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Midwest and Rocky Mountain Transportation Fuels Markets

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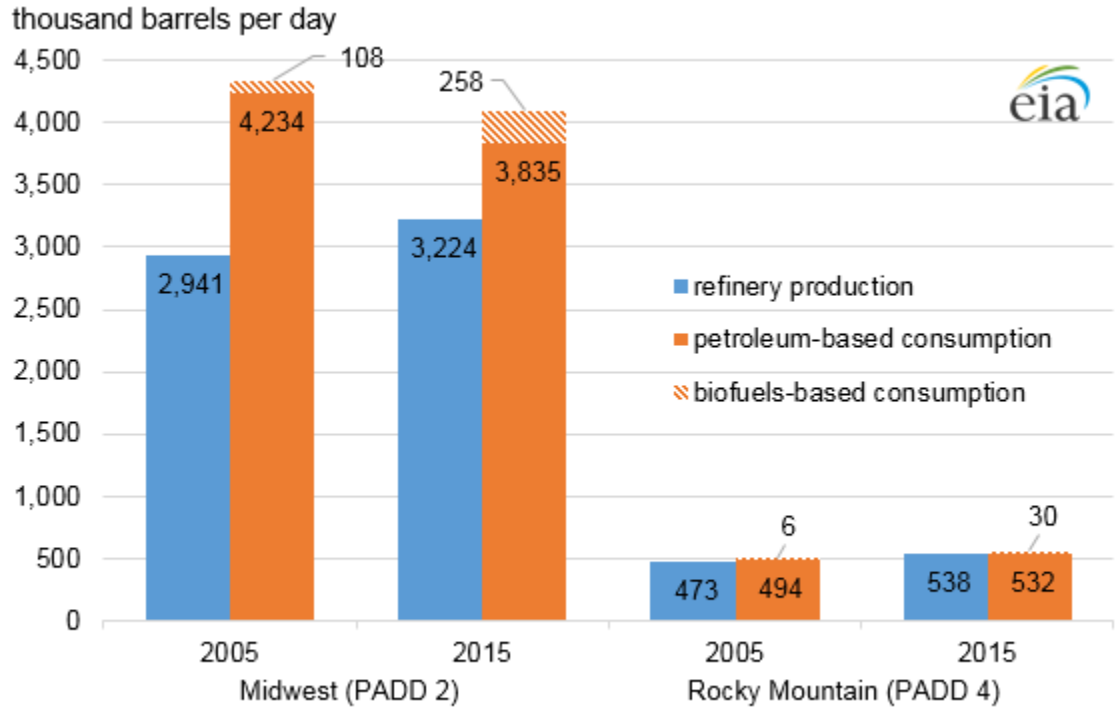
Introduction

A new study commissioned by the U.S. Energy Information Administration (EIA), find that changes in North American energy markets over the past decade have strengthened the supply of transportation fuels including motor gasoline, distillates, and jet fuel in the Midwest and Rocky Mountain regions.

The development of Canadian oil sands crude and the emergence of light, tight crude oil in the United States have provided refiners in the Midwest and Rocky Mountain regions with access to abundant, cost-advantaged crude supply, providing opportunities to optimize crude slates and expand refinery capacity and utilization. Increased refinery production, combined with moderating demands for transportation fuels, has enabled suppliers in the Midwest and Rocky Mountain regions to reduce their dependence on inbound transportation fuels supply from the Gulf Coast, and has enhanced the redundancy and resiliency of their transportation fuels supply chains.

Refinery capacity and production of transportation fuels in the Midwest and Rocky Mountain regions grew significantly between 2005 and 2015, and fuels markets and supply chains in these regions have become increasingly self-sufficient. Meanwhile, demand for transportation fuels has been stagnant in the Midwest (but has grown in the Rocky Mountain Region), while increasing volumes of renewable fuels—ethanol and biodiesel—have been added to the supply mix. As a result, in-region refinery production of fuels used (net of ethanol and biodiesel inputs) in 2015 has grown to 84% in the Midwest and 101% in the Rocky Mountain region, up from 69% and 97%, respectively, in 2005. Figure 1 compares transportation fuels production with consumption in the Midwest and Rocky Mountain regions in 2005 and 2015.

Figure 1. Midwest and Rocky Mountain transportation fuels production and consumption, 2005 vs. 2015

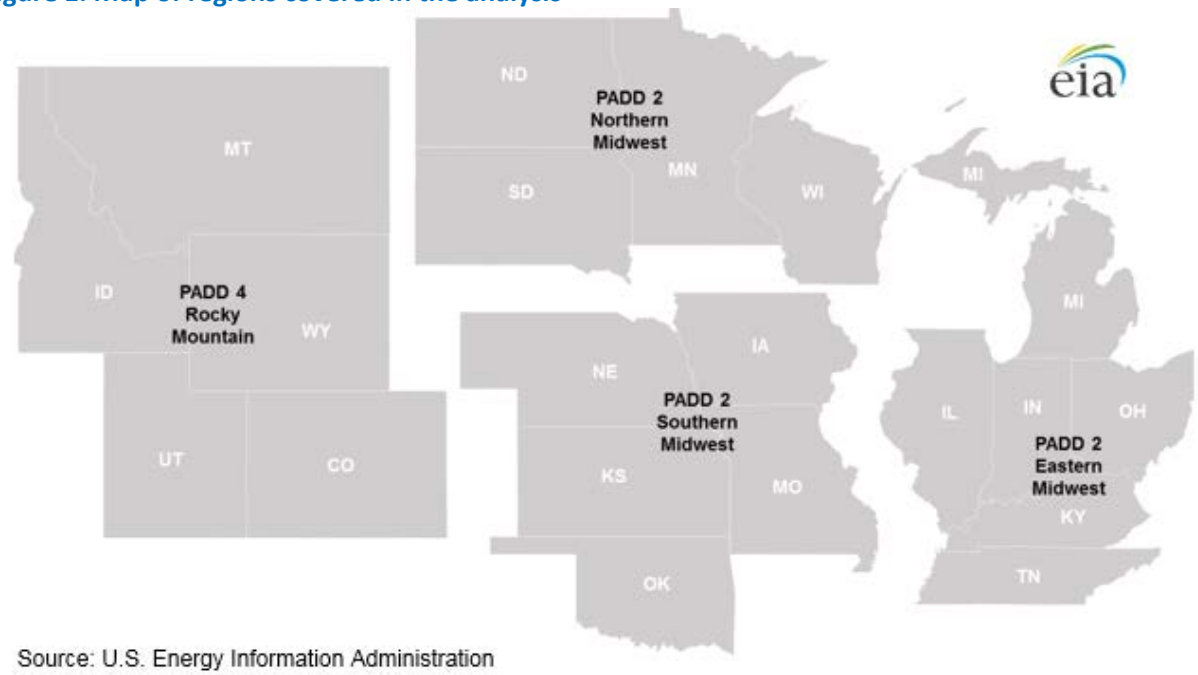


Source: ICF, based on U.S. Energy Information Administration

This study is the third and final in a series of reports that examines supply, consumption, and distribution of gasoline, diesel fuel, and jet fuel across the United States. This study focuses on the Midwest and Rocky Mountain regions. The Midwest region comprises 15 states in the north central United States, and the Rocky Mountain region comprises five states in the western north-central United States, corresponding to Petroleum Administration for Defense Districts (PADDs) 2 and 4. Previously published studies focused on the East and Gulf Coasts and the West Coast.

This study examines transportation fuels supply, demand, and distribution at both the regional level and for three areas within the Midwest (which are referred to as sub-PADD regions in this analysis). The Midwest and the Rocky Mountain regions cover a large and diverse geography, and supply/demand balances and supply patterns vary within each region. Consequently, the Midwest has been divided into three regions including the Eastern Midwest region corresponding to EIA's Indiana-Illinois-Kentucky refining district, the Northern Midwest region corresponding to EIA's Minnesota-Wisconsin-North and South Dakota refining district, and the Southern Midwest region corresponding to EIA's Oklahoma-Kansas-Missouri refining district. The Rocky Mountain region is not subdivided in this analysis. Each region is depicted with its corresponding states in Figure 2.

Figure 1. Map of regions covered in the analysis



Source: U.S. Energy Information Administration

For each of these regional markets, this study uses 2015 as a base year and takes into account expected changes in infrastructure and supply in subsequent years. Demand includes in-region consumption, movements of fuels to other regions of the United States, and exports to the global market. Supply includes in-region refinery production, receipt of fuels transferred from other U.S. regions and other Midwest and Rocky Mountain regional markets, and foreign imports. Distribution infrastructure includes storage terminals, pipelines, marine loading and unloading facilities, marine vessels, and rail facilities.

For this study, ICF, LLC analyzed data and information from EIA, Airlines for America, the Federal Energy Regulatory Commission, the U.S. Army Corps of Engineers Waterborne Commerce Statistics Center, the U.S. International Trade Commission, and publicly available data on companies and fuels infrastructure from U.S. Securities and Exchange Commission 10-K reports, investor presentations, and various other sources.

This report completes a series of three studies that EIA has conducted to inform its analyses of petroleum product markets, especially during periods of supply disruption and market change.

Midwest and Rocky Mountain Transportation Fuels Markets

A report prepared by ICF for EIA

March 2017

Acknowledgements

This report was prepared by ICF for the U.S. Energy Information Administration (EIA) under the general guidance of Lynn Westfall, Director of Office of Energy Markets and Financial Analysis.

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Introduction

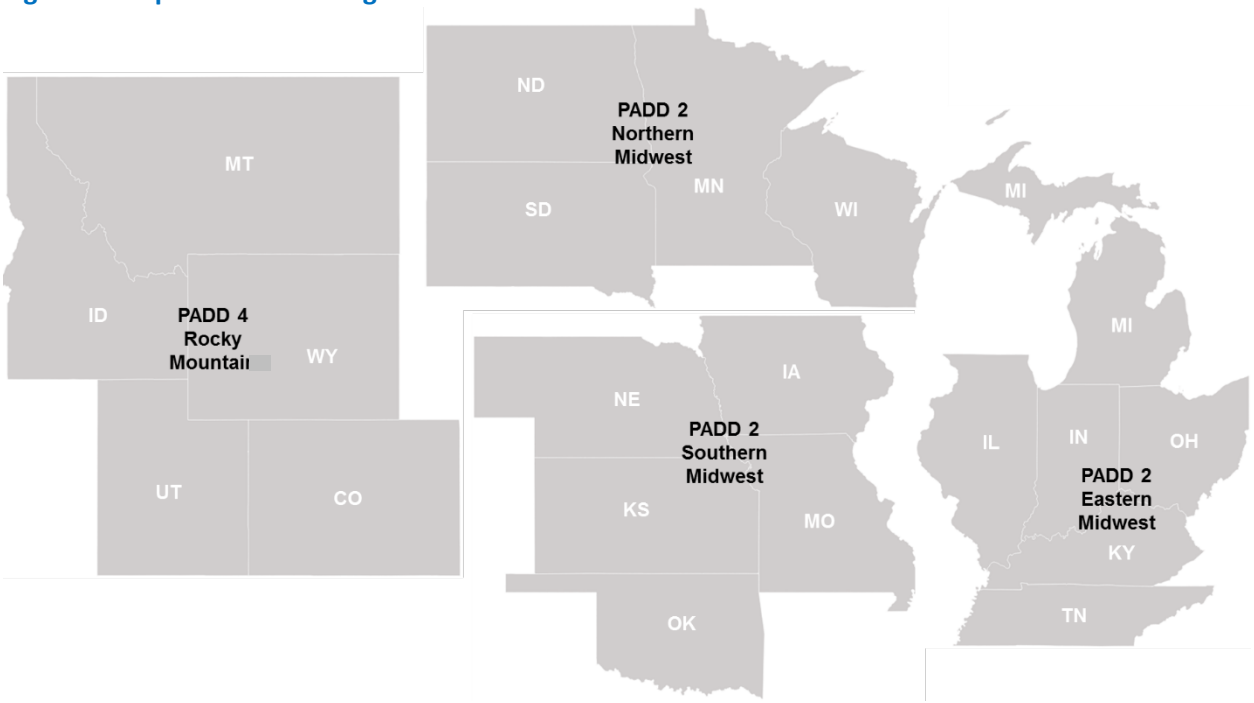
This study, commissioned by the U.S. Energy Information Administration (EIA), examines supply, demand, and distribution of transportation fuels in Petroleum Administration for Defense District (PADD) 2 and PADD 4. PADD 2 (the Midwest region) comprises 15 states in the north central United States. PADD 4 (the Rocky Mountain region) comprises five states in the western north-central United States. A map of all five U.S. PADDs is shown in Figure 1.

Figure 1. Petroleum Administration for Defense Districts (PADDs)

Source: U.S. Energy Information Administration.

This study examines transportation fuels supply, demand, and distribution at both the PADD level and for specific areas within PADD 2, which are referred to as sub-PADD regions in this analysis. PADDs 2 and 4 cover a large and diverse geography, and supply/demand balances and supply patterns vary within each PADD. For the purposes of this study, the Midwest (PADD 2) has been divided into three sub-PADD regions that correspond with EIA's refining districts. The Eastern Midwest sub-PADD region corresponds with EIA's Indiana-Illinois-Kentucky refining district. The Northern Midwest sub-PADD region corresponds with EIA's Minnesota-Wisconsin-North Dakota and South Dakota refining district. The Southern Midwest sub-PADD region corresponds with EIA's Oklahoma-Kansas-Missouri refining district. The Rocky Mountain region (PADD 4) is analyzed at the PADD level in this analysis. Each region is depicted in Figure 2.

Figure 2. Map of sub-PADD regions



Source: U.S. Energy Information Administration.

For each of these regional markets, the study considers demand, supply, supply patterns, and distribution infrastructure, using 2015 as a base year and taking into account expected changes in infrastructure and supply in subsequent years. Demand includes in-region consumption, movements of fuels to other parts of the United States (other PADDs and sub-PADDs), and exports to the global market. Supply includes in-region refinery production, receipt of fuels produced in other U.S. regions and other PADD 2 and PADD 4 regional markets, and foreign imports. Distribution infrastructure includes storage terminals, pipelines, marine loading and unloading facilities, marine vessels, and rail facilities.

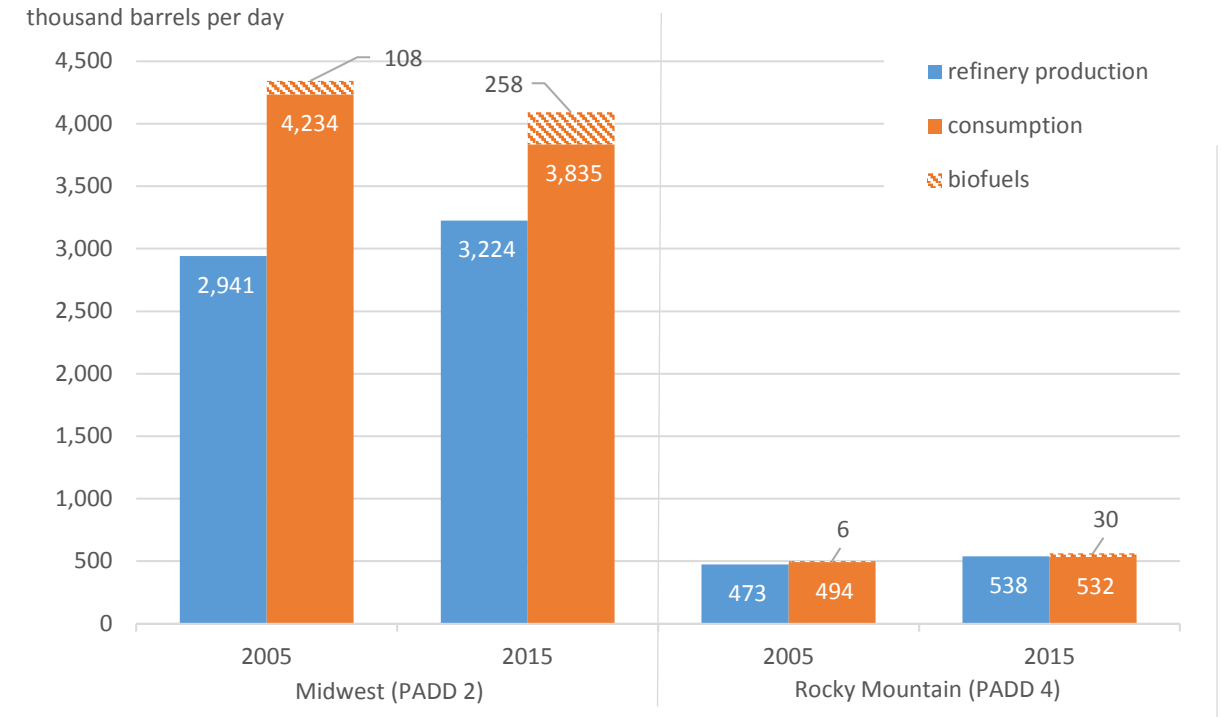
EIA retained ICF, LLC, a Fairfax, Virginia-based energy, environment, and transportation fuels consultant, to conduct the research and analysis for the PADD 2 and PADD 4 study. ICF analyzed data and information from EIA, Airlines for America, the Federal Energy Regulatory Commission, the U.S. Army Corps of Engineers Waterborne Commerce Statistics Center, the U.S. International Trade Commission, and publicly available data on companies and fuels infrastructure from company U.S. Securities and Exchange Commission 10-K reports, investor presentations, and various other sources.

This study is the third in a series of studies that EIA is conducting to inform its analyses of petroleum product markets, especially during periods of supply disruption and market change.

Executive Summary

Refinery capacity and production of transportation fuels (motor gasoline, distillates, and jet fuel) in the Midwest (Petroleum Administration for Defense District [PADD] 2) and Rocky Mountain (PADD 4) regions grew significantly between 2005 and 2015, and fuels markets and supply chains in these regions have become increasingly self-sufficient. Driven by proximity to increasing, cost-advantaged North American crude streams, including production from the Bakken Formation in North Dakota and Montana, and from the Alberta Oil Sands in Western Canada, refining capacity in PADDs 2 and 4 has grown primarily through expansions at existing plants. From January 2005 through December 2015, refining capacity in PADD 2 increased by 323,000 barrels per calendar day (b/cd), or approximately 9%, while refining capacity in PADD 4 increased by 63,000 b/cd, or 11%.[1] Moreover, refinery upgrading projects in PADDs 2 and 4 over the same period have incrementally increased refinery yields of gasoline and distillate per barrel of crude oil processed. Meanwhile, demand for transportation fuels has been stagnant in PADD 2 (but has grown in PADD 4), while increasing volumes of renewable fuels—ethanol and biodiesel—have been added to the supply mix. As a result of these trends, in-region refinery production in 2015 has grown to 84% of PADD 2 and 101% of PADD 4 transportation fuels consumption (net of ethanol and biodiesel inputs), up from 69% and 97%, respectively, in 2005. Figure 3 compares transportation fuels production versus consumption in PADDs 2 and 4 in 2005 and 2015.

Figure 3. PADD 2 and PADD 4 transportation fuels production vs. consumption, 2005 vs. 2015



Source: U.S. Energy Information Administration, *Petroleum Supply Annual*

[1] U.S. Energy Information Administration, "Monthly Refinery Report", accessed November 1, 2016, available at http://www.eia.gov/dnav/pet/pet_pnp_unc_a_(na)_YRL_mbblpd_m.htm.

Increased refinery production has allowed refiners in PADDs 2 and 4 to meet a greater share of local demand and has also allowed them to expand supply into markets in adjacent PADDs. At the same time, PADDs 2 and 4 have reduced inbound shipments of transportation fuels by pipeline and barge from refineries in Texas and Louisiana in PADD 3.

Greater self-sufficiency in fuels production has enhanced the security and flexibility of fuel supply chains in PADDs 2 and 4. Although product movements from PADD 3 into PADD 2 have decreased in recent years, many of the pipeline and waterborne supply systems that facilitated these movements remain in place and can be used to provide swing supply into PADD 2 to compensate for outages at in-region refineries. For instance, when a series of planned and unplanned refinery outages affected PADD 2 transportation fuels production in the second half of 2015, shippers responded by increasing shipments by pipeline and barge from PADD 3 to PADD 2 by as much as 276,000 barrels per day (b/d).

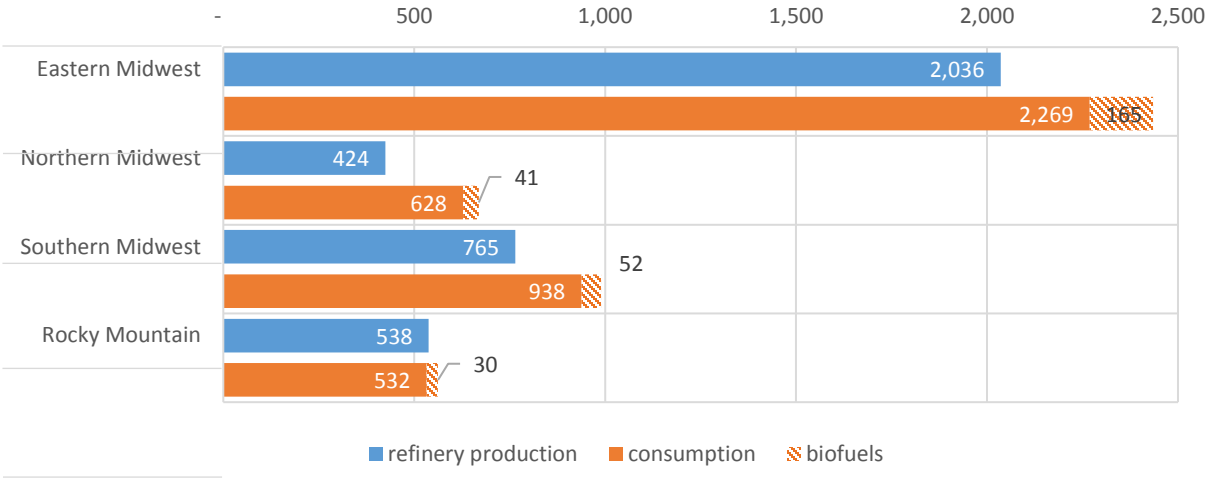
Supply chains in PADDs 2 and 4 are also strengthened by the hub-and-spoke configuration of pipeline systems serving these regions. These pipeline networks connect geographically dispersed refineries and downstream markets in PADDs 2 and 4 through multiple, often redundant, small-diameter pipelines. This configuration provides suppliers with the flexibility to shift supplies between supply and demand centers to compensate for outages. Despite this flexibility, supply chains in PADDs 2 and 4 often cover long distances, and shifting supply to relatively isolated markets in PADDs 2 and 4 can often take considerable time.

Study regions

This study examines four geographic markets—the Rocky Mountain (PADD 4) region and three sub-PADD regional markets within the Midwest (PADD 2): the Eastern Midwest, the Northern Midwest, and the Southern Midwest. While there are many similarities among these study areas, each market is characterized by different supply and consumption patterns. Refinery production and consumption of transportation fuels in each of these study regions are summarized in Figure 4.

Figure 4. Transportation fuels production and consumption study regions

thousand barrels per day



Sources: ICF analysis of U.S. Energy Information Administration and Airlines for America data.

Figure 4 shows that transportation fuels production and consumption vary from region to region. Refinery production varies by region based on the number, capacity, utilization, and yield of refineries in each region. Consumption is driven primarily by population but also by a number of sector-specific demand factors, including demand for jet fuel at major international airports and military bases, and demand for distillate fuels in the agricultural sector and for use in oil industry applications. In each region, consumption (which includes ethanol and biodiesel volumes) exceeds refinery production of petroleum-based transportation fuels. The supply and consumption dynamics and supply logistics of each study region are briefly summarized in the sections below.

Midwest (PADD 2)

Eastern Midwest

Eastern Midwest refinery production of transportation fuels averaged 2.0 million b/d in 2015, enough to meet 90% of consumption (net of ethanol and biodiesel inputs). Supply patterns in the Eastern Midwest are diverse. The region's supply networks originate from the Chicago supply hub, which draws products from regional refineries and from long-distance pipelines originating on the Gulf Coast (PADD 3), and from the Detroit, Michigan-to-Lima, Ohio, refining hub. Pipelines extend from these supply hubs primarily to population centers in Illinois, Indiana, Michigan, Ohio, and Kentucky. Significant volumes of transportation fuels also move along the Ohio River system from refineries in southern Illinois and Indiana, and northern Kentucky, primarily to other markets along the river system, including Cincinnati, Ohio, and Louisville, Kentucky. Meanwhile, refineries along the Mississippi River primarily serve Memphis, Tennessee, and the St. Louis, Missouri, metropolitan area, which includes portions of Illinois. Central and eastern Tennessee receive nearly all of their fuel supply from stub lines off the Colonial and Plantation pipeline systems, which run from Gulf Coast supply centers to markets along the Eastern Seaboard.

Northern Midwest

Northern Midwest refinery production of transportation fuels averaged 424,000 b/d in 2015, enough to meet 68% of consumption (net of ethanol and biodiesel inputs). The region's core supply and logistics hub, including the bulk of the region's refining capacity, is located in the Minneapolis-St. Paul (the Twin Cities) area in Minnesota. From the Twin Cities, pipelines extend radially, supplying markets throughout the region. The region is also supplied from refineries near Bismarck, North Dakota, and Duluth, Minnesota, and by pipeline from external sources, including from the Billings, Montana, refining center in PADD 4 into North Dakota; from Midcontinent refiners in the Southern Midwest into the Dakotas; and from the Chicago supply hub in the Eastern Midwest into eastern Wisconsin.

Southern Midwest

Southern Midwest refinery production of transportation fuels averaged 765,000 b/d in 2015, enough to meet 82% of consumption (net of ethanol and biodiesel inputs). The core of the Southern Midwest's supply system lies in the Midcontinent region (Oklahoma and Kansas), where numerous refineries ship fuels via a network of pipelines to markets in Missouri, Iowa, and Nebraska in the Southern Midwest, and also into the Dakotas in the Northern Midwest and Arkansas in PADD 3. In-region refinery supply is supplemented by pipeline movements from refining centers in PADD 3, the Eastern Midwest, and the Northern Midwest.

Rocky Mountain (PADD 4)

PADD 4 refinery production of transportation fuels averaged 538,000 b/d in 2015, enough to meet 101% of consumption (net of ethanol and biodiesel inputs). Refineries in PADD 4 are primarily clustered in groups near major demand centers—in Salt Lake City, Utah; Billings, Montana; and Denver, Colorado—but are also located near local crude sources in Wyoming. Although supply and demand in PADD 4 is largely balanced on a macro level, significant volumes of transportation fuels are shipped into and out of the region by pipeline. Fuels move into the Denver area from refineries in Kansas (in PADD 2) and in the Texas Panhandle (in PADD 3), while the Salt Lake City supply hub ships fuels to eastern Washington state and Las Vegas, Nevada (in PADD 5), and the Billings supply hub ships fuels to North Dakota (in PADD 2) and eastern Washington state. The Wyoming refineries are connected by pipeline to the Denver, Salt Lake City, and Billings hubs, and Wyoming production acts to balance supply across the major PADD 4 markets.

Conclusion

Refining capacity and transportation fuels production in the Midwest (PADD 2) and Rocky Mountain (PADD 4) regions have expanded significantly over the past decade, driven by access to cost-advantaged North American crude streams. Increased in-region production coupled with flat demand has allowed refiners in PADDs 2 and 4 to reduce dependence upon supply from the Gulf Coast (PADD 3) and expand markets for their products in adjacent parts of the East Coast (PADD 1), West Coast (PADD 5), and PADD 3. Increased self-sufficiency has also strengthened the security and flexibility of the fuel supply chains in PADDs 2 and 4. Despite reduced utilization, many of the pipeline and barge supply systems connecting PADD 3 with PADD 2 remain in place and are capable of providing swing supply during periods of planned or unplanned refinery outages. Fuel supply chains in PADDs 2 and 4 are also strengthened by the hub-

and-spoke configuration of their pipeline networks, which provide flexibility for suppliers to shift supply patterns in response to outages.

Overview

Changes in North American energy markets over the past decade have strengthened the supply of transportation fuels (motor gasoline, distillates, and jet fuel) in the Midwest (PADD 2) and Rocky Mountain (PADD 4) regions of the United States. The development of Canadian oil sands crude and the emergence of light, tight crude oil in the United States have provided refiners in PADDs 2 and 4 with access to abundant, cost-advantaged crude supply, providing opportunities to optimize crude slates and expand refinery capacity and utilization. Increased refinery production, combined with moderating demands for transportation fuels, has enabled suppliers in PADDs 2 and 4 to reduce their dependence on inbound transportation fuels supply from the Gulf Coast (PADD 3), and has enhanced the redundancy and resiliency of their transportation fuels supply chains.

Demand

Table 1 presents 2015 demands for gasoline, distillate, and jet fuel in PADDs 2 and 4 and for the three sub-PADD regions within PADD 2. The table also indicates each PADD or sub-PADD region's share of total PADD and total U.S. demands.

Table 1. PADD 2 and PADD 4 regional transportation fuels demand, 2015

thousand barrels per day, or %

	Gasoline			Distillate			Jet fuel			Total
Consumption by region	**2015**	**% of PADD**	**% of U.S.**	**2015**	**% of PADD**	**% of U.S.**	**2015**	**% of PADD**	**% of U.S.**	**2015**
Midwest (PADD 2)										
Eastern Midwest	1,611	62%	19%	635	51%	16%	190	79%	13%	2,436
Northern Midwest	422	16%	5%	215	17%	5%	32	13%	2%	669
Southern Midwest	584	22%	7%	387	31%	10%	18	8%	1%	989
Total	**2,615**		**30%**	**1,235**		**31%**	**239**		**17%**	**4,094**
Rocky Mountain (PADD 4)										
Rocky Mountain	316	100%	4%	195	100%	5%	51	100%	4%	563
Total	**316**		**4%**	**195**		**5%**	**51**		**4%**	**563**

Note: Totals may not sum due to independent rounding.

Sources: ICF analysis of U.S. Energy Information Administration (EIA) and Airlines for America data.

In 2015, states in PADD 2 had a combined population of 82.8 million, equal to 26% of the total U.S. population.[2] Table 1 shows that PADD 2 consumed 30% of total U.S. gasoline consumption, 31% of total U.S. distillate (including diesel) consumption, and 17% of total U.S. jet fuel consumption. PADD 2's share of U.S. jet fuel consumption is about 9 percentage points below its share of the U.S. population due to fewer major international airports in PADD 2 and fewer long-distance international flights from those airports, compared with airports in other regions. Within PADD 2, consumption of all fuels is highest in

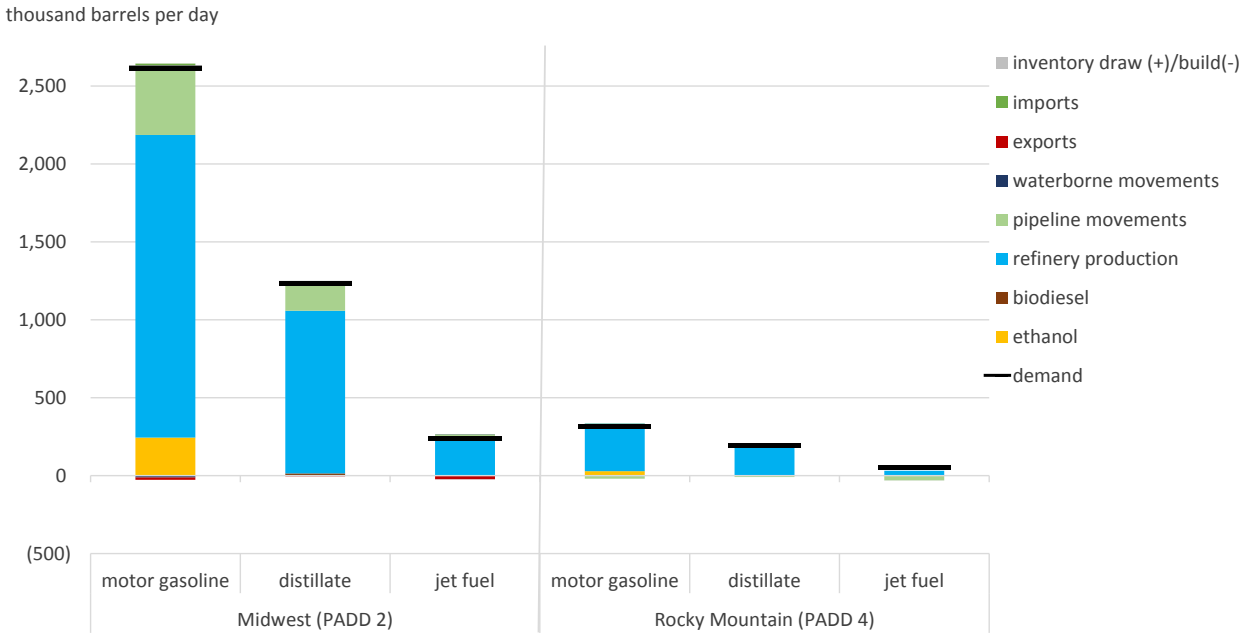
[2] U.S. Census Bureau, Population Division, Table 1. Annual Estimates of the Resident Population for the United States, Regions, States, and Puerto Rico: April 1, 2010 to July 1, 2015 (NST-EST2015-01), December 2015.

the Eastern Midwest, which is the most populous of the Midwest sub-PADD regions. The Eastern Midwest's share of PADD 2's jet fuel consumption, at 79%, is significantly higher than its share of PADD 2's gasoline and distillate consumption due primarily to O'Hare International Airport in Chicago, which is the third busiest airport in the country. Meanwhile, the Southern Midwest's share of PADD 2's distillate consumption is higher than its share of gasoline and jet fuel consumption due, in part, to heavy use of distillates in the region's agricultural sector. In 2015, states in PADD 4 had a combined population of 22.5 million, equal to 7% of the total U.S. population.[3] PADD 4's consumption of transportation fuels accounted for 4-5% of the U.S. total, slightly below the region's share of the U.S. population.

Supply/Demand balances

Transportation fuel demands in the Midwest (PADD 2) and Rocky Mountain (PADD 4) regions are predominantly supplied by in-region refinery production. Figure 5 compares the 2015 motor gasoline, distillate, and jet fuel supply/demand balances for each region. The figure compares fuel demands with supply elements in each PADD, including in-region refinery production, net pipeline movements from (positive) or to (negative) other regions, net waterborne movements from or to other regions, gross imports from Canada, gross exports to Canada, and net inventory draws (positive) or builds (negative). For a full accounting of supply, the figure also indicates how much ethanol was blended into the gasoline pool (in either E10, E15, or E85 blends) and how much biodiesel was blended into distillate fuels, although the latter fuel is barely visible in the balance.

Figure 5. PADD 2 and PADD 4 transportation fuels supply/demand balances, 2015



Note: All domestic movements and inventory changes are on a net basis.
Sources: ICF analysis of EIA data.

[3] Ibid.

Figure 5 shows that PADD 2 and PADD 4 refinery production is robust compared to demand. In 2015, PADD 2 production was sufficient to meet 74% of total gasoline demand (82% net of ethanol inputs), 84% of distillate demand, and 100% of jet fuel demand. Meanwhile, PADD 4 refinery production was sufficient to meet 97% of gasoline demand (106% net of ethanol inputs) and 103% of distillate demand, but only 60% of jet fuel demand (the reasons for this will be discussed in the next section). Despite refinery production accounting for a high percentage of demand, and relatively low pipeline and waterborne movements on a net basis, PADDs 2 and 4 engage in significant inter-PADD transfers of transportation fuels, and gross volumes into and out of each region are considerable. These movements will be discussed in greater detail later in this chapter.

