Independent Statistics & Analysis
U.S. Energy Information Administration

Refinery Outages: First Half 2017

February 2017

Independent Statistics & Analysis
www.eia.gov

U.S. Department of Energy
Washington, DC 20585

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1. Preface

This report examines U.S. refinery outages planned for January through June 2017 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 January 10, 2017. 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 by region[1].

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.

[1] The regions used in this report are the Petroleum Administration for Defense Districts (PADDs). See http://www.eia.gov/todayinenergy/detail.php?id=4890 for a comprehensive explanation of PADDs.

2. Executive Summary

The U.S. Energy Information Administration's (EIA's) latest analysis of planned refinery outages during the first half of 2017 finds that such outages are not expected to cause a shortfall in the supply of petroleum products including gasoline, jet fuel, and distillate fuel, relative to expected demand, either nationally or within any U.S. region. This result occurs notwithstanding the current high level of U.S. gasoline demand, which in 2016 was as high as or higher than in any past year.

National supply and demand balances have limited implications regionally because pipeline infrastructure, geography, and marine shipping regulations constrain the amount of product that can flow between regions in the United States. Likely supply available despite planned refinery outages appears to be adequate in all regions.

EIA's national and regional conclusions are the result of simulating regional supply on a monthly basis based on a set of assumptions about refinery operations. The report considers planned shutdowns of refinery units as reported by Industrial Info Resources (IIR) and provides EIA's analysis of the implications of outages affecting atmospheric crude distillation units, fluidized catalytic cracking units, catalytic reforming units, hydrocracking units, and coking units. Barring unusually high unplanned outages, planned outages that extend beyond schedule, or higher-than-expected demand, the supply of gasoline, jet fuel, and distillate fuel is expected to be adequate in all regions through June 2017.

Planned outages in the Gulf Coast region for the first half of 2017 are higher than average, but regional inventories appear to be sufficient to offset lost production from those planned outages. The Gulf Coast region has more than half the refining capacity in the United States[2], and as a result produces far more petroleum products than it consumes. The region's surplus production supplies other U.S. regions, most notably the East Coast and the Midwest, as well as international markets. EIA's calculations indicate above-average Gulf Coast production reductions due to planned capacity outages, with gasoline reductions from full capacity production of roughly 344,000 b/d in February and March, and 311,000 b/d of distillate fuel in February and 246,000 b/d in March. In total over the first half of 2017, gasoline reductions represent 27% of current inventory, jet fuel reductions represent 28% of current inventory, and distillate reductions represent 36% of existing inventory. With Gulf Coast gasoline and jet fuel inventories at their highest level in 10 years, distillate inventories close to the 10-year average, and high levels of gasoline and distillate exports that could be diverted to domestic markets to offset reductions in refinery production, there are several options to make up for production losses due to planned refinery outages in the Gulf Coast.

Planned outages in the Midwest region for the first half of 2017 are lower than average levels for all types of refinery units, so supply of petroleum products is likely to be adequate to meet domestic demand in the Midwest during the first half of 2017. Production losses from planned outages in the Midwest are expected to reach their highest level in April, with slightly lower losses in May. Total

[2] The regions used in this report are the Petroleum Administration for Defense Districts (PADDs). See https://www.eia.gov/todayinenergy/detail.php?id=4890 for a comprehensive explanation of PADDs.

estimated production losses for gasoline, jet fuel, and distillate fuel over the first half of 2017 are equivalent to 7%, 16% and 6% of existing inventories in the region as of January 20. The Midwest has 21% of the nation's refining capacity and represents 25% of total U.S. demand for petroleum products. As a result, Midwest refineries produce most of the gasoline and distillate fuel consumed in the region, particularly during the winter when consumption is lower. Additional supply is available from inventories and from the Gulf Coast, if needed.

Planned outages in the West Coast region for the first half of 2017 are close to average, and regional inventories appear to be sufficient to offset lost production from brief periods of higher planned outages. The West Coast has 16% of the nation's refining capacity and represents 15% of total U.S. demand for petroleum products. Planned outages, which are expected to peak in March will produce cumulative reductions in petroleum product production over the first half of 2017 equivalent to 19% of existing gasoline inventory, 32% of jet fuel inventory, and 45% of distillate fuel inventory.

Planned outages in the East Coast region for the first half of 2017 are lower than average, so supply of petroleum products is likely to be adequate to meet domestic demand in the East Coast during the first half of 2017. The East Coast has 7% of the nation's refinery capacity and represents 29% of total U.S. demand for petroleum products. Consequently, supplies are transferred into the East Coast from other regions, primarily from the Gulf Coast and from imports out of the Atlantic Basin market.

Planned outages in the Rocky Mountain region for the first quarter of 2017 are lower than average, with some higher outages in the second quarter. Regional product inventories, which are currently at or above average levels for this time of year, appear to be sufficient to offset lost production from those planned outages. The Rocky Mountain region has 4% of the nation's refining capacity and represents 4% of total U.S. demand for petroleum products.

While unanticipated events could result in some issues, EIA's detailed review found no region in which planned refinery outages are likely to lead to inadequate gasoline, distillate, or jet fuel supplies during the first half of 2017.

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.

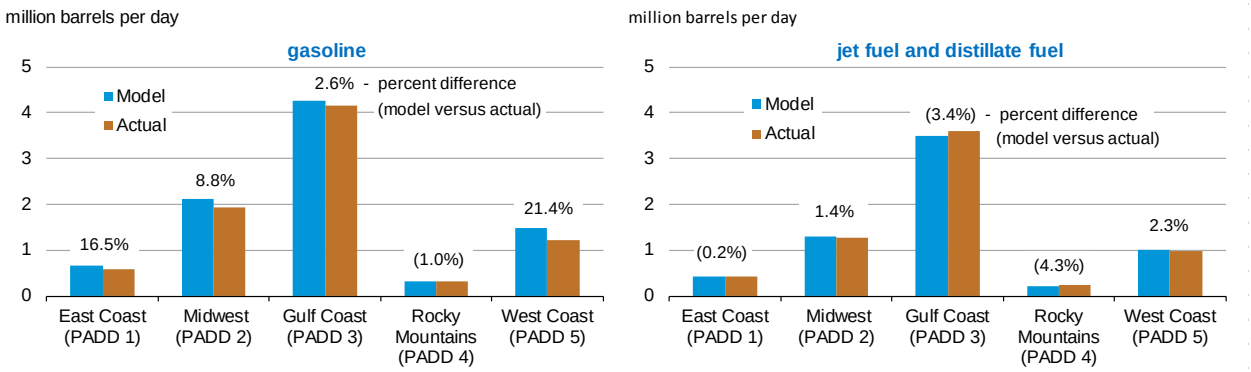
PRISM includes detailed computer models of 118 of the 137 operating U.S. refineries reported on by EIA. Each refinery model contains individual refinery unit simulations that can be manipulated to change unit operations, including a complete shutdown of the unit. The remaining refinery units can be operated through operational changes, by use of inventoried or purchased feedstocks, and by changes in refinery crude slates. The resulting petroleum product output with units 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 which identifies source country, API gravity level, and sulfur level. The data 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 2015, a year of very high refinery utilization. For gasoline and middle distillate (including jet fuel, diesel, and heating oil) production, the model results are close to the 2015 actuals and can therefore provide a reasonable approximation of refinery production capability.

Figure 1. U.S. refinery production base-case results vs. 2015 actual



Source: U.S. Energy Information Administration

4. Recent Market Conditions

As of January 31, the price of North Sea Brent crude oil was $55.25 per barrel (b). In the February *Short-Term Energy Outlook* (STEO), EIA forecasted that Brent will average $55/b for all of 2017, $11/b higher than the 2016 average. The higher price reflects a crude oil market that has largely returned to balance, following several consecutive quarters of significant global oversupply of crude oil.

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. The increase in supply outpaced consumption growth, resulting high levels of implied inventory builds that put significant downward pressure on crude oil prices. The lower crude prices resulted in U.S. crude oil production declining by an estimated 54,000 b/d in 2016, averaging 8.88 million b/d. The February STEO estimated that U.S. crude production will average 8.98 million barrels per day (b/d) in 2017 and 9.53 million b/d in 2018.

