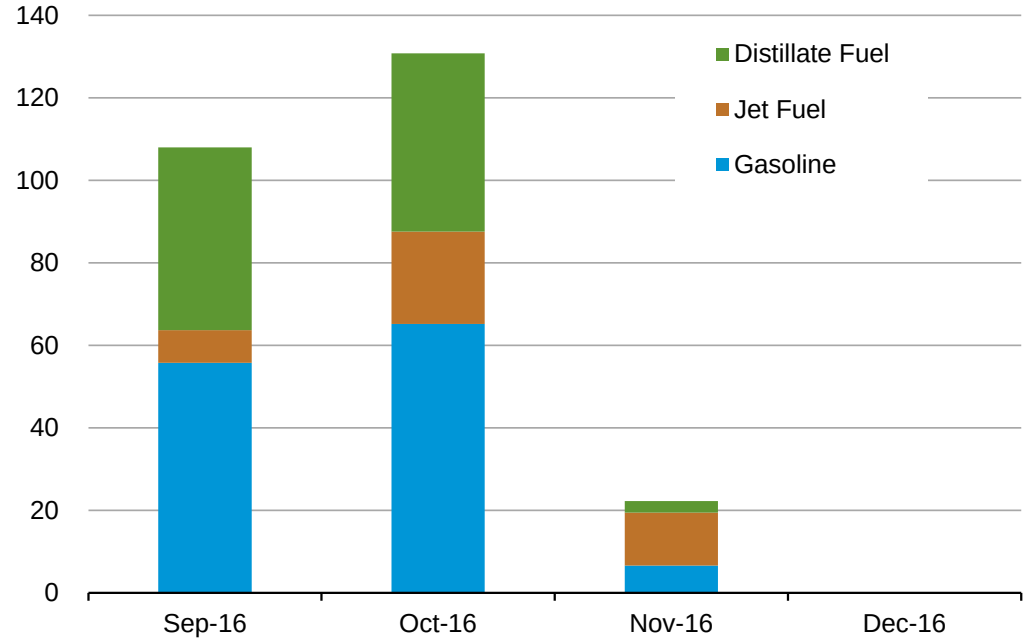


Source: U.S. Energy Information Administration, using IIR data as of August 16, 2016

The outages will result in production losses of gasoline supply of 56,000 b/d in September and 65,000 b/d in October, jet fuel supply of 22,000 in October, and distillate fuel supply of 43,000 b/d September and October (Figure 6).

Figure 6. Midwest (PADD 2) production losses as a result of planned outages

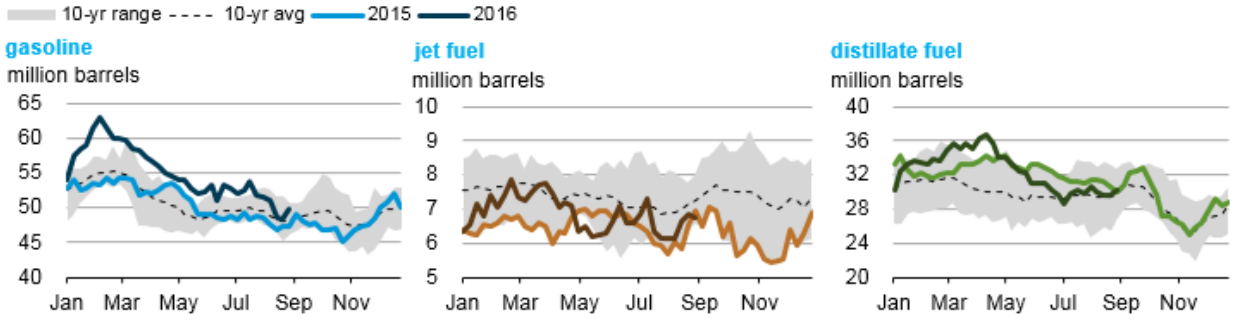
thousand barrels per day



Source: U.S. Energy Information Administration

The total estimated production losses in gasoline, jet fuel, and distillate fuel account for 8%, 20%, and 9%, respectively, of existing regional inventories as of August 26. The regional inventories will likely be sufficient to make up for lost in-region production.

Figure 7. Midwest (PADD 2) petroleum product inventories, 2015–present



Source: U.S. Energy Information Administration

7. Gulf Coast (PADD 3) Regional Outage Review

PADD 3 comprises the southern central states of Alabama, Mississippi, Louisiana, Arkansas, Texas, and New Mexico. The region has 52 operating refineries with combined crude distillation capacity totaling 9.5 million barrels per stream day[3] (b/sd), fluidized catalytic cracking capacity of 2.9 million b/sd, catalytic reforming capacity of 1.7 million b/sd, hydrocracking capacity of 1.2 million b/sd, and coking capacity of 1.5 million b/sd.