Refineries

Table 2 lists the number and operable capacity of refineries in the Midwest (PADD 2) and Rocky Mountain (PADD 4) regions as of January 1, 2016, and disaggregates this data for each of the three sub-PADD regions in PADD 2. For each region, the table also shows the share of total refining capacity in PADDs 2 and 4.

Table 2. PADD 2 and PADD 4 refinery counts and operable capacity, 2016

Region	Number	Operable capacity [a] (b/cd)	Share of PADDs 2 and 4 total
Midwest (PADD 2)			
Eastern Midwest	14	2,561,640	56%
Northern Midwest	5	510,260	11%
Southern Midwest	8	850,300	18%
Total	**27**	**3,922,200**	**85%**
Rocky Mountain (PADD 4)			
Total	**17**	**678,550**	**15%**
PADDs 2 and 4 total	**44**	**4,600,750**	

[a] Barrels per calendar day, as of January 1, 2016.

Source: U.S. Energy Information Administration, *Refinery Capacity Report*, 2016.

PADDs 2 and 4 have a total of 44 refineries, with a combined crude atmospheric distillation capacity of 4.6 million barrels per calendar day (b/cd).[4] The vast majority of this capacity—3.9 million b/cd, or 85%—is located in PADD 2. Within PADD 2, refining capacity is further concentrated in the Eastern Midwest sub-PADD region, which accounts for 56% of total refining capacity in both PADDs. On average, refineries in PADD 4 are smaller than those in PADD 2. PADD 4's 17 refineries have an average capacity of 40,000 b/cd, while PADD 2's 27 refineries have an average capacity of 145,000 b/cd. The smaller PADD 4 refineries remain economically viable due to their close proximity to cost-advantaged local crude production and Canadian imports; their lower complexity compared to larger refineries (e.g., fewer

[4] Barrels per calendar day is a measure of the amount of input that a distillation unit can process in a 24-hour period under the usual operating conditions. It takes into account both planned and unplanned maintenance. 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. Stream day capacity is typically about 6% higher than calendar day capacity.

multiple units), which can result in lower operating costs; and growth in PADD 4 demands. All of these factors have worked to keep PADD 4 refinery margins strong.

Almost all of the crude oil processed at refineries in PADDs 2 and 4 comes from inland North American sources, including the Alberta Oil Sands in Canada, the Bakken region in North Dakota and Montana, the Permian Basin in Texas, the Niobrara Formation and other producing areas in the Rocky Mountains, and local Midcontinent basins.

Refinery yields

At a typical refinery, each barrel of crude oil processed yields approximately 0.80 to 0.85 barrels of transportation fuels. However, yields can vary from refinery to refinery due to a number of factors, including the type of crude oil processed and the specific configuration of the refinery's processing units. All things being equal, a full upgrading refinery processing light crude produces higher yields of lighter, cleaner products (which are primarily used as transportation fuels), while a refinery processing heavy crude will produce higher yields of heavier products, such as asphalt and petroleum coke. Regardless of the crude type, refiners can increase yields of transportation fuels by the addition of secondary processing units that crack, combine, and reshape molecules from initial crude distillation yields. In such a manner, a sophisticated refinery with the right configuration of secondary units can produce a higher yield of transportation fuels from a heavy crude stream than a simple refinery running a lighter crude stream. The makeup of the U.S. refining system reflects the sum of individual refinery configurations, processing of different domestic and foreign crude oil varieties, and the regional market demands and regulatory requirements, all of which drive refinery investment and yield patterns. Table 3 shows the average refinery yields by product in 2015 for the United States, the Midwest (PADD 2) region, the Rocky Mountain (PADD 4) region, and for individual sub-PADD regions within PADD 2.

Table 3. U.S., PADD 2, and PADD 4 refinery yields, 2016

Percent (%)			PADD 2 sub-PADD regions			
Product	**U.S. total**	**Midwest (PADD 2)**	**Eastern Midwest**	**Northern Midwest**	**Southern Midwest**	**Rocky Mountain (PADD 4)**
Transportation fuels						
Gasoline	46.0	51.7	52.5	51.4	49.5	47.3
Distillate	29.5	28.6	25.3	28.3	38.3	33.4
Jet fuel	9.6	6.7	7.8	6.2	3.8	5.1
Total	**85.1**	**87.0**	**85.6**	**85.9**	**91.6**	**85.8**
Other products						
Liquefied refinery gases	3.7	3.1	4.1	1.2	0.0	2.1
Residual	2.5	1.5	1.7	2.0	0.5	2.1
Other	15.0	13.9	14.3	17.7	10.9	14.3
Total	**21.2**	**18.5**	**20.1**	**20.9**	**11.4**	**18.5**
Volume gain	(6.4)	(5.8)	(5.8)	(7.4)	(4.6)	(4.2)

Notes: Totals may not equal sum of the components due to independent rounding. Total yields exceed 100% due to processing gains (volume gain). Based on crude oil input and net reruns of unfinished oils.

Source: U.S. Energy Information Administration, *Monthly Refinery Report*.

Table 3 breaks out refinery yields between transportation fuels (gasoline, distillate, and jet fuel) and other products, including liquefied refinery gas (LRG),[5] residual fuel oil, and other (a category that includes petroleum coke, asphalt and road oil, lubricants, petrochemical feedstocks, still gas, kerosene, special naphthas, waxes, and miscellaneous petroleum products). Table 3 indicates that the yields of transportation fuels in PADDs 2 and 4 are 87.0% and 85.8%, respectively, which are higher than the U.S. average of 85.1%. PADD 2 gasoline yield is nearly 6 percentage points higher than the U.S. average because PADD 2 refiners direct higher volumes of naphtha, gas oil, and other intermediate products toward gasoline production. In contrast, refiners in the Gulf Coast (PADD 3) region, the largest U.S. refining region, utilize some of these intermediate stocks for petrochemical processing, thus reducing gasoline yield. PADD 4 refinery configurations and crude mix contribute to slightly higher gasoline yields and significantly higher distillate yields when compared with U.S. averages. These higher yields come at the expense of a lower jet fuel yield, which is less than half the U.S. average of 9.6%.

Table 3 also indicates the volume gain, which is represented as a negative value and indicates the volume gained from distilling and cracking heavier crude oil into lighter, less dense products. Overall volume gain per barrel of input in PADD 2 is close to the U.S. average of 6.4%; however, PADD 4 is 2 percentage points lower due to the lack of upgrading units, such as cokers, and, to a lesser extent, catalytic crackers, which upgrade heavy residuals and gas oils from crude distillation into lighter components.

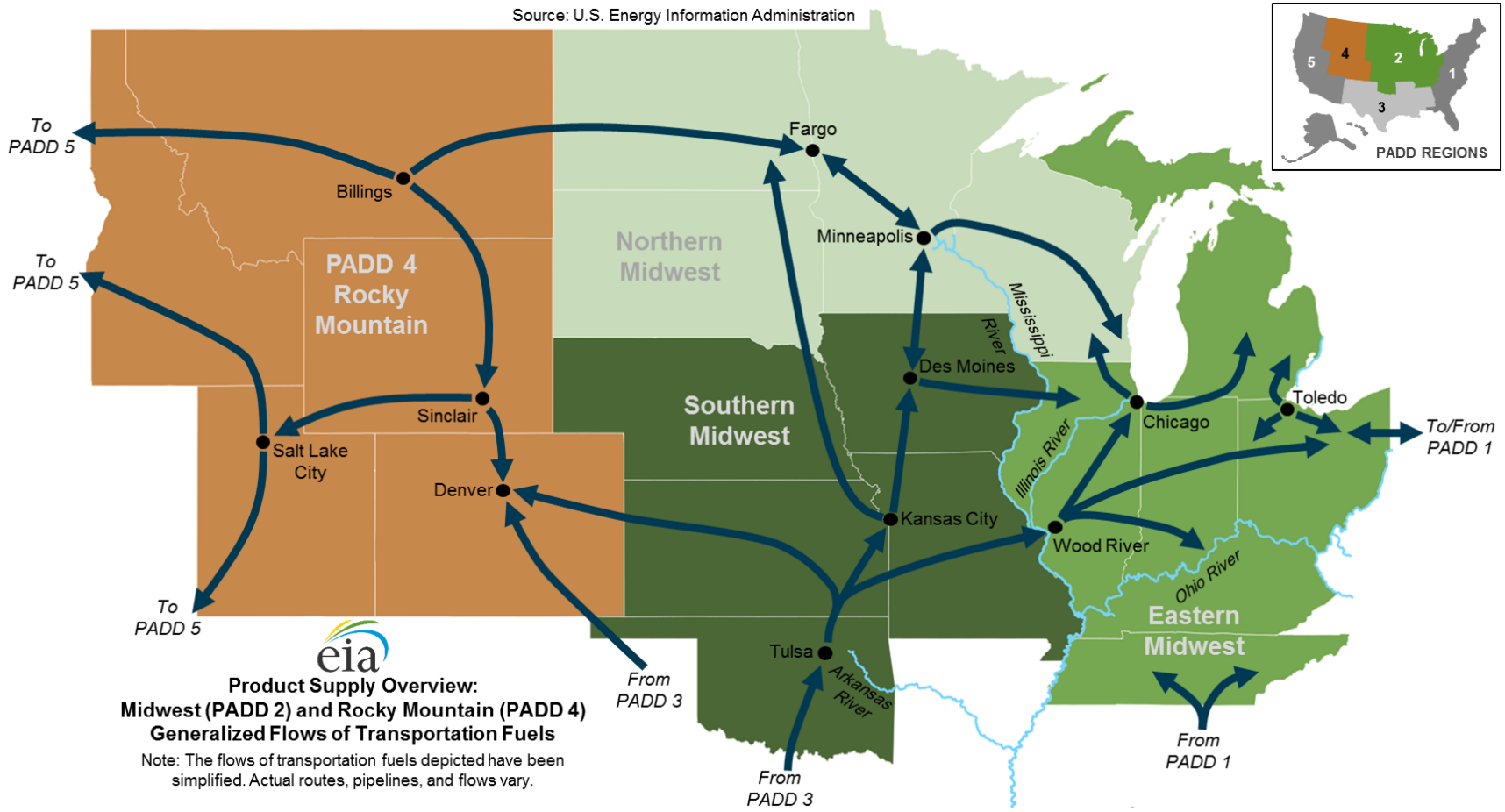
Supply and logistics

Petroleum products supply chains in the Midwest (PADD 2) and Rocky Mountain (PADD 4) regions are configured in a hub and spoke manner, with supply moving from in-region refining and logistical hubs (often near major metropolitan centers) outward to geographically dispersed markets. Figure 6 on page 6 identifies select supply and demand centers in PADDs 2 and 4, identifies major waterways and provides a generalized overview of major pipeline flows. Due to the number and complexity of pipeline systems in PADDs 2 and 4, Figure 6 focuses on major pipeline routes and corridors rather than identifying each individual pipeline system. Detailed infrastructure maps for each study region are included in the region-specific chapters later in this report.

Refining centers in PADD 2 include hubs around Chicago, Illinois; the Detroit-to-Lima corridor in southeastern Michigan and northwest Ohio; St. Louis, Missouri; Memphis, Tennessee; Cattlettsburg, Kentucky (near Huntington, West Virginia); Minneapolis, Minnesota; Bismarck, North Dakota; and multiple refineries in Oklahoma and Kansas. Refining centers in PADD 4 include hubs around Salt Lake City, Utah; Billings, Montana; Denver, Colorado; and a number of refineries spread out across Wyoming. From these supply centers, relatively small-diameter pipeline networks extend outward. Many population centers in PADDs 2 and 4 can be supplied from multiple supply hubs, allowing the system to rebalance itself during planned and uplannned refinery outages.

[5] According to EIA, liquefied refinery gases are fractionated from refinery or still gas. Through compression and/or refrigeration, they are retained in the liquid state. The reported categories are ethane/ethylene, propane/propylene, normal butane/butylene, and isobutane/isobutylene. Excludes still gas.

Figure 6. Generalized Midwest and Rocky Mountain key refinery hubs and product flows



Pipelines

Pipeline systems in the Midwest (PADD 2) and Rocky Mountain (PADD 4) regions are largely configured as hub-and-spoke networks, with small-diameter (12-inch or less) pipelines moving product from regional refining and logistics hubs to geographically dispersed markets. Key pipeline systems internal to PADD 2 include systems operated by Magellan Midstream, Marathon Petroleum, and Buckeye Partners. Internal systems in PADD 4 are largely operated by Phillips 66, Sinclair Transportation, and Tesoro Corp. While both PADDs 2 and 4 rely substantially on internal pipeline distribution networks, significant volumes of transportation fuels also move into, out of, and between both regions.

Table 4 lists inbound and outbound pipeline movements of transportation fuels in PADDs 2 and 4 in 2015, broken out by fuel type and origin and destination regions.

Table 4. Pipeline movements of transportation fuels between PADDs, 2015

thousand b/d	Inbound						Outbound					
	From PADD					Total	To PADD					Total
	1	2	3	4	5		1	2	3	4	5	
Midwest (PADD 2)												
Gasoline	213		246	17	-	476	14		27	46	-	88
Distillate	87		106	13	-	207	12		19	16	-	47
Jet Fuel	7		48	1	-	56	2		1	21	-	23
Total	**307**		**400**	**31**	**-**	**738**	**27**		**48**	**83**	**-**	**158**
Rocky Mountain (PADD 4)												
Gasoline	-	46	-		-	46	-	17	-		46	62
Distillate	-	16	-		-	16	-	13	-		11	24
Jet fuel	-	21	-		-	21	-	1	-		0	1
Total	**-**	**83**	**-**		**-**	**83**	**-**	**31**	**-**		**57**	**87**

Note: Individual line items many not sum to totals due to independent rounding.
Source: U.S. Energy Information Administration, *Monthly Product Pipeline Report*.

PADD 2 inbound movements averaged 738,000 b/d in 2015, equal to approximately 18% of total PADD 2 demand for transportation fuels. Of these volumes, 400,000 b/d entered from the Gulf Coast (PADD 3) primarily via the Explorer, Magellan, and Enterprise TEPPCO systems, and 307,000 b/d entered from the East Coast (PADD 1), primarily via the Colonial and Plantation systems into central and eastern Tennessee. Although supply on the Colonial and Plantation systems enters PADD 2 from Georgia in PADD 1, the products shipped on these systems originate at refining centers in PADD 3. PADD 2 also receives 31,000 b/d from PADD 4 via the Cenex Pipeline system from Montana into North Dakota, and via a Magellan lateral from Wyoming into Rapid City, South Dakota.

Outbound shipments from PADD 2 averaged 158,000 b/d in 2015. Approximately 83,000 b/d moved from PADD 2 to PADD 4 primarily via Magellan's Chase Pipeline from Kansas refineries to the Denver area, but also via two pipelines that originate at refineries on the Texas Panhandle in PADD 3 and cross the Oklahoma Panhandle in PADD 2 before entering Colorado in PADD 4. Meanwhile, 48,000 b/d moved from PADD 2 to PADD 3 on Magellan pipelines from Oklahoma and Kansas refineries to Arkansas, and 27,000 b/d moved from PADD 2 to PADD 1 on Buckeye, Sunoco, and Marathon pipelines from Ohio refineries into the Pittsburgh market in western Pennsylvania.

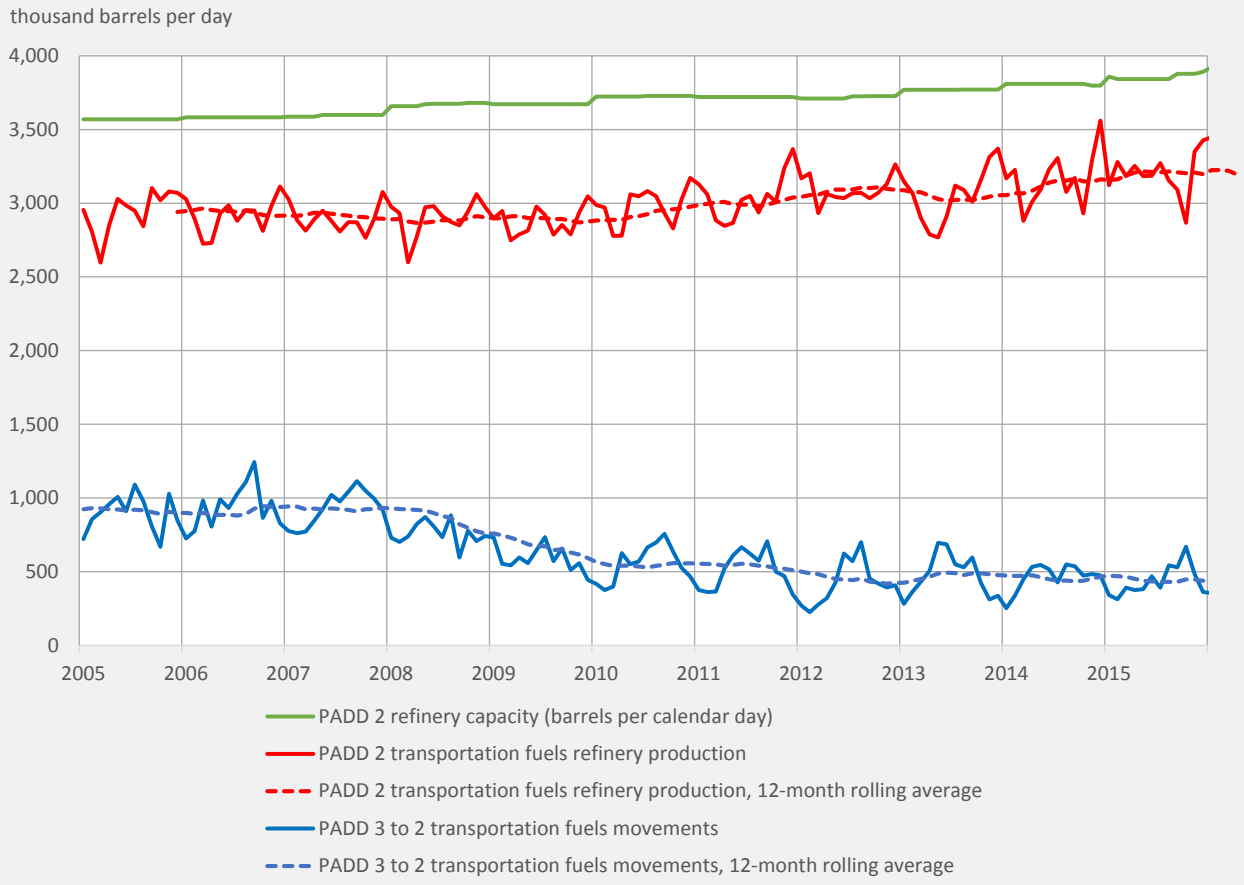
PADD 4 inbound transportation fuels volumes averaged 83,000 b/d in 2015, equal to 15% of in-region demand. All of these volumes entered the Denver market from PADD 2 via the Chase Pipeline from Kansas and the two pipelines from the Texas Panhandle, as previously noted. PADD 4 outbound volumes averaged 87,000 b/d in 2015, with 57,000 b/d moving to markets on the West Coast (PADD 5) and 31,000 b/d moving to PADD 2, as previously noted. Movements from PADD 4 to PADD 5 include volumes from Billings to eastern Washington state via the Yellowstone Pipeline; from Salt Lake City to eastern Washington state via the Northwest Products Pipeline; and from Salt Lake City to Las Vegas, Nevada, via the UNEV pipeline.

Trend: Decline in PADD 3 to PADD 2 transportation fuels shipments

Over the past decade, increased Midwest (PADD 2) refining activity, increased ethanol blending in the gasoline supply, and stagnant demands have led to a decrease in pipeline and waterborne shipments of transportation fuels from the Gulf Coast (PADD 3) into PADD 2.

Figure 7 charts operable refining capacity and transportation fuels production at PADD 2 refineries against movements of transportation fuels from PADD 3 to PADD 2 by pipeline and barge from January 2005 through December 2015.

Figure 7. PADD 2 refinery capacity and transportation fuels production vs. PADD 3 to PADD 2 transportation fuel movements, Jan. 2005 to Dec. 2015



Source: U.S. Energy Information Administration, *Petroleum Supply Monthly*

Over the 10-year period, PADD 2 operable refining capacity increased by approximately 320,000 b/cd, or 9%, from 3.57 million b/cd in January 2005 to 3.89 million b/cd in December 2015. Only one new refinery—with a capacity of approximately 20,000 b/cd—was constructed in PADD 2 between 2005 and 2015. The remaining 300,000 b/cd increase in PADD 2 refining capacity came through expansions at existing plants. Increased PADD 2 refining capacity has been accompanied by higher refinery crude runs and increased upgrading capability, which has been driven by abundant crude oil production from the Bakken Formation in North Dakota and Montana, and increased Canadian crude imports. As a result, PADD 2 refinery production of transportation fuels—motor gasoline (net of ethanol), distillate fuel oil, and jet fuel—increased by 260,000 b/d, or 8%, from an average of 2.94 million b/d in 2005 to 3.20 million b/d in 2015. In addition, ethanol produced in PADD 2 has been increasingly added to the region's gasoline pool over the past decade, more than doubling from 108,000 b/d in 2005 to 244,000 b/d in 2015.[6] In 2015, ethanol volumes in PADD 2 made up approximately 10% of the region's total gasoline supply.

These two factors—greater PADD 2 refinery production and greater ethanol blending—combined with flat PADD 2 demand for gasoline and distillates, and declining demand for jet fuel, have led to a decrease in transportation fuel movements into the region from PADD 3 over the 10-year period.[7] From 2005 to 2015, annual average movements of transportation fuels by pipeline and barge from PADD 3 to PADD 2 have declined by 0.46 million b/d, or more than 50%, from approximately 0.90 million b/d in 2005 to 0.44 million b/d in 2015. While the sharpest year-on-year declines in movements occurred during the recession in 2008 and 2009, year-on-year declines have persisted over subsequent years, with movements falling in five out of the six years from 2010 through 2015.

The decline in PADD 3 to PADD 2 transportation fuel movements has led to an excess of product pipeline capacity between the two regions, leading to the idling or repurposing of several pipelines in recent years. In 2013, TEPPCO, which previously delivered fuels from PADD 3 to PADD 2 and the East Coast (PADD 1), reversed one of the two pipelines that make up its mainline system to carry ethane from the Marcellus Shale region to PADD 3, and no longer delivers transportation fuels on its remaining south-to-north mainline beyond eastern Indiana in PADD 2. In addition, both TEPPCO and Explorer Pipeline are using excess capacity on their systems to ship increasing volumes of condensates for ultimate delivery to Western Canada for use as a diluent in oil sands production. The Centennial Pipeline, which was completed in 2002, has essentially been idle since mid-2011, and its operators are considering reversing and repurposing the pipeline as part of a project to carry natural gas liquids from the Marcellus Shale region to the Gulf Coast.

Although fuel movements from PADD 3 now make up a smaller portion of PADD 2's total supply portfolio, excess pipeline capacity has enabled such movements to retain an important role in providing swing supply into the region: Pipeline movements from PADD 3 to PADD 2 ramp up to meet high gasoline demand during the summer driving season and, in some cases, spike sharply when planned or unplanned

[6] U.S. Energy Information Administration, "Midwest (PADD 2) Refinery and Blender Net Input of Fuel Ethanol," available at https://www.eia.gov/dnav/pet/hist/LeafHandler.ashx?n=PET&s=MFERIP22&f=A.
[7] Gasoline and distillate fuel oil product supplied has been mostly flat, while jet fuel demand has fallen by 120,000 b/d.

refinery outages in PADD 2 reduce in-region supply. In September and October 2015, for example, PADD 3 to PADD 2 fuel movements rose by as much as 276,000 b/d when an unusually high number of refinery outages reduced Midwest refinery crude runs by 800,000 b/d.

Ports and waterways

States in the Midwest (PADD 2) and Rocky Mountain (PADD 4) regions are landlocked with no direct access to international petroleum product markets via large-scale oceangoing vessels; however, significant barge movements of transportation fuels take place on major inland waterways in PADD 2, and to a lesser degree on the Great Lakes. There are no waterborne movements of transportation fuels in PADD 4. Table 5 lists major waterways in PADD 2 and their inbound and outbound shipments of transportation fuels in 2014, the latest year for which domestic marine movement data is available from the U.S. Army Corps of Engineers. Movements do not include shipments of ethanol.

Table 5. Waterborne movements of transportation fuels in the Midwest by waterway, 2014

barrels per day

Port/Waterway	Total Inbound [a]	Total Outbound [a]
Ohio River system	113,000	139,800
Illinois and Mississippi rivers	33,100	70,600
Tennessee and Cumberland rivers	19,500	2,100
Great Lakes	6,000	13,100
Total	**171,600**	**225,600**

[a] Does not include ethanol volumes or local shipments of fuels between two docks within the same port.
Source: U.S. Army Corps of Engineers, 2014 Waterborne Commerce of the United States Waterways and Harbors

In 2014, total inbound shipments of transportation fuels at ports in PADD 2 averaged approximately 172,000 b/d, while outbound shipments averaged approximately 226,000 b/d. The region's largest product movements take place on the Ohio River system. Refineries located on the Ohio River or with pipeline connections to barge loading terminals on the river (in Catlettsburg, Kentucky; Robinson, Illinois; and Mt. Vernon, Indiana) loaded approximately 140,000 b/d of transportation fuels onto barges in 2014. Most of these products were delivered to receipt locations elsewhere on the Ohio River in PADD 2, including Cincinnati, Ohio, and Louisville, Kentucky. Deliveries on the Ohio River system outside of PADD 2—to receipt locations in West Virginia and western Pennsylvania in the East Coast (PADD 1) region—are not counted in Table 21. Some of the products originating on the Ohio River system were also shipped to receipt points in PADD 2 on the Tennessee and Cumberland rivers.

In 2014, inbound movements of transportation fuels to PADD 2 ports along the Mississippi and Illinois rivers averaged 33,100 b/d, while outbound shipments from refineries (in Memphis, Tennessee, and Wood River, Joliet, and Lemont, Illinois) averaged 70,600 b/d.

EIA tracks waterborne movements of transportation fuels between PADD regions. Waterborne movements on the Ohio River from PADD 2 to PADD 1 averaged approximately 30,000 b/d in 2015.[8] Meanwhile, approximately 19,000 b/d moved south from PADD 2 to PADD 3, while approximately 38,000 b/d of transportation fuels moved north along the Mississippi River from PADD 3 to PADD 2.

[8] U.S. Energy Information Administration, "Movements by Tanker and Barge between PAD Districts: PADD 2 to PADD 1," accessed September 30, 2016, available at http://www.eia.gov/dnav/pet/pet_move_tb_dc_R10-R20_mbbl_a.htm.

Supply vulnerability

The Midwest (PADD 2) and Rocky Mountain (PADD 4) regions both have strong in-region refinery production relative to in-region demands, and the configuration of the supply chain (a hub-and-spoke network) provides significant flexibility to shift supply patterns between supply and demand centers to compensate for planned or unplanned refinery outages. In addition, both PADDs 2 and 4 maintain pipeline connections to the Gulf Coast (PADD 3) refining region and have the capability to bring in supply from external refineries, when needed, to meet demand. Nevertheless, supply chains in PADDs 2 and 4 cover long distances, and shifting supply to relatively isolated markets can often take considerable time.

Midwest (PADD 2)

In 2015, PADD 2 refineries produced 3.2 million b/d of transportation fuels, enough to meet 84% of in-region demand (net of ethanol inputs). PADD 2 also has significant capacity to bring in swing supply from PADD 3 when needed to compensate for in-region refinery outages, primarily through the Explorer, Magellan, and Enterprise TEPPCO systems, but also through barge shipments up the Mississippi River. For example, when a series of planned and unplanned refinery outages reduced PADD 2 transportation fuels production by more than 400,000 b/d between July and October 2015, shippers responded by moving an additional 276,000 b/d of transportation fuels from PADD 3 to PADD 2, with 243,000 b/d of this volume moving by pipeline and 33,000 b/d moving by barge.

Despite PADD 2's ability to access supplemental supply from PADD 3, it can often be difficult to obtain space to ship additional transportation fuels on major pipeline systems from PADD 3. In recent years, two product pipelines between PADD 3 and PADD 2 have been idled or repurposed: the Centennial Pipeline has been idle since mid-2011, and Enterprise Product Partners reversed and repurposed one of the two pipelines making up its TEPPCO mainline system to carry ethane from the Marcellus Shale region to the Gulf Coast. Furthermore, two of the pipeline systems that still carry products from PADD 3 to PADD 2 (Explorer and TEPPCO) have been shipping increasing volumes of diluent on their systems for ultimate delivery to the Alberta Oil Sands. As a result, some shippers have complained that it can be difficult to move product from PADD 3 to PADD 2, particularly on the Explorer Pipeline, which typically runs at capacity.[9]

Suppliers in PADD 2 can also manage in-region supply shortfalls by reducing shipments out of PADD 2 to the East Coast (PADD 1) and PADD 4. Historically, the Pittsburgh, Pennsylvania, market in PADD 1 has acted as a balancing point for product supply between PADD 2 and PADD 1 supply sources. In 2015, the Pittsburgh market received product from Ohio and Michigan refiners in PADD 2 via the Buckeye, Sunoco, and Marathon pipeline systems, and also from coastal PADD 1 supply centers via Buckeye's Laurel Pipeline system, which often ran below capacity. As a result, if unplanned outages in PADD 2 caused shortages of transportation fuels, Ohio refiners could shift supply away from Pittsburgh, and instead supply customers in the Pittsburgh market through increased flows along the Laurel Pipeline (although Pittsburgh's gasoline specification requirements complicate this supply flexibility). However, Buckeye announced plans in 2016

[9] S&P Global Platts, "Chicago RBOB dips amid interest in shipping Houston barrels north," June 9, 2016, available at http://www.platts.com/latest-news/oil/houston/chicago-rbob-dips-amid-interest-in-shipping-houston-21674268.

to partially reverse the Laurel system by 2018 to move product from Pittsburgh to central Pennsylvania, potentially reducing Pittsburgh's role as a balancing point between PADD 2 and PADD 1.[10] Another balancing point for PADD 2 is the Denver, Colorado, market in PADD 4, which balances supply between Kansas refineries in PADD 2, Texas Panhandle refineries in PADD 3, and Denver-area and Wyoming refineries in PADD 4.

Despite the supply flexibility in much of PADD 2, some isolated markets in the region are highly dependent upon a single source of supply. In particular, markets in central and eastern Tennessee—Nashville, Knoxville, and Chattanooga—are supplied almost entirely via stub lines off of the Colonial and Plantation systems from the Gulf Coast, and lack access to alternative supply sources. In 2015, an estimated 250,000 to 300,000 b/d of transportation fuels flowed on the Colonial and Plantation systems from Georgia in PADD 1 (where the stub lines originate) to Tennessee in PADD 2. Two unplanned outages to the Colonial Pipeline system, which supplies more than 70% of Tennessee's transportation fuels, caused gasoline shortages and price spikes in Tennessee in September and November 2016. Tennessee markets can also be impacted when hurricanes and other tropical weather patterns disrupt refineries or the Colonial or the Plantation pipeline facilities on the Gulf Coast. Markets in the Northern Midwest—Minnesota, Wisconsin, and the Dakotas—are also relatively isolated with limited connections to external supply centers. With the exception of Wisconsin, which has access to the Chicago refining hub, markets in this region primarily rely on in-region refinery production to meet demand, and unplanned refinery outages can quickly lead to sharp price increases.

Rocky Mountain (PADD 4)

Demand centers in the Rocky Mountain (PADD 4) region are largely isolated from major supply centers in other regions, and supply and demand of transportation fuels within the region are tightly balanced. In 2015, the region's 17 small-scale refineries produced 538,000 b/d of transportation fuels, enough to meet 101% of demand (net of ethanol and biodiesel inputs). However, supply and demand centers in the Rocky Mountain region are geographically dispersed and supply/demand balances vary from market to market within the region. Production in the Salt Lake City and Billings areas, and in Wyoming, exceeds demand in those markets, while production in the Front Range Urban Corridor, which includes Denver, Colorado, is in deficit.

The Front Range Urban Corridor has connections to several supply sources. The Front Range receives the majority of its supply from Colorado and Wyoming refineries, but is also connected by pipeline to refineries on the Texas Panhandle (PADD 3) and in Kansas (PADD 2). Capacity on pipelines from these refineries totals more than 130,000 b/d, but flows averaged 83,000 b/d in 2015, meaning that significant excess capacity is available for incremental shipments into the market, if needed.

The most vulnerable markets in the Rocky Mountain region are smaller markets that rely on a single pipeline for supply. In particular, Boise and other southern Idaho markets are entirely dependent upon

[10] "Buckeye Partners, L.P. Announces Open Season For Second Phase Of Michigan/Ohio Pipeline Expansion Project." Buckeye Partners, L.P. August 31, 2016, http://www.buckeye.com/LinkClick.aspx?fileticket=F7Btc06PKZE%3D&tabid=36.

shipments via Tesoro's Northwest Product Pipeline system from Salt Lake City, and many markets in western Montana are solely dependent upon the Yellowstone Pipeline system from Billings.

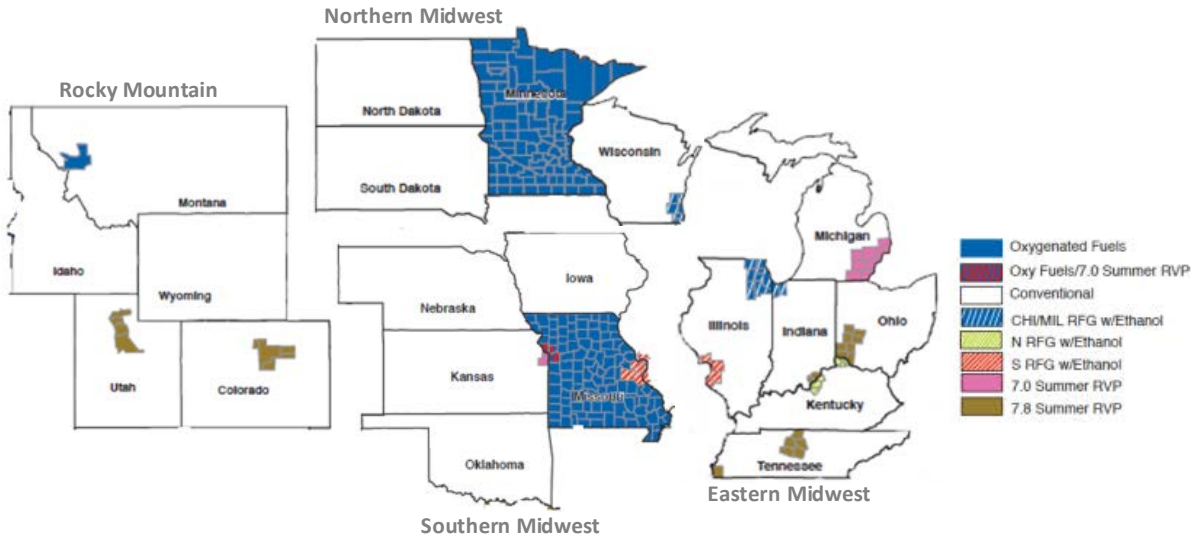
Fuel specifications and regulations

Federal, state, and local laws regulate the type of transportation fuels (gasolines, distillates, and jet fuels) that are allowed to be sold in specific areas of the country. These laws are primarily designed to limit smog-forming emissions, as well as the sulfur and particulate content of fuels, but in some cases also mandate the inclusion of renewable fuels, such as ethanol and biodiesel. Some of these regulations are in effect year-round, while others are in effect only during the summer or winter months, as warranted by ambient temperatures. The various gasoline and distillate fuel specifications mandated in the Midwest (PADD 2) and Rocky Mountain (PADD 4) regions require that fuels produced at U.S. refineries adhere to different specifications, depending on the time of the year and the market where the fuel will be sold. The seasonal nature of some regulations means that pipeline and terminal operators must carefully schedule deliveries of various product grades and manage storage and distribution dynamics to ensure compliance.