Global consumption of petroleum and other liquid fuels is estimated to have grown by 1.4 million b/d in 2016. EIA expects global consumption to increase by 1.6 million b/d in 2017 and by 1.5 million b/d in 2018, mostly driven by growth in countries outside of the Organization for Economic Cooperation and Development (OECD). Non-OECD consumption growth was 1.1 million b/d in 2016, and it is expected to be 1.2 million b/d in 2017 and 1.2 million b/d in 2018. India and China are expected to be the largest contributors to non-OECD petroleum consumption growth, with each country's consumption forecast to increase by about 0.3 million b/d annually in both 2017 and 2018.

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 November 2016, gross refinery inputs averaged 16.5 million b/d, slightly exceeding 2015 as the highest annual average since EIA began collecting data in 1985. 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 36 cents/gal in the fourth quarter of 2016. Higher U.S. gasoline production and inventory levels in 2016 contributed to lower gasoline margins than in 2015. Margins averaged 48 cents/gal and 41 cents/gal in 2015 and 2016, respectively. Margins are expected to be slightly lower in 2017, averaging 36 cents/gal, largely because of higher crude oil prices.

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 except for the West Coast were above their respective five-year averages for the week ending January 27. West Coast inventories of gasoline were 8% below the five-year average as of January 27. Distillate inventories in all regions of the country except for the West Coast were also above their five-year averages for the week ending January 27 and were persistently high in 2016. Inventories of kerosene-type jet fuel are within or above the five-year ranges for all regions except the East Coast.

Rising crude oil prices have led to increases in gasoline and distillate prices in recent months. After averaging $2.15 per gallon (gal) in 2016, the U.S. average retail price for regular gasoline is forecast to average $2.40/gal in 2017, which would be the first annual increase in gasoline prices since 2012. The U.S. average retail price for ultra-low sulfur diesel is expected to average $2.72/gal in 2017, also the first annual increase since 2012.

EIA estimates that U.S. gasoline consumption increased by 120,000 b/d (1.3%) in 2016. At 9.3 million b/d, U.S. gasoline consumption in 2016 was the highest level since the peak of 9.3 million b/d in 2007. Although total nonfarm employment and total vehicle-miles traveled were 4.6 % and 5.8% higher in 2016 compared with 2007, respectively, improving vehicle fuel economy has steadily contributed to lower gasoline consumption. In 2017, gasoline consumption is forecast to also average 9.3 million b/d.

U.S. distillate consumption fell by an estimated 140,000 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 80,000 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 4.6 million b/d through the first 11 months of 2016, 417,000 b/d higher than during the same period in 2015 and up 2.7 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. Through the first 11 months of 2016, the U.S. East Coast imported an average of 0.8 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[3] (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 on the East Coast is expected to be relatively light in the first half of 2017. Planned atmospheric crude distillation capacity maintenance is expected to average 197,000 b/d, or 15% of regional capacity, in February. Planned fluidized catalytic cracking capacity maintenance is expected to average 65,000 b/d, or 13% of regional capacity, in March. Planned reforming capacity maintenance averaged 32,000 b/d, or 12% of regional capacity, in January. Planned hydrocracking capacity maintenance is expected to average 4,000 b/d, or 9% of regional capacity, in April. Planned outage rates of crude distillation, fluidized catalytic cracking, reforming, and hydrocracking capacities in other months are expected to be lighter (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	
	2017 planned outages	2016 planned outages	2007-16 average planned outages	2017 planned outages	2016 planned outages
January	41	0	89	3%	0%
February	197	7	113	15%	1%
March	99	51	185	7%	4%
April	27	8	85	2%	1%
May	7	4	46	1%	0%
June	0	0	38	0%	0%

[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	
	2017 planned outages	2016 planned outages	2007-16 average planned outages	2017 planned outages	2016 planned outages
January	0	0	30	0%	0%
February	0	0	47	0%	0%
March	65	0	92	14%	0%
April	2	0	40	0%	0%
May	0	0	18	0%	0%
June	0	0	8	0%	0%

Reforming

Month	thousand barrels per day			as percentage of capacity	
	2017 planned outages	2016 planned outages	2007-16 average planned outages	2017 planned outages	2016 planned outages
January	32	0	18	12%	0%
February	18	0	22	7%	0%
March	10	11	38	4%	4%
April	4	14	25	1%	5%
May	1	2	14	0%	1%
June	0	0	14	0%	0%

Hydrocracking

Month	thousand barrels per day			as percentage of capacity	
	2017 planned outages	2016 planned outages	2007-16 average planned outages	2017 planned outages	2016 planned outages
January	0	0	6	0%	0%
February	0	17	6	0%	38%
March	1	10	7	2%	22%
April	4	0	5	9%	0%
May	1	0	4	3%	0%
June	0	0	4	0%	0%

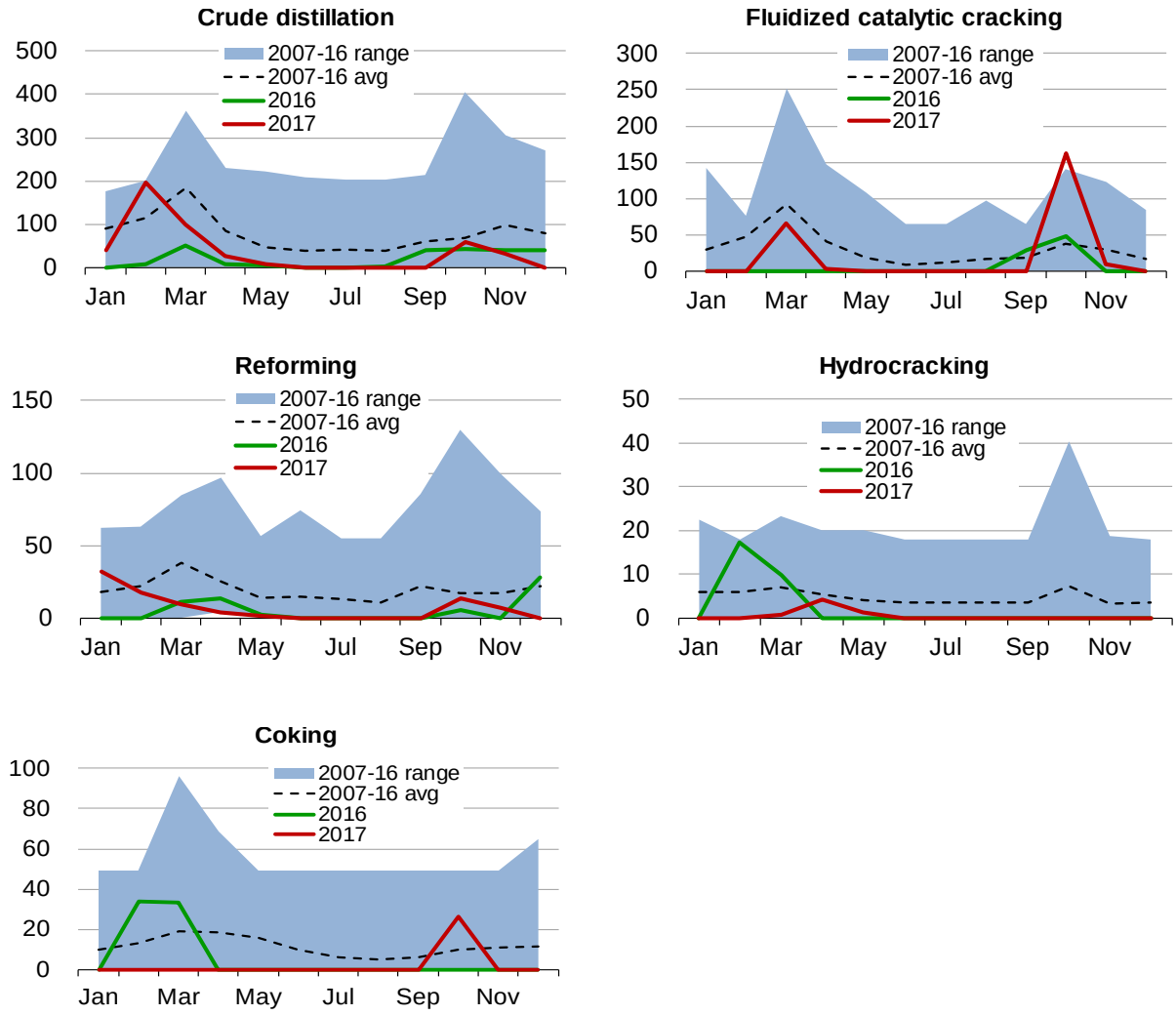
Coking

Month	thousand barrels per day			as percentage of capacity	
	2017 planned outages	2016 planned outages	2007-16 average planned outages	2017 planned outages	2016 planned outages
January	0	0	10	0%	0%
February	0	34	13	0%	41%
March	0	33	19	0%	41%
April	0	0	19	0%	0%
May	0	0	16	0%	0%
June	0	0	10	0%	0%