The Gulf Coast region is the largest refining center in the United States and is home to slightly more than half of the country's capacity. Data on refinery capacity in PADD 3 are grouped into five refining districts: New Mexico, Texas Inland, Texas Gulf Coast, Louisiana Gulf Coast (which includes coastal portions of Mississippi and Alabama), and North Louisiana-Arkansas (which includes northern Mississippi and Alabama). Regional capacity is concentrated primarily in the Texas Gulf Coast and Louisiana Gulf Coast districts. These two districts have 16 refineries each, with 49% and 39% of regional crude distillation capacity, respectively.

The Gulf Coast region, which has far more refining capacity than is needed to meet the in-region product demand, supplies substantial volumes of petroleum products to other U.S. regions, most notably the East Coast and the Midwest, as well as international markets.

In September through November, planned maintenance in the Gulf Coast region is, on average, moderately above the 10-year average and peaks in October. Planned maintenance of reforming and coking capacity is moderately above the 10-year maximum in October. Planned maintenance for atmospheric crude distillation, fluidized catalytic cracking, and hydrocracking capacity is at or slightly above the 10-year average level for most of the fall turnaround season. There is currently no planned maintenance at Gulf Coast refineries for December (Table 3 and Figure 8).

Table 3. Gulf Coast (PADD 3) planned refinery capacity outages

Atmospheric crude distillation

Month	thousand barrels per day			as percentage of capacity	
	2016 planned outages	2015 planned outages	2006–15 average planned outages	2016 planned outages	2015 planned outages
September	191	496	222	2%	5%
October	463	660	436	5%	7%
November	39	22	186	0%	0%
December	0	50	62	0%	1%

[3] Stream day capacity is the maximum number of barrels of input that a distillation facility can process within a 24-hour period when running at full capacity under optimal crude and product slate conditions with no allowance for downtime. Barrels per calendar day is a measure of the amount of input that a distillation unit can process in a 24-hour period under usual operating conditions. It takes into account both planned and unplanned maintenance. Stream day capacity is typically about 6% higher than calendar day capacity.

Fluidized catalytic cracking

Month	thousand barrels per day			as percentage of capacity	
	2016 planned outages	2015 planned outages	2006–15 average planned outages	2016 planned outages	2015 planned outages
September	228	97	103	8%	3%
October	265	193	214	9%	7%
November	26	123	137	1%	4%
December	0	35	36	0%	1%

Reforming

Month	thousand barrels per day			as percentage of capacity	
	2016 planned outages	2015 planned outages	2006–15 average planned outages	2016 planned outages	2015 planned outages
September	82	18	57	5%	1%
October	215	47	103	13%	3%
November	34	45	53	2%	3%
December	0	16	21	0%	1%

Hydrocracking

Month	thousand barrels per day			as percentage of capacity	
	2016 planned outages	2015 planned outages	2006–15 average planned outages	2016 planned outages	2015 planned outages
September	74	104	37	6%	9%
October	164	104	65	14%	9%
November	44	39	38	4%	3%
December	0	0	7	0%	0%