Gasoline

Gasoline is a complex mixture of relatively volatile hydrocarbons with or without small quantities of additives, blended to form a fuel suitable for use in spark-ignition engines. Motor gasoline, as defined in American Society for Testing and Materials (ASTM) D4814 or Federal Specification VV-G-1690C, is characterized as having a boiling range of 122–158 degrees Fahrenheit (°F) at the 10% recovery point to 365–374°F at the 90% recovery point. Motor gasoline regulations are primarily designed to control smog formation and toxic emissions in urban areas. There are three main types of gasoline specifications: reformulated gasoline, summer-grade (low Reid vapor pressure [RVP]) gasoline, and winter oxygenated gasoline. Figure 8 depicts federal, state, and local fuel requirements in effect in the Midwest and Rocky Mountain regions as of June 2015.

Figure 8. Gasoline requirements by region



Source: ICF adaption of Exxon Mobil, "U.S. Gasoline Requirements (as of June 2015)."

Reformulated gasoline

The U.S. Environmental Protection Agency (U.S. EPA) requires the sale of reformulated gasoline (RFG) in select urban areas in order to reduce smog-forming emissions. RFG is finished motor gasoline that meets the composition and properties for RFG under the Clean Air Act, including standards for benzene content and oxygen content. RFG must be blended with an additive to raise its oxygen content, a characteristic that reduces the emissions of ozone-forming volatile organic compounds during vehicle operation.[11] The most common oxygenate additive is ethanol. Finished RFG is produced by refineries and blenders only when ethanol is added to gasoline; however, ethanol is not normally shipped with gasoline in pipelines due to both the corrosive nature of ethanol and its chemical affinity for entrained water.[12] As a result, refineries produce and ship an unfinished blendstock product—reformulated blendstock for gasoline blending (RBOB)—to distribution terminals in end-user markets. At the terminals, ethanol is blended with RBOB during the loading of tanker trucks, either in out-loading pipelines as they move to the trucks (in-line blending) or in the truck itself (splash blending).

U.S. EPA requires the sale and use of reformulated gasoline in the Chicago, Illinois, and Milwaukee, Wisconsin, metropolitan areas in PADD 2. In addition, state governors have "opted in" to the RFG program in the St. Louis, Missouri; Louisville, Kentucky; and Cincinnati, Ohio, metropolitan areas. No areas in PADD 4 require the use of RFG. Table 6 shows prime supplier sales of motor gasoline by gasoline type (reformulated or conventional) and region.

Table 6. Motor gasoline prime supplier sales by type and region, 2015

thousand barrels per day

Region	Conventional	Reformulated (RFG)	Total	% RFG
Midwest (PADD 2)	**2,003**	**368**	**2,371**	16%
Eastern Midwest	1,205	255	1,459	17%
Northern Midwest	333	50	383	13%
Southern Midwest	466	63	529	12%
Rocky Mountain (PADD 4)	**341**	**–**	**341**	0%
Total	**2,344**	**368**	**2,712**	14%

Source: U.S. Energy Information Administration, "Monthly Report of Prime Supplier Sales of Petroleum Products Sold for Local Consumption."

Summer-grade gasoline

In urban areas that are not required to use RFG, U.S. EPA regulates the volatility of conventional gasoline during the summer ozone season. Gasoline volatility is commonly measured by RVP, which is measured in pounds per square inch (psi) when ambient temperature is 100°F. A higher RVP indicates higher evaporative characteristics of the gasoline blendstock. Depending upon the state and month, U.S. EPA limits gasoline RVP to 9.0 psi or 7.8 psi, and provides a 1.0-psi RVP allowance for conventional gasoline

[11] U.S. Environmental Protection Agency, "Reformulated Gasoline," accessed December 10, 2015, available at http://www2.epa.gov/gasoline-standards/reformulated-gasoline.

[12] The minor amounts of entrained water in pipeline shipments and in tank bottoms can cause ethanol to "fall out" of the blend and accumulate in tank bottoms; hence it is normally blended at the terminal into trucks.

that is blended with ethanol at 9% to 10% by volume.[13] A 9.0-psi RVP limit is in place for all states in PADDs 2 and 4, although several metropolitan areas observe stricter limits during the summer months. A 7.8-psi RVP limit is observed in the metropolitan areas surrounding Memphis and Nashville, Tennessee; Cincinnati, Ohio; and the Indiana portion of the Louisville, Kentucky, metropolitan area in PADD 2, and the Denver, Colorado, and Salt Lake City, Utah, metropolitan areas in PADD 4; while a 7.0-psi RVP limit is observed in the Detroit, Michigan, metropolitan area and the Missouri portion of the Kansas City, Missouri, metropolitan area in PADD 2.[14]

In addition to limiting evaporative emissions, low-RVP gasoline is important for avoiding engine vapor lock in hot climates. Refineries produce low-RVP gasoline by including less butane (a lighter, more volatile hydrocarbon component of gasoline) in conventional gasoline blends. During the winter months, conventional gasoline RVP is allowed to be as high as 15.0 psi in some areas. Refineries typically switch production from winter-grade to summer-grade gasoline in the spring, and switch from summer-grade to winter-grade gasoline in the early fall. The inclusion of butane in gasoline in the winter increases gasoline refinery yields by as much as 4–5%.

Winter oxygenated gasoline

The Clean Air Act requires the use of oxygenated gasoline, which is required in certain areas of the country where wintertime carbon monoxide levels exceed federal air quality standards. Vehicles using oxygenated gasoline emit lower levels of carbon monoxide during operation. U.S. EPA does not require the use of oxygenated fuels anywhere in PADDs 2 or 4, except in the Missoula, Montana, metropolitan area.[15] However, two states—Minnesota and Missouri—maintain winter oxygenated gasoline programs at the state level. In Minnesota, the state requires the use of ethanol-blended fuels.[16] In Missouri, distributors are required to sell ethanol-blended gasoline if it can be acquired at the same price as unblended gasoline.[17]

Distillate

Distillate fuel oil is a general classification for one of the petroleum fractions produced in conventional distillation operations. It includes diesel fuels and fuel oils. Products known as No. 1, No. 2, and No. 4 diesel fuel are used in on-highway diesel engines, such as those in trucks and automobiles, as well as off-highway engines, such as those in railroad locomotives and agricultural machinery. Products known as No. 1, No. 2, and No. 4 fuel oils are used primarily for space heating and electric power generation.

[13] U.S. Environmental Protection Agency, "Gasoline Reid Vapor Pressure," accessed December 11, 2015, available at http://www.epa.gov/gasoline-standards/gasoline-reid-vapor-pressure.
[14] Ibid.
[15] U.S. Environmental Protection Agency, "State Winter Oxygenated Fuel Program Requirements for Attainment or Maintenance of CO NAAQS," accessed December 11, 2015, available at https://www.epa.gov/sites/production/files/2015-09/documents/420b08006.pdf
[16] Minnesota Department of Agriculture, "About the Minnesota Ethanol Program," accessed November 22, 2016, available at http://www.mda.state.mn.us/renewable/ethanol/about.aspx.
[17] American Fuel and Petrochemical Manufacturers, "State Motor Fuel Specifications: Missouri," accessed November 22, 2016, available at https://www.afpm.org/content.aspx?id=1446.

Regulations on distillate fuel oils primarily limit sulfur and particulate content and are aimed at reducing toxic emissions, including nitrogen oxide, sulfur oxide, and particulate matter. As of December 2014, all highway, non-road, locomotive, and marine diesel fuel in the United States is required by U.S. EPA to be ultra-low sulfur diesel (ULSD)—diesel fuel with a sulfur content of less than 15 parts per million (ppm).[18] Distillate fuel oil used for space heating (heating oil) has a maximum sulfur content of 2,000 ppm, although several East Coast (PADD 1) states have enacted, or are transitioning toward, more stringent sulfur limits at the state level. Households in PADDs 2 and 4 do not widely use heating oil for home heating.

Jet fuel

Jet fuel is a kerosene-based product that has a maximum distillation temperature of 400°F at the 10% recovery point and a final maximum boiling point of 572°F, and meets ASTM D1655 and Military Specifications MIL-T-5624P and MIL-T-83133D (grades JP-5 and JP-8, respectively). It is used for commercial and military turbojet and turboprop aircraft engines.

Renewable fuels

Renewable fuels, including ethanol and biodiesel, have become a significant component of U.S. transportation fuels supply. At the federal level, the Renewable Fuel Standard (RFS) requires renewable fuel to be blended into transportation fuels in increasing volumes each year.[19]

Ethanol

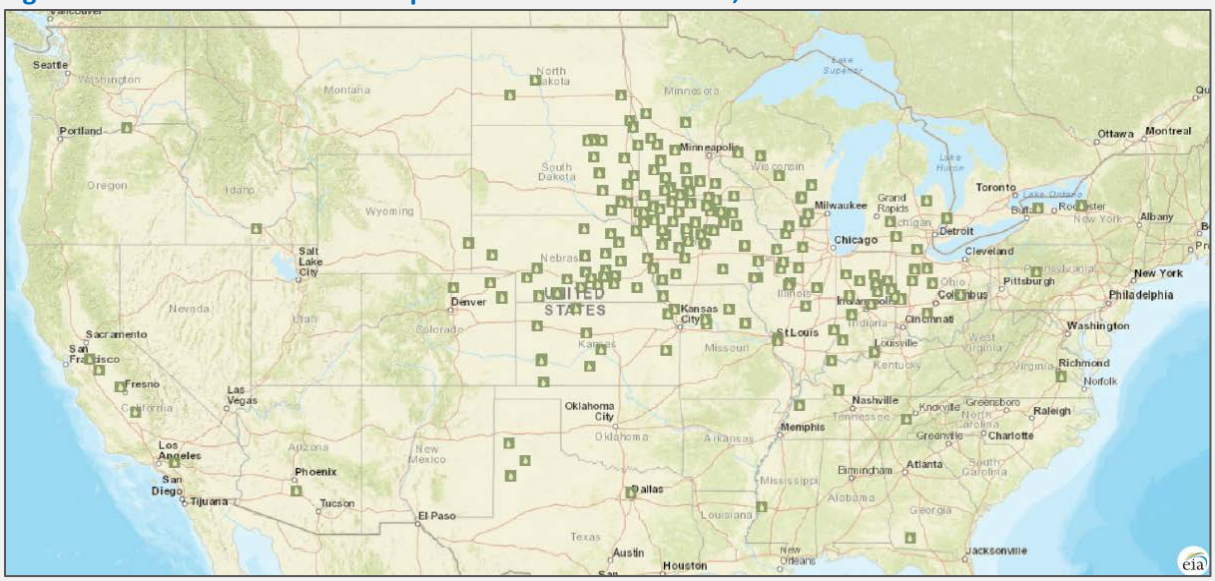
Ethanol, which is used as an oxygenate, is blended with either reformulated or conventional gasoline blendstocks (RBOB or CBOB) to produce finished motor gasoline. Ethanol can also be blended with finished gasoline that is not specifically designed for oxygenate blending. According to the U.S. Department of Energy's Alternative Fuels Data Center (AFDC), approximately 97% of the gasoline sold in the United States contains some amount of ethanol.[20] The most common blend is E10 (10% ethanol and 90% gasoline blendstock). Higher ethanol blends include E15, which contains between 10.5% and 15% ethanol, and E85 (also known as "flex fuel"), which contains between 51% and 83% ethanol.[21, 22] U.S. EPA has approved the use of E15 in light-duty conventional vehicles of model year 2001 and newer; however, the fuel is not widely distributed. Both E15 and E85 sales are largely concentrated in PADD 2. In 2015, ethanol blending averaged 244,000 barrels per day (b/d) in PADD 2 and 29,000 b/d in PADD 4, accounting for more than 9% of total gasoline supply in each region.[23]

[18] U.S. Environmental Protection Agency, "Diesel Fuel Standards & Rulemakings," accessed January 8, 2016, available at http://www.epa.gov/diesel-fuel-standards/diesel-fuel-standards-rulemakings.
[19] Alternative Fuels Data Center, "RFS Requirements," accessed November 22, 2016, available at http://www.afdc.energy.gov/laws/RFS.
[20] U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, "Ethanol Fuel Basics," Alternative Fuels Data Center: Fuels & Vehicles, updated March 30, 2016, available at http://www.afdc.energy.gov/fuels/ethanol_fuel_basics.html.
[21] U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, "E15," Alternative Fuels Data Center: Fuels & Vehicles, updated March 30, 2016, available at http://www.afdc.energy.gov/fuels/ethanol_e15.html.
[22] U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, "E85," Alternative Fuels Data Center: Fuels & Vehicles, updated March 30, 2016, available at http://www.afdc.energy.gov/fuels/ethanol_e85.html.
[23] U.S. Energy Information Administration, "Refinery and Blender Net Input: Fuel Ethanol," available at https://www.eia.gov/dnav/pet/pet_pnp_inpt_a_epooxe_yir_mbblpd_a.htm.

Ethanol production and disposition

U.S. ethanol production plants are heavily concentrated in corn-producing areas of the Midwest (PADD 2). Figure 9 shows the locations of all ethanol plants in the United States. Table 7 shows the number and production capacity of ethanol plants located in PADDs 2 and 4, and in each sub-PADD region in PADD 2.

Figure 9. Location of fuel ethanol plants in the United States, 2016



Source: U.S. Energy Information Administration, "U.S. Energy Mapping System," 2016.

Table 7. Ethanol plants and production capacity by region, 2016

Region [a]	Number of Plants	Production Capacity: Million gal. per year	Production Capacity: thousand b/cd [b]
Midwest (PADD 2)	**174**	**13,500**	**883**
Eastern Midwest	42	3,700	242
Northern Midwest	50	3,100	200
Southern Midwest	82	6,700	440
Rocky Mountain (PADD 4)	**4**	**200**	**13**
Total	**178**	**13,700**	**895**

[a] Individual line items may not sum to total due to independent rounding.

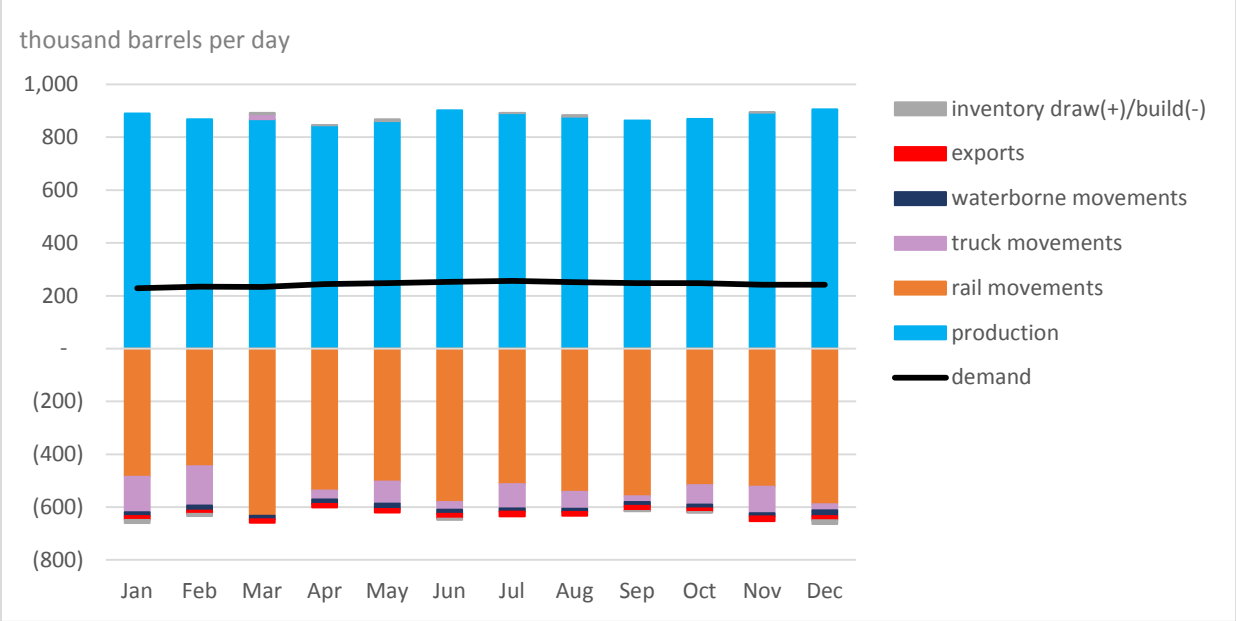
[a] Barrels per calendar day as of January 1, 2016.

Source: U.S. Energy Information Administration, "U.S. Fuel Ethanol Plant Production Capacity," 2016.

There are 178 fuel ethanol plants in PADDs 2 and 4, with a combined capacity of nearly 0.9 million b/d, equal to 92% of the ethanol production capacity in the United States. The vast majority of these plants are located in PADD 2, particularly in the Corn Belt, which stretches from Ohio in the east to Minnesota and the Dakotas in the west. Iowa, located in the Southern Midwest, leads all states with a total of 41 ethanol plants, which together account for 29% of the production capacity in PADD 2. Illinois and Indiana, in the Eastern Midwest, together have 27 plants, which account for 20% of total PADD 2 capacity, while Minnesota's 20 plants, in the Northern Midwest, account for approximately 9% of capacity. PADD 4 has only four ethanol plants, with a combined capacity of 13,000 b/d.

Figure 10 presents a supply/demand balance for fuel ethanol in PADD 2 in 2015.[24] The figure shows in-region production versus consumption, as well as exports, inventory changes, and domestic movements from PADD 2 to other U.S. regions by rail, barge, and truck.

Figure 10. Midwest (PADD 2) fuel ethanol supply/demand balance, 2015



Note: All domestic movements and inventory changes are reported on a net basis.
Source: ICF analysis of U.S. Energy Information Administration data.

In 2015, PADD 2 produced 878,000 b/d of fuel ethanol, or 91% of total U.S. production.[25] Approximately 244,000 b/d of this production is transported from ethanol plants to terminals and refineries within PADD 2, where it is blended to produce finished gasoline. PADD 2 ethanol production exceeds in-region demand by 634,000 b/d, or more than 250%. This surplus production is shipped to other regions, with shipments by rail averaging 545,000 b/d, or 86% of the surplus, and shipments by truck and barge, and exports to Canada, accounting for the remainder.

Biodiesel

Biodiesel is typically blended with conventional diesel at concentrations of 2% (B2), 5% (B5), or 20% (B20). Biodiesel blending in PADDs 2 and 4 averaged 15,000 b/d in 2015, or approximately 1% of total diesel consumption. Biodiesel blending as a share of total diesel consumption is highest in the Northern Midwest sub-PADD region due to Minnesota's statewide biodiesel mandate, which requires the use of B10 during the summer months and B5 during the winter months. Like ethanol, biodiesel production plants and capacity are heavily concentrated in PADD 2. As of August 2016, there were 42 biodiesel production plants

[24] Note: PADD 4 production figures for fuel ethanol were withheld in 2015.
[25] U.S. Energy Information Administration, "Weekly Ethanol Plant Production," November 9, 2016, available at https://www.eia.gov/dnav/pet/pet_pnp_wprode_s1_w.htm.

in PADD 2 with a combined production capacity of 75,000 b/d, equal to 55% of total U.S. capacity, and one plant in PADD 4 with a production capacity of 3,000 b/d.[26]

Propane

The terms *propane* and *liquefied petroleum gas* (LPG) are often used interchangeably. This report uses the term *propane* throughout. Propane is produced from the processing of natural gas liquids and petroleum refining. Consumer-grade propane in the United States contains more than 90% propane, with the remainder consisting of ethane, propylene, butylene, and various other light hydrocarbons.

Propane is not a major transportation fuel, but is widely used throughout the United States for a variety of purposes, including space heating, water heating, cooking, and grain drying. Propane is discussed in this report because of its widespread use as a home heating fuel in the Midwest (PADD 2) and Rocky Mountain (PADD 4) regions. In PADD 2, propane is the primary space heating fuel for nearly 2.3 million households, equal to 7.2% of the region's households. In PADD 4, propane is the primary heating fuel for 218,000 households, or 5% of the region's households.[27] In 2015, the residential and commercial sectors, which use propane for space heating, accounted for approximately 67% and 74% of total propane sales in PADD 2 and PADD 4, respectively, according to data from the American Petroleum Institute.[28] Propane is also widely used in the agricultural sector, particularly for drying grain. The agricultural sector made up 15% of total PADD 2 propane sales in 2015, while agricultural sales in PADD 4 were negligible.[29]

Gasoline market structure[30]

The Midwest (PADD 2) and Rocky Mountain (PADD 4) markets for gasoline are large and complex due to the varying gasoline specifications required in different regions. The gasoline markets in PADDs 2 and 4 include four separate but interrelated markets:

Spot market: Sizeable volumes (typically parcels of at least 1 million gallons [approximately 25,000 barrels]) are sold at the refinery gate and delivered into a specified pipeline or storage facility, as agreed upon by the buyer and the seller. There are numerous participants in this market, including refiners and wholesale suppliers that buy and sell products to balance refinery production and sales commitments, trading companies that are in the business of buying and selling gasoline but that typically have no presence in wholesale or retail gasoline markets, brokers with market knowledge and understanding that identify buyers and sellers and arrange deals, and independent retail marketers that move large volumes of gasoline through their own retail outlets. Prices in the spot market move with perceived changes in supply and demand. There are numerous spot markets for gasoline in PADDs 2 and 4 that are located in

[26] U.S Energy Information Administration, "Monthly Biodiesel Production Survey," Table 4, accessed November 22, 2016, available at http://www.eia.gov/biofuels/biodiesel/production.
[27] U.S. Census Bureau, "American Community Survey (ACS)," updated July 21, 2014, available at https://www.census.gov/programs-surveys/acs.
[28] American Petroleum Institute, "Sales of Natural Gas Liquids and Liquid Refinery Gases Survey," 2015 edition, available at http://www.api.org/products-and-services/statistics/reports-and-surveys.
[29] Ibid.
[30] This section has been adapted from EIA's *PADD 5 Transportation Fuels Markets*, September 2015, available at https://www.eia.gov/analysis/transportationfuels/padd5/pdf/transportation_fuels.pdf.

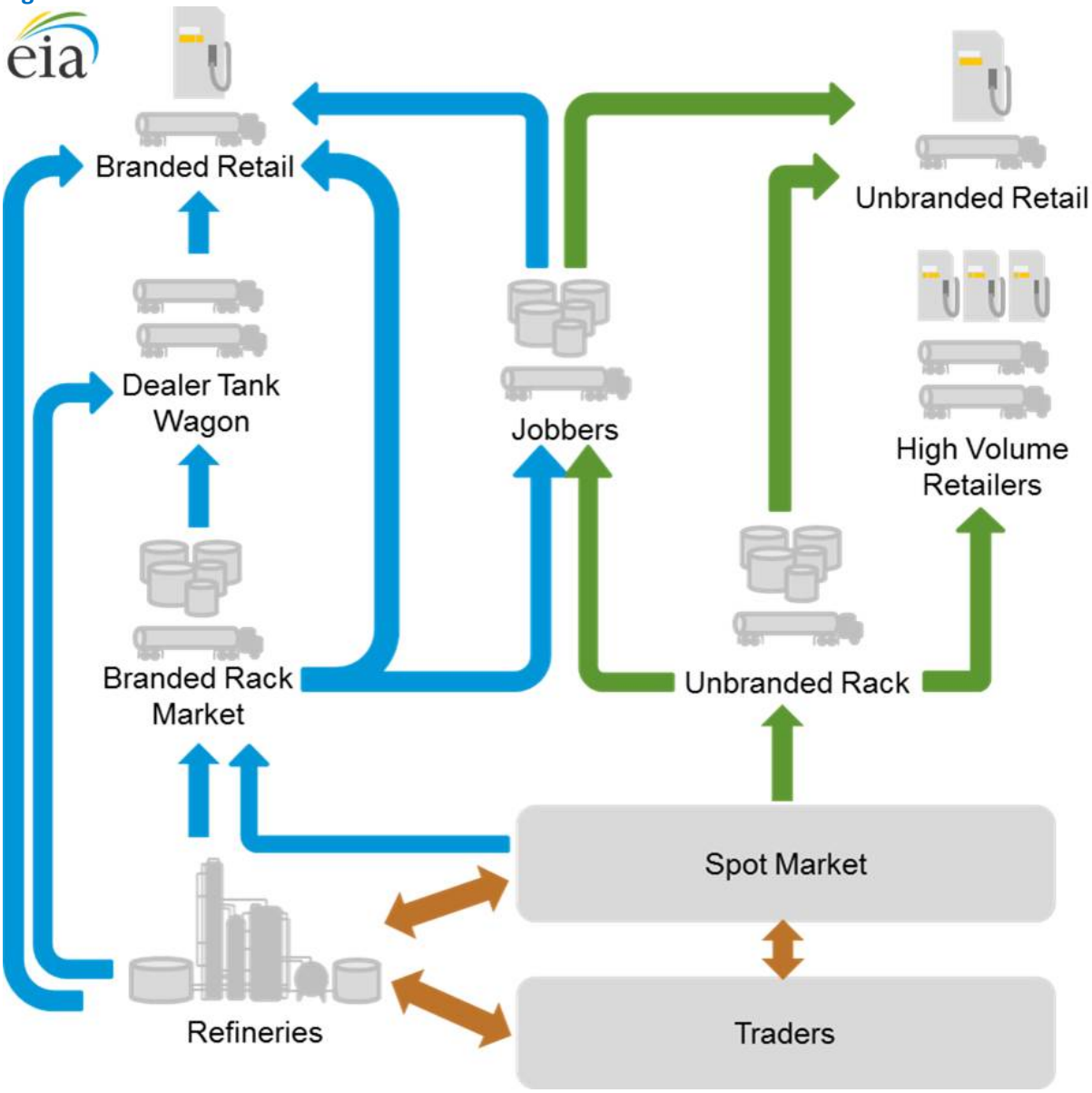
both supply and demand centers. Prices in these markets reflect regional supply/demand balances, as well as the cost to move product between the markets and product quality differences.

Rack market: Wholesale buyers, such as independent retailers or distributors that operate their own trucks, purchase product delivered into a tank truck at a truck loading rack located at a storage and distribution terminal or refinery. Rack market participants can be distributors that buy branded products that must be sold at a retail outlet under the name of a major oil company; alternatively, the rack market participants can be unbranded suppliers who buy the lowest cost products at a local truck rack for resale to independent, unbranded service stations or for use by commercial/industrial consumers. Branded and unbranded rack pricing varies, and many branded suppliers also post unbranded rack prices. Unbranded product is generally cheaper than branded product; however, these buyers do not get major brand additive packages, and do not have their supply protected when supply is short. During shortages, unbranded buyers may be required to pay above the branded price, and/or be cut off by the branded supplier.

Dealer tank wagon (DTW) market: Branded retail outlets (dealers) purchase branded gasoline that is delivered by tank truck (tank wagon) to their retail outlets. The price of the gasoline reflects the cost of the product and the cost of delivery.

Retail market: Gasoline is sold to the end consumer at the pump at a gas station or other retail outlet. Retailers typically set prices by comparison to prices at other retail outlets. However, high-volume retailers (HVRs), such as large chain stores, or *big box* stores, which are focused on selling large volumes of gasoline at low margins, tend to price gasoline based on cost plus the desired margin, rather than based on prices at other retail outlets.

Figure 11. Gasoline market structure



Source: U.S. Energy Information Administration, *California Strategic Reserve Study: Consultant Report*, 2002.[31]

[31] Stillwater Associates, *California Strategic Reserve Study: Consultant Report*, March 10, 2002, available at http://www.energy.ca.gov/reports/2002-03-11_600-02-004CR.PDF.

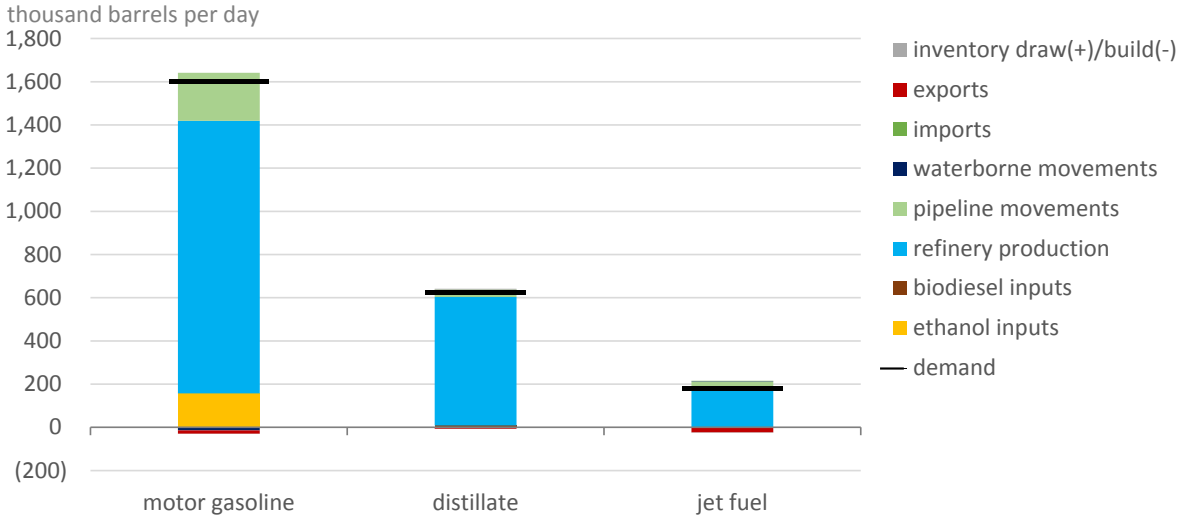
Eastern Midwest

The Eastern Midwest region includes six states: Illinois, Indiana, Kentucky, Michigan, Ohio, and Tennessee. The region is bounded by the Great Lakes (Erie, Huron, and Michigan) and Canada to the north, the Mississippi River to the west, the East Coast (Petroleum Administration for Defense District [PADD] 1) states to the east, and Alabama and Mississippi in the Gulf Coast (PADD 3) to the south. Estimated total demand for transportation fuels (motor gasoline, distillate fuel oil, and commercial jet fuel) in the Eastern Midwest was 2.44 million barrels per day (b/d) in 2015, or 59% of Midwest (PADD 2) demands. The region's principal demand centers include Chicago, Illinois; Indianapolis, Indiana; Louisville, Kentucky; Detroit and Grand Rapids, Michigan; Cincinnati, Cleveland, and Columbus, Ohio; and Nashville and Memphis, Tennessee.[32] Other demand centers include Lexington, Kentucky; Dayton, Akron, Toledo, and Youngstown, Ohio; and Knoxville and Chattanooga, Tennessee.

Supply/demand balances

The Eastern Midwest has 14 refineries that together produced 2.04 million b/d of transportation fuels in 2015, enough to meet 84% of in-region demand (90% of demand net of ethanol and biodiesel inputs). Products move into the region primarily via major pipeline systems originating in the Gulf Coast that deliver fuels to Illinois and Indiana from the Southern Midwest, and to eastern Tennessee from Georgia in PADD 1. Figure 12 presents the Eastern Midwest's 2015 annual supply and demand balances for motor gasoline, distillate, and jet fuel. From the Eastern Midwest, products are moved by pipeline into Wisconsin in the Northern Midwest and into Iowa and Missouri in the Southern Midwest, by pipeline and barge into western Pennsylvania and West Virginia in PADD 1, by barge south along the Mississippi River into PADD 3, and by truck and rail to Canada.

Figure 12. Eastern Midwest supply/demand balances, 2015



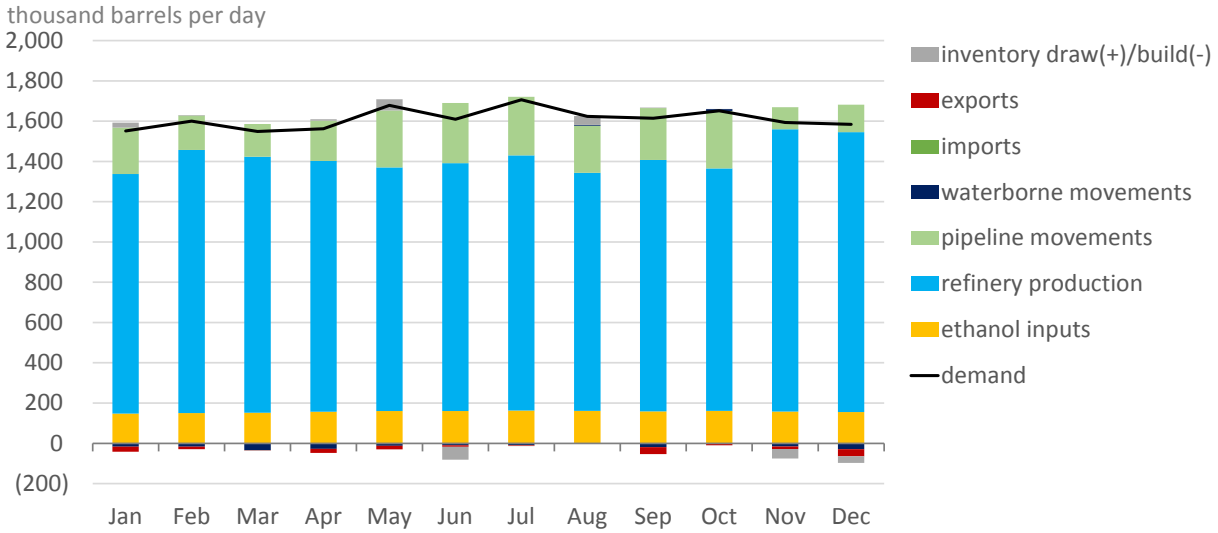
Note: All domestic movements and inventory changes are reported on a net basis.
Sources: ICF analysis of EIA, Airlines for America, USACE, FERC, and company 10-K data.

[32] Principal demand centers defined as metropolitan statistical areas with 1 million or more people as of July 1, 2015.

Gasoline

Figure 13 presents the 2015 monthly motor gasoline supply/demand balance in the Eastern Midwest. In 2015, in-region demand averaged 1.61 million b/d, including approximately 0.16 million b/d of ethanol. Demand is typically highest during the summer driving season. Peak demand in 2015 occurred in July at just under 1.71 million b/d, up from the year's low of 1.55 million b/d in March. In-region refinery production of gasoline averaged 1.26 million b/d in 2015, enough to meet approximately 87% of annual demand net of ethanol inputs. On a net basis, the Eastern Midwest received 200,000 b/d more gasoline by pipeline from other U.S. markets than it shipped to other regions in 2015. Conversely, the region shipped 15,000 b/d more gasoline by barge than it received. An additional 15,000 b/d were exported to Canada in 2015, primarily by truck, while imports were negligible.