Source: U.S. Energy Information Administration, using IIR data as of January 10, 2017

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

thousand barrels per day

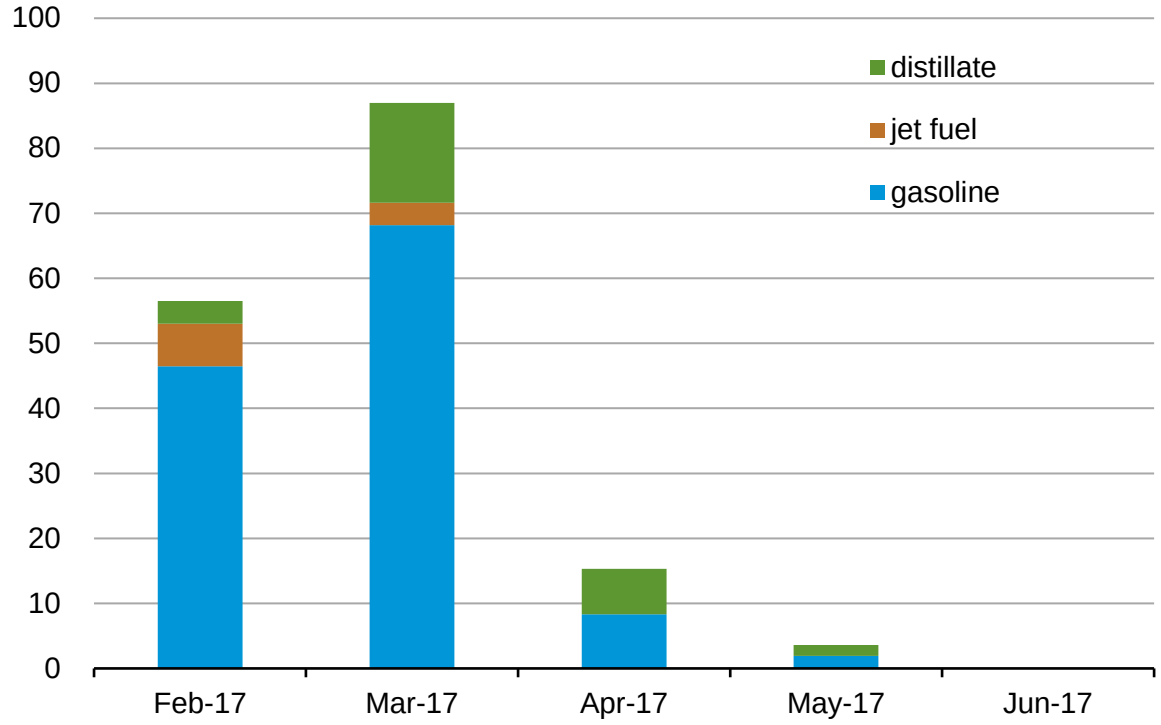


Source: U.S. Energy Information Administration, using IIR data as of January 10, 2017

The planned outages resulted in estimated production losses in gasoline of 46,000 b/d in February. Estimated production losses in March are expected to be larger, at 68,000 b/d and 15,000 b/d of gasoline and distillate, respectively. Production losses are low in April and will likely be negligible in May and June (Figure 3).

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

thousand barrels per day

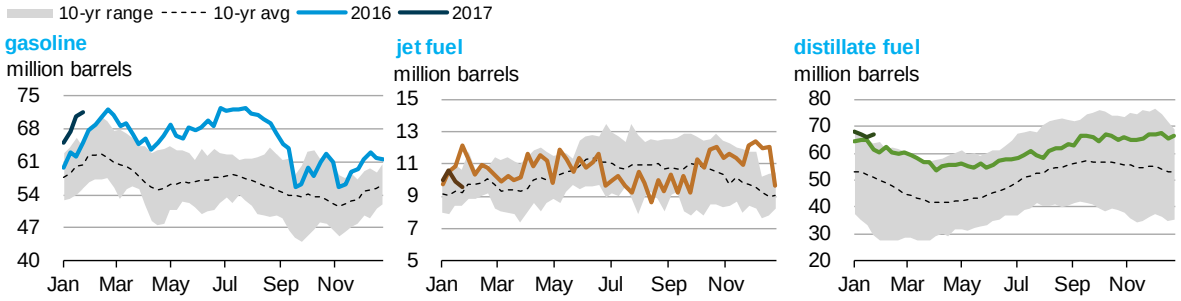


Source: U.S. Energy Information Administration

According to EIA's assessment of regional movement of petroleum products, in the first six month of 2016, the East Coast received, on average, 1.6 million b/d of gasoline blending components, 436,000 b/d of jet fuel, and 824,000 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 5.2% of existing gasoline inventories, 3.0% of existing jet fuel inventories, and 1.2% of distillate inventories as of January 20. Therefore, the production loss in the East Coast could be covered by existing product inventory (Figure 4).

Figure 4. East Coast (PADD 1) petroleum product inventories, 2016–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 3.92 million barrels per stream day[4] (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.

Planned refinery maintenance in the Midwest is expected to be very light in the first half of 2017, far below the 10-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	
	2017 planned outages	2016 planned outages	2007-16 average planned outages	2017 planned outages	2016 planned outages
January	0	87	56	0%	2%
February	0	60	111	0%	1%
March	92	428	327	2%	10%
April	94	515	302	2%	12%
May	80	185	175	2%	4%
June	0	130	109	0%	3%

[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.

Fluidized catalytic cracking

Month	thousand barrels per day			as percentage of capacity	
	2017 planned outages	2016 planned outages	2007-16 average planned outages	2017 planned outages	2016 planned outages
January	0	3	4	0%	0%
February	0	29	19	0%	2%
March	0	45	54	0%	4%
April	43	40	75	3%	3%
May	30	37	57	2%	3%
June	0	55	25	0%	4%

Reforming

Month	thousand barrels per day			as percentage of capacity	
	2017 planned outages	2016 planned outages	2007-16 average planned outages	2017 planned outages	2016 planned outages
January	7	1	3	1%	0%
February	15	15	12	2%	2%
March	10	92	52	1%	10%
April	18	166	66	2%	19%
May	18	105	44	2%	12%
June	69	68	21	8%	8%