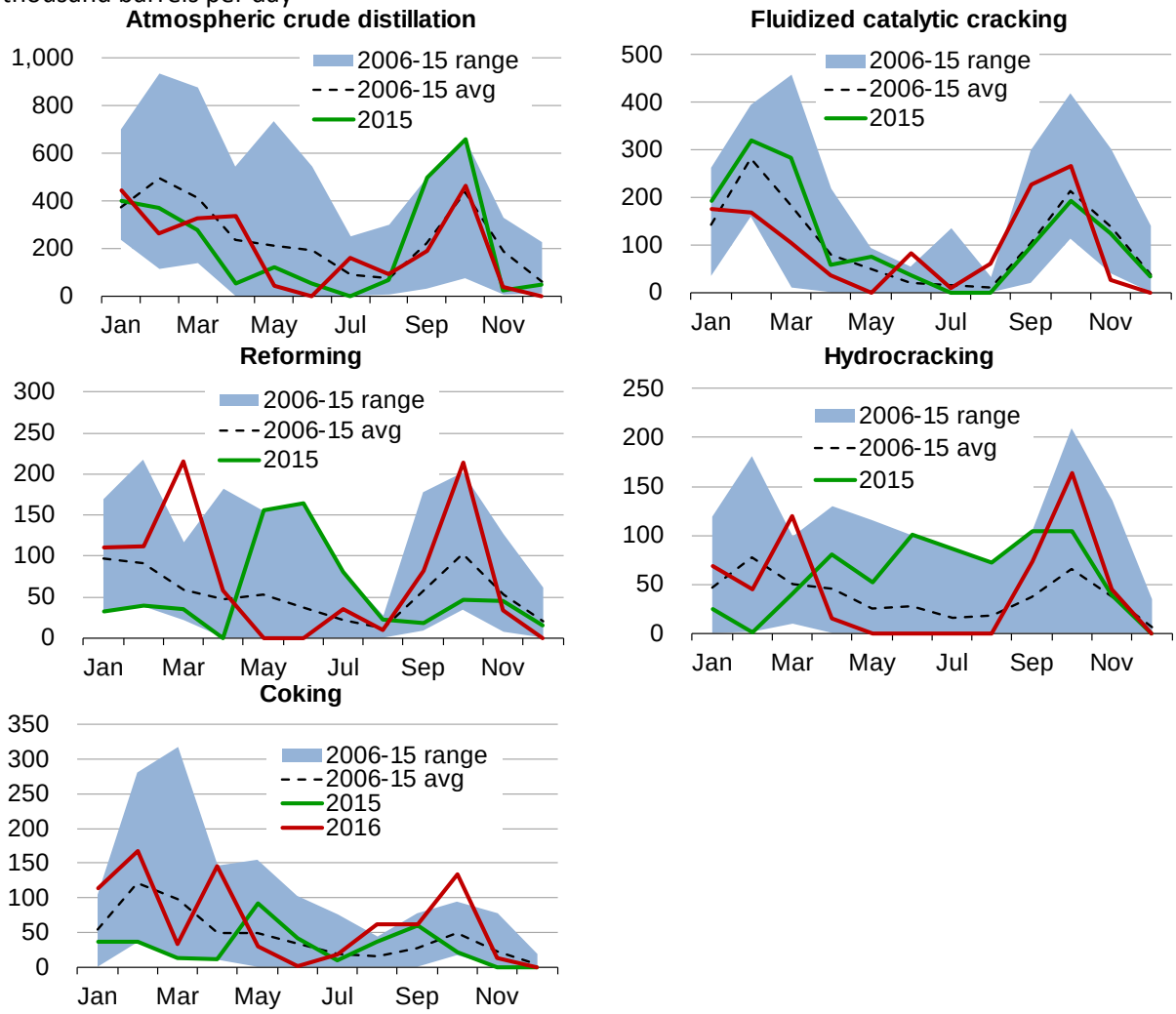
Coking

Month	thousand barrels per day			as percentage of capacity	
	2016 planned outages	2015 planned outages	2006–15 average planned outages	2016 planned outages	2015 planned outages
September	61	60	27	4%	4%
October	135	22	49	9%	1%
November	12	0	23	1%	0%
December	0	0	4	0%	0%

Source: U.S. Energy Information Administration, using IIR data as of August 16, 2016

Figure 8. Gulf Coast (PADD 3) planned refinery capacity outages

thousand barrels per day

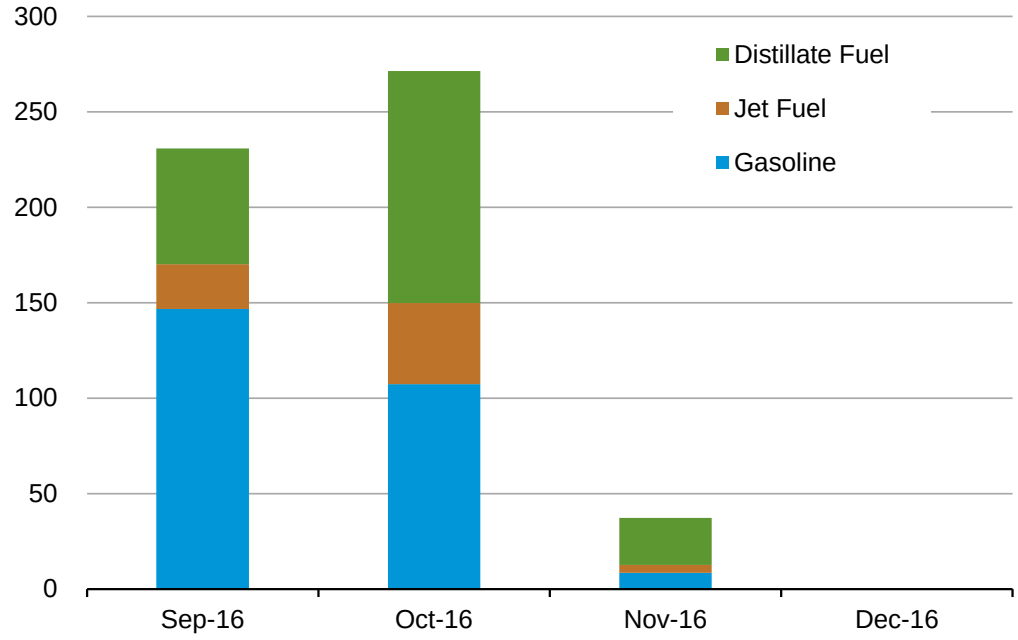


Source: U.S. Energy Information Administration, using IIR data as of August 16, 2016

The planned refinery outages in the Gulf Coast are expected to result in moderate production losses in petroleum products. In September and October, the expected average losses are 127,000 b/d in gasoline, 33,000 b/d in jet fuel, and 91,000 b/d in distillate fuel (Figure 9).