Figure 13. Eastern Midwest motor gasoline supply/demand balance, 2015



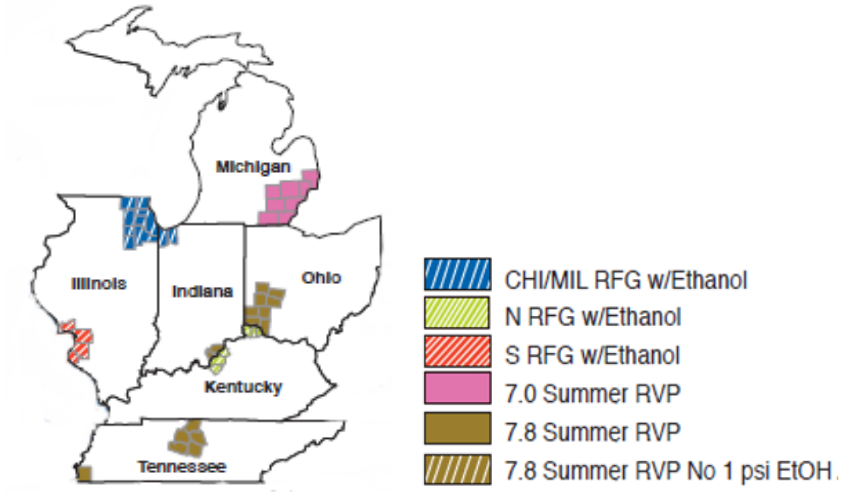
Note: All domestic movements and inventory changes are reported on a net basis.
Sources: ICF analysis of EIA, FERC, and company 10-K data.

The U.S. Environmental Protection Agency (EPA) requires the use of reformulated gasoline in the Chicago metropolitan area, including eight counties in Illinois and two in Indiana.[33] In addition, four counties in Illinois that are part of the St. Louis, Missouri metropolitan area and six counties in Kentucky that belong either to the Cincinnati or Louisville metropolitan area are reformulated gasoline "opt-in" areas, where the states' governors have requested that EPA require the sale of reformulated gasoline. In accordance with the Clean Air Act, EPA requires the adoption of a summer Reid vapor pressure (RVP) standard that limits the volatility of conventional gasoline sold in certain areas of the country. From May 1 through September 15, each of the six states in the Eastern Midwest region enforces a statewide 9.0 RVP limit. Most states also enforce a stricter RVP limit in select urban areas. These include two counties in Indiana that belong to the Louisville metropolitan area (7.8 RVP), eight counties in Michigan that compose the greater Detroit metropolitan area (7.0 RVP), nine counties in Ohio that compose the Cincinnati-Dayton

[33] U.S. Environmental Protection Agency, "Reformulated Gasoline" (accessed June 21, 2016), http://www.epa.gov/gasoline-standards/reformulated-gasoline.

corridor (7.8 RVP), and six counties in Tennessee, which include both Nashville and Memphis (7.8 RVP).[34] Figure 14 provides a map of Eastern Midwest gasoline regulations and Table 8 below provides a schedule for when they are in effect.

Figure 14. Map of Eastern Midwest motor gasoline regulations



Source: Exxon Mobil, as of June 2015.

Table 8. Eastern Midwest motor gasoline regulations

Regulation	Area(s)	Dates
Reformulated gasoline	*Chicago metropolitan area:* Cook, DuPage, Kane, Lake, McHenry, and Will counties, as well as parts of Grundy and Kendall counties in Illinois; Lake and Porter counties in Indiana	Year-round
Reformulated gasoline (opt-in areas)	*St. Louis metropolitan area:* Jersey, Madison, Monroe, and St. Clair counties in Illinois *Louisville metropolitan area:* Jefferson county in Kentucky, as well as parts of Bullitt and Oldham counties *Cincinnati metropolitan area:* Boone, Campbell, and Kenton counties in Kentucky	Year-round
Summer gasoline volatility <9.0 RVP	All counties in Illinois, Indiana, Kentucky, Michigan, Ohio, and Tennessee	May 1 – Sept. 15
Summer gasoline volatility <7.8 RVP	*Louisville metropolitan area:* Clark and Floyd counties in Indiana *Cincinnati-Dayton metropolitan corridor:* Butler, Clark, Clermont, Clinton, Greene, Hamilton, Miami, Montgomery, and Warren counties in Ohio *Nashville metropolitan area:* Davidson, Rutherford, Sumner, Williamson, and Wilson counties in Tennessee *Memphis metropolitan area:* Shelby county in Tennessee	June 1 – Sept. 15
Summer gasoline volatility <7.0 RVP	*Greater Detroit metropolitan area:* Lenawee, Livingston, Macomb, Monroe, Oakland, St. Clair, Washtenaw, and Wayne counties in Michigan	June 1 – Sept. 15

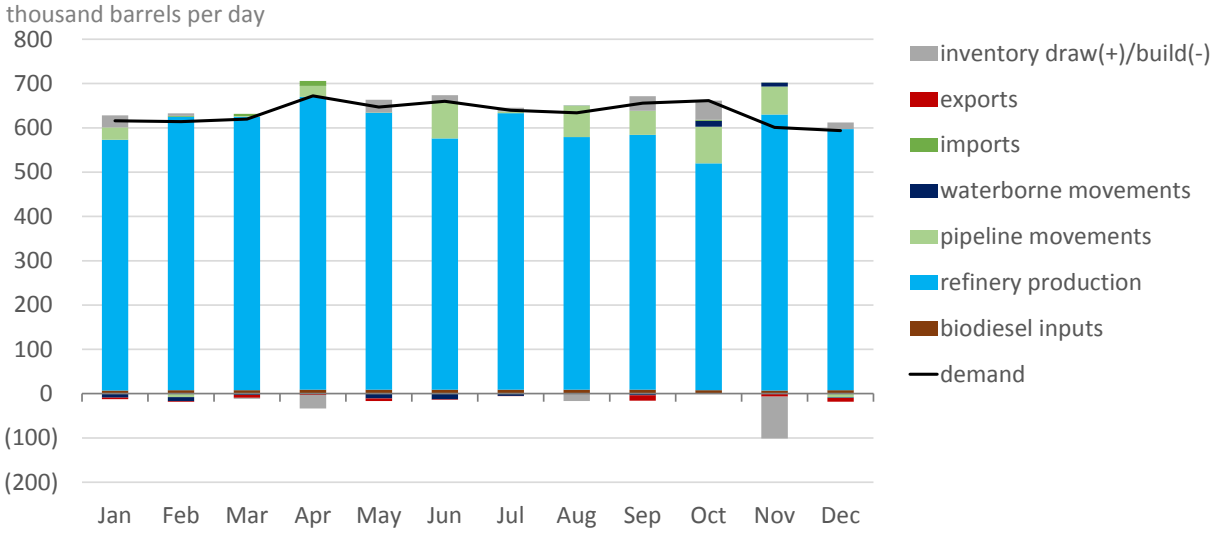
Source: U.S. EPA Office of Transportation and Air Quality

[34] U.S. Environmental Protection Agency, "Gasoline Reid Vapor Pressure" (accessed June 29, 2016), http://www.epa.gov/gasoline-standards/gasoline-reid-vapor-pressure.

Distillate

Figure 15 presents the 2015 monthly distillate supply/demand balance for the Eastern Midwest. In 2015, demand for distillate fuels averaged 635,000 b/d. Distillate fuel oil demand in the Eastern Midwest is driven primarily by on-highway use; however, demand is also significant from the railroad and agricultural sectors.[35] Demand is typically highest from April to November. In 2014, farm use accounted for 5.9% of the region's distillate sales, with farm use accounting for as much as 9.4% of sales in Illinois. These shares compare with a national average of 5%.[36] Imports and exports, which were primarily received to or delivered from the Detroit area, were marginal in 2015.

Figure 15. Eastern Midwest distillate supply/demand balance, 2015



Note: All domestic movements and inventory changes are reported on a net basis.
Source: ICF analysis of EIA, FERC, and company 10-K data.

The Eastern Midwest region, as with the rest of the country, is required by federal law to use ultra-low sulfur diesel (ULSD)—diesel fuel with a maximum sulfur content of 15 parts per million (ppm)—for all highway, non-road, locomotive, and marine diesel fuel. No states in the Eastern Midwest have mandates requiring biodiesel blending in distillate fuel oil; however, several states maintain biodiesel incentive programs, or require a certain percentage of government-owned fleet vehicles to be flexible- or renewable-fuel vehicles.[37]

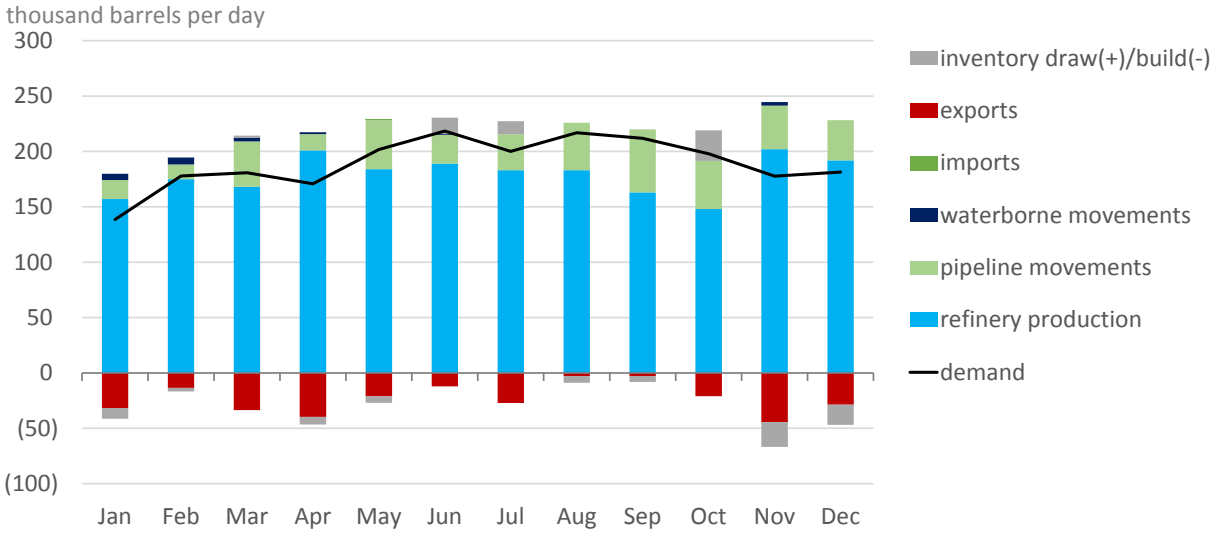
Jet fuel

Figure 16 presents the Eastern Midwest region's monthly 2015 jet fuel supply/demand balance. Commercial jet fuel demand in the region averaged 190,000 b/d in 2015, while in-region refinery production averaged 179,000 b/d, enough to meet 94% of demand. Jet fuel demand generally follows a seasonal pattern, with consumption higher in the summer months. In 2015, demand peaked at 218,000

[35] U.S. Energy Information Administration, *Sales of Distillate Fuel Oil by End Use*, (accessed June 29, 2016).
[36] Ibid.
[37] Alternative Fuels Data Center, "State Laws and Incentives" U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, updated June 4, 2014, http://www.afdc.energy.gov/laws/state.

b/d in June and was lowest in January at 139,000 b/d. Jet fuel exports—from Detroit to Toronto, Canada by rail—averaged 23,000 b/d for the year, with a high of 44,000 b/d in November.

Figure 16. Eastern Midwest jet fuel supply/demand balance, 2015



Source: ICF analysis of EIA, FERC, and company 10-K data.

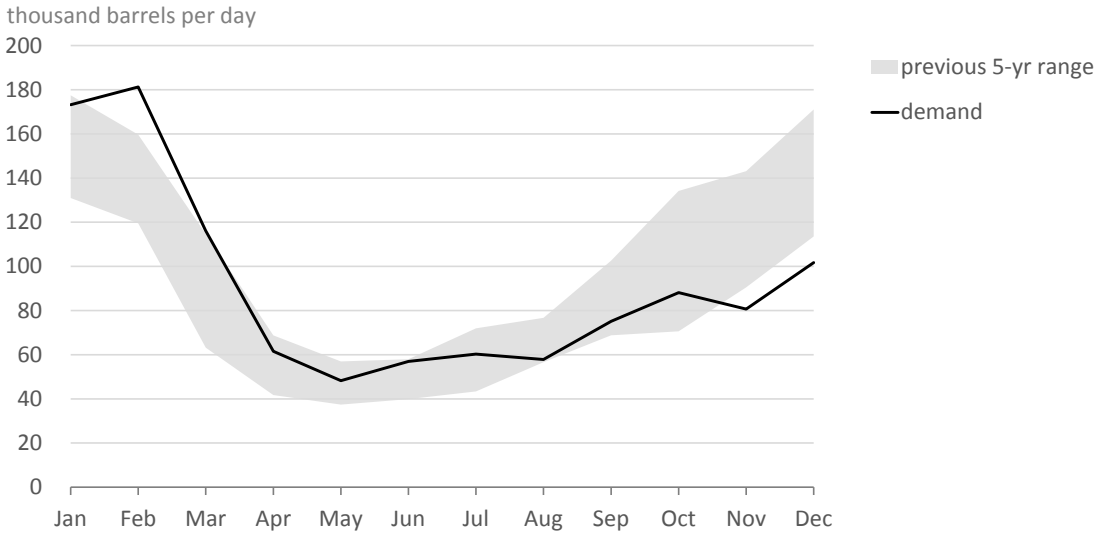
Three airports in the Eastern Midwest region are designated as large hubs by the Federal Aviation Administration: Chicago O'Hare International Airport (ORD), Chicago Midway International Airport (MDW), and Detroit Metropolitan Wayne County Airport (DTW). The Eastern Midwest region also includes five medium hubs serving Nashville, Indianapolis, Cincinnati, Cleveland, and Columbus, in addition to eight small hubs. One small hub—Memphis International Airport—is also the central cargo hub for FedEx's air freight business.[38] In addition to these hubs, 38 smaller commercial service airports operate in the region, as well as five air force bases (AFBs), one in each Eastern Midwest state except Kentucky. These bases may consume commercial-quality Jet A fuel in addition to high-performance jet fuel blends.[39]

Propane

The Eastern Midwest is the largest market for propane sales in the Midwest (PADD 2), with sales in 2015 averaging around 93,000 b/d. Sales are largely dominated by the residential and commercial sectors, which accounted for approximately 50% and 20% of total 2014 sales, respectively, according to the American Petroleum Institute.[40] There are more than 1.1 million households in the Eastern Midwest that use propane as a primary space heating fuel, equating to a 6% market share.[41] Figure 17 shows monthly prime supplier sales of propane in 2015. Due to its use in space heating, demand is highly seasonal, peaking at more than 180,000 b/d in February 2015.

[38] Federal Aviation Administration, "Passenger Boarding (Enplanement) and All-Cargo Data for U.S. Airports" (accessed November 23, 2016), https://www.faa.gov/airports/planning_capacity/passenger_allcargo_stats/passenger/.
[39] MilitaryBases.com, "State Military Bases" (accessed June 29, 2016), http://militarybases.com.
[40] American Petroleum Institute, *Sales of Natural Gas Liquids and Liquefied Refinery Gases Survey*, 2015 edition, http://www.api.org/products-and-services/statistics/reports-and-surveys.
[41] U.S. Census Bureau, *American Community Survey*, updated July 21, 2014, https://www.census.gov/programs-surveys/acs.

Figure 17. Monthly consumer-grade propane sales in the Eastern Midwest, 2015



Source: U.S. Energy Information Administration, *Monthly Report of Prime Supplier Sales of Petroleum Products Sold for Local Consumption.*

Propane demand in the Eastern Midwest is highly seasonal and weather conditions, including temperature and precipitation, are a significant source of demand variability. Extreme cold temperatures can drive demand for heating during the winter months, while heavy rainfall during the harvest season can lead to wetter crops, driving demand for propane use in grain-drying equipment. Fall demand for propane is also affected by the overall size of the harvest, with larger harvests contributing to increased propane use. The Eastern Midwest experienced high demand for propane during fall 2013 due to a large and wet harvest. The fall demand was followed by high winter sales in January and February 2014 amid near record cold throughout much of the region. The size and timing of these two demand spikes, combined with concurrent infrastructure outages, led to a shortage of propane in the Eastern Midwest in early 2014.[42] Weather conditions can also have the reverse effect on propane sales. In November and December 2015, much of the Eastern Midwest experienced record high or much above average temperatures, driving sales below the previous seasonal five-year lows.[43]

Refineries

The Eastern Midwest has 14 refineries with a combined atmospheric crude distillation capacity of 2.56 million barrels per calendar day (b/cd).[44] This refining capacity is dispersed throughout the region, but can

[42] U.S. Department of Energy, Office of Electricity Delivery and Energy Reliability, *An Assessment of Heating Fuels and Electricity Markets During the Winters of 2013–2014 and 2014–2015*, prepared for U.S. DOE by ICF, October 2015, http://energy.gov/sites/prod/files/2015/10/f27/DOE_OE_Two%20Winters%20Report_Final_10.19.15.pdf.

[43] National Oceanic and Atmospheric Administration, "National Temperature and Precipitation Maps," National Centers for Environmental Information: Temperature, Precipitation and Drought, March 6, 2015 release, https://www.ncdc.noaa.gov/temp-and-precip/us-maps/.

[44] 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 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.

generally be grouped into four geographical areas: the Chicago area, Ohio and Michigan, the Ohio River area, and the Mississippi River area. Table 9 lists each refinery and its operable capacity as of January 1, 2016.

Table 9. Eastern Midwest refineries, 2016

Owner	Site	Operable capacity (b/cd) [a]
Chicago Area		
BP	Whiting, IN	413,500
ExxonMobil	Joliet, IL	238,600
CITGO Petroleum	Lemont, IL	175,940
	Total	**828,040**
Ohio & Michigan		
PBF Energy	Toledo, OH	160,000
BP Husky Refining	Toledo, OH	153,000
Husky Energy	Lima, OH	152,000
Marathon Petroleum	Detroit, MI	132,000
Marathon Petroleum	Canton, OH	93,000
	Total	**690,000**
Ohio River		
Marathon Petroleum	Catlettsburg, KY	273,000
Marathon Petroleum	Robinson, IL	212,000
CountryMark	Mount Vernon, IN	27,100
	Total	**512,100**
Mississippi River		
WRB Refining	Wood River, IL	336,000
Valero Energy	Memphis, TN	190,000
	Total	**526,000**
Other		
Continental Refining	Somerset, KY	5,500
	Eastern Midwest Total	**2,561,640**

[a] Barrels per calendar day, as of January 1, 2016
Source: U.S. Energy Information Administration, *Refinery Capacity Report*, 2016.

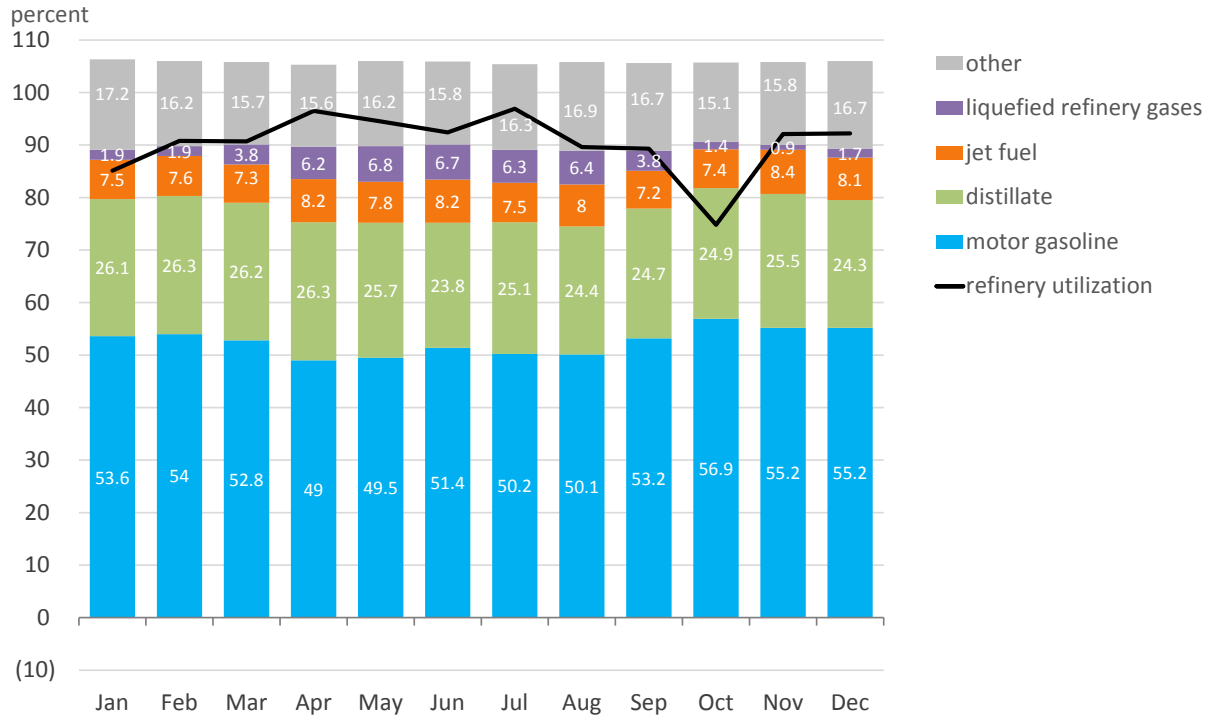
Transportation fuels produced at Eastern Midwest refineries are distributed by truck to local markets, and by pipeline and river barge to markets both inside and outside of the region. Refineries in the Chicago area distribute products to the local Chicago market and access markets throughout the Midwest (PADD 2) via pipeline. Ohio and Michigan have five refineries serving local markets, as well as markets in western Pennsylvania in PADD 1. The Ohio River refineries in Kentucky, Illinois, and Indiana distribute products by barge to markets on the Ohio River system, and also by pipeline to other markets in the Eastern Midwest. The two refineries on the Mississippi River primarily serve local markets in the St. Louis and Memphis metropolitan areas; however, the Wood River refinery also ships products to other markets by pipeline, while Memphis ships to other markets by barge.

Crude supply to Eastern Midwest refineries is primarily received by pipeline from inland North American sources, including the Bakken Formation in North Dakota and Montana, Western Canada, the Midcontinent, and the Permian Basin in West Texas and New Mexico. Historically, the region processed significant volumes of crude oil from the U.S. Gulf of Mexico and from overseas suppliers; however, receipts from these sources have declined due to burgeoning supplies from onshore North American production areas. In addition, some refineries in Ohio and Kentucky are increasing runs of locally produced condensates, a form of ultra-light crude oil from the Utica Formation in western Pennsylvania and eastern Ohio.

Refinery yields

Figure 18 shows monthly refinery utilization and yield percentages for motor gasoline (both finished gasoline and blendstocks), distillate fuel oil, liquefied refinery gases (LRGs), and other products.[45]

Figure 18. Eastern Midwest refinery yields, 2015



Note: Yield percentages sum to higher than 100% due to processing gains.
Source: U.S. Energy Information Administration, *Petroleum Supply Monthly*, 2016.

Refinery utilization in the Eastern Midwest averaged 90.4% in 2015, with a high of 96.9% in July. Utilization dropped to a low of 74.8% in October amid an unusually large number of planned refinery outages, which took more than 535,000 b/cd of capacity offline across the Midwest (PADD 2), much of it in the Eastern Midwest.[46] In 2015, Eastern Midwest production of transportation fuels (motor gasoline, distillate, and

[45] Liquefied petroleum gases are products fractionated from refinery or still gases; through compression and/or refrigeration, they are retained in the liquid state. The reported categories are ethane/ethylene, propane/propylene, normal butane/butylene, and isobutane/isobutylene. These exclude still gas.
[46] U.S. Energy Information Administration, *Refinery Outages: First-Half 2016*, accessed November 23, 2016.

jet fuel) accounted for 85.6% of the region's annual yield, just above the national average of 84.8%. Eastern Midwest refineries have a higher average yield of motor gasoline than the national average, at 52.6%, compared with 45.3%; a lower yield for distillate at 25.3%, compared with 29.8%; and a lower yield for jet fuel at 7.8%, compared with 9.7%.

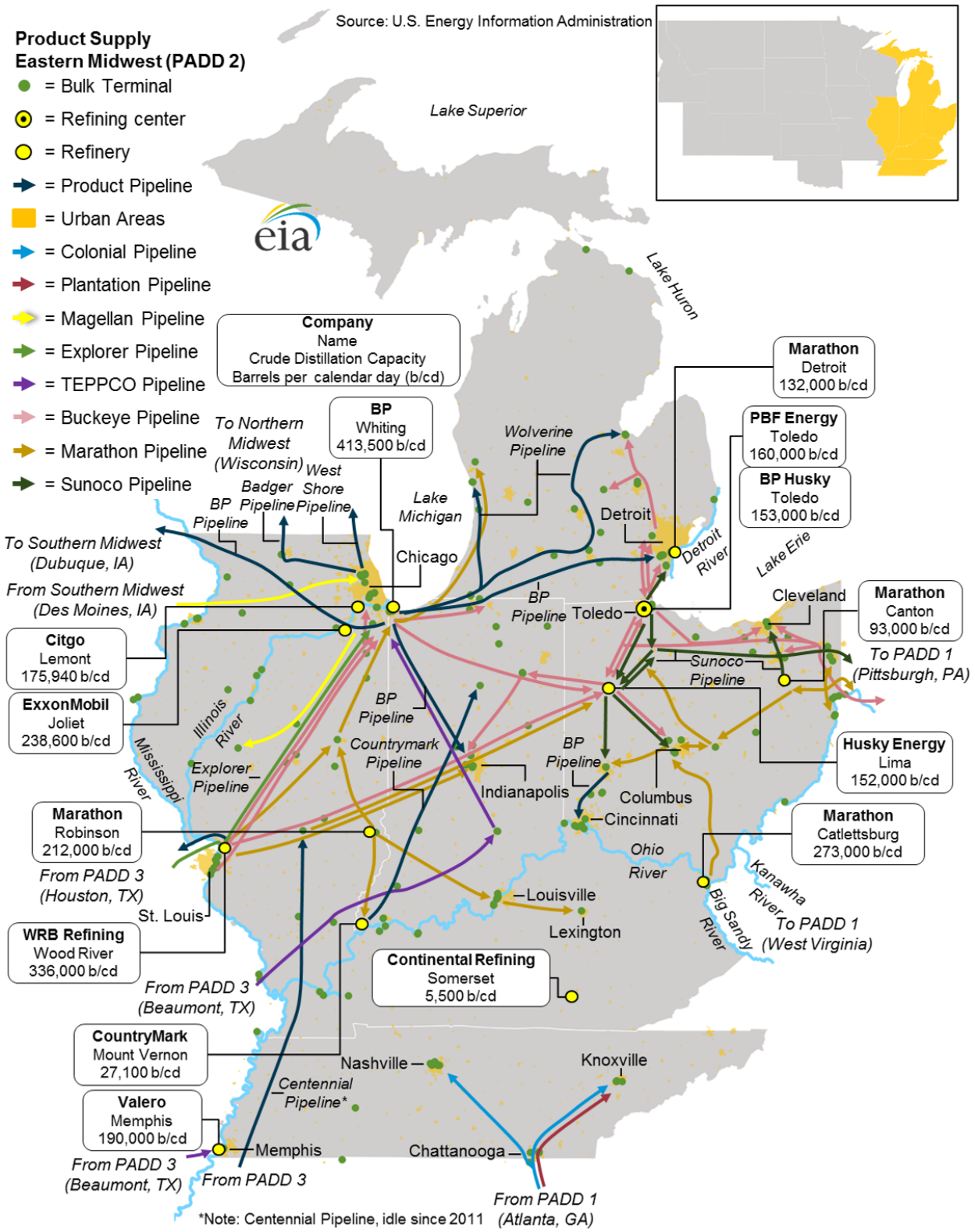
In the fall and winter, Eastern Midwest refineries blend additional butane into supplies of winter-blend gasoline to provide sufficient vapors for engine ignition, up to higher seasonal RVP limits. Supplies of butane are obtained through the distillation of crude oil and other processes at the refineries, but are also brought in from outside sources, primarily from regional natural gas liquid (NGL) fractionators. Proportionally, refineries in the Eastern Midwest consume more butane from outside sources than the average U.S. refinery. In November 2015, Eastern Midwest refinery inputs of butane from outside sources averaged 59,000 b/d, or 4.2% of total refinery gasoline production (excluding ethanol inputs), compared with a national average of 2.5% in the same month.[47, 48] Due to the impact of higher butane blending in winter gasoline, motor gasoline yield is typically higher by 3 to 5 percentage points in the fall and winter months than in the spring and summer months. Increased butane blending in the gasoline pool has the opposite effect on LRG yield, increasing the yield during the spring and summer months and decreasing the yield during the fall and winter months when butanes are utilized for raising gasoline RVP.

Supply and logistics

Figure 19 on page 31 presents an overview map of the refineries, product pipelines, storage terminals, petroleum ports, and inland waterways serving the Eastern Midwest region. The Eastern Midwest's primary supply center is located in the Chicago area in northeastern Illinois and northwestern Indiana where three refineries house more than 828,000 b/d of refining capacity, and several major pipeline systems from the Gulf Coast terminate. From Chicago, product moves throughout the Eastern Midwest and adjacent regions by pipeline. Other refining and supply centers are dispersed throughout the Eastern Midwest mostly in close proximity to major demand centers, including four refineries in the Detroit-to-Lima corridor in southeastern Michigan and northwestern Ohio; WRB's Wood River refinery near St. Louis, Missouri; Marathon's Catlettsburg, Kentucky refinery near Huntington, West Virginia; and Valero's Memphis, Tennessee refinery. Products primarily move throughout the region by pipeline with flows typically moving from the southwest to the northeast; however, significant barge movements also take place on the Ohio, Mississippi, and Illinois rivers.

[47] U.S. Energy Information Administration, *Refining District Indiana-Illinois-Kentucky Refinery Net Production of Normal Butane*, accessed October 31, 2016.
[48] U.S. Energy Information Administration, *U.S. Refinery Net Production of Normal Butane*, accessed October 31, 2016.

Figure 19. Eastern Midwest refined petroleum infrastructure



Internal Pipelines

Refined product pipeline infrastructure in the Eastern Midwest primarily distributes in-region refinery production to in-region demand centers. Key pipeline systems internal to the Eastern Midwest include the Marathon, Buckeye, BP, and Sunoco systems, which extend outward from regional supply centers. Pipelines also move product from Eastern Midwest supply centers (primarily Chicago and Wood River) to adjacent regions, including into the Northern Midwest (West Shore Pipe Line Co. to Wisconsin), Southern Midwest (BP to Iowa and Missouri, and multiple short-distance lines from Wood River, Illinois to St. Louis, Missouri), and the East Coast (PADD 1) (Buckeye, Marathon, and Sunoco lines into western Pennsylvania). In addition, two major systems terminate in the Chicago area, supplying the Eastern Midwest with products from the Gulf Coast (PADD 3). These lines include the Explorer and Enterprise TEPPCO pipelines into Illinois and Indiana, and spurs from the Colonial and Plantation pipeline systems into eastern Tennessee from junctions near Atlanta, Georgia. The following sections of this report provide descriptions of key pipeline systems in the Eastern Midwest, including operational details on pipeline capacities, flows, and/or diameters, when known.

Marathon Petroleum

Marathon Petroleum Corp.[49] operates an extensive network of pipelines that distribute fuel from its Eastern Midwest refineries and support its terminals across the region. Systems operated by Marathon include the Robinson Products system, the Wabash Pipeline system,[50] the Ohio River Pipe Line (ORPL) Products system, and the Louisville Airport Products system. These systems collectively shipped nearly 445,000 b/d of transportation fuels in 2015, according to FERC filings.[51] [52] In addition, Marathon also operates the Muskegon Pipeline through a business agreement with Buckeye Partners.[53] Table 10 lists Marathon pipeline systems operating in the Eastern Midwest region, as well as their origin points, destination points, and capacities, where publically available.

[49] Includes subsidiaries MPLX Energy Logistics LP and Marathon Pipe Line LLC.
[50] Marathon categorizes the Wabash System as a component of its Robinson Products system in its financial filings; however, they are broken out separately in this study.
[51] Marathon Pipe Line LLC, FERC Form No. 6: Annual Report of Oil Pipeline Companies, 2015/Q4.
[52] Ohio River Pipe Line LLC, FERC Form No. 6: Annual Report of Oil Pipeline Companies, 2015/Q4.
[53] Buckeye Partners, L.P., U.S. Securities and Exchange Commission Form 10-K, February 26, 2016, p. 7, http://www.buckeye.com/LinkClick.aspx?fileticket=4xge-xiR7bM%3d&tabid=222&mid=2146.

Table 10. Select Marathon Petroleum refined product pipelines in the Eastern Midwest

System	Origin	Destination	Dist. (mi.)	Diam. (in.)	Capacity (b/d)	2015 Shipments [d] (b/d)
Robinson Products	Robinson, IL	Louisville, KY	129	16	92,000	286,000
	Louisville, KY	Lexington, KY	87	8	36,000	
	Robinson, IL	Lima, OH	250	10	51,000	
	Robinson, IL	Mt. Vernon, IN	79	10	43,000	
	Dieterich, IL	Martinsville, IL	40	10	59,000	
	Wood River, IL	Clermont, IN	317	10	48,000	
Louisville Arpt.	Louisville, KY	Louisville Intl. Airport	14	8/6 [c]	29,000	
Wabash	Robinson, IL	Champaign, IL	86	12	99,000	
	Wood River, IL	Champaign, IL	130	12	71,000	
	Champaign, IL	Griffith/Hammond, IN	140	16/12 [c]	85,000	
Muskegon	Griffith, IN	Muskegon, MI	170	10	N/A [b]	27,000
Ohio River Pipe Line (ORPL) Products	Kenova, WV	Columbus, OH	150	14	68,000	159,000
	Canton, OH	East Sparta, OH [a]	8.5	6	42,000	
	Canton, OH	East Sparta, OH	8.5	6	31,000	
	East Sparta, OH	Heath, OH [a]	81	8	29,000	
	East Sparta, OH	Midland, PA [a]	62	8	32,000	
	Heath, OH	Dayton, OH [a]	108	6	24,000	
	Heath, OH	Findlay, OH	100	10/8 [c]	18,000	
Youngstown to Steubenville	Youngstown, OH	Steubenville, OH	N/A [b]	8/6 [c]	N/A [b]	N/A [b]

[a] Indicates bidirectional flow capability.

[b] N/A = not available

[c] Denotes continuous pipeline of varying diameter.

[d] Only includes shipments of transportation fuels (motor gasoline, distillates, and jet fuel).

Sources: MPLX Energy Logistics website; Marathon Pipe Line, LLC, FERC Form No. 6, 2015/Q4; Muskegon Pipeline, LLC, FERC Form No. 6, 2015/Q4; Ohio River Pipe Line, LLC, FERC Form No. 6, 2015/Q4.