Hydrocracking

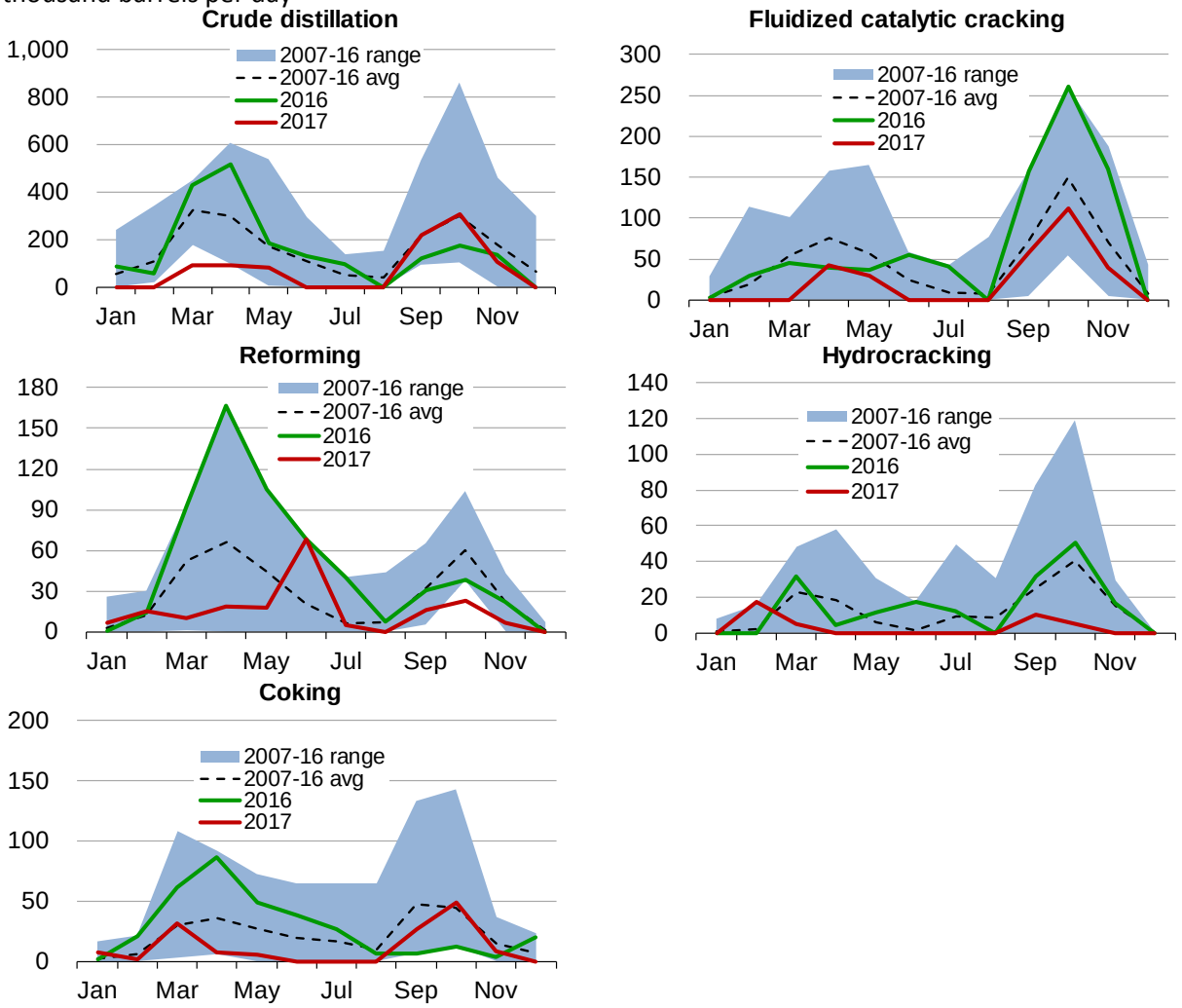
Month	thousand barrels per day			as percentage of capacity	
	2017 planned outages	2016 planned outages	2007-16 average planned outages	2017 planned outages	2016 planned outages
January	0	0	1	0%	0%
February	17	0	2	5%	0%
March	5	32	23	2%	10%
April	0	4	18	0%	1%
May	0	12	6	0%	4%
June	0	18	2	0%	5%

Coking

Month	thousand barrels per day			as percentage of capacity	
	2017 planned outages	2016 planned outages	2007-16 average planned outages	2017 planned outages	2016 planned outages
January	7	2	2	1%	0%
February	2	21	6	0%	3%
March	31	61	30	5%	10%
April	8	87	36	1%	14%
May	5	49	27	1%	8%
June	0	38	19	0%	6%

Source: U.S. Energy Information Administration, using IIR data as of January 10, 2017

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

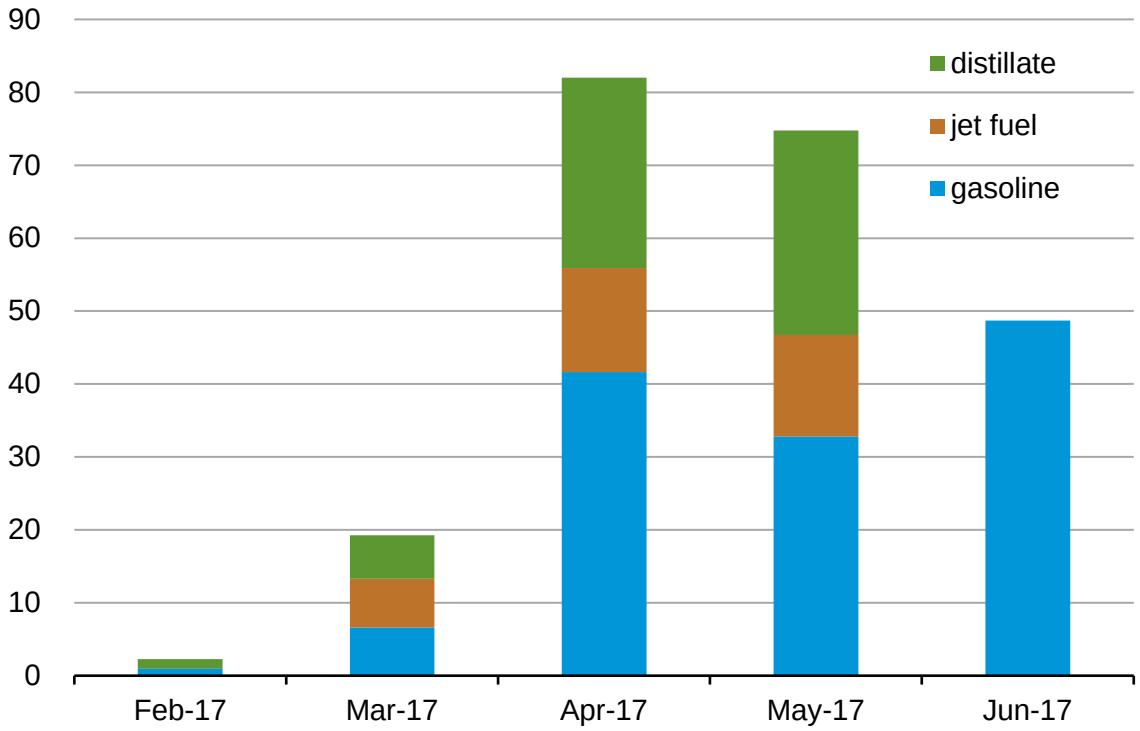


Source: U.S. Energy Information Administration, using IIR data as of January 10, 2017

The outages will result in production losses of gasoline supply of 42,000 b/d in April, 33,000 b/d in May, and 49,000 b/d in June. There are modest production losses of jet fuel supply of 14,000 b/d in April and May, and losses of distillate fuel supply of 26,000 b/d in April and 28,000 b/d in May (Figure 6).

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

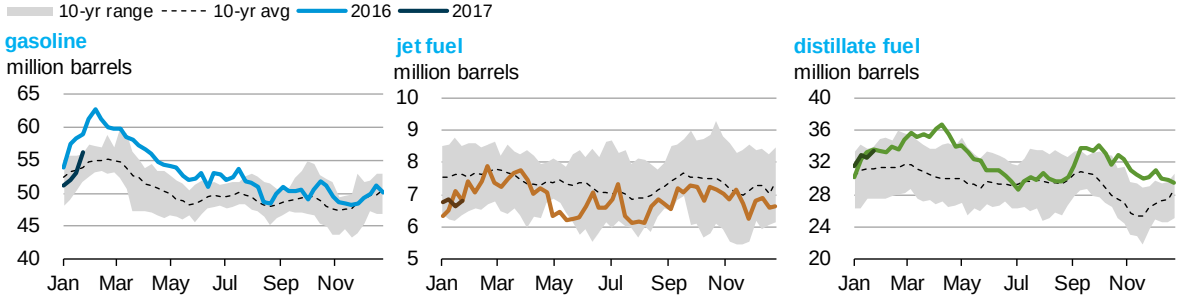
thousand barrels per day



Source: U.S. Energy Information Administration

The total estimated production losses in gasoline, jet fuel, and distillate fuel account for 7.0%, 15.7%, and 5.6%, respectively, of existing regional inventories as of January 20. The regional inventories will likely be sufficient to make up for lost in-region production.