Figure 9. Gulf Coast (PADD 3) production losses as a result of planned outages

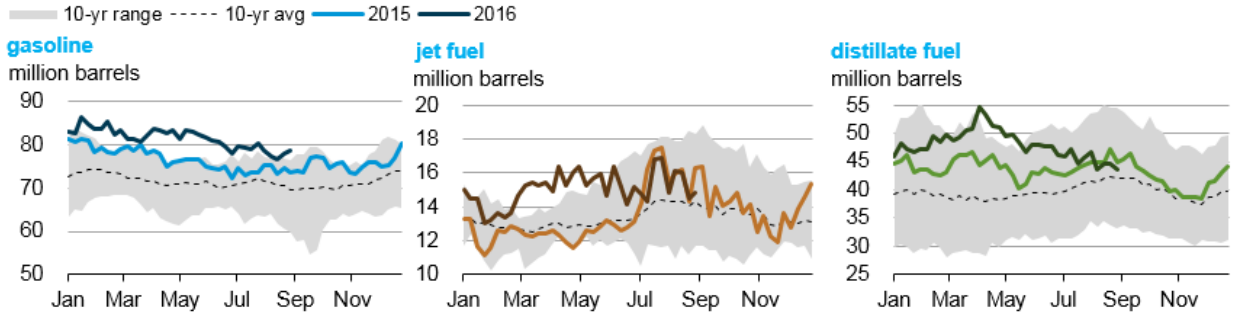
thousand barrels per day



Source: U.S. Energy Information Administration

As of August 26, Gulf Coast gasoline inventories are above the 10-year maximum, and jet fuel and distillate fuel inventories are above the 10-year average (Figure 10). The total estimated production loss as a result of the planned outages accounts for 10% of existing gasoline inventory, 14% of jet fuel inventory, and 15% of existing distillate inventory. As a result, regional stocks are sufficient to offset lost production from the planned outages.

Figure 10. Gulf Coast (PADD 3) petroleum product inventories, 2015–present



Source: U.S. Energy Information Administration

8. Rocky Mountains (PADD 4) Regional Outage Review

PADD 4, which includes Idaho, Montana, Wyoming, Utah, and Colorado, has 17 operating refineries and the smallest refining capacity of any PADD region in the United States, with combined atmospheric crude distillation capacity of 0.7 million barrels per stream day[4] (b/sd), fluidized catalytic cracking capacity of 0.2 million b/sd, catalytic reforming capacity of 0.1 million b/sd, hydrocracking capacity of 52,000 b/sd, and delayed coking capacity of 83,000 b/sd.

Although refineries in the Rocky Mountain region supply most of the in-region gasoline and distillate demand, the region does receive small volumes of products from refineries in the Midwest and the Gulf Coast, which are possible sources of supplemental supply during a shortage.

The only planned refinery maintenance in PADD 4 this fall is in October and November for fluidized catalytic cracking capacity, when 28,000 b/d (14% of regional capacity) and 6,000 b/d (3% of regional capacity) will be offline, respectively (Table 4 and Figure 11). No other refinery maintenance is planned as of the writing of this report. The light maintenance planned for the Rocky Mountain region in the fall should not affect product availability as inventories of petroleum products are above the 10-year average, consumption is typically lower in October, and other regions can provide additional supply to markets in PADD 4 if needed.

Table 4. Rocky Mountains (PADD 4) planned refinery capacity outages

Atmospheric crude distillation

Month	thousand barrels per day			as percentage of capacity	
	2016 planned outages	2015 planned outages	2006–15 average planned outages	2016 planned outages	2016 planned outages
September	0	25	14	0%	4%
October	0	20	28	0%	3%
November	0	5	11	0%	1%
December	0	0	12	0%	0%

[4] Stream day capacity is the maximum number of barrels of input that a distillation facility can process within a 24-hour period when running at full capacity under optimal crude and product slate conditions with no allowance for downtime. Barrels per calendar day is a measure of the amount of input that a distillation unit can process in a 24-hour period under usual operating conditions. It takes into account both planned and unplanned maintenance. Stream day capacity is typically about 6% higher than calendar day capacity.

Fluidized catalytic cracking

Month	thousand barrels per day			as percentage of capacity	
	2016 planned outages	2015 planned outages	2006–15 average planned outages	2016 planned outages	2016 planned outages
September	0	23	6	0%	12%
October	28	6	11	14%	3%
November	6	5	3	3%	2%
December	0	0	0	0%	0%

Reforming

Month	thousand barrels per day			as percentage of capacity	
	2016 planned outages	2015 planned outages	2006–15 average planned outages	2016 planned outages	2016 planned outages
September	0	1	5	0%	1%
October	0	5	6	0%	4%
November	0	1	5	0%	1%
December	0	0	0	0%	0%

Hydrocracking

Month	thousand barrels per day			as percentage of capacity	
	2016 planned outages	2015 planned outages	2006–15 average planned outages	2016 planned outages	2016 planned outages
September	0	2	1	0%	3%
October	0	5	2	0%	9%
November	0	1	1	0%	3%
December	0	0	0	0%	0%