The Robinson Products and Wabash Products systems channel supply from the Marathon Robinson refinery and the Wood River supply center to Chicago and Indianapolis, and to marine terminals along the Ohio River. Shipments of transportation fuels on these systems averaged approximately 286,000 b/d in 2015, according to FERC filings. From the Robinson refinery, two segments flow south toward the Ohio River: a 43,000 b/d segment runs south to Marathon's Mount Vernon marine loading terminal and a 92,000 b/d segment ships supply to terminals in the Louisville area, including marine loading terminals. From Louisville, supply also continues to Lexington via a 36,000 b/d segment that Marathon jointly owns with another party.[54] In addition, Marathon operates the 29,000 b/d Louisville Airport Products system, which delivers jet fuel to the Louisville International Airport. Marathon's Robinson Products system also ships products from Robinson to Indianapolis and Muncie via a 51,000 b/d segment, which also delivers

[54] Marathon Petroleum Corp., U.S. Securities and Exchange Commission Form 10-K, February 26, 2016, p. 54, http://ir.marathonpetroleum.com/phoenix.zhtml?c=246631&p=irol-sec.

liquefied petroleum gas (LPG) and light petroleum-based feedstocks further east to the Lima, Ohio refining hub. A separate 48,000 b/d Marathon line from Wood River ships products to Clermont in the Indianapolis area. The line has a bidirectional connection to the Robinson refinery via breakout tankage in Martinsville, Illinois.

Marathon's Wabash Pipeline system, which is part of the company's Robinson Products system, consists of three interconnected segments that move products from the Robinson and Wood River hubs north to terminals in the Chicago metropolitan area. A 99,000 b/d segment from Robinson and a 71,000 b/d segment from Wood River converge at a junction point in Champaign, Illinois where an 85,000 b/d segment extends north, terminating at Marathon's Griffith and Hammond, Indiana terminals in the Chicago area. Between Griffith and Hammond, the Wabash system connects to other Chicago area pipelines and terminals through a portion of the system known as the "Wabash Loop."

Through a business agreement with Buckeye Partners, Marathon operates the Muskegon Pipeline system, which originates at Marathon's Griffith terminal and extends along the eastern coastline of Lake Michigan to North Muskegon, Michigan.[55] [56] In 2015, Muskegon Pipeline shipped approximately 27,000 b/d of transportation fuels, according to FERC filings.[57]

The ORPL Products system is a network of one-way and bidirectional pipelines that connect Marathon's Canton and Catlettsburg refineries to terminals in Ohio and western Pennsylvania. The ORPL system shipped approximately 159,000 b/d of transportation fuels in 2015, according to FERC filings. The East Sparta and Heath junctions are key logistical points in the ORPL system. East Sparta serves as breakout tankage for the Canton refinery, receiving transportation fuels from the Canton refinery through two dedicated product pipelines with a combined capacity of 73,000 b/d. From East Sparta, product is shipped east via a 32,000 b/d bidirectional pipeline to Midland, Pennsylvania, which interconnects with Buckeye's 717 pipeline supplying terminals in the Pittsburgh, Pennsylvania metropolitan area, and west via a 29,000 b/d bidirectional line to the Heath Junction in central Ohio. [58] From Heath, product connects via an 18,000 b/d line to Findlay in northwestern Ohio and via a 24,000 b/d line to Columbus and Dayton in central and southwestern Ohio. Marathon's Catlettsburg refinery in northeastern Kentucky feeds products into the ORPL system from the refinery's breakout tankage in Kenova, West Virginia, which is located just across the Big Sandy River from the refinery. From Kenova, a 68,000 b/d segment known as the Cardinal Pipeline channels supply north to terminals in the Columbus area. This segment shipped nearly 44,000 b/d of transportation fuels in 2015, according to FERC filings. From Columbus, products from Catlettsburg can be shipped either west to Dayton or east to Heath via the Heath-to-Dayton segment, which is bidirectional between Heath and Columbus.

[55] Marathon Petroleum Corp., U.S. Securities and Exchange Commission Form 10-K, February 26, 2016, p. 53, http://ir.marathonpetroleum.com/phoenix.zhtml?c=246631&p=irol-sec.
[56] Buckeye Partner, L.P., U.S. Securities and Exchange Commission Form 10-K, February 26, 2016, p. 7, http://www.buckeye.com/LinkClick.aspx?fileticket=4xge-xiR7bM%3d&tabid=222&mid=2146.
[57] Muskegon Pipeline, LLC, FERC Form No. 6: Annual Report of Oil Pipeline Companies, 2015/Q4.
[58] FERC filings show that approximately 5,700 b/d of ORPL system shipments originated in Pennsylvania, presumably delivered into PADD 2 via the bidirectional East Sparta to Midland segment.

In addition, a bidirectional Marathon Petroleum Corp. pipeline runs north and south in eastern Ohio among terminals in Youngstown, Wellsville, and Steubenville, although it operates independently from the ORPL system.[59] This system receives product via an interconnection with Marathon's East Sparta-Midland pipeline in West Point, Ohio. The Wellsville terminal also has barge access on the Ohio River.

Marathon's multimodal supply and logistics system, which includes the company's refineries, pipelines, and barge loading/unloading terminals on the Ohio River, enables the company to adjust product movements in response to planned or unplanned production or transportation outages. Key swing points in the Marathon system include Louisville, which can receive product by pipeline from the Robinson refinery and can both receive and load out product by barge; Lima, Findlay, and Detroit, which are located in the Lima-Detroit refinery corridor; and the Pittsburgh market, which can be fed from the west from Marathon's Eastern Midwest refineries, or from the east via Buckeye's Laurel Pipeline from East Coast supply centers. The Marathon system can also tap into supplemental supplies from the Gulf Coast via interconnections with the Explorer Pipeline system in Wood River and Chicago, and through its barge fleet bringing fuel up the Mississippi River.

Buckeye Partners

Buckeye Partners[60] operates approximately 1,800 miles of common-carrier pipeline systems in the Eastern Midwest, including Buckeye Pipe Line and Buckeye Pipe Line Transportation's northern Ohio and eastern Michigan network, NORCO East pipeline across northern Indiana, Wood River Pipe Lines' southern Illinois system, and Buckeye Aviation's Memphis jet fuel pipeline. In addition, Buckeye operates the West Shore Pipe Line system through a business agreement with West Shore Pipe Line Co., Sunoco Logistics Partners, and other parties.[61, 62] Table 11 lists select Eastern Midwest pipelines operated by Buckeye Partners as well as the various operating subsidiaries, origin points, destination points, and 2015 transportation fuel shipments, where publically available.

[59] MPXL, "UBS MLP Conference," January 13–14, 2015, slide 41, http://www.mplx.com/content/documents/mplx/investor_center/UBS_MPLX_Jan_2015_Web.pdf.
[60] Includes subsidiaries Buckeye Pipe Line Co.; Buckeye Pipe Line Transportation; NORCO Pipeline Co., LLC; Wood River Pipe Lines, LLC; and Buckeye Aviation (Memphis) LLC.
[61] Buckeye Partners, L.P., U.S. Securities and Exchange Commission Form 10-K, February 26, 2016, pp. 4–7, http://www.buckeye.com/LinkClick.aspx?fileticket=4xge-xiR7bM%3d&tabid=222&mid=2146.
[62] Sunoco Logistics Partners L.P., U.S. Securities and Exchange Commission Form 10-K, February 26, 2016, p. 10, http://www.sunocologistics.com/SiteData/docs/10K2015Dra/43f69cf3f247fa20/10-K;%202015%20Draft%20-%20FINAL.pdf.

Table 11. Select Buckeye Partners refined product pipelines in the Eastern Midwest

Company	Origin	Destination	Diam. (in.)	2015 Shipments [e] (b/d)
Buckeye Pipe Line	East Chicago/Hammond, IN	Huntington, IN; Lima, OH	8/10 [b]	267,000
	Huntington, IN	Lima, OH	12/10 [b]	
	Lima, OH	Huntington, IN	8	
	Huntington, IN	Clermont/Avon, IN	8	
	Lima, OH	Columbus, OH	8.5	
	Lima, OH	Toledo, OH	10, 12 [c]	
	Cygnet, OH	Mantua, OH	12	
	Mantua, OH	Cleveland, OH	12	
	Mantua, OH	Midland/Coraopolis, PA	10	
	Toledo, OH	Lima, OH	10, 10 [c]	
	Toledo, OH	Cuyahoga, OH	16/12 [b]	
	Toledo, OH	Woodhaven/Detroit, MI	12	
	Toledo, OH	Wayne, MI [a]	12, 12 [c]	
	Woodhaven, MI	Wayne, MI	10	
	Detroit, MI	Dearborn, MI [a]	8	
	Dearborn, MI	Inkster, MI [a]	N/A [d]	
	Inkster, MI	Wayne, MI	N/A [d]	
	Wayne, MI	Novi, MI	8	
	Wayne, MI	Flint, MI	8.5	
	Flint, MI	Owosso, MI	8	
	Flint, MI	Bay City, MI	8	
Buckeye Pipe Line Transportation	Toledo, OH	West Toledo, OH	6	55,000
	Bradley, OH	Cuyahoga, OH	6, 8 [c]	
	Mogadore, OH	Youngstown, OH	8	
NORCO Pipe Line	Lake George, IN	Hartsdale, IN	8, 8	13,000
	Hartsdale, IN	Toledo, OH	8	
	Hartsdale, IN	Galesburg, IL	8	
Wood River Pipe Lines	Wood River, IL	Peotone, IL; Hammond, IN	14	46,000
	East St. Louis, IL	Hammond/East Chicago, IN	8	
	Hammond, IN	Kankakee, IL	8	
	Peotone, IL	Argo/Des Plaines, IL	14	
	Wood River, IL	Lima, OH	12	
	Wood River, IL	St. Louis Municipal Airport	10	
	Wood River, IL	South St. Louis, MO	8	
	Hartford, IL	Lawrenceville, IL	12	
	Robinson, IL	Lawrenceville, IL [a]	10	
	Lawrenceville, IL	Mt. Vernon, IN	10	
Buckeye Aviation	Memphis, TN	Memphis Intl. Airport	N/A [d]	N/A [d]

[a] Indicates bidirectional flow capability.

[b] Denotes continuous pipeline of varying diameter.

[c] Denotes parallel pipeline segments.
[d] N/A = Not available
[e] Only includes shipments of transportation fuels (motor gasoline, distillates, and jet fuel).
Sources: Buckeye Partners, L.P., website; Buckeye Pipe Line Co., FERC Form No. 6, 2015/Q4; Buckeye Pipe Line Transportation LLC, FERC Form No. 6, 2015/Q4; Wood River Pipe Lines LLC, FERC Form No. 6, 2015/Q4.

Buckeye Partners' main system—operated by Buckeye Pipe Line Co.—shipped approximately 267,000 b/d of transportation fuels in the Eastern Midwest in 2015. The core of Buckeye Pipe Line's system consists of a central pipeline corridor running from Lima through Toledo, Ohio, to Detroit, Michigan. There are multiple lines within this corridor and many of them have bidirectional capabilities, allowing products to move either north or south through the corridor, interconnecting nearly 600,000 b/d of refining capacity. From this core, pipelines spread out to markets throughout the region, including eastbound lines to Columbus and Cleveland, Ohio, and further east into western Pennsylvania; northbound lines to Detroit and locations further north in eastern Michigan; and a westbound line to Indianapolis, which flows through Buckeye's Huntington Junction. In addition, a Buckeye Pipe Line eastbound line from Chicago connects into Huntington, allowing supply from Chicago to move to Indianapolis. This line transported 35,000 b/d in 2015, according to FERC data.

Buckeye Partners' other operating companies in the Eastern Midwest are Buckeye Pipe Line Transportation, NORCO Pipe Line, and Wood River Pipe Lines. In 2015, these systems shipped 55,000 b/d, 13,000 b/d, and 46,000 b/d, respectively.[63] Buckeye Pipe Line Transportation provides several connections between receipt points in northern Ohio. NORCO Pipe Line moves fuel from the Chicago hub to South Bend and Elkhart, Indiana via the NORCO East pipeline. Meanwhile, Buckeye's Wood River Pipe Lines system links the Wood River hub to supply hubs in Chicago, Robinson, and Lima. The Wood River system also includes two segments that extend west across the Mississippi River to supply terminals in the St. Louis metropolitan area and the St. Louis Municipal Airport.

[63] Shipments between Buckeye Pipe Line and subsidiary systems may include shipments between systems.

West Shore Pipe Line

West Shore Pipe Line Company owns the West Shore and Badger pipeline systems, which span approximately 650 miles and are operated by Buckeye Partners.[64] Table 12 lists select segments of the West Shore and Badger Pipeline systems as well as their origins, destinations, lengths, diameters, and 2015 transportation fuel shipments.

Table 12. Select West Shore Pipe Line Company refined product pipelines in the Eastern Midwest

System	Origin	Destination	Distance (mi.)	Diameter (in.)	2015 Shipments [b] (b/d)
West Shore	Romeo, IL	Busse Station, IL	36	16	326,000
	Hammond, IN	Bell, IL	26	16	
	Bell, IL	Granville, WI	64	16	
	Granville, WI	Green Bay/Fox River, WI	98	10	
	St. Marin Jct., WI	Mitchell Field, WI	10	16	
Badger	East Chicago, IN	Canal Jct., IL	26	12	
	Lemont, IL	Canal Jct./Harlem, IL	18	10	
	Canal Jct., IL	Des Plaines, IL	25	12, 16 [a]	
	Des Plaines, IL	O'Hare Intl Airport	3	6, 8 [a]	
	Des Plaines, IL	Rockford, IL/Madison, WI	127	12	

[a] Denotes parallel pipeline segments.

[b] Only includes shipments of transportation fuels (motor gasoline, distillates, and jet fuel).

Sources: West Shore Pipe Line Company website; West Shore Pipe Line Company, FERC Form No. 6, 2015/Q4.

The West Shore system draws supply from Chicago area refineries and terminals, and extends along the western shore of Lake Michigan, supplying points to Milwaukee and Green Bay.[65] As of June 2016, however, West Shore had suspended service indefinitely on the segment of the system north of Milwaukee in order to rebuild the line.[66] This shutdown affects deliveries to the Green Bay and Fox River Valley markets in northeastern Wisconsin. The Badger system originates in the Chicago area, but primarily serves delivery points within the metropolitan area, including O'Hare International Airport. A 12-inch segment of the Badger system extends west from Chicago to supply Rockford, Illinois before traversing north to Madison, Wisconsin. In 2015, the West Shore and Badger systems together shipped approximately 326,000 b/d of transportation fuels, of which a significant portion—a rough estimate of 150,000 b/d—was delivered into Wisconsin.[67]

[64] Buckeye Partners, L.P., U.S. Securities and Exchange Commission Form 10-K, February 26, 2016, p. 7, http://www.buckeye.com/LinkClick.aspx?fileticket=4xge-xiR7bM%3d&tabid=222&mid=2146.
[65] West Shore Pipe Line Co. also offers crude oil transportation service from Lockport to Lemont, Illinois, in west Chicago.
[66] Behm, Don, "Pipeline serving Green Bay closes indefinitely," *Journal Sentinel*, June 22, 2016, http://www.jsonline.com/news/wisconsin/pipeline-serving-green-bay-closes-indefinitely-b99749027z1-383975071.html.
[67] West Shore Pipe Line Co., FERC Form No. 6: Annual Report of Oil Pipeline Companies, 2015/Q4.

Wolverine Pipe Line

Wolverine Pipe Line Company, which is partly owned by Sunoco Logistics Partners and Marathon Petroleum Corp., operates pipeline systems that connect the Chicago supply hub to markets in northwest Indiana and Michigan.[68, 69] Table 13 lists the systems operated by Wolverine Pipe Line Co., including their origins, destinations, mileage, diameters, and 2015 transportation fuel shipments.

Table 13. Select Wolverine Pipe Line Company refined product pipelines in the Eastern Midwest

System	Origin	Destination	Distance (mi.)	Diameter (in.)	2015 Shipments (b/d) [b]
Hammond	Lemont/Lockport, IL	Hammond, IN	41	16	385,000
	Joliet, IL	Hammond, IN	50	16	
Mainline	Hammond, IN	Jackson, MI	174	16	
Spartan	Jackson, MI	Bay City, MI	109	6/8/12 [a]	
Loop	Hammond, IN	Niles, MI	68	16	
Extension	Niles, MI	Grand Haven/Ferrysburg, MI	96	8	

[a] Denotes continuous pipeline of varying diameter.

[b] Only includes shipments of transportation fuels (motor gasoline, distillates, and jet fuel).

Source: Wolverine Pipe Line Co. website; West Shore Pipe Line Co., FERC Form No. 6, 2015/Q4.

Wolverine's Hammond system gathers production from refineries (ExxonMobil Joliet and CITGO Lemont) and pipeline interconnections in the Chicago area and delivers them to the Hammond, Indiana terminal cluster. From Hammond, two parallel pipelines cross northwestern Indiana before splitting into separate routes into Michigan. Wolverine's Mainline system pushes supply into south central Michigan, where it feeds the Spartan system north to Lansing and Bay City. Meanwhile, Wolverine's Loop system pushes fuel into southwestern Michigan, where it feeds the Extension system north to delivery points along the east shore of Lake Michigan.[70] In 2015, Wolverine's system shipped approximately 385,000 b/d, most of which was delivered to receipt points in Michigan.[71]

[68] Sunoco Logistics Partners L.P., U.S. Securities and Exchange Commission Form 10-K, February 26, 2016, p. 10, http://www.sunocologistics.com/SiteData/docs/10K2015Dra/43f69cf3f247fa20/10-K;%202015%20Draft%20-%20FINAL.pdf.

[69] Marathon Petroleum Corp., U.S. Securities and Exchange Commission Form 10-K, February 26, 2016, p. 53, http://ir.marathonpetroleum.com/phoenix.zhtml?c=246631&p=irol-sec.

[70] Wolverine Pipe Line Co., "System Overview" (accessed November 23, 2016), http://wolverinepipeline.com/about-us/system-overview.

[71] Wolverine Pipe Line Co., FERC Form 6: Annual Report of Oil Pipeline Companies, 2015/Q4.

Sunoco Logistics

Sunoco Logistics Partners is the majority owner and operator of three pipeline systems in the Eastern Midwest. Table 14 lists the origins and destinations of these systems, as well as their lengths, diameters, and 2015 shipments of transportation fuels, if available.

Table 14. Select Sunoco Logistics refined product pipelines in the Eastern Midwest

System	Origin	Destination	Dist. (mi.)	Diam. (in.)	2015 Shipments (b/d) [b]
Inland	Toledo, OH	Fostoria, OH	38	10	116,000
	Fostoria, OH	Lima, OH	52	10	
	Lima, OH	Fostoria, OH	51	8	
	Lima, OH	Dayton, OH	68	12	
	Lima, OH	Columbus, OH	78	10	
	Canton, OH	Mogadore, OH	18	5	
	Mogadore, OH	Akron/Cleveland, OH	38	10/12 [a]	
Toledo North	Toledo, OH	Inkster, MI	84	10/6 [a]	N/A [c]
Fostoria-Pittsburgh	Fostoria, OH	Mogadore, OH/ Delmont, PA	176	10/12 [a]	N/A [c]

[a] Denotes continuous pipeline of varying diameter.

[b] Only includes shipments of transportation fuels (motor gasoline, distillates, and jet fuel).

[c] N/A = Not available.

Sources: Sunoco Logistics Partners website; Sunoco Pipeline L.P., FERC Form No. 6, 2015/Q4; Inland Corp., FERC Form No. 6, 2015/Q4.

Sunoco's Inland system supplies products from the Toledo and Lima refineries south to distribution terminals in Dayton and Columbus, Ohio, and to an interconnection point in Fostoria, Ohio, which is the origin of the company's Fostoria-Pittsburgh system.[72] A separate leg of the Inland system supplies products from the Marathon Canton refinery to Akron and Cleveland, Ohio. The Inland system shipped 116,000 b/d of transportation fuels in 2015, according to FERC filings. Meanwhile, Sunoco's Toledo North segment connects the Toledo hub to Detroit, while its Fostoria-Pittsburgh system supplies product off the Inland system in Fostoria to the Pittsburgh market in western Pennsylvania. During the first quarter of 2015, Sunoco commenced operations on its 85,000 b/d Allegheny Access project, which transports products to markets in eastern Ohio and western Pennsylvania, utilizing existing portions of Sunoco's Inland and Fostoria-Pittsburgh systems.[73]

[72] Sunoco Logistics Partners L.P., U.S. Securities and Exchange Commission Form 10-K, February 26, 2016, p. 10, http://www.sunocologistics.com/SiteData/docs/10K2015Dra/43f69cf3f247fa20/10-K;%202015%20Draft%20-%20FINAL.pdf.

[73] Sunoco Logistics, "Mariner West & Allegheny Access Pipeline Projects" (accessed November 23, 2016), http://www.shelbytwp.org/docs/Sunoco_packet.pdf.

BP Pipelines North America

BP Pipelines North America ships fuel within the Eastern Midwest region, and also supplies fuel into adjacent regions within PADD 2. Table 15 lists the pipeline systems operated by BP in the Eastern Midwest as well as their origins, destinations, diameters, and 2015 shipments of transportation fuels.

Table 15. Select BP Pipelines North America refined product pipelines in the Eastern Midwest

Route	Origin	Destination	Diameter (in.)	2015 Shipments (b/d) [d]
O'Hare Airport	Manhattan, IL	O'Hare Airport	8	196,000
Whiting to Detroit	Whiting, IN	River Rouge, MI	10	
Whiting to Indianapolis	Whiting, IN	Indianapolis, IN	8	
Whiting to Springfield	Manhattan, IL	Wilmington, IL [a]	12	
Whiting to Minneapolis	Whiting, IN	Dubuque, IA [b]	10/12 [c]	
	Dubuque, IA	Minneapolis, MN	10	
Wood River to Milan	Wood River, IL	Milan, MO [b]	12	24,000
Dayton to Cincinnati	Dayton, OH	Bromley, KY	8/6 [c]	27,000
	Bromley, KY	Cincinnati, OH	6	

[a] Connects to Magellan's Wilmington-to-Petersburg, Illinois segment, which supplies central Illinois.[74]

[b] Connects to Buckeye's Lower V system.

[c] Denotes continuous pipeline of varying diameter.

[d] Only includes shipments of transportation fuels (motor gasoline, distillates, and jet fuel).

Sources: BP Pipelines North America Inc., Tariffs, effective July 1, 2016; BP Pipelines North America Inc., FERC Form No. 6, 2015/Q4; Buckeye Pipe Line Transportation LLC, FERC Form No. 6, 2015/Q4.

The largest group of BP pipelines originates at BP's 413,500 b/cd Whiting, Indiana refinery, the largest refinery in PADD 2. Several significant pipelines extend from Whiting: a westward line connects the refinery to Dubuque, Iowa, the origin of Buckeye's Lower V system in the Southern Midwest, and further to Minneapolis, Minnesota; an eastward segment connects Whiting to markets in southern Michigan before terminating at River Rouge in the Detroit area; and a southbound segment moves fuel south to Wilmington, Illinois where an interconnection with the Magellan Pipeline system provides access to the markets in central Illinois. According to FERC filings, approximately 196,000 b/d of transportation fuels originated on BP lines in Whiting, Indiana in 2015, equal to nearly half of the refinery's crude distillation capacity. Of those shipments, approximately 53,000 b/d were delivered into the Detroit market. Other BP lines in the Eastern Midwest include a line extending west from the Wood River hub to an interconnection with Buckeye's Lower V system in Milan, Missouri; and a line extending south from Dayton, Ohio to BP-owned terminals in the Cincinnati metropolitan area. In 2015, shipments on the Wood River to the Milan line averaged 24,000 b/d, while shipments on BP's Dayton-to-Cincinnati system averaged 27,000 b/d, with half of this supply originating at pipeline interconnections in Ohio and the other half originating from barge receipts at BP's Bromley, Kentucky terminal.

[74] Magellan Pipeline Company, L.P., FERC No. 164.6.0, https://www.magellanlp.com/directory/MPLLP/FERC/FERC%20164.6.0%20MPLLP%20Wilmington%20Local.pdf.

Magellan Pipeline Company

Table 16 lists the active Magellan segments in the Eastern Midwest, including their origins, destinations, lengths, diameters, and 2015 shipments of transportation fuels, if available. Magellan operates a 12-inch pipeline between Wilmington, Illinois, just south of Chicago, and Lincoln, Illinois in the central part of the state. Product on this line originates from an interconnection with BP's Chicago area pipeline system in Wilmington and flows south to delivery points in central Illinois, including the Springfield area. In 2015, approximately 24,000 b/d of transportation fuels originated on this Magellan segment in Illinois.[75] A separate bidirectional 12-inch segment connects Des Moines, Iowa—a logistical hub on Magellan's system—to the Chicago market. The Davenport, Iowa metropolitan area is supplied from this pipeline.

Table 16. Select Magellan Pipeline Company refined product pipelines in the Eastern Midwest

Route	Origin	Destination	Dist. (mi.)	Diam. (in.)	2015 Shipments (b/d) [a]
Chicago to Springfield	Wilmington, IL	Lincoln, IL	129	12	24,000
Des Moines to Chicago	Des Moines, IA	Chicago, IL	304	12	N/A [b]

[a] Only includes shipments of transportation fuels (motor gasoline, distillates, and jet fuel).

[b] N/A = Not available

Source: Magellan Pipeline Company, L.P., FERC Form No. 6, 2015/Q4.

Other Pipelines

Other internal pipelines in the Eastern Midwest include systems operated by Phillips 66, Valero Energy Partners, and CountryMark. Table 17 lists these systems, including their origins, destinations, and capacities, where publically available.

Table 17. Select other refined product pipelines in the Eastern Midwest

System	Origin	Destination	Capacity (b/d)
Phillips 66 Gold Line	Paola, KS	Cahokia, IL	53,000
Valero Shorthorn Pipeline System	Memphis, TN	West Memphis, AR	120,000
Valero Memphis Airport Pipeline System	Memphis, TN	Memphis Intl Airport	20,000
CountryMark	Mt. Vernon, IN	Peru, IN	N/A [a]

[a] N/A = Not available

Sources: Phillips 66 Partners, Gold Line Factsheet; Valero Energy Partners website; CountryMark website.

Phillips 66's 681-mile, 132,000 b/d Gold Line Pipeline system, which draws supply from refineries in the Texas Panhandle and Oklahoma, primarily serves demand centers in the Southern Midwest region, but also extends east into the Wood River supply hub via a 53,000 b/d segment between Paola, Kansas and Cahokia, Illinois. Valero's Memphis Products system is the primary distribution outlet for transportation fuels produced at Valero's 190,000 b/cd Memphis, Tennessee refinery. The system comprises the 120,000 b/d Shorthorn Pipeline system, which links the Memphis refinery to terminals in Memphis, Tennessee and across the Mississippi River in West Memphis, Arkansas; and the 20,000 b/d Memphis Airport Pipeline, which transports jet fuel to the Memphis International Airport. Finally, CountryMark owns and operates

[75] Magellan Pipeline Company, L.P., FERC Form No. 6: Annual Report of Oil Pipeline Companies, 2015/Q4.

a proprietary pipeline that originates at its 27,100 b/cd Mount Vernon, Indiana refinery and extends 238 miles northeast, delivering fuels to the Indianapolis area and smaller markets in central Indiana.[76]

Pipelines from the Gulf Coast

Pipeline systems with the capability to move supply from the Gulf Coast (PADD 3) into the Eastern Midwest include Colonial Pipeline, Plantation Pipeline, Explorer Pipeline, Enterprise TEPPCO, and Centennial Pipeline. These systems are described below.

Colonial and Plantation

The Colonial and Plantation pipeline systems transport refined products from Gulf Coast refining centers up the Eastern Seaboard to markets as far north as the New York City area. Colonial's system-wide capacity is approximately 2.5 million b/d and Plantation's system-wide capacity is approximately 700,000 b/d. In the Eastern Midwest, the Colonial and Plantation pipeline systems supply products into eastern and central Tennessee via spur pipelines that originate near Atlanta, Georgia in PADD 1. Table 18 lists the spur segments of the Colonial and Plantation pipeline systems, as well as their origins, destinations, diameters, and estimated combined shipments of transportation fuels in 2015.

Table 18. Select Colonial and Plantation refined product pipelines in the Eastern Midwest

System	Segment	Origin	Destination	Diam. (in.)	2015 Shipments (b/d) [a]
Colonial Pipeline	Line 19	Atlanta, GA	Chattanooga Jct./Nashville, TN	10/12	250,000-300,000
	Line 20	Atlanta, GA	Chattanooga Jct./Nashville, TN	8	
	Knoxville Spur	Atlanta, GA	Chattanooga Jct./Knoxville, TN	16/10	
Plantation Pipeline	Knoxville Spur	Bremen, GA	Chattanooga/Knoxville, TN	8	

[a] Only includes shipments of transportation fuels (motor gasoline, distillates, and jet fuel).
Sources: Colonial Pipeline Co., System Map; Kinder Morgan, Plantation Pipeline System Map.

Three Colonial pipelines extend northwest from Colonial's Atlanta junction toward a junction in Chattanooga, Tennessee. From Chattanooga, Lines 19 and 20 extend further northwest to Nashville, while the third spur extends northeast to Knoxville, Tennessee. Lines 19 and 20, which run parallel to each other, handle gasoline and distillate respectively.[77] Jet fuel, which is transported on Line 19, supplies the Nashville International Airport. Similarly, a spur from the Plantation Pipeline system extends north from its Bremen, Georgia junction to Chattanooga, and then further northeast to Knoxville. In 2015, total movements of transportation fuels between PADD 1 and PADD 2 averaged 309,000 b/d.[78] Of this volume, approximately 250,000 to 300,000 b/d is estimated to have moved from Georgia to Tennessee on the Colonial and Plantation systems.

[76] CountryMark, "Products Pipeline" (accessed September 30, 2016), http://www.countrymark.com/countrymark/AboutUs/ProductsPipelineMap.aspx.
[77] Reuters, "Colonial Pipeline reports Tennessee gasoline spill," October 4, 2012, http://www.reuters.com/article/pipeline-operations-colonial-atlanta-idUSL1E8L50F120121005.
[78] U.S. Energy Information Administration, *Movements by Pipeline between PAD Districts: PADD 1 to PADD 2*, (accessed September 30, 2016).

Explorer Pipeline

Explorer Pipeline's 1,830-mile pipeline system carries refined products from the Gulf Coast (PADD 3) to the Midwest (PADD 2). Table 19 lists the segments making up Explorer Pipeline's Northern system, which enters the Eastern Midwest from the Southern Midwest. The table includes each segment's origin, destination, and diameter, as well as each system's total capacity.

Table 19. Select Explorer Pipeline refined product pipelines in the Eastern Midwest

System	Origin	Destination	Diameter (in.)	Capacity (b/d)
Southern	Houston, TX	Glenpool, OK	28	660,000
	Glenpool, OK	West Tulsa, OK	28	
	Houston, TX	Ardmore, OK	10/8 [a]	
Northern	Glenpool, OK	Wood River, IL	24	450,000
	Wood River, IL	St. Louis, MO	14	
	Wood River, IL	Hammond, IN	24	

[a] Denotes continuous pipeline of varying diameter.

Source: Explorer Pipeline website.

Explorer Pipeline's mainline system is split into a 660,000 b/d Southern system, which runs from the Texas Gulf Coast to Glenpool, Oklahoma; and a 450,000 b/d Northern system, which extends from Glenpool to the Wood River and Chicago area supply hubs in the Eastern Midwest. From Wood River, an Explorer spur carries fuel back across the Mississippi River to St. Louis, Missouri. In 2015, total flows on the Explorer system averaged approximately 610,000 b/d, a volume that includes shipments of diluent for ultimate delivery via connecting carriers to the Alberta Oil Sands.[79] While the vast majority of shipments originated in Texas, approximately 28,000 b/d originated from Wood River in 2015, presumably for delivery to the Chicago market.[80]

[79] Explorer Pipeline Co., FERC Form No. 6: Annual Report of Oil Pipeline Companies, 2015/Q4.
[80] Ibid.

Enterprise TEPPCO

The Enterprise TEPPCO pipeline system is a 3,396-mile pipeline system that carries transportation fuels, propane, and diluent from the Gulf Coast (PADD 3) to destination points across the Midwest (PADD 2) and East Coast (PADD 1). Table 20 lists the major segments and spurs that make up the TEPPCO system in the Eastern Midwest, as well as their lengths, diameters, and capacities, when available.

Table 20. Select Enterprise TEPPCO refined product pipelines in the Eastern Midwest

Segment	Origin	Destination	Distance (mi.)	Diameter (in.)	Capacity (b/d)
TEPPCO Mainline (P-2)	Beaumont, TX	Seymour, IN	921	20	330,000 [a]
Chicago Lateral (P-35)	Seymour, IN	Chicago, IL	234	14	N/A [b]
Memphis Lateral (P-74/P-107)	Garner, AR	Memphis, TN	98	12	N/A [b]
Lima Lateral (P-45)	Lebanon, OH	Lima, OH	96	10	N/A [b]
Cincinnati Airport Lateral (TO-1)	Todhunter, OH	Cincinnati Intl Airport (KY)	48	6	N/A [b]

[a] Estimated

[b] N/A = Not available

Sources: Enterprise Products Partners L.P., U.S. Securities and Exchange Commission Form 10-K, February 26, 2016; Enterprise TE Products Pipeline System Oil Spill Response Plan (Pipeline and Hazardous Materials Safety Administration [PHMSA]).

In 2015, the system transported 440,000 b/d of refined products, according to the company's annual report; however, this number includes volumes shipped on parts of its system that lie within PADD 3 only, shipments of propane, and may include some northbound movements of diluent for ultimate delivery to the Alberta Oil Sands. Northbound flows of transportation fuels on the TEPPCO pipeline have declined significantly in recent years and Enterprise reversed and repurposed one of TEPPCO's two mainline pipelines to carry ethane from the Marcellus/Utica Shale region in the Northeast to destinations in the Gulf Coast. In addition, TEPPCO no longer delivers distillates or jet fuel from the Gulf Coast into the Midwest on its mainline system, and gasoline cannot be shipped further east than Seymour, Indiana, although a spur of the system allows gasoline to be delivered from Seymour into the Chicago market. A spur segment from TEPPCO's mainline in Arkansas also delivers transportation fuels, including jet fuel, to Memphis, Tennessee. In addition, two TEPPCO lateral segments independent of the mainline system move transportation fuels in Ohio and Kentucky, including a line that delivers jet fuel to Cincinnati International Airport in northern Kentucky.[81] According to FERC filings, these lines in Ohio and Kentucky shipped approximately 14,000 b/d in 2015.[82]

Centennial Pipeline

Marathon Petroleum operates the Centennial Pipeline system through a business agreement with Enterprise Products Partners.[83] The system has the capacity to ship 210,000 b/d from the Beaumont-Port Arthur, Texas refinery hub to Dietrich, Illinois, where the system interconnects with Marathon's Robinson

[81] Federal Energy Regulatory Commission, Docket No. IS13-265-000, accessed July 16, 2016.
[82] Enterprise TE Products Pipeline Co., FERC Form No. 6: Annual Report of Oil Pipeline Companies, 2015/Q4.
[83] Marathon Petroleum Corp., U.S. Securities and Exchange Commission Form 10-K, February 26, 2016, p. 53, http://ir.marathonpetroleum.com/phoenix.zhtml?c=246631&p=irol-sec.