Figure 7. Midwest (PADD 2) petroleum product inventories, 2016–present



Source: U.S. Energy Information Administration

7. Gulf Coast (PADD 3) Regional Outage Review

The Gulf Coast region 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[5] (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 the Gulf Coast 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 50% and 38% 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.

Above-average planned maintenance is expected in the Gulf Coast region in the first few months of 2017. Planned maintenance for fluidized catalytic cracking capacity is expected to average 404,000 b/d in February and 415,000 b/d in March, or 13% of regional capacity. Planned maintenance for hydrocracking capacity is expected to average 147,000 b/d, or 12% of regional capacity, in January and 244,000 b/d, or 21% of regional capacity, in February (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	
	2017 planned outages	2016 planned outages	2007-16 average planned outages	2017 planned outages	2016 planned outages
January	809	373	442	8%	4%
February	722	477	647	7%	5%
March	595	413	501	6%	4%
April	94	355	286	1%	4%
May	100	260	212	1%	3%
June	20	208	166	0%	2%

Fluidized catalytic cracking

[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.

Month	thousand barrels per day			as percentage of capacity	
	2017 planned outages	2016 planned outages	2007-16 average planned outages	2017 planned outages	2016 planned outages
January	250	120	160	8%	4%
February	404	161	289	13%	5%
March	415	138	185	13%	4%
April	113	78	86	4%	3%
May	0	58	61	0%	2%
June	0	83	27	0%	3%

Reforming

Month	thousand barrels per day			as percentage of capacity	
	2017 planned outages	2016 planned outages	2007-16 average planned outages	2017 planned outages	2016 planned outages
January	132	128	109	7%	7%
February	149	192	120	8%	10%
March	110	83	82	6%	4%
April	27	29	53	1%	2%
May	0	37	52	0%	2%
June	0	22	38	0%	1%

Hydrocracking

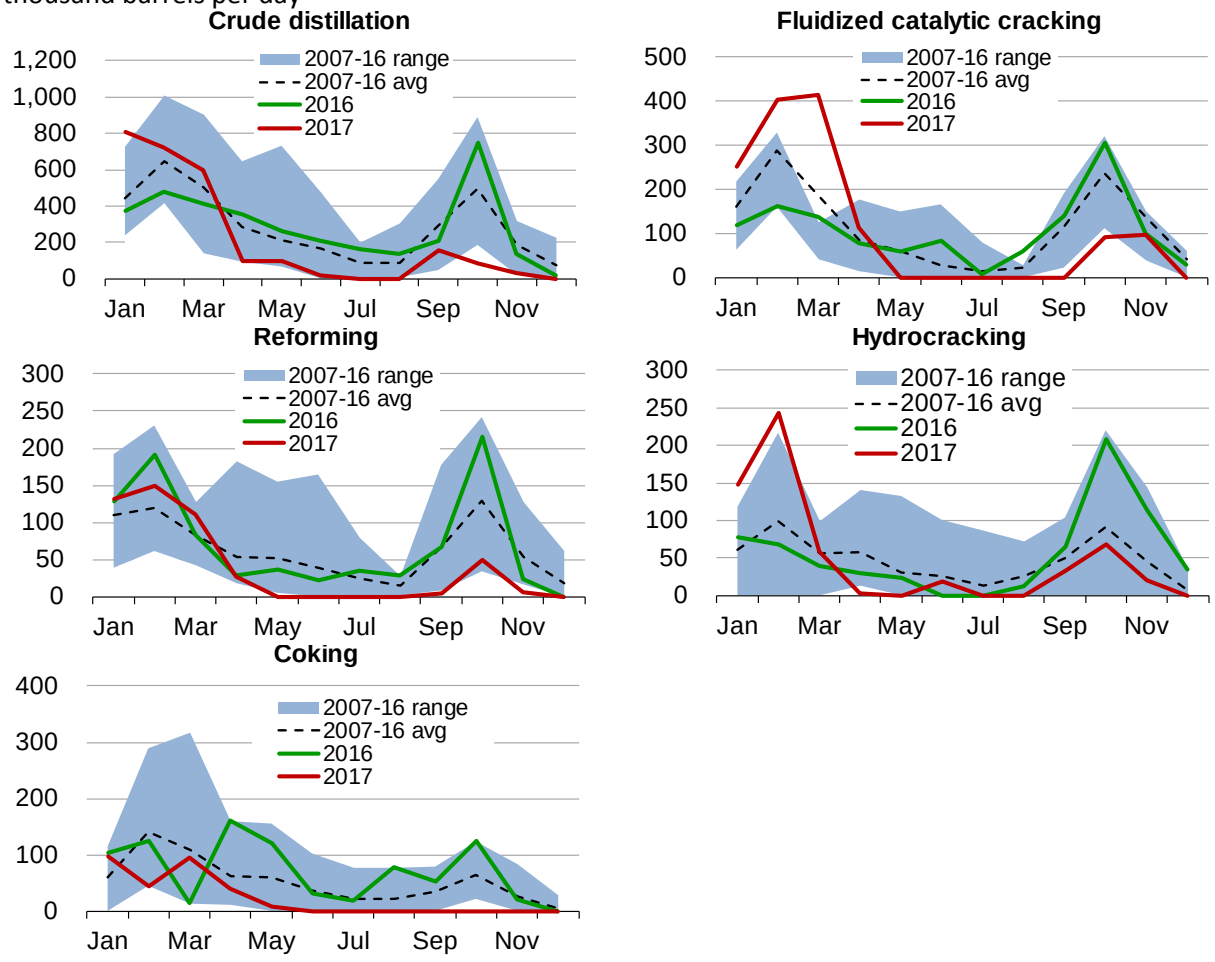
Month	thousand barrels per day			as percentage of capacity	
	2017 planned outages	2016 planned outages	2007-16 average planned outages	2017 planned outages	2016 planned outages
January	147	77	61	12%	7%
February	244	69	99	21%	6%
March	59	40	57	5%	3%
April	3	31	58	0%	3%
May	0	23	30	0%	2%
June	19	0	25	2%	0%

Coking

Month	thousand barrels per day			as percentage of capacity	
	2017 planned outages	2016 planned outages	2007-16 average planned outages	2017 planned outages	2016 planned outages
January	98	104	59	6%	7%
February	44	125	142	3%	8%
March	96	14	108	6%	1%
April	41	161	61	3%	10%
May	8	120	61	1%	8%
June	0	32	37	0%	2%

Source: U.S. Energy Information Administration, using IIR data as of January 10, 2017

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

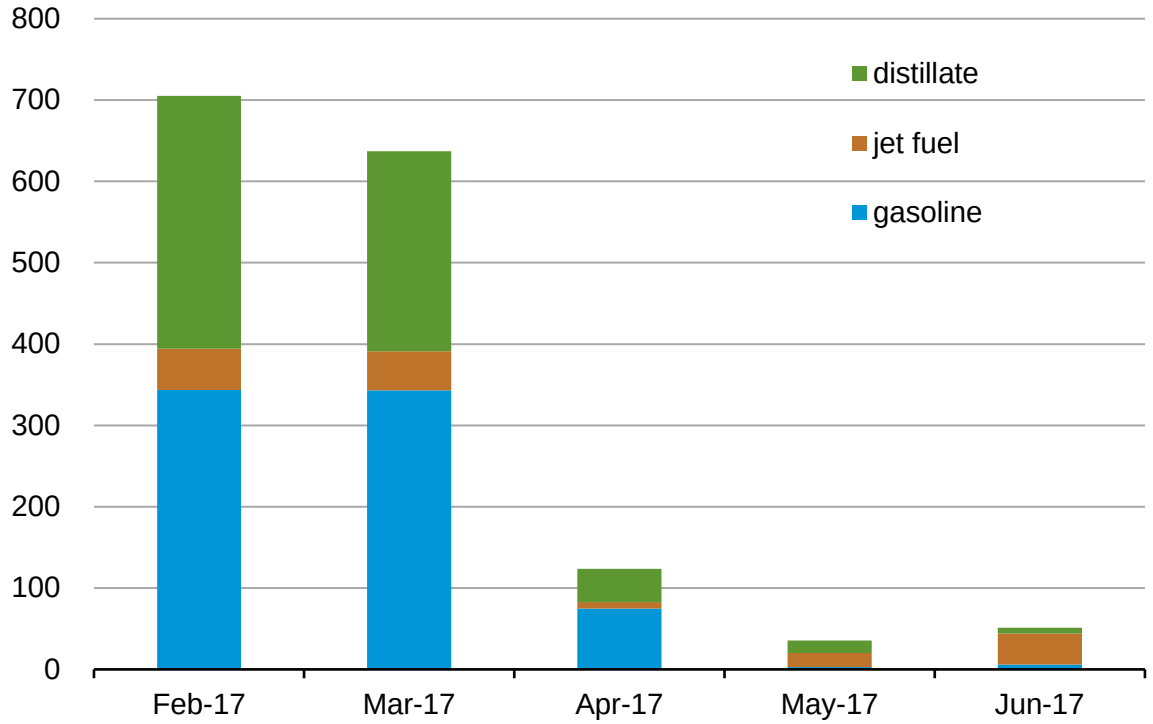


Source: U.S. Energy Information Administration, using IIR data as of January 10, 2017