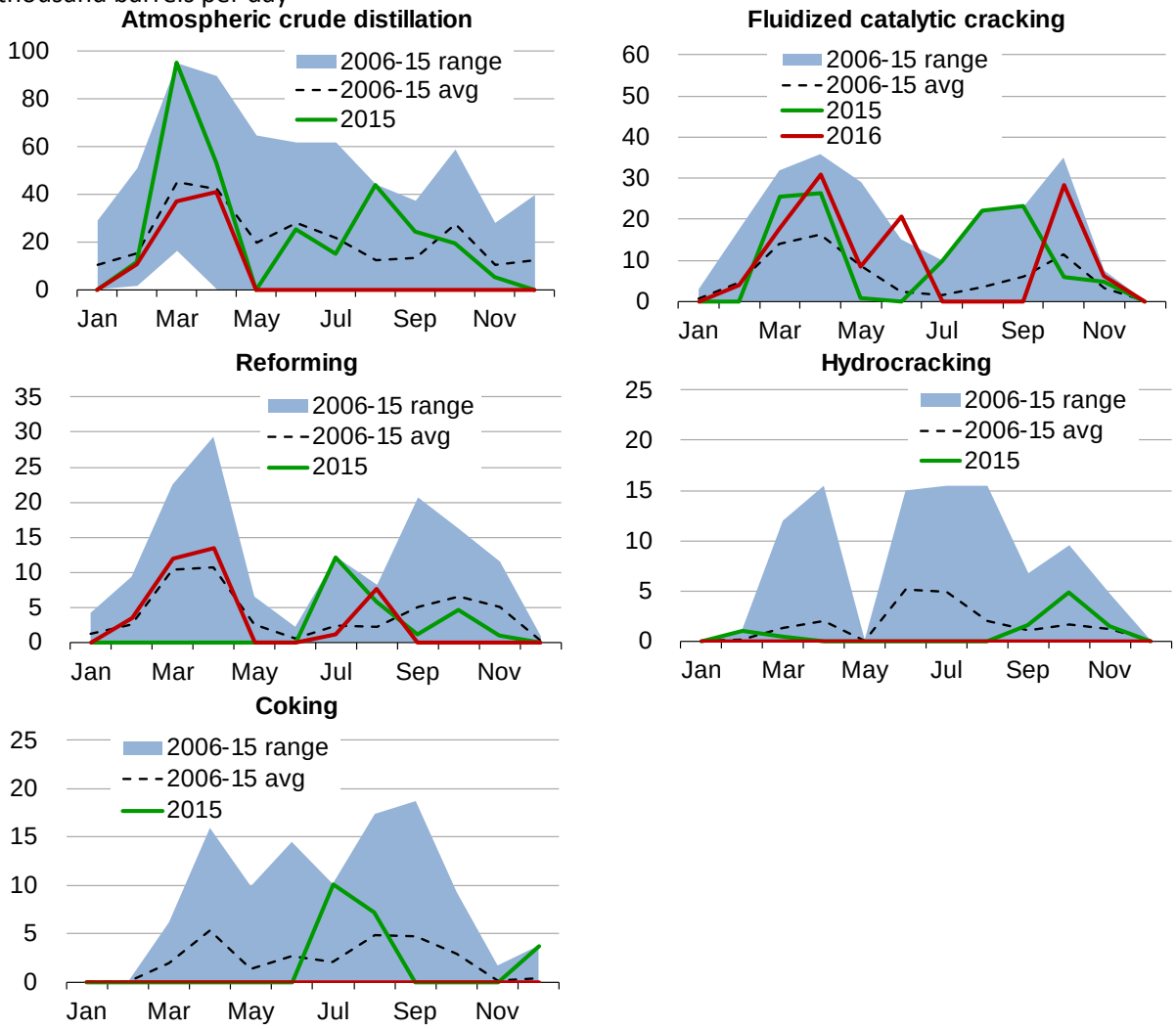
Coking

Month	thousand barrels per day			as percentage of capacity	
	2016 planned outages	2015 planned outages	2006–15 average planned outages	2016 planned outages	2016 planned outages
September	0	0	5	0%	0%
October	0	0	3	0%	0%
November	0	0	0	0%	0%
December	0	4	0	0%	5%

Source: U.S. Energy Information Administration, using IIR data as of August 16, 2016