Products system.[84]Centennial has been largely empty since 2011 and its owners are considering repurposing the line as part of a project to ship NGLs from Northeast shale plays to the Gulf Coast.[85]

Ports and Waterways

Significant volumes of transportation fuels are shipped by barge into, out of, and within the Eastern Midwest along the region's waterways, including the Illinois and Mississippi rivers, the Ohio and Big Sandy rivers, the Tennessee and Cumberland rivers, and the Great Lakes. Table 21 lists the Eastern Midwest ports located along these waterways, including their inbound and outbound shipments of transportation fuels in 2014, the latest year for which domestic waterborne movement data are available from the U.S. Army Corps of Engineers (USACE).

Table 21. Waterborne movements of transportation fuels at Eastern Midwest ports, 2014

barrels per day

Port/Waterway [a]	Inbound [e]	Outbound [e]
Illinois and Mississippi Rivers		
Illinois Waterway (incl. Chicago, IL)	4,100	23,600
Port of St. Louis [b]	2,600	7,800
Memphis, TN	20,200	38,700
Total	**26,900**	**70,100**
Ohio and Big Sandy Rivers		
Catlettsburg, KY [c]	7,400	106,800
Big Sandy River (KY)	4,900	-
Cincinnati, OH (incl. KY side)	47,900	5,000
Louisville, KY	51,400	4,100
Mount Vernon, IN	1,400	23,800
Total	**113,000**	**139,800**
Tennessee and Cumberland Rivers		
Tennessee River (TN, AL, and KY) [d]	16,000	2,100
Cumberland River (KY and TN)	3,500	-
Total	**19,500**	**2,100**
Great Lakes		
Cleveland, OH	1,800	-
Toledo, OH	900	2,700
Detroit, MI	700	400
Cheboygan Harbor, MI	1,500	-
Indiana Harbor, IN	1,000	8,700
Total	**6,000**	**11,800**
Total Eastern Midwest	**165,500**	**223,800**

[a] Line items may not sum to total due to independent rounding.

[b] Includes Wood River and Hartford, Illinois.

[c] Volumes for Port of Huntington Tri-State (Kentucky, West Virginia, and Ohio).

[d] Includes deliveries to Alabama locations.

[e] Does not include ethanol volumes or local shipments of fuels between two docks within the same port.

Source: U.S. Army Corps of Engineers, 2014 Waterborne Commerce of the United States Waterways and Harbors.

[84] Marathon Petroleum Corp., "Dietrich to Martinsville" (accessed November 23, 2016), http://www.mplx.com/About_MPLX/Asset_Map.

[85] Reuters, "Enterprise: Centennial conversion to NGLs a two-year project," September 8, 2015, http://www.reuters.com/article/centennial-pipeline-enterprise-idAFL1N11E18720150908.

While the table shows considerable volumes moving into and out of the region's ports, the majority of shipments originate and terminate wholly within the Eastern Midwest. More than 140,000 b/d of transportation fuels moved along the Ohio River in 2014, with volumes primarily loaded at Marathon's Catlettsburg refinery in Kentucky (107,000 b/d), and at Mount Vernon, Indiana, where supply of 24,000 b/d was sourced from the Marathon Robinson refinery and the CountryMark Mount Vernon refinery. Major receipt points on the Ohio River include terminals in the Louisville and Cincinnati metropolitan areas. Memphis was the largest-volume port on the Mississippi River in 2014, loading out 39,000 b/d of transportation fuels from the Valero Memphis refinery, and receiving approximately 20,000 b/d of inbound shipments by barge. Meanwhile, ports along the Illinois River in the Chicago metropolitan area loaded out approximately 24,000 b/d.

Significant movements of transportation fuels take place between Eastern Midwest ports and ports in adjacent regions. EIA tracks movements by tanker and barge between PADD regions. Waterborne movements between the Eastern Midwest and the East Coast (PADD 1) take place along the Ohio River between the Catlettsburg refinery and receipt points in West Virginia and western Pennsylvania. In 2015, barge movements to PADD 1 markets averaged approximately 30,000 b/d.[86] Waterborne movements between the Eastern Midwest and the Gulf Coast (PADD 3) along the Mississippi River flow in both directions, with 38,000 b/d flowing north from the Gulf Coast into the Eastern Midwest in 2015, and approximately 19,000 b/d moving south from the Eastern Midwest into the Gulf Coast.

Markets

Chicago

The Chicago metropolitan area is the Eastern Midwest's largest supply and logistics center, as well as the region's largest demand center. Supply gathered in Chicago reaches a wide swath of PADD 2, including Wisconsin, Indiana, Michigan, and Ohio, as well as local markets in northern Illinois. Local fuel production comes from BP's 415,000 b/cd Whiting, Indiana refinery, located on the southern shore of Lake Michigan, and ExxonMobil's 238,600 b/cd Joliet and Citgo's 175,940 b/cd Lemont refineries located along the Des Plaines River in Illinois. Inbound pipelines supply Chicago from refineries in Wood River and Robinson, Illinois via Marathon's Robinson Products and Wabash Pipeline systems, and Buckeye's Wood River Pipeline system; and from refineries in the Gulf Coast via the Explorer Pipeline and Enterprise TEPPCO systems. In addition, a 12-inch Magellan line from Des Moines, Iowa provides access to refining centers in the Southern Midwest and Northern Midwest.

Numerous outbound pipelines ship fuel from the Chicago hub to markets across the region. From Chicago, the Wolverine and North Muskegon pipeline systems extend northeast to delivery points in Michigan. Transportation fuel shipments on these systems averaged 412,000 b/d in 2015.[87] Meanwhile, the West Shore Pipe Line system (including the Badger system) supplies terminals within the Chicago metropolitan area before extending northwest to supply markets in central and eastern Wisconsin. Shipments on this

[86] U.S. Energy Information Administration, *Movements by Tanker and Barge between PAD Districts: PADD 2 to PADD 1*, (accessed September 30, 2016).
[87] Wolverine Pipe Line Co. and Muskegon Pipeline LLC, FERC Form 6: Annual Report of Oil Pipeline Companies, 2015/Q4.

system averaged 326,000 b/d in 2015.[88] Buckeye's NORCO East and Hammond-to-Lima systems channel fuel eastward to markets in Indiana and Ohio, with combined shipments averaging 48,000 b/d in 2015.[89] Production from BP's Whiting refinery is also distributed via a network of BP pipelines stretching west to Dubuque, Iowa; south to Wilmington, Illinois; and east to Rouge River, Michigan (in the Detroit area). Flows on these lines averaged 196,000 b/d in 2015, equal to nearly half of the Whiting refinery's crude distillation capacity. In addition, petroleum barges move along the Illinois River, primarily loading out products from the Lemont and Joliet refineries. In 2014, terminals along the Illinois River system loaded out approximately 24,000 b/d of transportation fuels according to USACE.

Northern Ohio and Eastern Michigan

Transportation fuels markets in northern Ohio and eastern Michigan are largely supplied by five local refineries with a combined crude distillation capacity of 690,000 b/cd. Four of these refineries, with nearly 600,000 b/cd of capacity, are located along a bidirectional pipeline corridor, stretching from Lima to Detroit, including Husky Energy's 152,000 b/cd Lima refinery, PBF Energy's 160,000 b/cd Toledo refinery, BP Husky Refining's 153,000 b/cd Toledo refinery, and Marathon's 130,000 b/cd Detroit refinery. Supply is also delivered into the Lima-Detroit corridor from supply hubs in Indiana and Illinois: a BP line runs from BP's Whiting refinery to Detroit, while a Marathon line runs from Marathon's Robinson refinery to Lima.

From the central Lima-Detroit corridor, pipelines operated by Buckeye Partners and Sunoco Logistics branch north to terminals in Detroit, and to points further north in eastern Michigan; east to Cleveland and further east to Pittsburgh in PADD 1; and south to Columbus. The region is also supplied by Marathon's 93,000 b/cd refinery in Canton, Ohio, which delivers products via Marathon's Ohio River Pipeline System (ORPL) system west to Columbus and Dayton, Ohio; east into the Pittsburgh market; and via interconnections with other Marathon lines to Youngstown and Steubenville in eastern Ohio. Supply is also shipped into Columbus from Marathon's refinery in Catlettsburg, Kentucky via Cardinal Pipeline. In 2015, the ORPL system shipped approximately 156,000 b/d, including 45,000 b/d via Cardinal Pipeline.

From the Detroit area, product is also exported to Canada. Small volumes of gasoline and distillates primarily move by truck to neighboring population centers across the border in Ontario, while larger volumes of jet fuel move by rail from Detroit area terminals to Toronto Pearson International Airport. In 2015, jet fuel exports to Canada from Detroit averaged 23,000 b/d, although export volumes varied significantly from a low of 3,000 b/d in August and September to a high of 44,000 b/d in November.

Ohio River

Demand centers along the Ohio River system, including Louisville, Kentucky and Cincinnati, Ohio, receive significant volumes of petroleum products supplied by barge from refineries and barge loading terminals at other locations on the river, but also receive volumes by pipeline. Refineries located directly on the Ohio River include Marathon's 273,000 b/cd Catlettsburg, Kentucky refinery and CountryMarks's 27,100 b/cd Mount Vernon, Indiana refinery. In addition, Marathon's 212,000 b/cd Robinson, Illinois refinery is connected by pipeline to barge loading terminals in Mount Vernon and Louisville. According to USACE,

[88] West Shore Pipe Line Co., FERC Form 6: Annual Report of Oil Pipeline Companies, 2015/Q4.

[89] Buckeye Pipe Line Co. and NORCO Pipeline Co., FERC Form 6: Annual Report of Oil Pipeline Companies, 2015/Q4.

shipments of transportation fuels outloaded on the Ohio River system averaged nearly 140,000 b/d in 2014, including 107,000 b/d sourced from Catlettsburg, 24,000 b/d sourced from Mount Vernon, and 4,000 b/d sourced from Louisville. Meanwhile, ports on the Ohio River received approximately 113,000 b/d of transportation fuels by barge in 2014, with 51,000 b/d received in Louisville, and 48,000 b/d received in the Cincinnati area. Ohio River markets also receive supply by pipeline, including via a 92,000 b/d Marathon pipeline segment, which supplies products from the Robinson refinery to Louisville (and via an extension to Lexington), and via a proprietary BP pipeline from Dayton south to terminals in the Cincinnati area. Louisville is a key flex point for supply on the Ohio River, with the ability to receive product by pipeline and barge but also to outload product, if needed, to supply other Ohio River markets.

St. Louis/Wood River

The St. Louis metropolitan area, which straddles the Mississippi River between Missouri and Illinois, is primarily supplied from Phillips 66 and Cenovus Energy's 336,000 b/d joint-venture refinery in Wood River, Illinois (WRB Refining). Wood River is also a major pipeline hub, serving as both an origin and a destination point for numerous pipeline systems. From the west, Explorer Pipeline delivers supply from the Gulf Coast via its 450,000 b/d Northern system, which passes through Wood River before continuing northeast to the Chicago market, and Phillips 66's Gold Line from refineries in the Texas Panhandle and Midcontinent delivers up to 53,000 b/d via a segment of its system running from Paola, Kansas to East St. Louis, Illinois, just south of Wood River.

From Wood River, Buckeye pipelines move fuel to the Chicago market (14-inch), to Indianapolis and Lima (12-inch), and to destination points in southeastern Illinois (12-inch), while Marathon's Wabash system ships gasoline and distillates to Chicago (12-inch) and Indianapolis (10-inch). In addition, BP Pipelines (North America) ships products from Wood River to an interconnection with Buckeye's Lower V system in Milan, Missouri. Shipments along this line averaged 18,000 b/d in 2015, according to FERC filings. Within the St. Louis area, several short-distance pipelines operated by Explorer, Buckeye, and Marathon move gasoline and distillates from the Wood River hub to terminals in St. Louis and East St. Louis. In addition, two pipelines from Wood River—a 10-inch Buckeye line and Allied Aviation's St. Louis Pipeline—supply jet fuel to Lambert-St. Louis International Airport.[90] Although several terminals in the St. Louis area are capable of receiving shipments by barge, receipts of transportation fuels are minimal—only 4,000 b/d were received into the Port of St. Louis in 2014, including approximately 1,500 b/d shipped locally within the port. Meanwhile, approximately 8,000 b/d were loaded onto barges for outbound shipment, primarily from Wood River.[91]

Memphis

The Memphis market is predominantly supplied by Valero's 190,000 b/cd Memphis refinery, but it also receives inbound barge shipments on the Mississippi River and inbound pipeline movements from a 12-inch spur off of the Enterprise TEPPCO mainline in Arkansas. Products from the Memphis refinery are primarily distributed from the refinery's truck rack and via Valero's 120,000 b/d Shorthorn Pipeline

[90] Allied Aviation, "Pipelines" (accessed September 30, 2016), http://www.alliedaviation.com/locations/pipeline/pipeline.html.
[91] Cited volumes do not include ethanol.

system, which connects the refinery to local terminals in Memphis, Tennessee and West Memphis, Arkansas, and Valero's 20,000 b/d Memphis Airport pipeline, which supplies jet fuel to Memphis International Airport, including a spur to the tank farm serving FedEx Express, a cargo airline that uses the Memphis airport as its central hub. A 16-mile Buckeye Aviation pipeline also supplies jet fuel to both the airport and FedEx tank farms. Products are also loaded onto barges from the Memphis refinery and received by barge at Memphis area terminals along the Mississippi River. In 2014, outbound barge shipments averaged 39,000 b/d (25,000 b/d of gasoline and 14,000 b/d of distillates), while inbound shipments were 20,000 b/d (6,000 b/d of gasoline, 12,000 b/d of distillates, and 2,000 b/d of jet fuel).

Central and Eastern Tennessee

Markets in central and eastern Tennessee, including Nashville, Knoxville, and Chattanooga, are geographically isolated from major supply and logistics infrastructure supplying other parts of the Eastern Midwest. These markets are supplied almost entirely from the Gulf Coast via spurs off of the Colonial and Plantation pipeline systems from pipeline junctions in Georgia. Nashville is supplied via Colonial Lines 19 and 20, while two spurs—one Colonial and one Planation—supply the Knoxville market. In 2015, flows on these systems were estimated to be 250,000 to 300,000 b/d. Some terminals in the Nashville market are also capable of receiving fuel deliveries by barge along the Cumberland River. In 2014, inbound barge receipts of gasoline and distillates to the Nashville market averaged 3,000 b/d.

Supply vulnerability

The Eastern Midwest has ample in-region fuel production, and the region's supply and demand centers are connected to one another through a broad network of pipeline systems, providing significant supply flexibility between most of the region's major markets. In 2015, Eastern Midwest refineries produced 2.04 million b/d, enough to meet 90% of in-region transportation fuel demand net of ethanol and biodiesel inputs. The major supply hubs across the region's northern tier—Chicago, Wood River, the Lima-Detroit corridor, Catlettsburg, Robinson, and Canton—are geographically dispersed but are connected by pipelines and major waterways to each other and many of the region's primary demand centers, including Chicago, Indianapolis, Detroit, and Cleveland. These pipeline networks, which are primarily operated by Buckeye and Marathon, include several bidirectional lines that allow products to flow to major markets from multiple directions, providing significant competition and supply source flexibility.

The Eastern Midwest also has significant inter-PADD flexibility through pipeline connections to the East Coast (PADD 1) and the Gulf Coast (PADD 3). Historically, the Pittsburgh market in western Pennsylvania has acted as a balancing point for product supply between the East Coast and the Eastern Midwest. In 2015, product flows primarily moved west from Ohio into western Pennsylvania along several pipeline systems—Buckeye, Sunoco, and Marathon. However, the Pittsburgh market was also supplied from East Coast supply centers via Buckeye's Laurel Pipeline system, which, as of 2016, had an 180,000 b/d capacity into Pittsburgh and typically ran below capacity. As a result, if unplanned outages in the Eastern Midwest lead to shortages of transportation fuels, Ohio refiners could shift supply away from Pittsburgh, and instead supply customers in the Pittsburgh market through increased flows from East Coast supply centers along the Laurel Pipeline (although Pittsburgh's gasoline specification requirements can complicate this supply flexibility). Buckeye announced plans in 2016 to partially reverse the Laurel system by 2018 to

move product from Pittsburgh to central Pennsylvania, potentially reducing Pittsburgh's role as a balancing point between the Eastern Midwest and PADD 1.[92]

The Eastern Midwest also has access to two major inter-PADD pipelines that supply fuels into the region from the Gulf Coast: Explorer and TEPPCO. These lines provide the Eastern Midwest with significant flexibility to bring in supplemental fuels either to meet seasonal increases in consumption, or to compensate for in-region refinery outages. These systems feed into supply hubs in Chicago and Wood River. In 2015, inter-PADD transportation fuel movements between the Gulf Coast (PADD 3) and the Midwest (PADD 2) averaged 400,000 b/d, with flows varying from a low of 270,000 b/d in February to a high of more than 600,000 b/d in October amid an unusually high number of planned refinery outages. The majority of these flows were delivered into the Eastern Midwest region, although some volumes were delivered into the Southern Midwest or were trans-shipped across PADD 2 to the Rocky Mountain (PADD 4) region.

Despite these connections, it has grown more challenging to move products from the Gulf Coast into the Eastern Midwest. In 2013, TEPPCO, which initially delivered fuels from the Gulf Coast to the Midwest and East Coast, reversed one of the two pipelines making up its mainline system to carry ethane from the Marcellus Shale region to the Gulf Coast and TEPPCO no longer delivers transportation fuels on its remaining mainline pipeline beyond eastern Indiana. In addition, both TEPPCO and Explorer are using excess capacity on their systems to ship increasing volumes of light hydrocarbons (such as natural gasoline) for ultimate delivery to the Alberta Oil Sands for use as a diluent for bitumen. In recent years, shippers have reported difficulty moving product into the Chicago market, noting that Explorer Pipeline consistently lacks available space.[93]

In addition to these challenges, several markets in the region's southern tier are relatively isolated from region's northern supply networks, making them more vulnerable to disruption. Markets in central and eastern Tennessee—Nashville, Knoxville, and Chattanooga—are supplied almost entirely via spur pipelines from the Colonial and Plantation systems from the Gulf Coast. These spur lines originate at pipeline junctions in Georgia. In 2015, an estimated 250,000 to 300,000 b/d of transportation fuels flowed from the East Coast (PADD 1) to the Midwest (PADD 2) along these lines. Central and eastern Tennessee markets are landlocked and lack access to significant supply alternatives, although some Nashville terminals have the ability to receive barge supply along the Cumberland River. In recent years, the Colonial and Plantation pipelines have been shut down or forced to reduce flows due to hurricane impacts to refineries and pipeline pumping stations on the Gulf Coast. These impacts have quickly resulted in fuel shortages and price spikes in eastern Tennessee.

In addition to disruptions in the Gulf Coast region, other problems along the Colonial and Plantation pipeline systems can impact supply into eastern Tennessee. In September 2016, Colonial Pipeline's main

[92] "Buckeye Partners, L.P. Announces Open Season For Second Phase Of Michigan/Ohio Pipeline Expansion Project." Buckeye Partners, L.P. August 31, 2016, http://www.buckeye.com/LinkClick.aspx?fileticket=F7Btc06PKZE%3D&tabid=36.
[93] S&P Global Platts, "Chicago RBOB dips amid interest in shipping Houston barrels north," June 9, 2016, http://www.platts.com/latest-news/oil/houston/chicago-rbob-dips-amid-interest-in-shipping-houston-21674268.

gasoline line—the 1.37 million b/d Line 1—was shut down for 12 days following the discovery of a leak in Alabama. The incident cut gasoline supplies to delivery locations across the East Coast, including to the pipeline junction in Georgia where the spur lines to central and eastern Tennessee originate. Although Colonial was able to temporarily shift some gasoline shipments on to its distillate Line 2, the outage resulted in gasoline shortages and retail price spikes of more than 20 cents per gallon in parts of Tennessee. During the outage, supply to eastern Tennessee was trucked in from Memphis, and from other locations in the Eastern Midwest. Following the September 2016 incident, two subsequent Colonial incidents caused supply disruptions affecting Tennessee. At the end of October 2016, crews working to permanently fix Line 1 accidentally punctured the line, causing an explosion in Alabama, leading to another multi-day shutdown; and in January 2017, a leak on Colonial's Line 19 in southeastern Tennessee cut off gasoline supply into Nashville.

Markets along the Ohio River corridor—Cincinnati, Louisville, and Lexington—are also vulnerable to supply disruptions. In 2014, the latest year for which data are available from USACE, ports in Cincinnati and Louisville received approximately 90,000 b/d of petroleum products by barge, primarily from Marathon's 237,000 b/d refinery in Catlettsburg, Kentucky, located upriver near Huntington, West Virginia. This supply chain can be impacted by river flooding, which can make some barge terminals unavailable to load or discharge products. Despite this vulnerability, Ohio River markets have access to alternative supply sources, including Marathon's 92,000 b/d pipeline running from Robinson, Illinois to Louisville and Lexington and a BP pipeline providing supply into the Cincinnati area from Dayton, Ohio. Even so, it can be challenging for Ohio River markets to compensate for unplanned outages at the Catlettsburg refinery or when barge traffic along the Ohio River is disrupted.

Many terminals on the Mississippi and Ohio rivers are also dependent upon ethanol delivered by barge via the Mississippi River. As a result, flooding on the Mississippi River and occasional wintertime freezing on the northern portions of the river can impact ethanol supply and thus finished gasoline supply to these terminals. Severe snow storms can also impact movements of ethanol by rail, truck, and barge.

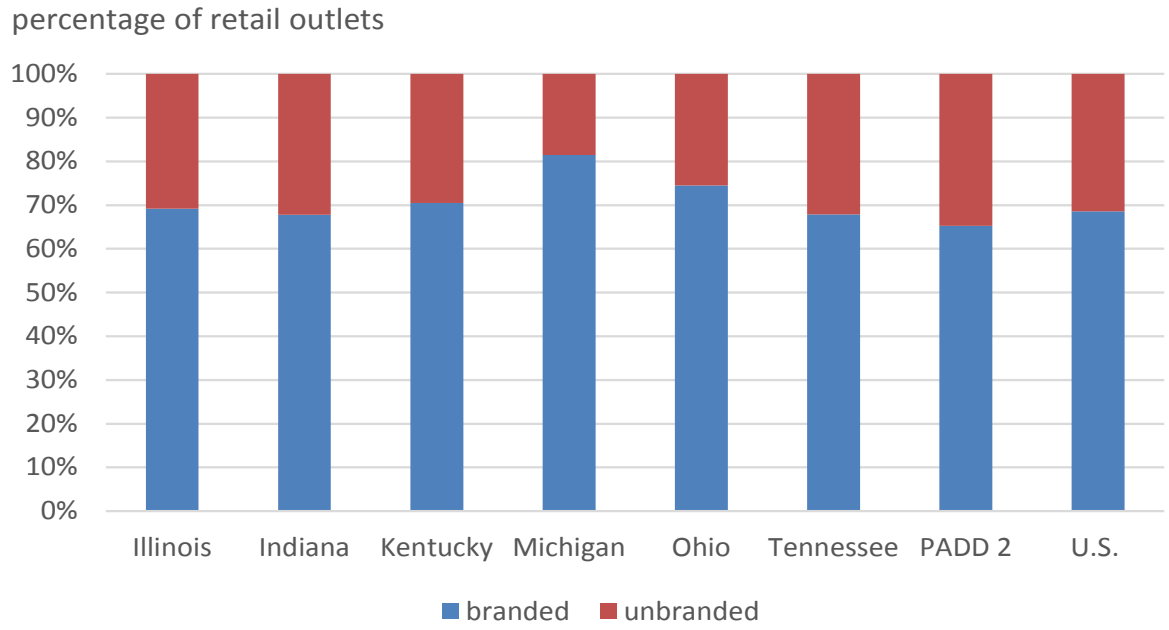
Retail markets

There are 19,323 retail service outlets in the Eastern Midwest.[94] Figure 20 shows the share of these outlets that are branded versus unbranded by state. Stations were assigned to the branded versus unbranded designations according to their ownership. If a station is owned by or affiliated with a major oil company, it is categorized as branded. Seventy-three percent of the Eastern Midwest's retail stations are branded, which is higher than the national average of 69%. However, the share of branded outlets varies within the region: Michigan has the highest share of branded stations with 82%, while Indiana and Tennessee each has the smallest share, with 68%. The top five brands in the Southern Midwest are BP; Marathon, along with its subsidiary Speedway brand; Shell; and Citgo. Together, these brands account for 57% of the region's retail outlets. Fifty-five percent of the region's stations offer diesel fuel, compared with a national average of 53%. As of June 2015, there were 948 public and 58 private filling stations in the Eastern Midwest region offering E85, and 35 public and 45 private filling stations offering biodiesel (B20 and

[94] Retail station data provided by the Homeland Security Infrastructure Program.

above).[95] Illinois is home to the largest number of E85 stations in the region, with 265, while Tennessee leads the region for biodiesel with 35 stations.

Figure 20. Eastern Midwest retail market structure



Source: Homeland Security Infrastructure Program, 2015.

Recent and future changes

Refineries

Several projects are underway at Eastern Midwest refineries to increase capabilities to process regionally available (and discounted) crude supplies, including light crude oil from the Bakken region of North Dakota and Montana, heavy crude oil from Western Canada, and growing condensate production from the Utica Shale play in western Pennsylvania and eastern Ohio. These projects are summarized below:

- **Marathon:** Two of Marathon's refineries in the Eastern Midwest recently completed condensate splitter projects aimed at processing greater volumes of condensates from the Utica Shale play. In 2014 Marathon added a 25,000 b/cd splitter at its Canton refinery in eastern Ohio, and in 2015 the company added a 35,000 b/cd splitter at its Catlettsburg refinery in northeastern Kentucky. In addition, a project is currently underway at Marathon's 212,000 b/cd Robinson refinery to increase light crude oil processing capacity by 30,000 b/cd, allowing the refinery to process 100% light crude oil. The project is expected to be completed in 2016. A separate project at the Robinson refinery was completed in 2016, upgrading the distillate hydrocracker to enable the processing of more feedstock and to shift about 5,000 b/cd of lighter products to ULSD production. At its 132,000 b/cd Detroit refinery, Marathon is undertaking a fluid catalytic cracking unit (FCCU)

[95] U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, "Alternative Fuels Data Center" (accessed July 26, 2016), http://www.afdc.energy.gov/states.

project to increase production capacity for alkylate and light products. The project is scheduled for completion in 2018.[96]

- **BP:** BP is planning the construction of a new hydrotreater at its Whiting, Indiana refinery in order to meet Tier 3 gasoline standards required by EPA. Once complete, the new unit will enable the refinery to reduce sulfur content and other pollutants in gasoline. The project is scheduled to begin in 2017.[97]
- **BP Husky Refining:** BP Husky Refining is planning a feedstock optimization project to improve the processing of crudes with high amounts of naphthenic acids (also referred to as high total acid number [High-TAN] crude). The project, which is expected to be completed in the second quarter of 2016, will allow the refinery to process an extra 35,000 b/d of High-TAN crude, which is typically sold at a discount to non-High-TAN crudes.[98] A separate project at the refinery aims to increase heavy crude processing capacity by up to 40,000 b/cd starting in 2017.[99] The project will allow the refinery to process greater volumes of heavy crude oil from Western Canada.

Pipelines

Major pipeline infrastructure changes in the Eastern Midwest region include the expansion of Buckeye Partners' refined product system in the eastern Ohio, western Pennsylvania, and Chicago markets; and the repurposing of two Marathon-operated systems to accommodate the distribution of NGL production from the Utica and Marcellus Shale plays in Ohio. These projects are summarized below:

- **Buckeye Partners:** Buckeye Partners is developing a Michigan-Ohio pipeline and terminal expansion project that will expand transportation service of refined petroleum products from refineries in Michigan and western Ohio to destinations in eastern Ohio and western Pennsylvania. The project is expected to be in operation in the fourth quarter of 2016, although the full run rate will not be realized until 2017. In August 2016, Buckeye announced it was seeking commitments for a second phase of the project, which would reverse a portion of its existing Laurel Pipeline to ship fuel from Pittsburgh to as far east as Altoona in central Pennsylvania.[100] The Laurel Pipeline currently ships products from the Philadelphia area to markets in central and western Pennsylvania. The segment of the Laurel system into Pittsburgh has a capacity of 180,000 b/d. Future reversals of the Laurel system could allow products from Michigan and Ohio refiners to be shipped as far east as the Philadelphia area.
- **Marathon:** Marathon Petroleum Corp. has plans to repurpose and reverse its idled 45,000 b/d RIO Petroleum product pipeline system in Ohio, Indiana, and Illinois to deliver NGLs from Lima,

[96] MPXL, "UBS MLP Conference," presented January 13–14, 2015, slide 17, http://www.mplx.com/content/documents/mplx/investor_center/UBS_MPLX_Jan_2015_Web.pdf.
[97] Reuters, "BP OKs Whiting refinery Tier 3 hydrotreater," August 31, 2016, http://uk.reuters.com/article/uk-refinery-operations-bp-whiting-idUKKCN1162XR.
[98] BP Husky Refining, *Annual Report 2015* (accessed July 28, 2016), http://www.huskyenergy.com/downloads/abouthusky/publications/annualreports/HSE_Annual2015.pdf.
[99] "Husky Advances Lima refinery expansion," *Oil and Gas Journal*, February 3, 2014, http://www.ogj.com/articles/2014/02/husky-advances-lima-refinery-expansion.html.
[100] "Buckeye Partners, L.P. Announces Open Season For Second Phase Of Michigan/Ohio Pipeline Expansion Project." Buckeye Partners, L.P. August 31, 2016, http://www.buckeye.com/LinkClick.aspx?fileticket=F7Btc06PKZE%3D&tabid=36.

Ohio to Marathon's Robinson, Illinois refinery.[101, 102] In Lima, the RIO pipeline would receive NGL supply from expansions of Marathon's Utica NGL pipeline systems, which will also deliver condensates and natural gasoline to Marathon's refineries in Canton, Detroit, and Catlettsburg. The RIO reversal project is expected to be in service in mid-2017.

- **Centennial Pipeline:** The 210,000 b/d Centennial Pipeline, which originates in the Beaumont-Port Arthur area and runs to southern Illinois, has largely been empty since mid-2011, and the pipeline's owners—Marathon Petroleum Corp. and Enterprise Products Partners—are considering taking the pipeline out of petroleum product service and reversing its flow to carry NGLs to Texas. As part of the project, the owners would repurpose other lines to connect the Centennial system with NGL production in the Utica and Marcellus Shale plays.[103]

[101] McIntire, Carol, "Marathon ramps up pipeline project," The Free Press Standard, April 8, 2016, http://freepressstandard.com/1957-2.
[102] MPXL, "UBS MLP Conference," presented January 13–14, 2015, slides 17–18, http://www.mplx.com/content/documents/mplx/investor_center/UBS_MPLX_Jan_2015_Web.pdf.
[103] Reuters, "Enterprise: Centennial conversion to NGLs a two-year project," September 8, 2015, http://www.reuters.com/article/centennial-pipeline-enterprise-idAFL1N11E18720150908.

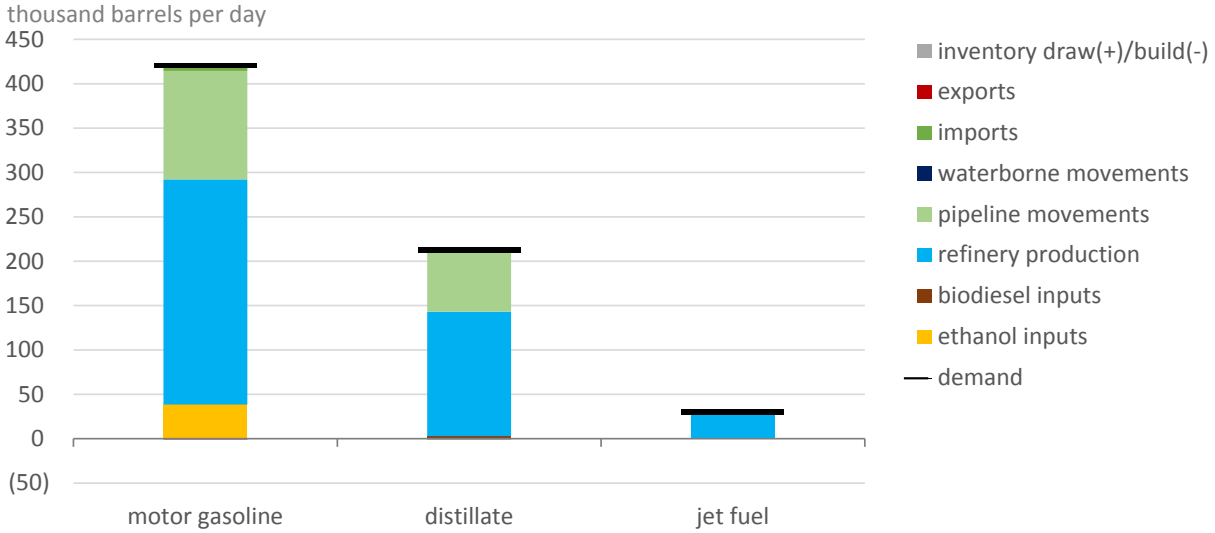
Northern Midwest

The Northern Midwest region includes four states: Minnesota, North Dakota, South Dakota, and Wisconsin. The region is bounded by Canada to the north, the Southern and Eastern Midwest regions to the south, Lake Michigan to the east, and the Rocky Mountain region (Petroleum Administration for Defense District [PADD] 4) to the west. Estimated total demand for transportation fuels (motor gasoline, distillate fuel oil, and commercial jet fuel) in the Northern Midwest was 669,000 barrels per day (b/d) in 2015, or 16% of total Midwest (PADD 2) demands. The region's principal demand centers are located in the "Twin Cities" of Minneapolis and St. Paul, Minnesota, and the Milwaukee, Wisconsin metropolitan area.[104] Other demand centers include Duluth, Minnesota; Fargo, North Dakota; Sioux Falls, South Dakota; and Madison and Green Bay/Appleton, Wisconsin.

Supply/demand balances

The Northern Midwest has five refineries that together produced 424,000 b/d of transportation fuels in 2015, enough to meet 63% of in-region demand (68% of demand net of ethanol and biodiesel inputs). Additional supply is delivered by pipeline primarily from the Chicago supply hub into southern and eastern Wisconsin markets, and, to a lesser degree, to Minnesota and the Dakotas from supply hubs in the Southern Midwest and Rocky Mountain (PADD 4) regions. Imports from Canada averaged 10,000 b/d in 2015 and were primarily railed or trucked across the border in Minnesota and North Dakota. Exports to Canada are negligible.