The planned refinery outages in the Gulf Coast are expected to result in above-average production losses in petroleum products. In February and March, the expected average losses are 344,000 b/d and 343,000 b/d in gasoline and 311,000 b/d and 246,000 b/d in distillate fuel (Figure 9).

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

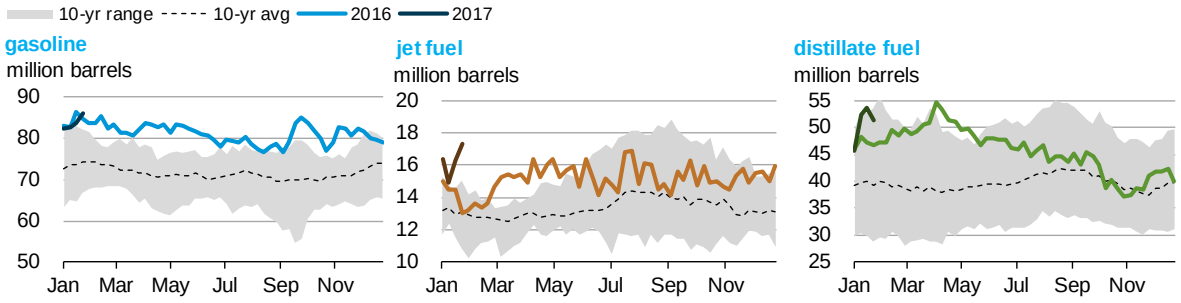
thousand barrels per day



Source: U.S. Energy Information Administration

As of January 20, Gulf Coast gasoline and jet fuel inventories are above the 10-year maximum, and distillate fuel inventories are close to the 10-year average (Figure 10). The total estimated production loss as a result of the planned outages accounts for 27% of existing gasoline inventory, 28% of jet fuel inventory, and 36% 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, 2016–present



Source: U.S. Energy Information Administration

8. Rocky Mountain (PADD 4) Regional Outage Review

The Rocky Mountain region, 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[6] (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.

Planned refinery maintenance for the Rocky Mountain region is expected to be light at the beginning of the first half of 2017, but above the 10-year average in May and June. Because consumption in the Rocky Mountain region is low and inventories of petroleum products are at or above the 10-year average, the planned maintenance should not affect product availability.

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

Atmospheric crude distillation

Month	thousand barrels per day			as percentage of capacity	
	2017 planned outages	2016 planned outages	2007-16 average planned outages	2017 planned outages	2016 planned outages
January	0	0	4	0%	0%
February	0	11	9	0%	1%
March	0	39	43	0%	5%
April	33	43	62	5%	6%
May	55	23	24	8%	3%
June	73	0	20	10%	0%

[6] 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.

Fluidized catalytic cracking

Month	thousand barrels per day			as percentage of capacity	
	2017 planned outages	2016 planned outages	2007-16 average planned outages	2017 planned outages	2016 planned outages
January	0	0	0	0%	0%
February	0	4	2	0%	2%
March	0	21	14	0%	10%
April	12	37	21	6%	18%
May	20	23	11	10%	11%
June	26	0	2	12%	0%

Reforming

Month	thousand barrels per day			as percentage of capacity	
	2017 planned outages	2016 planned outages	2007-16 average planned outages	2017 planned outages	2016 planned outages
January	3	0	1	2%	0%
February	0	3	1	0%	3%
March	3	13	11	2%	10%
April	7	14	14	5%	10%
May	12	8	3	9%	6%
June	3	0	1	2%	0%

Hydrocracking

Month	thousand barrels per day			as percentage of capacity	
	2017 planned outages	2016 planned outages	2007-16 average planned outages	2017 planned outages	2016 planned outages
January	0	0	0	0%	0%
February	0	0	0	0%	0%
March	0	0	1	0%	0%
April	0	0	3	0%	0%
May	0	0	0	0%	0%
June	15	0	4	27%	0%

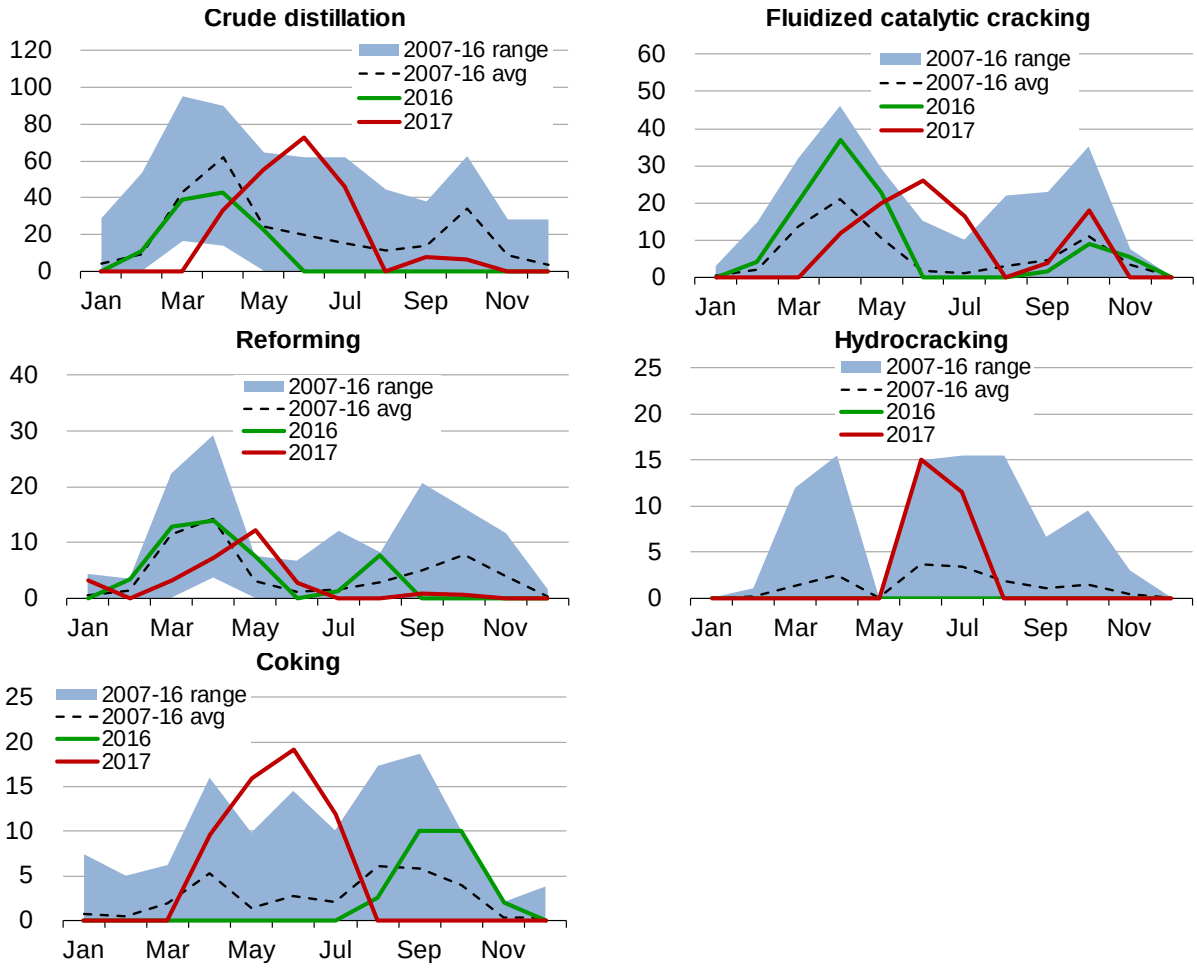
Coking

Month	thousand barrels per day			as percentage of capacity	
	2017 planned outages	2016 planned outages	2007-16 average planned outages	2017 planned outages	2016 planned outages
January	0	0	1	0%	0%
February	0	0	1	0%	0%
March	0	0	2	0%	0%
April	10	0	5	7%	0%
May	16	0	1	12%	0%
June	19	0	3	15%	0%