Figure 11. Rocky Mountains (PADD 4) refinery capacity outages

thousand barrels per day

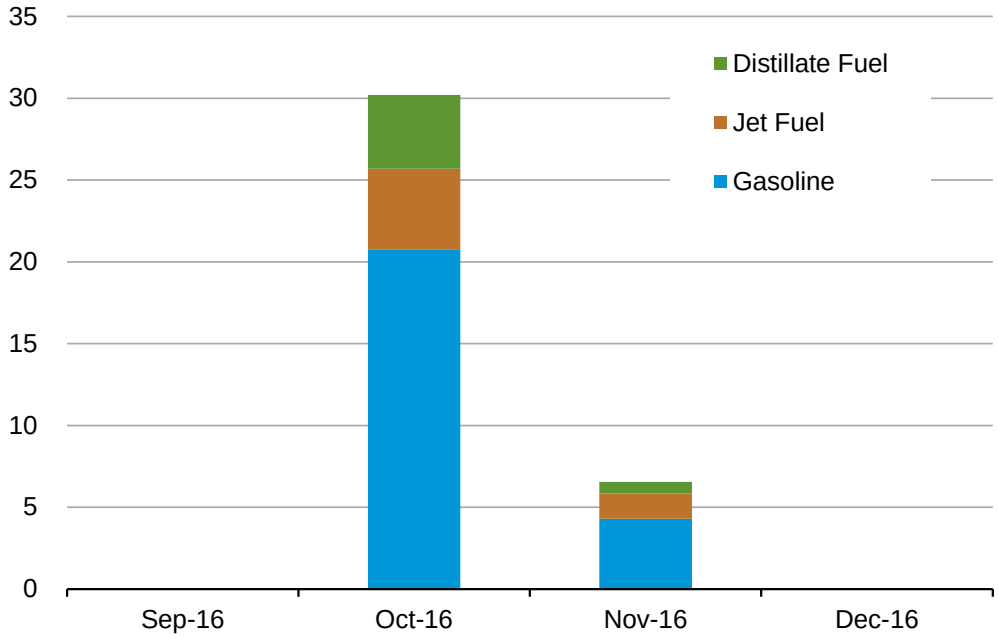


Source: U.S. Energy Information Administration, using IIR data as of August 16, 2016

Supply losses as a result of planned maintenance in PADD 4 are concentrated in October with reductions of 21,000 b/d in gasoline, 5,000 b/d in jet fuel, and 4,000 b/d in distillate fuel (Figure 12).

Figure 12. Rocky Mountains (PADD 4) production losses as a result of planned outages

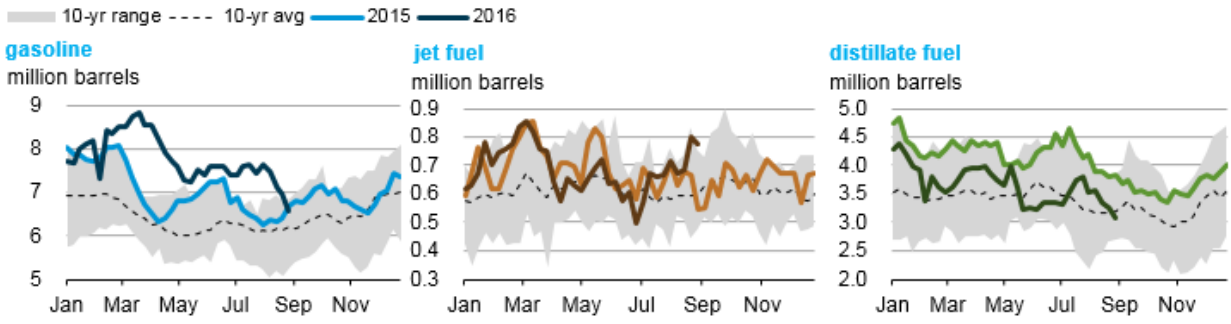
thousand barrels per day



Source: U.S. Energy Information Administration

Total estimated production losses from planned outages in PADD 4 account for 12% of regional gasoline inventories, 26% of jet fuel inventories, and 5% of distillate inventories. As of August 26, PADD 4 inventory levels for those products were all close to the 10-year average.

Figure 13. Rocky Mountains (PADD 4) petroleum product inventories, 2015–present



Source: U.S. Energy Information Administration

9. West Coast (PADD 5) Regional Outage Review

PADD 5 comprises the western states of California, Nevada, Oregon, Washington, Arizona, Alaska, and Hawaii, and has 30 operating refineries with combined crude distillation capacity of 2.9 million barrels per stream day[5] (b/sd), fluidized catalytic cracking capacity of 0.8 million b/sd, reforming capacity of 0.5 million b/sd, hydrocracking capacity of 0.5 million b/sd, and coking capacity of 0.5 million b/sd. California has 17 operating refineries (with 67% of PADD 5 crude distillation capacity) mostly clustered in two refining centers within the state. About 40% of California refinery capacity is in the San Francisco area, and the remaining 60% is in the southern part of the state, primarily near Los Angeles. Washington has 22% of PADD 5 crude capacity, and all five of its refineries are near Puget Sound. Alaska has five refineries, making up 6% of PADD 5 crude distillation capacity, and Hawaii, with two operating refineries, has 5% of regional capacity.

Planned maintenance of atmospheric crude distillation capacity in the West Coast region is significantly higher than the 10-year range in October and November, with little to no activity planned in September and December. Planned maintenance on coking capacity is also above the 10-year average in October and November, although to a lesser extent. There is currently no planned maintenance for hydrocracking and fluidized catalytic cracking capacity in the West Coast for September through December, while reforming capacity will undergo planned maintenance in October, in line with the 10-year average.

Table 5. West Coast (PADD 5) planned refinery capacity outages

Atmospheric crude distillation

Month	thousand barrels per day			as percentage of capacity	
	2016 planned outages	2015 planned outages	2006–15 average planned outages	2016 planned outages	2016 planned outages
September	0	23	36	0%	1%
October	491	76	87	17%	3%
November	354	85	69	12%	3%
December	1	15	8	0%	0%

[5] Stream day capacity is the maximum number of barrels of input that a distillation facility can process within a 24-hour period when running at full capacity under optimal crude and product slate conditions with no allowance for downtime. Barrels per calendar day is a measure of the amount of input that a distillation unit can process in a 24-hour period under usual operating conditions. It takes into account both planned and unplanned maintenance. Stream day capacity is typically about 6% higher than calendar day capacity.