Figure 21. Northern Midwest supply/demand balances, 2015



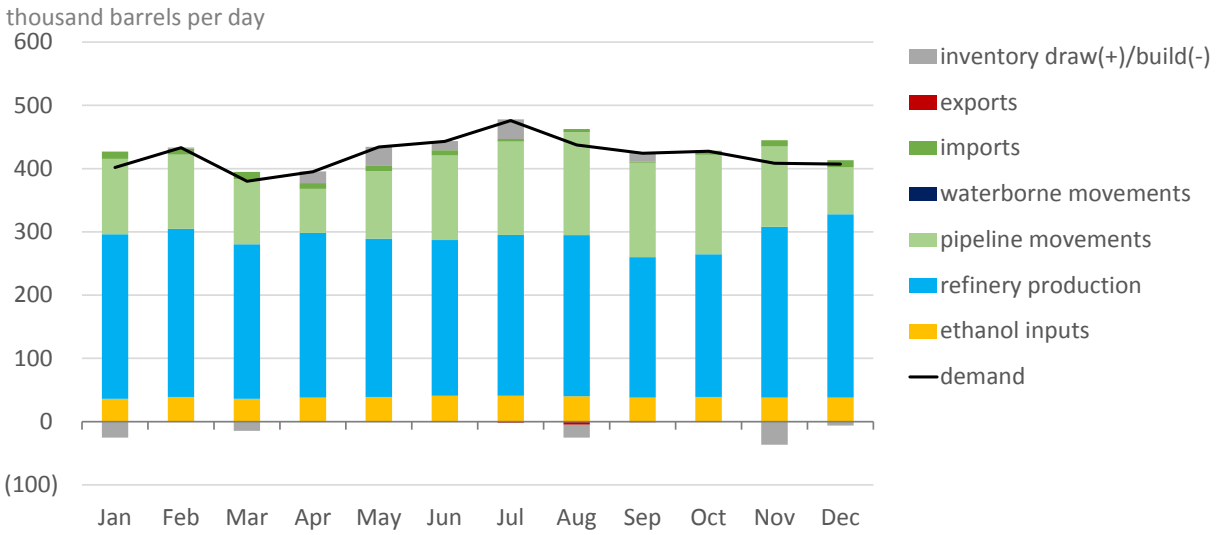
Note: All domestic movements and inventory changes are reported on a net basis.
Sources: ICF analysis of EIA, Airlines for America, USACE, FERC, and company 10-K data.

[104] Principal demand centers defined as metropolitan statistical areas with 1 million or more people as of July 1, 2015. Population estimates are from the U.S. Census Bureau, "2015 Population Estimates" (accessed November 23, 2016), http://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?pid=PEP_2015_PEPANNRES&src=pt.

Gasoline

Figure 22 presents the 2015 monthly motor gasoline supply/demand balance in the Northern Midwest. In 2015, in-region demand averaged 422,000 b/d, including approximately 39,000 b/d of ethanol. Demand exhibits seasonal variation, with higher volumes of gasoline consumed in the summer months compared with the winter months. Peak demand in 2015 occurred in July at 476,000 b/d, up from the year's low of 380,000 b/d in March. In-region refinery production of gasoline averaged 254,000 b/d in 2015, enough to meet approximately 66% of annual demand net of ethanol inputs. Refinery production of gasoline was lowest in September and October due to outages at the region's two largest refineries. Gasoline production rose to a high of 290,000 b/d in December, meeting 80% of demand (net of ethanol inputs), following the completion of a project in November that increased refining capacity and transportation fuels conversion at the region's largest refinery. In 2015, the Northern Midwest received, on average, 122,000 b/d more gasoline by pipeline from other U.S. markets than it shipped to other regions. An additional 8,000 b/d were imported on a gross basis from Canada in 2015.

Figure 22. Northern Midwest motor gasoline supply/demand balance, 2015



Note: All domestic movements and inventory changes are reported on a net basis.
Sources: ICF analysis of EIA, USACE, FERC, and company 10-K data.

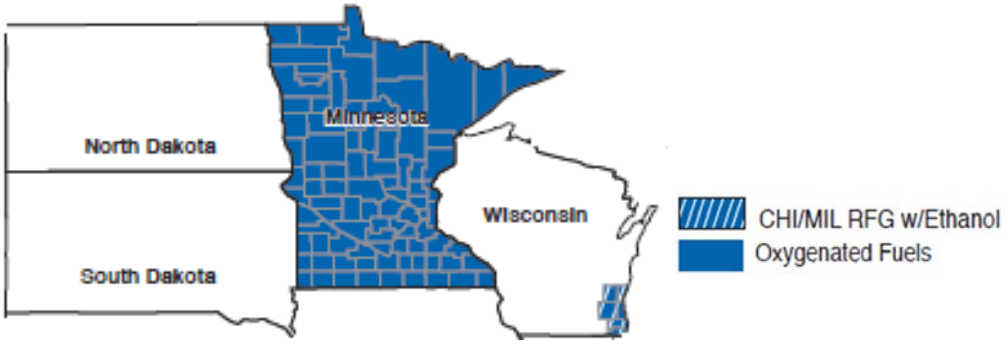
Minnesota enforces a year-round statewide oxygenated gasoline program, requiring 10% ethanol blending (E10), although there are exemptions for some off-road and specialty uses.[105] Legislation passed in the 2000s had aimed to increase the blending mandate to 20% ethanol (E20) by 2013, but the requirement never went into effect because the U.S. Environmental Protection Agency (EPA) has not certified E20 as a legal fuel.[106]

EPA requires the use of reformulated gasoline in six Wisconsin counties that are part of either the Milwaukee, Wisconsin metropolitan area, or the Chicago, Illinois metropolitan area, part of which

[105] American Fuel and Petrochemical Manufacturers, "State Motor Fuel Specifications: Minnesota," updated June 2014, https://www.afpm.org/content.aspx?id=1444.
[106] Minnesota Department of Agriculture, *E20 Report*, 2016, http://www.mda.state.mn.us/news/government/e20report.aspx.

stretches into southeastern Wisconsin. EPA also requires the adoption of a summer Reid vapor pressure (RVP) standard that limits the volatility of conventional gasoline sold in certain areas of the country. From May 1 through September 15, a statewide 9.0 RVP limit is enforced throughout the region. EPA and state-level motor gasoline regulations in the Northern Midwest region are mapped in Figure 23 and enforcement schedules are provided in Table 22.

Figure 23. Map of Northern Midwest gasoline regulations



Source: ExxonMobil, as of June 2015.

Table 22. Schedule of Northern Midwest motor gasoline regulations

Regulation	Area(s)	Dates
Reformulated gasoline	*Milwaukee metropolitan area:* Milwaukee, Ozaukee, Washington, and Waukesha counties in Wisconsin *Chicago metropolitan area (Wisconsin portion):* Kenosha and Racine counties in Wisconsin	Year-round
Oxygenated gasoline (state-level program)	*Minnesota:* Entire state	Year-round
Summer gasoline volatility <9.0 RVP	All counties in Minnesota, North Dakota, South Dakota, and Wisconsin	May 1 – Sept. 15

Sources: U.S. EPA Office of Transportation and Air Quality, American Fuel and Petrochemical Manufacturers.

Distillate

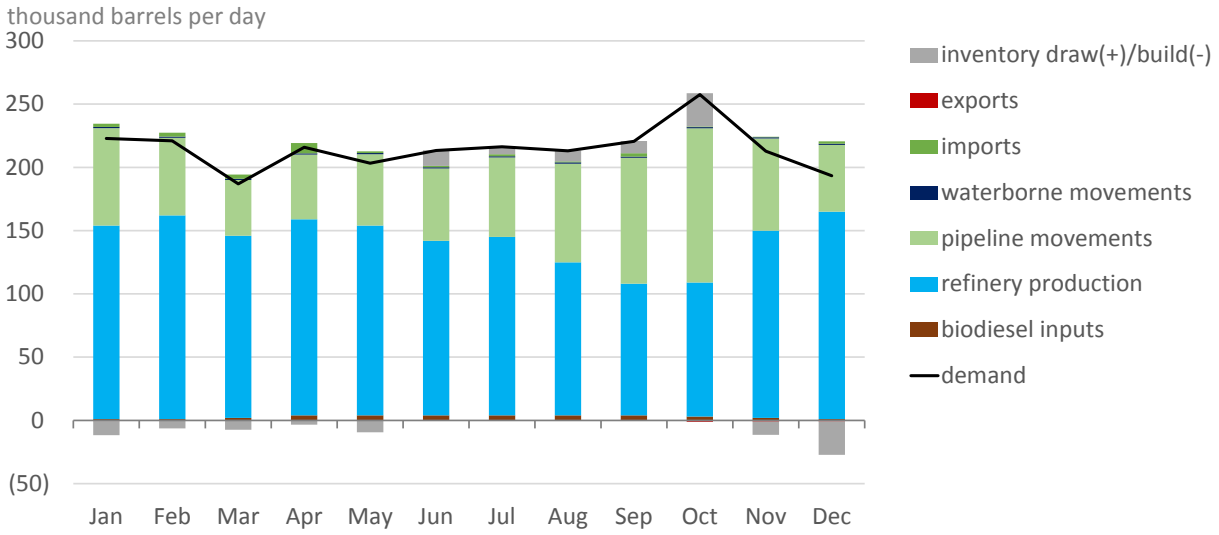
Figure 24 presents the 2015 monthly distillate supply/demand balance for the Northern Midwest. In 2015, demand for distillate fuels averaged 215,000 b/d, including biodiesel inputs of 3,000 b/d. Distillate fuel oil demand in the Northern Midwest is driven primarily by on-highway demand and farm use, which is higher than in other parts of the country. In 2014, the latest year for which data are available, farm use accounted for approximately 13% of the region's distillate sales, compared with a national average of 5%, with farm use accounting for as much as 20% of sales in South Dakota and Wisconsin.[107] High farm use drives demand spikes during the fall harvest season when distillate fuels are used in a number of applications, including to power heaters for grain drying. During the height of the 2015 fall harvest in October, distillate fuel use peaked above 250,000 b/d. In recent years, the Northern Midwest has seen an increase in

[107] U.S. Energy Information Administration, *Sales of Distillate Fuel Oil by End Use*, (accessed June 29, 2016).

distillate fuel use by oil producers operating in the Bakken shale region in North Dakota. In 2014, distillate sales to oil companies averaged 22,000 b/d, or more than 30% of North Dakota's total distillate sales.[108]

Northern Midwest refinery outages in September and October were responsible for the decreases in distillate production in those months, resulting in corresponding increases in net pipeline movements from other regions and withdrawals from inventory to meet demand.

Figure 24. Northern Midwest distillate supply/demand balance, 2015



Note: All domestic movements and inventory changes are reported on a net basis.
Sources: ICF analysis of EIA, USACE, FERC, and company 10-K data.

The Northern Midwest region, as with the rest of the country, is required by federal law to use ultra-low sulfur diesel (ULSD)—diesel fuel with a maximum sulfur content of 15 parts per million (ppm)—for all highway, non-road, locomotive, and marine diesel fuel. Due to extremely cold temperatures in the Northern Midwest, diesel supplies are often blended with No. 1 fuel oil (kerosene) or special additives during the winter to prevent possible gelling (freezing) of the fuel.

Minnesota enforces a statewide biodiesel mandate that requires the blending of 10% biodiesel in No. 2 diesel fuel (B10) between April 1 and September 30 of each year. This blending requirement is reduced to 5% (B5) during the winter months to minimize the gelling potential associated with higher biodiesel blends. The mandate results in the addition of up to 4,000 b/d of biodiesel into the Northern Midwest's distillate supply during the summer months and 1,000 b/d during the winter months.[109] Minnesota's biodiesel mandate includes a provision that increases the summer blend requirement to 20% on May 1,

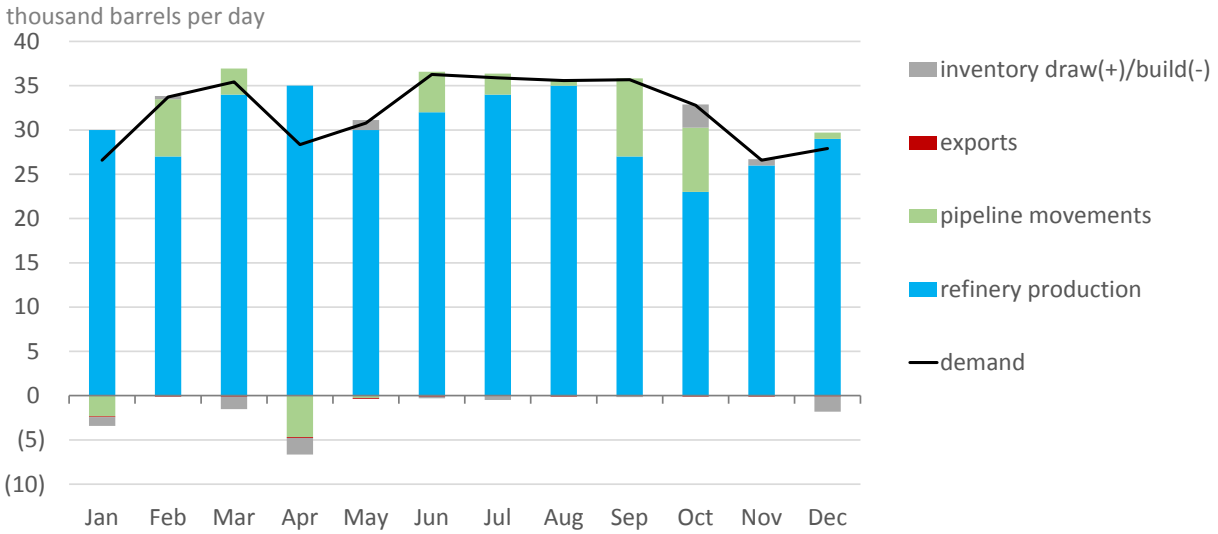
[108] U.S. Energy Information Administration, *Sales of Distillate Fuel Oil by End Use*, (accessed June 29, 2016).
[109] U.S. Energy Information Administration, *Refining District Minnesota-Wisconsin-North Dakota-South Dakota Blender Net Input of Renewable Diesel Fuel*, accessed July 29, 2016.

2018.[110] In addition to the biodiesel mandate, Minnesota and other states in the Northern Midwest all have one or more laws or incentive programs designed to encourage the further use of biodiesel.[111]

Jet fuel

Figure 25 presents the Northern Midwest region's monthly 2015 jet fuel supply/demand balance. Commercial jet fuel demand in the region averaged 32,000 b/d in 2015, while in-region refinery production averaged 30,000 b/d, enough to meet 94% of demand. Net jet fuel movements from other regions by pipeline, which make up the balance of the region's supply, varied from month to month in 2015, with net movements highest during refinery outages in September and October. The region's jet fuel demand generally follows a seasonal pattern with consumption highest in the summer months. In 2015, jet fuel consumption from June through September averaged 36,000 b/d, up from lows of 27,000 b/d in January and November.

Figure 25. Northern Midwest jet fuel supply/demand balance, 2015



Note: All domestic movements and inventory changes are reported on a net basis.
Sources: ICF analysis of EIA, Airlines for America, USACE, FERC, and company 10-K data.

Five airports in the Northern Midwest region are designated as hubs by the Federal Aviation Administration. Minneapolis-St. Paul International Airport (MSP) is a large hub, Milwaukee's General Mitchell International Airport (MKE) is a medium hub, and airports serving Madison, Sioux Falls, and Fargo are small hubs.[112] In addition, 23 smaller commercial service airports operate in the region, as well as three air force bases (AFBs): Grand Forks AFB and Minot AFB in North Dakota, and Ellsworth AFB in South

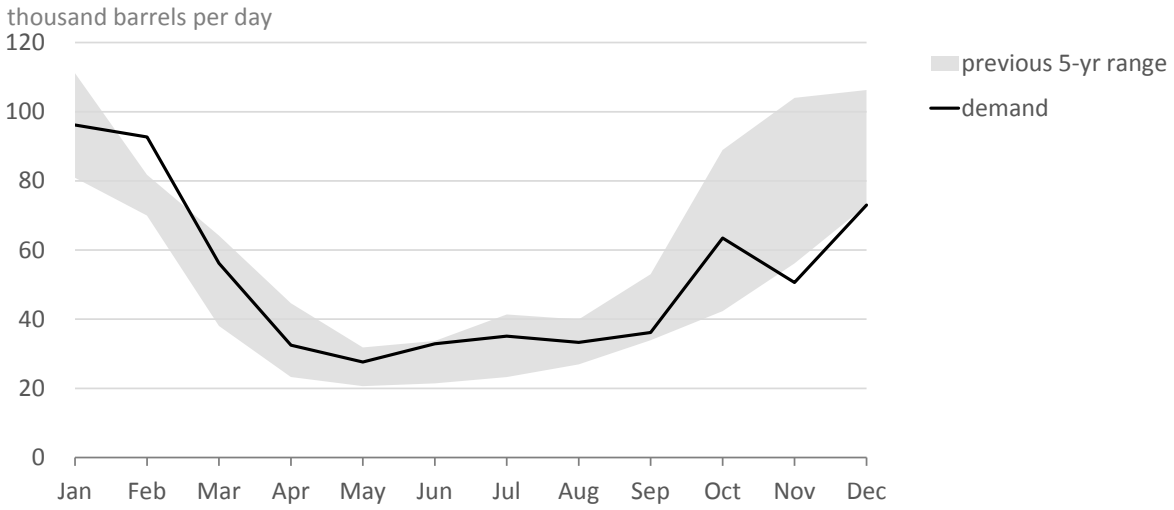
[110] Minnesota Department of Agriculture, "History of Minnesota's Biodiesel Program," Renewable Energy: Biodiesel Program, accessed August 18, 2016, http://www.mda.state.mn.us/renewable/biodiesel/aboutbiodiesel.aspx.
[111] Alternative Fuels Data Center, "Minnesota Laws and Incentives," U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, updated July 2016, available at http://www.afdc.energy.gov/laws/state_summary?state=MN.
[112] Federal Aviation Administration, "Passenger Boarding (Enplanement) and All-Cargo Data for U.S. Airports" (accessed November 23, 2016), https://www.faa.gov/airports/planning_capacity/passenger_allcargo_stats/passenger/.

Dakota. These bases may consume commercial quality Jet A fuel in addition to higher-performance military jet fuels.[113]

Propane

Figure 26 shows monthly prime supplier sales of consumer-grade propane in the Northern Midwest in 2015 compared with the range of sales over the previous five years (2010-2014). Propane sales averaged 52,000 b/d in 2015, equal to approximately 25% of total Midwest (PADD 2) sales. Residential and commercial heating applications together accounted for more than 70% of the region's total propane sales in 2015, while agricultural demand made up 17% of sales.[114] Approximately 500,000 households use propane for primary space heating in the Northern Midwest, and propane's share of the home heating market, at just over 10%, is higher than anywhere else in the Midwest (PADD 2) or Rocky Mountain (PADD 4) regions.[115]

Figure 26. Monthly consumer-grade propane sales in the Northern Midwest, 2015



Source: U.S. Energy Information Administration, *Monthly Report of Prime Supplier Sales of Petroleum Products Sold for Local Consumption.*

Propane demand in the Northern Midwest is highly seasonal, and weather conditions, including temperature and precipitation, are a significant source of demand variability. Extreme cold temperatures can drive demand for heating during the winter months, while heavy rainfall during the harvest season can lead to wetter crops, driving demand for propane use in grain-drying equipment. Fall demand for propane is also affected by the overall size of the harvest, with larger harvests contributing to increased propane use. Over the previous five years, fall sales peaked at 106,000 b/d in November 2013 due to a large and wet harvest, and winter sales peaked at more than 110,000 b/d in January 2014 amid near-record cold throughout much of the region. The size and timing of these two demand spikes, combined with concurrent infrastructure outages, led to a shortage of propane in the Northern Midwest in early

[113] MilitaryBases.com, "State Military Bases" (accessed June 29, 2016), http://militarybases.com.
[114] American Petroleum Institute, *Sales of Natural Gas Liquids and Liquefied Refinery Gases Survey*, 2015 edition, http://www.api.org/products-and-services/statistics/reports-and-surveys.
[115] U.S. Census Bureau, *American Community Survey*, updated July 21, 2014, https://www.census.gov/programs-surveys/acs.

2014.[116] Weather conditions can also have the reverse effect on propane sales. In November and December 2015, the Northern Midwest experienced temperatures much above average in Minnesota and Wisconsin, driving sales below the previous seasonal five-year lows.[117]

Refineries

The Northern Midwest has five refineries with a combined atmospheric crude distillation capacity of approximately 510,000 barrels per calendar day (b/cd).[118] Table 23 lists each refinery and its operable capacity as of January 1, 2016.

Table 23. Northern Midwest refineries, 2016

Owner	Site	Operable capacity [a] (b/cd)
Twin Cities		
Flint Hills Resources	St. Paul, MN	290,000
Western Refining [b]	St. Paul, MN	88,900
	Total	**378,900**
North Dakota		
Tesoro	Mandan, ND	73,860
Tesoro [c]	Dickinson, ND	19,500
	Total	**93,360**
Wisconsin		
Calumet	Superior, WI	38,000
Northern Midwest Total		**510,260**

[a] Barrels per calendar day, as of January 1, 2016

[b] Formerly Northern Tier Energy; Western Refining merged with Northern Tier in June 2016. In November 2016 Tesoro Corp. entered into a definitive agreement to acquire Western Refining.

[c] Formerly Dakota Prairie Refining; purchased by Tesoro Corp. in June 2016.

Source: U.S. Energy Information Administration, *Refinery Capacity Report*, 2015.

Refineries in the Northern Midwest primarily process heavy crude oil imported from Western Canada and regionally produced light oil from the Bakken Shale play in North Dakota. More than 80% of the Northern Midwest's refining capacity is located at Minnesota's two refineries in the Twin Cities area, which are owned by Flint Hills Resources and Western Refining (formerly Northern Tier Energy).[119] Flint Hills Resources' 290,000 b/cd refinery in St. Paul (also known as the Pine Bend refinery) is the largest refinery in the Northern Midwest and alone accounts for more than half of the region's refining capacity. The two

[116] U.S. Department of Energy, Office of Electricity Delivery and Energy Reliability, *An Assessment of Heating Fuels and Electricity Markets During the Winters of 2013–2014 and 2014–2015*, prepared for U.S. DOE by ICF, October 2015, http://energy.gov/sites/prod/files/2015/10/f27/DOE_OE_Two%20Winters%20Report_Final_10.19.15.pdf.

[117] National Oceanic and Atmospheric Administration, "National Temperature and Precipitation Maps," National Centers for Environmental Information: Temperature, Precipitation and Drought, March 6, 2015 release, https://www.ncdc.noaa.gov/temp-and-precip/us-maps/.

[118] 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 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.

[119] In November 2016 Tesoro Corp. entered into a definitive agreement to acquire Western Refining.

Twin Cities refineries supply the local metropolitan area and ship products primarily by pipeline to markets across the Northern Midwest, as well as to Des Moines, Iowa. The Pine Bend refinery also ships approximately 20% of its gasoline and diesel production by rail.[120] The 38,000 b/cd Calumet Specialty Products refinery in Superior, Wisconsin distributes production to the local Duluth, Minnesota metropolitan market and by pipeline to the Twin Cities supply hub.

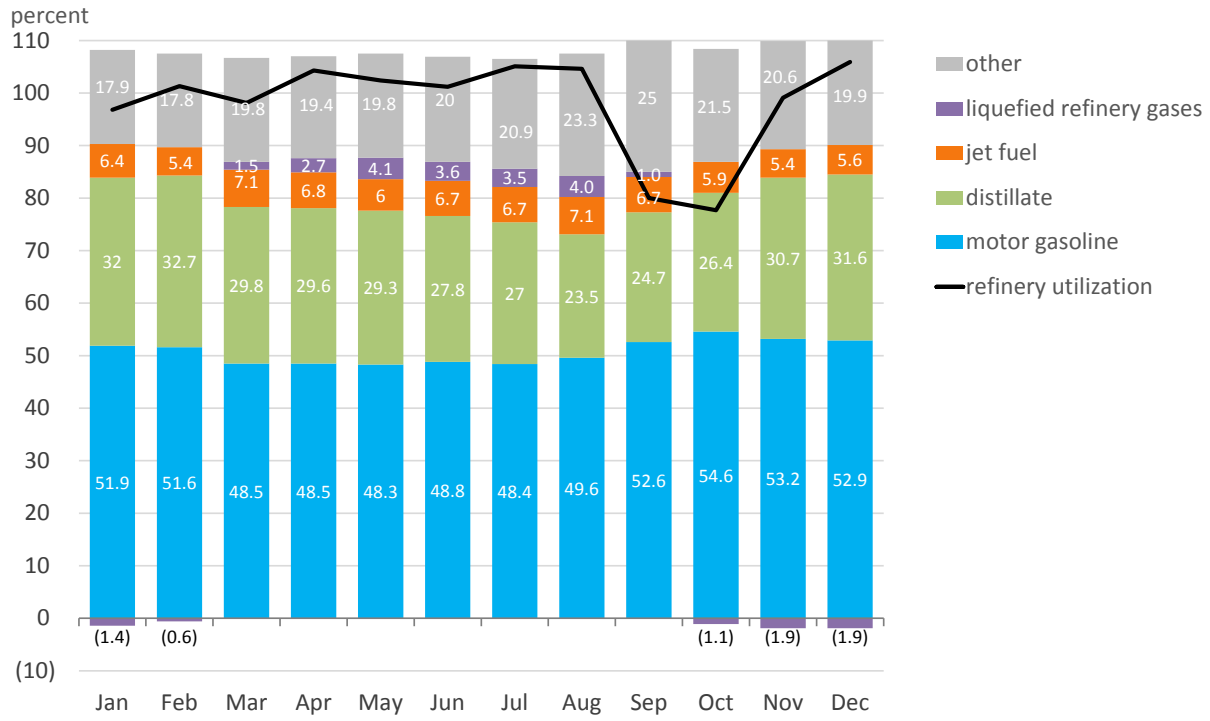
North Dakota has two refineries that primarily process local Bakken crude. The 73,860 b/cd Mandan refinery supplies the local Bismarck market and sends more than half of its transportation fuels production east by pipeline to markets in North Dakota and Minnesota, including into the Twin Cities. Meanwhile, Tesoro's 19,500 b/cd Dickinson refinery in western North Dakota, which came online in 2015, processes local Bakken crude oil to produce approximately 8,000 b/d of diesel fuel for local oil company use. The Dickinson refinery ships the remaining components of the crude oil (naphtha and atmospheric tank bottoms) primarily by rail to other refineries for further processing.[121] Tesoro Corp. purchased the Dickinson refinery from MDU Resources Group in 2016.

Refinery yields

Figure 27 shows monthly refinery utilization and yield percentages for motor gasoline (both finished gasoline and blendstocks), distillate fuel oil, liquefied refinery gases (LRGs), and other secondary products.[122] Northern Midwest refinery utilization averaged 98% in 2015, with utilization rates exceeding 100% for six months of the year. High refinery utilization in 2015 was punctuated by dips to 80% and below in September and October due to a planned turnaround at the Flint Hills refinery and unplanned maintenance at the Western refinery (at the time owned by Northern Tier).[123, 124] Refinery utilization peaked at near 106% in December when both refineries were back in full service and following the November completion of an upgrade project at the Flint Hills refinery that increased processing capacity by 20,000 b/cd. In 2015, production of transportation fuels (motor gasoline, distillate, and jet fuel) accounted for 85.8% of the region's refinery annual yield, which was close to the national average of 84.8%. Northern Midwest refineries have a higher average yield of motor gasoline than the national average, at 50.7%, compared with 45.3%; a slightly lower yield for distillate at 28.8%, compared with 29.8%; and a lower yield of jet fuel at 6.3%, compared with 9.7%.

[120] Flint Hills Resources, "Pine Bend Refinery: Rosemount, MN," http://pinebendrefinery.com/pine-bend-mn-oil-refining-process.
[121] Tesoro, "Dickinson Refinery" (accessed November 23, 2016), http://tsocorp.com/refining/dickinson-n-d/.
[122] Liquefied petroleum gases are products fractionated from refinery or still gases; through compression and/or refrigeration, they are retained in the liquid state. The reported categories are ethane/ethylene, propane/propylene, normal butane/butylene, and isobutane/isobutylene. These exclude still gas.
[123] Oil Price Information Service, *OPIS Refinery Turnaround Report*, December 31, 2015, available at http://www.opisnet.com/opis-refinery-turnaround-report.pdf.
[124] Seeking Alpha, "Northern Tier Energy – An Update on the Refinery Outage" (accessed July 15, 2015), http://seekingalpha.com/article/3561996-northern-tier-energy-update-refinery-outage.

Figure 27. Northern Midwest refinery yields, 2015



Note: Yield percentages sum to higher than 100% due to processing gains.
Source: U.S. Energy Information Administration, *Petroleum Supply Monthly*, 2016.

An unusual characteristic of Northern Midwest refinery yields is the negative yield of LRGs during several winter months. In the fall and winter, the region's refineries blend additional butane into supplies of winter-blend gasoline, which has a higher RVP limit than summer-blend gasoline. Supplies of butane are obtained through the distillation of crude oil at the refineries, but are also brought in from outside sources, including from natural gas liquid (NGL) fractionators. Negative yields occur when inputs of butane from outside sources exceed production of all other LRGs (primarily propane/propylene) at the refineries. Proportionally, refineries in the Northern Midwest consume more butane from outside sources than the U.S. average. In December 2015, Northern Midwest refinery inputs of normal butane from outside sources averaged 21,000 b/d, or 7.2% of total refinery gasoline production (excluding ethanol inputs), compared with a national average of 2.6% in the same month.[125, 126] Due to the impact of higher butane blending in winter gasoline, Northern Midwest motor gasoline yield is higher by about 3 to 5 percentage points in the fall and winter months than in the spring and summer months.

[125] U.S. Energy Information Administration, *Refining District Minnesota-Wisconsin-North Dakota-South Dakota Refinery Net Production of Normal Butane*, accessed July 29, 2016.
[126] U.S. Energy Information Administration, *U.S. Refinery Net Production of Normal Butane*, accessed November 23, 2016.

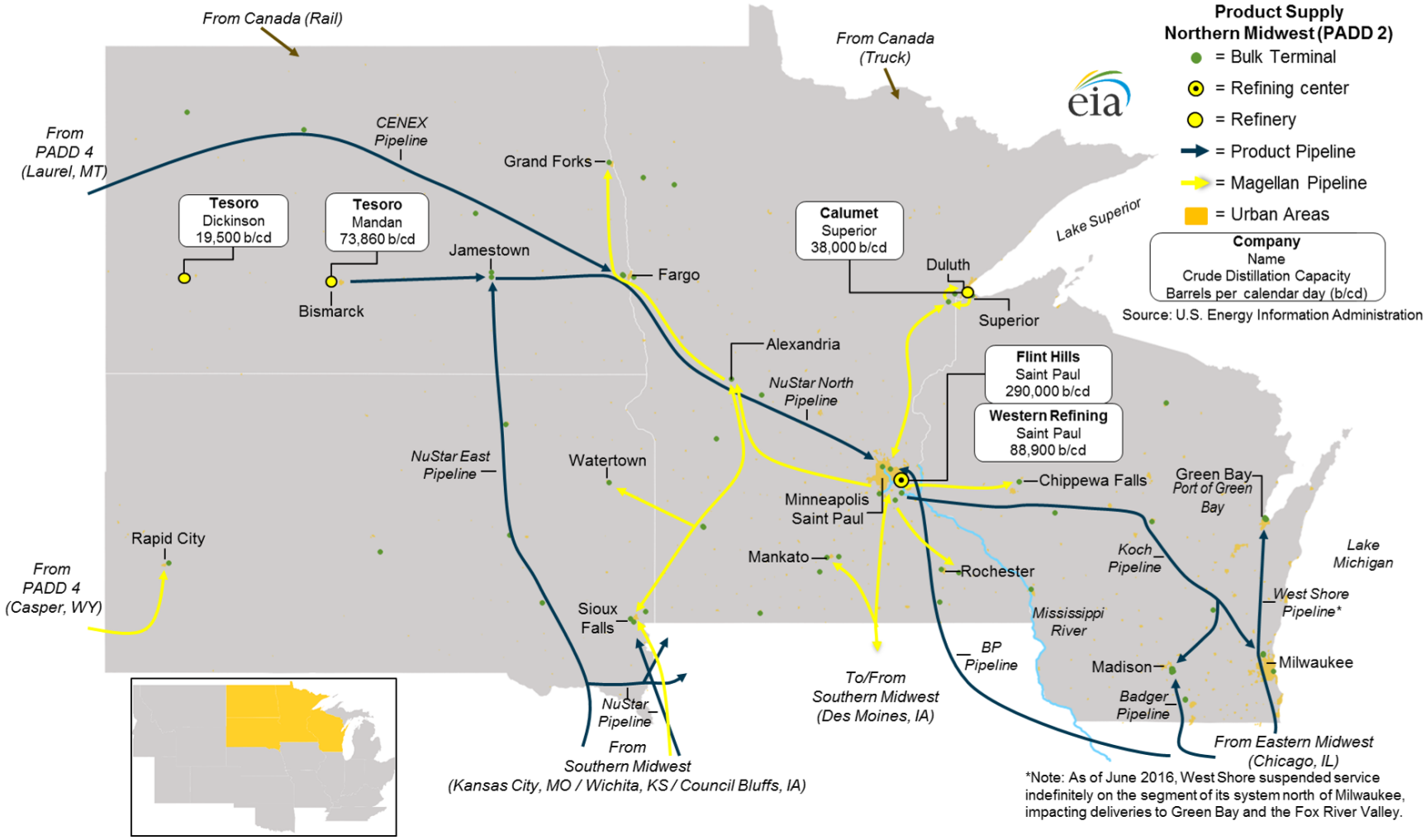
Supply and logistics

Figure 28 on page 66 presents an overview map of the refineries, product pipelines, storage terminals, petroleum ports, and petroleum serving the Northern Midwest region. The Northern Midwest's supply and distribution system is centered in the Twin Cities refining hub. From the Twin Cities, pipeline systems operated by Magellan Pipeline Company and Koch Pipeline Company extend radially, supplying markets throughout the region. Meanwhile, the NuStar North Pipeline system primarily distributes products from the Mandan, North Dakota refinery to North Dakota markets and into the Twin Cities hub; the Cenex Pipeline delivers fuel from the Billings, Montana refining center in PADD 4 into North Dakota; and the West Shore and Badger pipeline systems draw fuel from the Chicago area into markets in southern and eastern Wisconsin.

Pipelines

Several pipeline systems provide supply into and within the Northern Midwest. Product distribution in Minnesota is dominated by Magellan's pipeline system, which extends radially from the Twin Cities supply hub; Wisconsin markets are primarily served by the West Shore and Koch pipeline systems from the Chicago and Twin Cities supply hubs, respectively; and the Dakotas are served by the NuStar, Magellan, and Cenex systems.

Figure 28. Northern Midwest refined petroleum infrastructure



Magellan Pipeline

Magellan Pipeline Company's refined products pipeline system is the longest common carrier pipeline system for refined products in the United States, extending approximately 9,500 miles from the Gulf Coast and covering a 15-state area across the central United States.[127] Magellan's system is designed as a hub-and-spoke system with key storage and distribution centers spread throughout the Southern and Northern Midwest regions, including a hub in the Twin Cities area. Magellan's storage and distribution centers ship fuel to the company's primary and secondary terminals in the region. Magellan's primary terminals in the Northern Midwest include Sioux Falls, South Dakota; Alexandria, Minnesota; and Fargo, North Dakota.[128] Table 24 shows select Magellan pipeline routes serving the Northern Midwest region, as well as their lengths and diameters, if known.