Source: U.S. Energy Information Administration, using IIR data as of January 10, 2017

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

thousand barrels per day

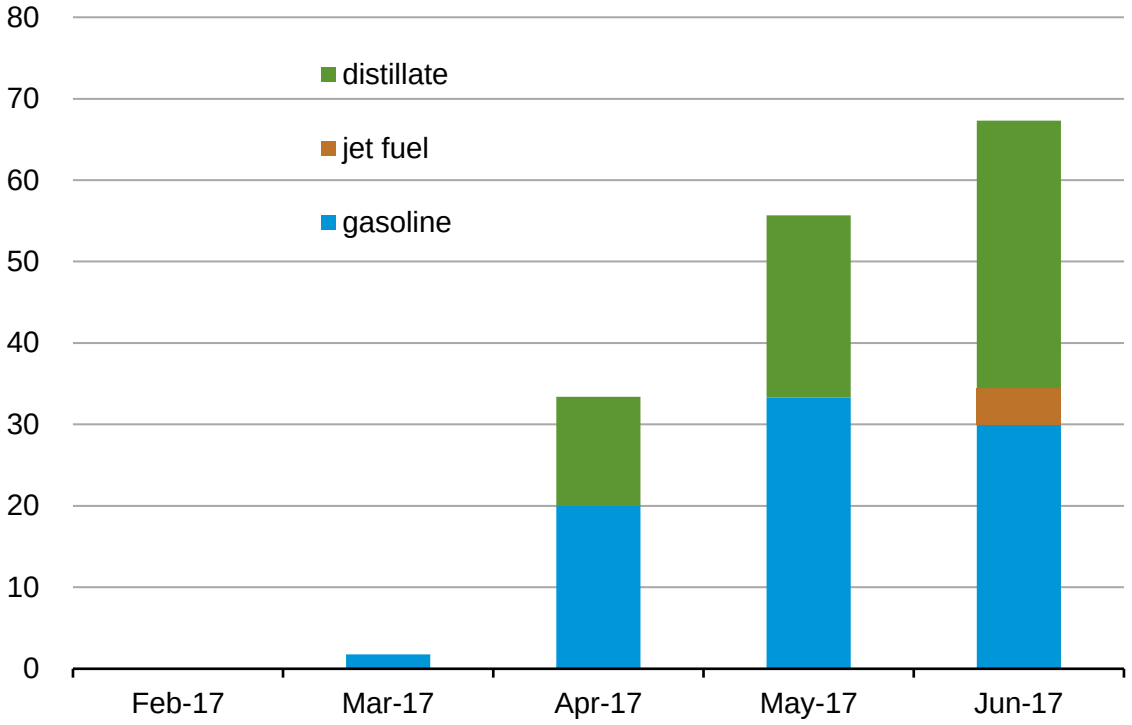


Source: U.S. Energy Information Administration, using IIR data as of January 10, 2017

Supply losses in June as a result of planned maintenance in the Rocky Mountain region are 30,000 b/d in gasoline, 4,000 b/d in jet fuel, and 33,000 b/d in distillate fuel (Figure 12).

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

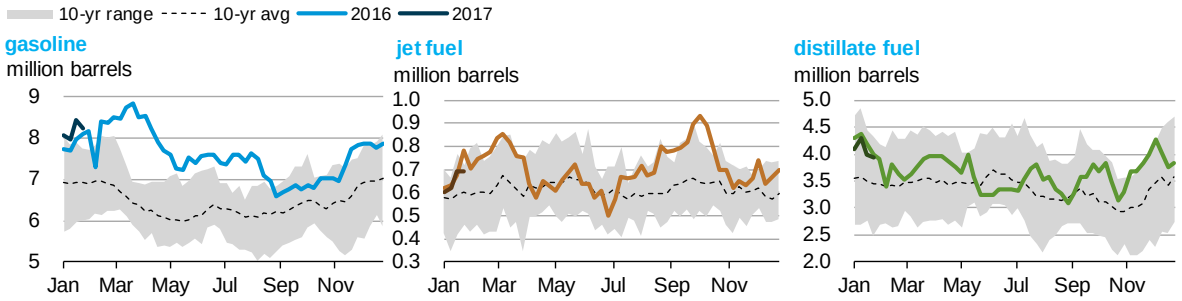
thousand barrels per day



Source: U.S. Energy Information Administration

Total estimated production losses from planned outages in the Rocky Mountain region account for 31% of regional gasoline inventories, 19% of jet fuel inventories, and 53% of distillate inventories. As of January 20, PADD 4 inventory levels for those products were all above or close to the 10-year average.

Figure 13. Rocky Mountain (PADD 4) petroleum product inventories, 2016–present



Source: U.S. Energy Information Administration

9. West Coast (PADD 5) Regional Outage Review

The West Coast region 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[7] (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 West Coast 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 West Coast 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 close to the 10-year average in the first half of 2017. Planned fluidized catalytic cracking capacity maintenance is expected to peak at an average of 121,000 b/d, or 14% of regional capacity, in March. Planned hydrocracking capacity maintenance averaged 72,000 b/d, or 12% of regional capacity in February and 74,000 b/d, or 13% of regional capacity in April. Planned maintenance on coking capacity is expected to average 69,000 b/d, or 13% of regional capacity, in March.

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

Atmospheric crude distillation

Month	thousand barrels per day			as percentage of capacity	
	2017 planned outages	2016 planned outages	2007-16 average planned outages	2017 planned outages	2016 planned outages
January	116	54	105	4%	2%
February	244	193	149	8%	6%
March	81	12	129	3%	0%
April	130	57	152	4%	2%
May	202	208	143	7%	7%
June	73	96	88	2%	3%

[7] 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.

Fluidized catalytic cracking

Month	thousand barrels per day			as percentage of capacity	
	2017 planned outages	2016 planned outages	2007-16 average planned outages	2017 planned outages	2016 planned outages
January	0	77	103	0%	9%
February	26	102	114	3%	12%
March	121	50	67	14%	6%
April	7	0	44	1%	0%
May	2	0	11	0%	0%
June	73	0	1	8%	0%

Reforming

Month	thousand barrels per day			as percentage of capacity	
	2017 planned outages	2016 planned outages	2007-16 average planned outages	2017 planned outages	2016 planned outages
January	0	52	43	0%	9%
February	12	68	37	2%	12%
March	10	26	42	2%	4%
April	0	4	36	0%	1%
May	15	10	30	3%	2%
June	2	0	17	0%	0%

Hydrocracking

Month	thousand barrels per day			as percentage of capacity	
	2017 planned outages	2016 planned outages	2007-16 average planned outages	2017 planned outages	2016 planned outages
January	24	73	34	4%	12%
February	72	46	34	12%	8%
March	9	0	31	2%	0%
April	74	5	35	13%	1%
May	24	10	40	4%	2%
June	4	0	20	1%	0%