Fluidized catalytic cracking

Month	thousand barrels per day			as percentage of capacity	
	2016 planned outages	2015 planned outages	2006–15 average planned outages	2016 planned outages	2016 planned outages
September	0	0	4	0%	0%
October	0	125	24	0%	15%
November	0	261	62	0%	32%
December	0	127	47	0%	15%

Reforming

Month	thousand barrels per day			as percentage of capacity	
	2016 planned outages	2015 planned outages	2006–15 average planned outages	2016 planned outages	2016 planned outages
September	0	0	19	0%	0%
October	27	9	29	5%	2%
November	0	0	23	0%	0%
December	0	0	3	0%	0%

Hydrocracking

Month	thousand barrels per day			as percentage of capacity	
	2016 planned outages	2015 planned outages	2006–15 average planned outages	2016 planned outages	2016 planned outages
September	0	31	7	0%	6%
October	0	1	17	0%	0%
November	0	0	14	0%	0%
December	0	0	1	0%	0%

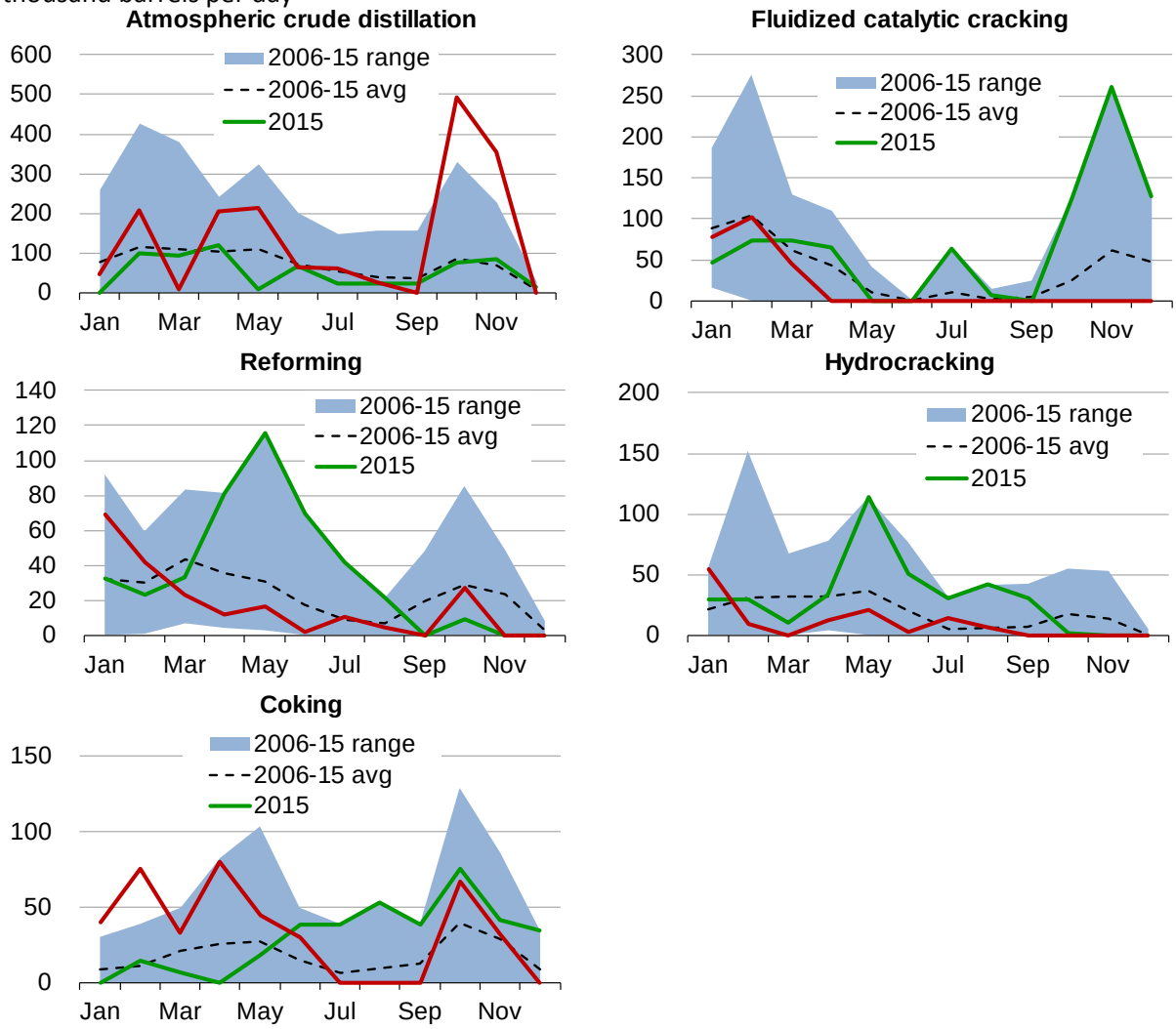
Coking

Month	thousand barrels per day			as percentage of capacity	
	2016 planned outages	2015 planned outages	2006–15 average planned outages	2016 planned outages	2016 planned outages
September	0	76	40	0%	14%
October	67	41	29	12%	8%
November	33	34	9	6%	6%
December	0	0	0	0%	0%

Source: U.S. Energy Information Administration, using IIR data as of August 16, 2016

Figure 14. West Coast (PADD 5) refinery capacity outages

thousand barrels per day

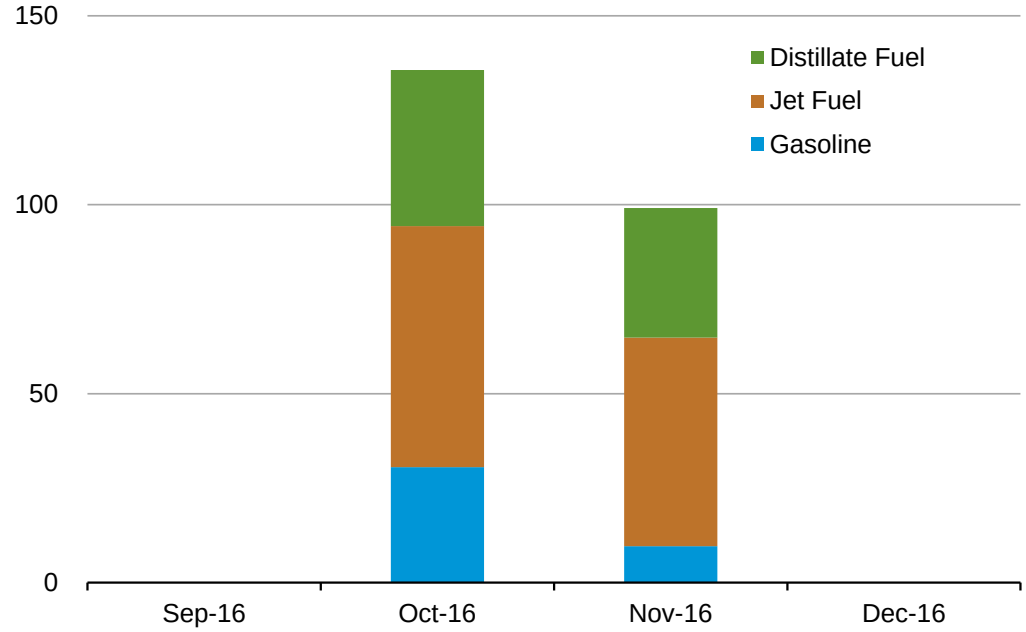


Source: U.S. Energy Information Administration, using IIR data as of August 16, 2016

To reduce the production loss because of the larger-than-normal outage rates in crude distillation capacity, refiners buy gas oil from regional and international markets to continue to utilize other refinery units. As a result, the production loss is only moderate. In October and November, the expected average losses are 20,000 b/d in gasoline, 59,000 b/d in jet fuel, and 38,000 b/d in distillate fuel (Figure 15).

Figure 15. West Coast (PADD 5) production losses as a result of planned outages

thousand barrels per day

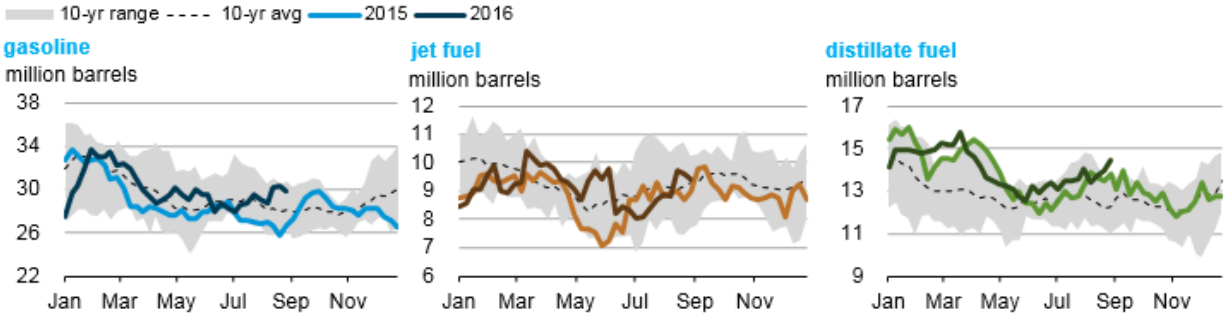


Source: U.S. Energy Information Administration

The total estimated reduction of petroleum products resulting from the outages accounts for 4% of the existing gasoline inventory, 39% of jet fuel inventory, and 16% of distillate fuel inventory.

Therefore, regional gasoline and distillate fuel stocks are sufficient to make up the production loss. When necessary, continued imports of jet fuel into the West Coast will be required to provide adequate supplies.

Figure 16. West Coast (PADD 5) petroleum product inventories, 2015–present



Source: U.S. Energy Information Administration