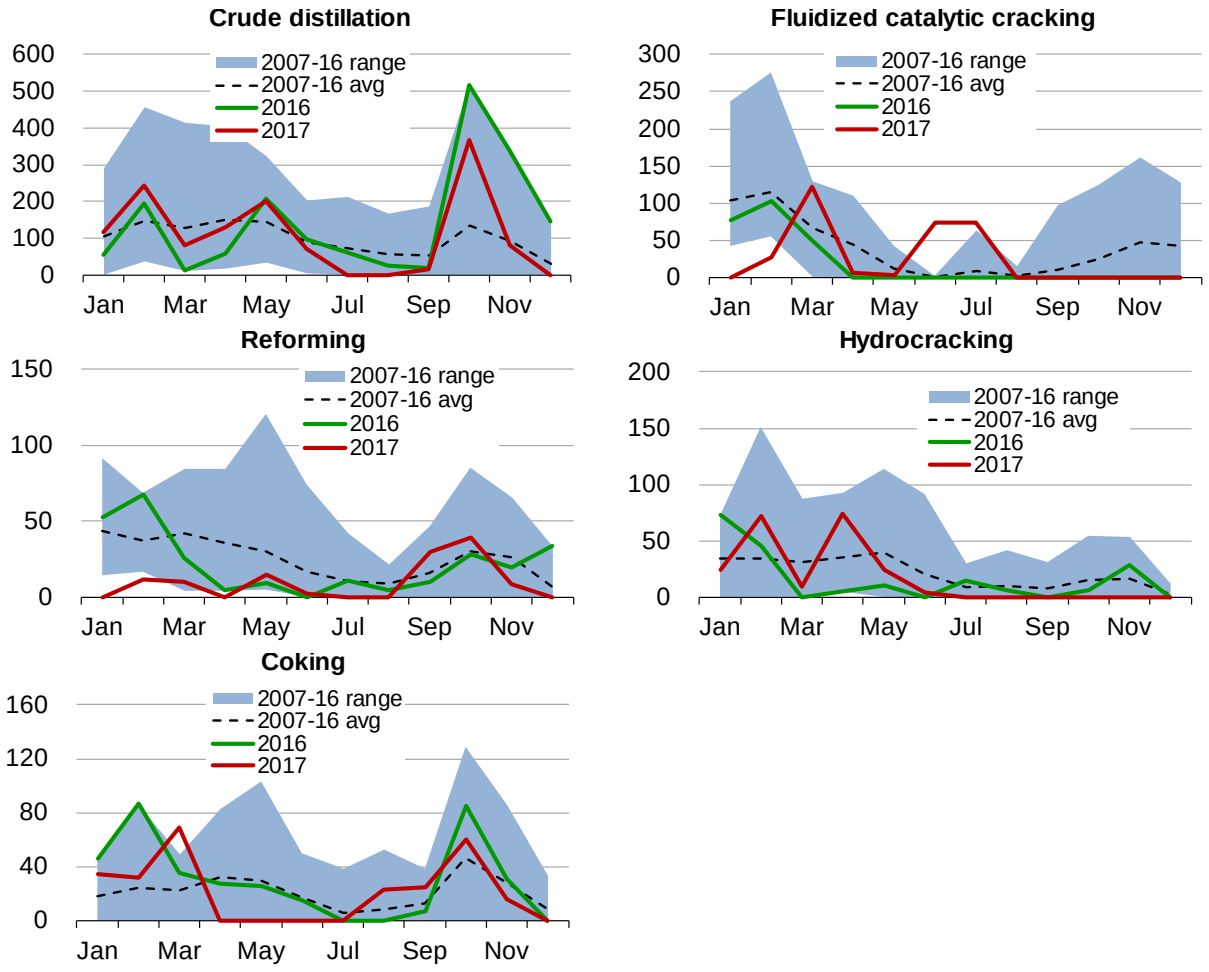
Coking

Month	thousand barrels per day			as percentage of capacity	
	2017 planned outages	2016 planned outages	2007-16 average planned outages	2017 planned outages	2016 planned outages
January	34	46	18	6%	9%
February	32	86	24	6%	16%
March	69	35	22	13%	7%
April	0	27	32	0%	5%
May	0	26	29	0%	5%
June	0	15	17	0%	3%

Source: U.S. Energy Information Administration, using IIR data as of January 10, 2017

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

thousand barrels per day

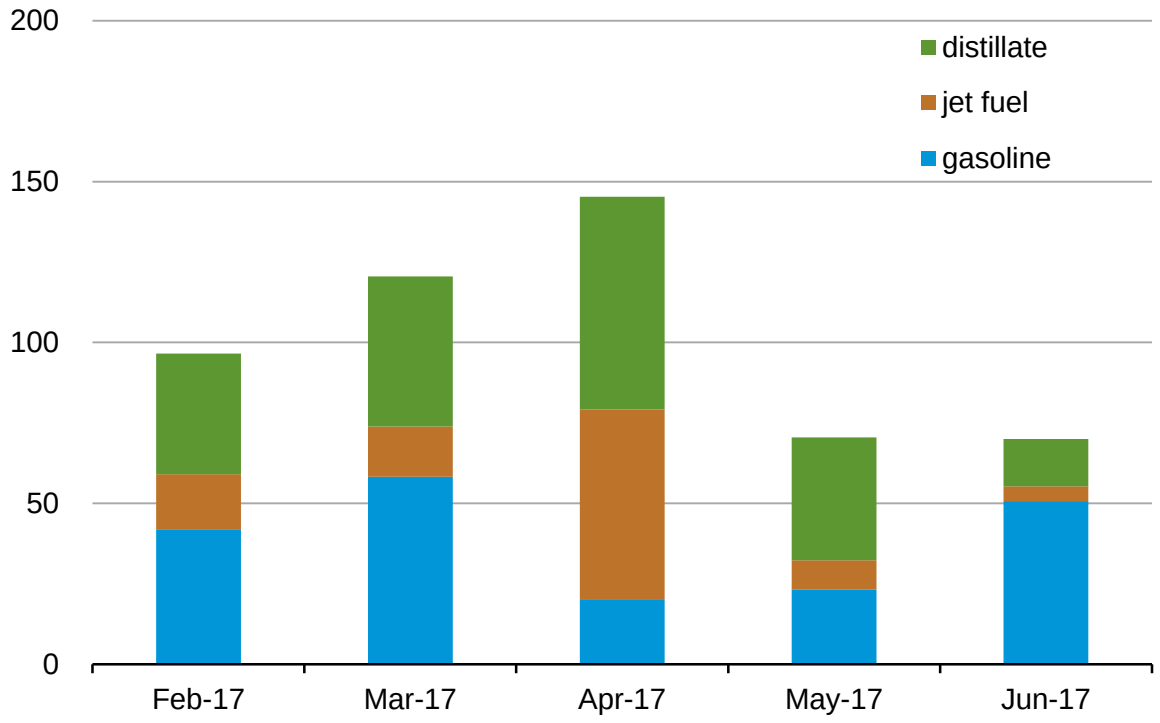


Source: U.S. Energy Information Administration, using IIR data as of January 10, 2017

The production loss is expected to peak in April, and include 20,000 b/d in gasoline, 59,000 b/d in jet fuel, and 66,000 in distillate. (Figure 15).

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

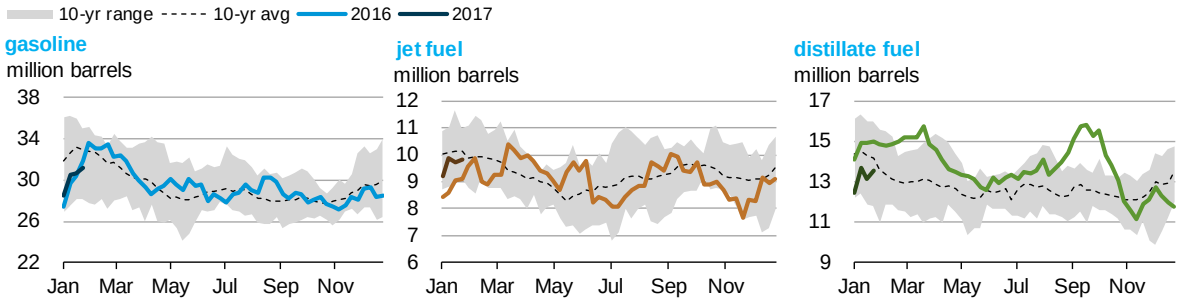
thousand barrels per day



Source: U.S. Energy Information Administration

The total estimated reduction of petroleum products resulting from the outages accounts for 19% of the existing gasoline inventory, 32% of jet fuel inventory, and 45% 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, 2016–present



Source: U.S. Energy Information Administration