Table 24. Select Magellan Pipeline Company refined product pipelines in the Northern Midwest, 2015

Route	Line Number	Origin	Destination	Distance (mi.)	Diameter (in.)
Twin Cities to Des Moines	6185 [a]	Minneapolis, MN	Des Moines, IA	240	12
	6200 (spur)	Albert Lea, MN	Mankato, MN	62	6
Twin Cities to Rochester	6315	Minneapolis, MN	Rochester, MN	74	8
Twin Cities to Eau Claire	6205	Minneapolis, MN	Bateman, WI	91	8
Twin Cities to Duluth	6215 [a]	Minneapolis, MN	Wrenshall/Duluth, MN	142	8
	6335 (spur)	Superior, WI	Superior Jct. (MN)	26	8
Twin Cities to Grand Forks	6305/6255	Rosemount, MN	Alexandria, MN	167	12
	6265	Alexandria, MN	Grand Forks, ND	179	6
	6270	Alexandria, MN	Fargo, ND	104	8
Kansas City to Sioux Falls	6225/6240	Kansas City, KS	Sioux Falls, SD	N/A [c]	12
Sioux Falls to Alexandria	6250 [a]	Sioux Falls, SD	Alexandria, MN	206	8
	6275 (spur)	Marshall, MN	Watertown, SD	71	6
Rapid City Lateral	7170	Douglas, WY	Rapid City, SD	189	6
MSP Airport Line	6305	Rosemount, MN	MSP Airport [b]	13	8

[a] Bidirectional pipelines

[b] Minneapolis-St. Paul International Airport

[c] N/A = Not available

Source: Magellan Pipeline Company, L.P., FERC Form No. 6, 2015/Q4.

The Twin Cities refining hub is the region's primary source of transportation fuels supply into the Magellan system. Over the first half of 2015, transportation fuels shipments on the Magellan system originating in the Twin Cities hub averaged 183,000 b/d, equal to nearly half of the refining hub's total crude distillation capacity.[129] Shipments were lower over the second half of 2015 due to extended outages at the two Twin Cities refineries. From the Twin Cities hub, pipelines extend radially: a bidirectional 12-inch pipeline

[127] Magellan Midstream Partners, L.P., U.S. Securities and Exchange Commission Form 10-K, 2015.

[128] Magellan Midstream Partners, L.P., "Iowa Renewable Fuels Association: Pipeline & Terminal 101," presented by Tom Byers (Des Moines, IA, August 16, 2012), http://www.biodieselfoundation.org/docs/4th-annual-biofuels-science-sustainability-tour/magellanbiofuelstourpresentation.pdf?sfvrsn=2.

[129] Magellan Pipeline Company, L.P., FERC Form No. 6: Annual Report of Oil Pipeline Companies and Supplemental Form 6-Q: Quarterly Financial Report, 2015/Q1 and 2015/Q2.

connects south to Magellan's hub in Des Moines, Iowa; 8-inch lines move supply east to Rochester, Minnesota, and Eau Claire, Wisconsin; a bidirectional 8-inch line connects north to Wrenshall and Duluth, Minnesota; and a 12-inch line flows west to Alexandria, Minnesota, before extending on 8- and 6-inch lines to Fargo and Grand Forks, North Dakota, respectively. A bidirectional 8-inch line also connects Alexandria to delivery points in southwestern Minnesota and Sioux Falls, South Dakota.

The bidirectional line between the Twin Cities and Des Moines hubs primarily flows from north to south, but also regularly flows in the opposite direction, particularly during planned or unplanned refinery outages in the Northern Midwest. Similarly, the 8-inch line between the Twin Cities and Wrenshall typically runs from north to south, delivering products from Calumet's nearby Superior refinery to the Twin Cities hub, but can be reversed to compensate for outages at the Superior refinery. In 2015, transportation fuels movements originating on Magellan's system from the Superior refinery averaged 16,000 b/d, or more than 40% of the refinery's capacity; however, it is unclear how much of this volume was delivered locally through the Magellan system to Calumet's terminal in Duluth and how much was delivered south to the Twin Cities area.[130]

Separately from Magellan's Twin Cities-centered system, a 12-inch line originating in Kansas City, Kansas delivers Midcontinent supply to Sioux Falls, South Dakota. The bidirectional 8-inch line between Sioux Falls and Alexandria allows points in southwestern Minnesota to be supplied from either the north or south. Finally, Rapid City in far western South Dakota is supplied from a 6-inch Magellan lateral originating near Sinclair Oil's Casper, Wyoming refinery in the Rocky Mountain (PADD 4) region.

According to company presentations, Magellan's deliveries of refined products (including LPG) averaged 124,000 b/d in Minnesota in 2015, and the pipeline system's deliveries of gasoline and distillates accounted for more than half of demand for those products in Minnesota and South Dakota.[131] While Magellan primarily provides transportation services for shippers, the company also contributes to the region's fuel supply through its butane blending activities. Magellan blends butane, a common gasoline blending component, into the gasoline pool throughout its system, particularly in the fall and winter months when sales of higher RVP gasoline are allowed. According to Magellan, butane blending volumes account for approximately 2% of all the gasoline it transports.[132]

[130] Magellan Pipeline Company, L.P., FERC Form No. 6: Annual Report of Oil Pipeline Companies and Supplemental Form 6-Q: Quarterly Financial Report, 2015/Q4, April 18, 2016.
[131] Magellan Midstream Partners, L.P., "2016 Analyst Day" (New York City, March 31, 2016), https://www.magellanlp.com/Investors/~/media/2D007DDCD87F4E8DB62904A0C90D3946.ashx?db=master.
[132] Ibid.

NuStar Energy

NuStar's North Pipeline and East Pipeline systems transport fuels into and within the Northern Midwest. Table 25 lists the major segments and spurs that make up NuStar's systems, as well as their lengths, diameters, and average 2015 transportation fuels shipments.

Table 25. Select NuStar Energy refined product pipelines in the Northern Midwest

System	Pipeline	Origin	Destination	Dist. (mi.)	Diam. (in.)	2015 Shipments [c] (b/d)
North Pipeline	**Mainline**	Mandan, ND	Roseville, MN	440	10/8 [b]	47,000 [d]
East Pipeline	**Mainline**	McPherson, KS	Geneva, NE	155	16	120,000
		Geneva, NE	Jamestown, ND	423	6	
		Geneva, NE	Wolsey, SD	202	8	
	Western Ext.	Geneva, NE	North Platte, NE	188	8	
	Eastern Ext.	Yankton, SD	Milford, IA	121	6	
		Sioux River Jct., SD	Rock Rapids, IA	41	6	
		Council Bluffs, IA [a]	Sioux Falls, SD	170	6	

[a] Interconnection with Buckeye's Lower V system.

[b] Denotes continuous pipeline of varying diameters.

[c] Only includes transportation fuels (gasoline, distillates, and jet fuel).

[d] Only includes originations from the Mandan refinery; does not include any shipments originating from the interconnection with the NuStar East Pipeline in Jamestown, ND.

Sources: NuStar Energy, L.P., U.S. Securities and Exchange Commission Form 10-K, 2015; NuStar Pipeline Operating Partnership, L.P., FERC Form No. 6, 2015/Q4.

NuStar's North Pipeline originates at Tesoro's Mandan, North Dakota refinery and runs east for approximately 440 miles, supplying markets in North Dakota and Minnesota before terminating at the Twin Cities supply hub. In 2015, 47,000 b/d of transportation fuels originated on the North Pipeline from the Mandan refinery, equal to nearly two-thirds of the refinery's crude distillation capacity.

Meanwhile, NuStar's East Pipeline covers 1,920 miles, moving refined products and NGLs north from refineries and pipeline interconnections in southern Kansas to delivery points in Kansas, Nebraska, and South Dakota, before interconnecting with the North Pipeline in Jamestown, North Dakota. An eastern extension runs from Yankton, South Dakota to delivery points in Sioux Falls, South Dakota, and northeastern Iowa. In 2015, transportation fuels shipments on NuStar's East Pipeline averaged 120,000 b/d, with flows as high 141,000 b/d amid Northern Midwest refinery outages in the fourth quarter. Although the East Pipeline's eastern extension is capable of receiving supply from an interconnection with Buckeye's Lower V system in Council Bluffs, Iowa, no products were received there in 2015. A substantial share of the products delivered through the East Pipeline system are ultimately used as railroad fuel; ethanol denaturant; or in agricultural operations, including fuel for farm equipment, irrigation systems, trucks used for transporting crops, and crop-drying facilities.[133]

[133] NuStar Energy, L.P., U.S. Securities and Exchange Commission Form 10-K, 2015.

West Shore Pipe Line

West Shore Pipe Line Company is the primary pipeline system serving southern and eastern Wisconsin, including the Milwaukee, Green Bay, and Madison markets. The company owns the West Shore and Badger pipeline systems, which span approximately 650 miles and are operated by Buckeye Partners.[134] Table 26 lists select segments of the West Shore and Badger pipeline systems, including their origins, destinations, lengths, diameters, and average 2015 shipments of transportation fuels.

Table 26. Select West Shore Pipe Line Company refined product pipelines in the Northern Midwest

System	Origin	Destination	Distance (mi.)	Diameter (in.)	2015 Shipments [b] (b/d)
West Shore	Romeo, IL	Busse Station, IL	36	16	326,000
	Hammond, IN	Bell, IL	26	16	
	Bell, IL	Granville, WI	64	16	
	Granville, WI	Green Bay/Fox River, WI	98	10	
	St. Marin Jct., WI	Mitchell Field, WI	10	16	
Badger	East Chicago, IN	Canal Jct., IL	26	12	
	Lemont, IL	Canal Jct./Harlem, IL	18	10	
	Canal Jct., IL	Des Plaines, IL	25	12, 16 [a]	
	Des Plaines, IL	O'Hare Intl. Airport	3	6, 8 [a]	
	Des Plaines, IL	Rockford, IL/Madison, WI	127	12	

[a] Denotes parallel pipeline segments.

[b] Only includes shipments of transportation fuels (motor gasoline, distillates, and jet fuel).

Sources: West Shore Pipe Line Company website; West Shore Pipe Line Company, FERC Form No. 6, 2015/Q4.

The West Shore system draws supply from Chicago area refineries and terminals, and extends along the western shore of Lake Michigan, supplying the Milwaukee and Green Bay markets.[135] In March 2016, however, the segment of the West Shore system north of Milwaukee was shut due to ongoing integrity issues, and as of June 2016, the company said it was suspending service indefinitely as it reviewed alternatives to rebuild the line.[136] This shutdown affects deliveries to the Green Bay and Fox River Valley markets in northeastern Wisconsin. Separately, the Badger system originates in the Chicago area, serving delivery points within the Chicago area before extending west via a 12-inch segment to supply Rockford, Illinois and Madison, Wisconsin. In 2015, the West Shore and Badger systems together shipped approximately 326,000 b/d of transportation fuels, of which a significant portion—a rough estimate of 150,000 b/d—was delivered into Wisconsin. Shipments on the two pipeline systems peaked at 345,000 b/d in the third quarter of 2015 amid refinery outages in the Twin Cities area.[137]

[134] Buckeye Partners, L.P., U.S. Securities and Exchange Commission Form 10-K, 2015.
[135] West Shore Pipe Line Company also offers crude oil transportation service from Lockport to Lemont, IL, in west Chicago.
[136] Behm, Don, "Pipeline Serving Green Bay Closes Indefinitely," *Journal Sentinel* (Milwaukee, WI, June 22, 2016), http://www.jsonline.com/news/wisconsin/pipeline-serving-green-bay-closes-indefinitely-b99749027z1-383975071.html.
[137] West Shore Pipe Line Company, FERC Form No. 6: Annual Report of Oil Pipeline Companies and Supplemental Form 6-Q: Quarterly Financial Report, 2015/Q4, April 18, 2016.

Other pipelines

Other pipelines in the Northern Midwest include systems operated by Koch Pipeline, Cenex Pipeline, and BP Pipelines North America. Table 27 lists these systems, including their origins, destinations, diameters, and average 2015 transportation fuels shipments, when publicly available.

Table 27. Select other refined product pipelines in the Northern Midwest

System	Origin	Destination(s)	Distance (mi.)	Diameter (in.)	2015 Shipments [c] (b/d)
Koch Pipeline Co.	Rosemount, MN	Waupun, WI	261	12/10 [b]	80,000 [d]
	Waupun, WI	Milwaukee, WI	51	10	
	Waupun, WI	McFarland, WI	66	8	
	Rosemount, MN	MSP Airport	13	10	N/A [a]
Cenex Pipeline	Laurel, MT	Fargo, ND	N/A [a]	N/A [a]	46,000
BP Pipelines North America	Whiting, IN	Dubuque, IA	N/A [a]	10	N/A [a]
	Dubuque, IA	Minneapolis, MN	N/A [a]	10	N/A [a]

[a] N/A = Not available

[b] Indicates continuous pipe of varying diameters.

[c] Only includes transportation fuels (gasoline, distillates, and jet fuel).

[d] Estimated as one-third of prime supplier sales volumes of gasoline and distillates in Wisconsin.

Sources: Pipeline and Hazardous Materials Safety Administration, National Pipeline Mapping System; Cenex Pipeline, LLC, FERC Form No. 6, 2015/Q4; Koch Pipeline Company, L.P., Wisconsin zone and Minnesota zone oil spill response plans.

Koch Pipeline Company operates its approximately 378-mile Wisconsin Pipeline system, which delivers refined products from the Flint Hills Pine Bend refinery in the Twin Cities area to markets across Wisconsin, including the Milwaukee and Madison metropolitan areas. Koch also operates a 10-inch jet fuel pipeline to the Minneapolis Airport. Koch Pipeline Company and Flint Hills Resources are both subsidiaries of Koch Industries. According to Flint Hills, the Koch Pipeline system supplies approximately one-third of the gasoline and diesel fuel used in Wisconsin, or an estimated 80,000 b/d.[138]

Cenex Pipeline, LLC, a wholly owned subsidiary of CHS Inc., operates a 683-mile pipeline system that moves fuel east from CHS's Laurel, Montana, refinery and other refineries in the Billings area to delivery points in eastern Montana and Minot, North Dakota, before terminating in Fargo, near the Minnesota border. In 2015, this system shipped approximately 46,000 b/d of gasoline and distillates.

Finally, BP Pipelines North America operates a proprietary pipeline system running hundreds of miles from its Whiting, Indiana refinery in the Eastern Midwest to company-owned terminals in Dubuque, Iowa, and Spring Valley, Minnesota before terminating in the Twin Cities area.

[138] Flint Hills Resources, "Flint Hills Resources to Begin Construction on $20 Million Fuel Terminal Expansion Serving Central and Northeastern Wisconsin," August 10, 2016, http://www.fhr.com/newsroom/news_detail.aspx?id=442; U.S. Energy Information Administration, *Prime Supplier Sales Volumes: Wisconsin*, accessed April 1, 2016.

Ports and waterways

There are minimal waterborne movements of transportation fuels in the Northern Midwest. In 2015 the Port of Green Bay, located in Green Bay off of Lake Michigan, loaded out approximately 1,300 b/d of transportation fuels to barges for delivery across Lake Michigan, primarily to Cheboygan, Michigan. In March 2016, however, the segment of the West Shore Pipe Line system supplying Green Bay was shut due to ongoing integrity issues, and as of June 2016, the company said it was suspending service indefinitely as it reviewed alternatives to rebuild the line. As a result of the outage, the outbound shipments from the Port of Green Bay have declined, and the port has begun bringing in inbound barge shipments of gasoline and diesel from Montreal, Canada; New York state; and Toledo, Ohio, and inbound shipments of diesel from Chicago, Illinois. In May 2016, inbound shipments averaged approximately 1,200 b/d, according to the trade press.[139]

Markets

Twin Cities

The Twin Cities (Minneapolis-St. Paul metropolitan area) refining hub is the primary supply hub for the Northern Midwest. The Twin Cities has two refineries, both located in St. Paul: Flint Hills Resources and Western Refining (formerly Northern Tier Energy), which have a combined refining capacity of 378,900 b/d, or more than 80% of total refining capacity in the Northern Midwest. Additional supply is brought into the Twin Cities hub via the 10- and 8-inch NuStar North Pipeline, which originates at Tesoro's Mandan, North Dakota refinery, and via an 8-inch Magellan pipeline from Wrenshall, Minnesota that delivers supply from Calumet's nearby refinery in Superior, Wisconsin. In 2015, 47,000 b/d and 16,000 b/d flowed on these NuStar and Magellan lines, respectively, although some of the shipments on the NuStar line also supply markets in North Dakota and western Minnesota, and some of the shipments on the Magellan line were delivered to Duluth.

From the Twin Cities hub, Magellan pipelines deliver products to local terminals in the Twin Cities area and extend radially south to Des Moines, Iowa (12-inch line); east to Rochester, Minnesota (8-inch line) and Eau Claire, Wisconsin (8-inch line); and west to Alexandria, Minnesota (12-inch line) for further delivery to markets in North Dakota and southwestern Minnesota. Over the first half of 2015 (when Twin Cities refineries were mostly operational), 183,000 b/d originated on the Magellan system in Minneapolis, equal to approximately half of total Twin Cities refining capacity. Meanwhile, Koch Pipeline Company, which is associated with the Flint Hills refinery, ships fuel from the Twin Cities east to Wisconsin markets on its Wisconsin Pipeline system. In 2015, estimated transportation fuels shipments on the Wisconsin Pipeline averaged 80,000 b/d, or more than 25% of the refinery's distillation capacity. The Magellan line from the Twin Cities to Des Moines has bidirectional capability, allowing products to flow into the Twin Cities from Des Moines to accommodate refinery outages in the Northern Midwest. Similarly, the line between Wrenshall and the Twin Cities can be reversed, allowing products to flow into the Duluth market when the nearby Superior refinery is down. In addition to these pipeline movements, Flint Hills' St. Paul

[139] S&P Global Platts, "Port of Green Bay becomes importer of refined products as pipeline shuts," Oil, July 8, 2016, http://blogs.platts.com/2016/07/08/port-green-bay-importer-refined-products-pipeline.

refinery distributes by rail approximately 20% of its gasoline and diesel production, or an estimated 40,000 to 50,000 b/d.

Wisconsin

Wisconsin's primary markets are in Milwaukee, Green Bay, and Madison. The Milwaukee market is primarily supplied by the West Shore Pipeline system, which originates in the Chicago supply hub and runs along the western shore of Lake Michigan; however, supply is also delivered via a 10-inch segment of Koch Pipeline's Wisconsin Pipeline system from the Twin Cities supply hub. Madison is similarly supplied from Chicago via a 12-inch segment of the Badger Pipeline system and via an 8-inch segment of Koch's Wisconsin Pipeline. Prior to March 2016, the Green Bay market was supplied by a segment of the West Shore Pipeline system extending north from Milwaukee; however, this line was taken out of service indefinitely in March 2016 due to ongoing problems with the pipeline. As a result, product is now being trucked into Green Bay from terminals in Milwaukee, and from a Koch Pipeline terminal near Fond du Lac, and the governors of Wisconsin and Michigan have issued emergency declarations, easing hours-of-service regulations on fuel truck drivers supplying products into Green Bay, northern Wisconsin, and the Upper Peninsula of Michigan. In addition, the Port of Green Bay, which previously loaded products from the West Shore system onto barges for outbound delivery via the Great Lakes, is now receiving barge deliveries. In May 2016 barge deliveries into Green Bay averaged 1,200 b/d. Finally, as a result of the West Shore outage, Flint Hills Resources, whose terminals currently supply one-third of Wisconsin's gasoline and diesel (approximately 80,000 b/d) via Koch's Wisconsin Pipeline, is expanding its capability to supply central and northeastern Wisconsin markets by at least 27,000 b/d.[140]

The Dakotas

The primary markets in the Dakotas are Sioux Falls, South Dakota, and Fargo, North Dakota. Sioux Falls is primarily supplied from Midcontinent refineries via a 12-inch segment of the Magellan Pipeline system originating in Kansas City and via the eastern extension of NuStar's East Pipeline, which originates at refineries and pipeline interconnections in southern Kansas. Fargo, meanwhile, is supplied from the Twin Cities supply hub via an 8-inch segment originating in Alexandria, Minnesota; from Tesoro's Mandan, North Dakota refinery via NuStar's North Pipeline; and from the Billings, Montana supply hub via the Cenex Pipeline system, which extends east to Fargo from CHS Inc.'s Laurel, Montana refinery. In 2015, shipments averaged 47,000 b/d and 46,000 b/d on the NuStar North Pipeline and Cenex Pipeline, respectively, although only a portion of the barrels on these systems were delivered to the Fargo market.

Supply vulnerability

Northern Midwest refineries produced 424,000 b/d of transportation fuels in 2015, equal to more than two-thirds of the region's demand (net of ethanol and biodiesel inputs). Supply and demand in the western portion of the Northern Midwest (Minnesota and the Dakotas) are closely balanced, making the area vulnerable to supply shortages and sharp price increases when there are unplanned refinery outages. The bidirectional configuration of the Magellan pipeline system between the Twin Cities and Des Moines,

[140] Flint Hills Resources, "Flint Hills Resources to Begin Construction on $20 Million Fuel Terminal Expansion Serving Central and Northeastern Wisconsin," August 10, 2016, http://www.fhr.com/newsroom/news_detail.aspx?id=442.

Iowa, and between Sioux Falls, South Dakota, and Alexandria, Minnesota provides flexibility to move products into the region from the Southern Midwest. However, markets in Minnesota and the Dakotas are hundreds of miles away from the Southern Midwest's refineries, which are located in Oklahoma and Kansas, and it can take significant time for replacement supplies to reach the Northern Midwest through Magellan's hub-and-spoke pipeline system.

In the eastern portion of the Northern Midwest (eastern and southern Wisconsin), markets are primarily dependent on supply from the Chicago supply hub delivered via the West Shore system (including the Badger system). The loss of the West Shore system, which supplies an estimated 60% of Wisconsin's total transportation fuel supply, would require increased shipments, to the extent possible, on Koch Pipeline's Wisconsin Pipeline system from the Twin Cities supply hub, or deliveries by truck directly from the Chicago area. In March 2016, a segment of the West Shore system between Milwaukee and Green Bay was shut due to ongoing integrity problems, and in June 2016 it was shut indefinitely while the company considered alternatives to rebuild the line. Fuel supply is now being delivered into northeastern Wisconsin markets by truck from Milwaukee and from a Koch Pipeline terminal near Fond du Lac, and, to a lesser extent, by barge into the Port of Green Bay.

In recent years, oil producers in the Bakken Shale play in western North Dakota have drastically increased their demand for diesel fuel for drilling operations. This has led to periodic shortages in diesel supply, particularly during the fall harvest season when demand increases for use in farm equipment. Between 2009 and 2014, the latest year for which data are available, distillate sales to oil companies in North Dakota increased from less than 2,000 b/d to approximately 22,000 b/d.[141] Tight diesel markets in the region eased in 2015 due to the slowdown in drilling activity, which saw Bakken rig counts drop from 193 to 73 between August 2014 and August 2015.[142] The situation has also been helped on the supply side by the start-up of the Dickinson, North Dakota, refinery, which added approximately 8,000 b/d of new diesel supply in close proximity to Bakken drillers.

Diesel fuel shortages can also occur in the Northern Midwest during sustained periods of extreme cold if sufficient supply of No. 1 fuel oil (kerosene) is not available to blend with No. 2 diesel to avoid fuel gelling/freezing. In-region storage for No. 1 fuel is not significant, and resupplying No. 1 fuel from the Midcontinent or the Gulf Coast can take significant time. Diesel fuel can also be "winterized" through the use of additives rather than blending with No. 1 fuel.

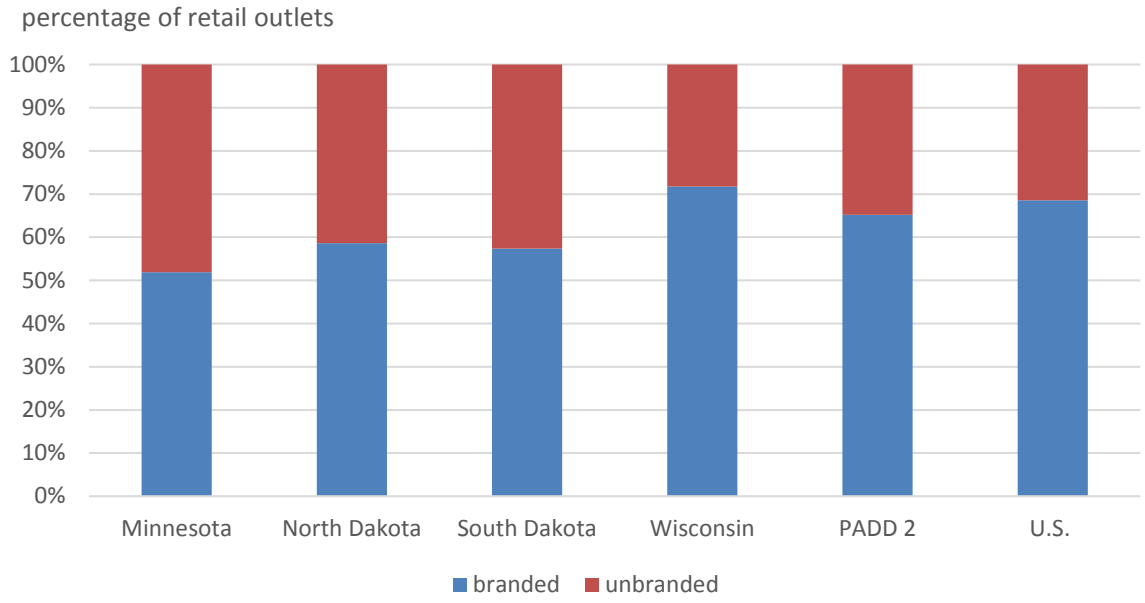
Retail markets

There are 5,887 retail service outlets in the Northern Midwest. Figure 29 shows the share of these outlets that are branded versus unbranded by state. Stations were assigned to the branded versus unbranded designations according to their ownership. If a station is owned by, or affiliated with, a major oil company, it is categorized as "branded". Sixty-two percent of the Northern Midwest's retail stations are branded,

[141] U.S. Energy Information Administration, *Adjusted Sale of Distillate Fuel Oil by End Use: North Dakota*, accessed December 22, 2015.
[142] MacPherson, James, "N.D. diesel shortage averted with drilling slowdown," Capital Press, August 18, 2015, http://www.capitalpress.com/Nation_World/Nation/20150818/nd-diesel-shortage-averted-with-drilling-slowdown.

compared with the national average of 69%. The share of branded outlets varies substantially within the region; however, Wisconsin has the highest share of branded stations with 72%, while Minnesota's 52% is the smallest. The top five brands in the Northern Midwest are BP, Cenex, Mobil, Shell, and Citgo. Together, these brands account for 45% of the region's retail outlets. Sixty-two percent of the region's stations also offer diesel fuel, compared with a national average of 53%. As of June 2015, there were 575 public and 18 private filling stations in the Northern Midwest region offering E85, and 10 public and 6 private filling stations offering biodiesel (B20 and above).[143] Minnesota is home to the largest number of E85 stations in the region, with 302. Wisconsin's six biodiesel stations is the highest in the Northern Midwest.

Figure 29. Northern Midwest retail market structure



Source: Homeland Security Infrastructure Program, 2015.

Recent and future changes

Refineries

Three projects have been recently completed, are underway, or are planned at Northern Midwest refineries. Two of these projects are aimed at taking advantage of locally available light crude oil from the Bakken Shale play in western North Dakota and eastern Montana.

- **Dakota Prairie Refining:** In May 2015, Calumet Specialty Products and MDU Resources opened the 19,500 b/d Dakota Prairie Refinery in western North Dakota, the first new U.S. refinery built in more than 30 years. The refinery processes locally produced Bakken crude oil to produce approximately 8,000 b/d of diesel fuel for local oil company use and ships the remaining components of the crude oil (naphtha and atmospheric tank bottoms) primarily by rail to other

[143] U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, "Alternative Fuels Data Center" (accessed July 26, 2016), http://www.afdc.energy.gov/states.

refineries for further processing.[144] Facing lower demand for diesel due to lower drilling activity in the Bakken shale play, the refinery was sold in June 2016 to Tesoro Corp. Tesoro, which owns the only other refinery in North Dakota, plans to use the naphtha and tank bottoms produced by the refinery in its integrated refining system. Tesoro is also considering several improvements at the refinery, including optimizing commercial feedstocks system-wide, increasing efficiencies in distribution, and reducing transportation and refining costs.[145]

- **Western Refining (formerly Northern Tier Energy):** Northern Tier, which merged with Western Refining in June 2016, announced plans in 2015 to invest $100 million in upgrades at its St. Paul refinery to increase refining capacity from 97,800 barrels per stream day (b/sd) to more than 100,000 b/sd, increase its ability to process light Bakken crude oil, and increase ULSD yield by 2%. The upgrades were expected to take place during a planned turnaround in spring 2016, but that turnaround was postponed to the third quarter of 2016 or later.[146]
- **Flint Hills Resources:** In November 2015 Flint Hills completed a planned turnaround at its Pine Bend refinery in St. Paul that included a crude/coker improvement project aimed at boosting utilization at the No. 3 Crude Unit closer to the unit's design rate of 150,000 b/sd and improving the refinery's ability to convert crude oil into transportation fuels.[147] The project, which debottlenecked processes at the refinery, increased Pine Bend's atmospheric crude distillation operable capacity from 270,000 b/cd to 290,000 b/cd, according to EIA data.[148] In 2016 the company announced plans to pursue a series of projects that would improve the efficiency of, and reduce emissions from, the refinery. The $750 million investment includes replacing aging equipment (including two coker units) with newer technology, improving energy efficiency, and making improvements to other refinery processing units.[149] Finally, a separate project is currently underway at the Pine Bend refinery to implement a new process to remove sulfur from gasoline

[144] Tesoro, "Dickinson Refinery" (accessed November 23, 2016), http://tsocorp.com/refining/dickinson-n-d/.
[145] Brelsford, Robert, "Tesoro acquires North Dakota refinery," *Oil & Gas Journal*, Processing News (Houston, TX, June 28, 2016), http://www.ogj.com/articles/2016/06/tesoro-acquires-north-dakota-refinery.html.
[146] Shaffer, David, "St. Paul Park Refinery increasingly focuses on Bakken oil," *Star Tribune*, East Metro, June 23, 2015, http://www.startribune.com/st-paul-park-refinery-increasingly-focuses-on-bakken-oil/308916331; Business and Industry Connection Magazine, "Western Refining plans turnaround at Minnesota refinery," August 8, 2016, http://www.bicmagazine.com/industry-segments/refining-petrochem-section/western-refining-plans-turnaround-at-minnesota-refinery/.
[147] Suzukamo, Leslie Brooks, "Rosemount Oil Refinery Plans $400 Million Upgrade," Twin Cities Pioneer Press, November 15, 2012, updated November 9, 2015, http://www.twincities.com/2012/11/15/rosemount-oil-refinery-plans-400-million-upgrade; Damico, Genevieve, Air Permits Section Chief, Reply to Tony Sullins, Field Supervisor at Twin Cities Minnesota Field Office, U.S. Environmental Protection Agency Region 5, Application for a Prevention of Significant Deterioration permit for Flint Hills Resources' proposed Rosemount, MN, facility. Letter received June 27, 2013, https://yosemite.epa.gov/r5/r5ard.nsf/2134f82000aa062c86257577004df4d7/d5a343c69158c02886257b970070992b/$FILE/Flint%20Hills%20Biological%20Assessment.pdf.
[148] U.S. Energy Information Administration, *Refinery Capacity Report*, with data as of January 1, 2016.
[149] Shaffer, David, "Flint Hills Resources plans $750 million in capital investment at its Minnesota refinery," *Star Tribune*, South Metro, February 4, 2016, http://www.startribune.com/flint-hills-resources-plans-750-million-in-capital-investment-at-its-minnesota-refinery/367759651.

to help meet pending EPA Tier 3 gasoline standards, which go into effect in 2017. The sulfur removed from the gasoline will be used to produce fertilizer.[150]

Pipelines and ports

Changes to supply and logistics in the Northern Midwest include changes designed to supply the Green Bay and Fox River Valley markets in northeastern Wisconsin, which have been impacted by the indefinite shutdown of the West Shore Pipeline between Milwaukee and Green Bay in March 2016, and a pipeline interconnection that will link the Billings, Montana (in PADD 4) and Twin Cities supply hubs.

- **Flint Hills Resources:** Flint Hills announced in May 2016 that it plans to expand its fuel distribution terminals in Waupun and Junction City, Wisconsin to help meet demand for transportation fuels in central and eastern Wisconsin, including the Fox River Valley and Green Bay markets. The Waupun and Junction City projects are expected to be completed in fall 2017 and fall 2016, respectively. When complete, the two projects will increase the company's capability to supply central and northeastern Wisconsin by at least 27,000 b/d.[151] Both the Waupun and Junction City terminals are supplied via Koch Pipeline's Wisconsin Pipeline system originating at Flint Hills' Pine Bend refinery in St. Paul, Minnesota. Flint Hills and Koch Pipeline are both subsidiaries of Koch Industries.
- **Port of Green Bay:** The Port of Green Bay has begun receiving barge deliveries of transportation fuels following the indefinite closure of the West Shore Pipeline segment supplying northeast Wisconsin. Outbound shipments from the port, which previously supplied Cheboygan, Michigan, have declined, and the port is now bringing in inbound shipments of gasoline and diesel from Montreal, Canada; New York state; and Toledo, Ohio, and inbound shipments of diesel from Chicago, Illinois. In May 2016, inbound shipments averaged approximately 1,200 b/d.[152]
- **Cenex/NuStar:** Cenex Pipeline and NuStar Energy are constructing an interconnection between their two systems near Fargo, North Dakota. The Cenex Pipeline, which is owned by CHS Inc., spans from CHS Inc.'s refinery in Laurel, Montana, to Fargo, North Dakota. NuStar's North Pipeline system originates at Tesoro's Mandan, North Dakota refinery and runs to the Twin Cities supply hub. The interconnection project, which is slated for completion in spring 2017, will enable product flows between the Billings, Montana and Twin Cities supply hubs. In addition, Cenex plans to upgrade portions of its system to expand distribution capacity.

Fuel regulations

- **Minnesota Biodiesel:** Minnesota's summer biodiesel mandate is expected to double by 2018. The current mandate, which was implemented in 2014, requires 10% biodiesel to be blended with No. 2 diesel fuel (B10) between April 1 and September 30 of each year, with a 5% requirement (B5)

[150] Koch News, "Flint Hills Resources Pursues New Innovations at Pine Bend Refinery," March 19, 2014, http://www.kochnews.com/articles/2014/flint-hills-resources-pursues-new-innovations-at-p.
[151] Flint Hills Resources, "Flint Hills Resources to Begin Construction on $20 Million Fuel Terminal Expansion Serving Central and Northeastern Wisconsin," August 10, 2016, http://www.fhr.com/newsroom/news_detail.aspx?id=442.
[152] S&P Global Platts, "Port of Green Bay becomes importer of refined products as pipeline shuts," Oil, July 8, 2016, http://blogs.platts.com/2016/07/08/port-green-bay-importer-refined-products-pipeline.

during the colder months of the year when higher biodiesel blends can lead to gelling. New requirements, set to take effect on May 1, 2018, will increase the summer biodiesel blend to 20% (B20), leaving the fall and winter requirement at 5%. Before the new requirements take effect, Minnesota officials must certify that sufficient biodiesel and/or feedstock supply exists, adequate blending infrastructure is accessible, and the necessary federal standards for mandated blends have been established.[153]

[153] Minnesota Department of Agriculture, "History of Minnesota's Biodiesel Program," Renewable Energy: Biodiesel Program, p. 1, accessed August 18, 2016, http://www.mda.state.mn.us/renewable/biodiesel/aboutbiodiesel.aspx.

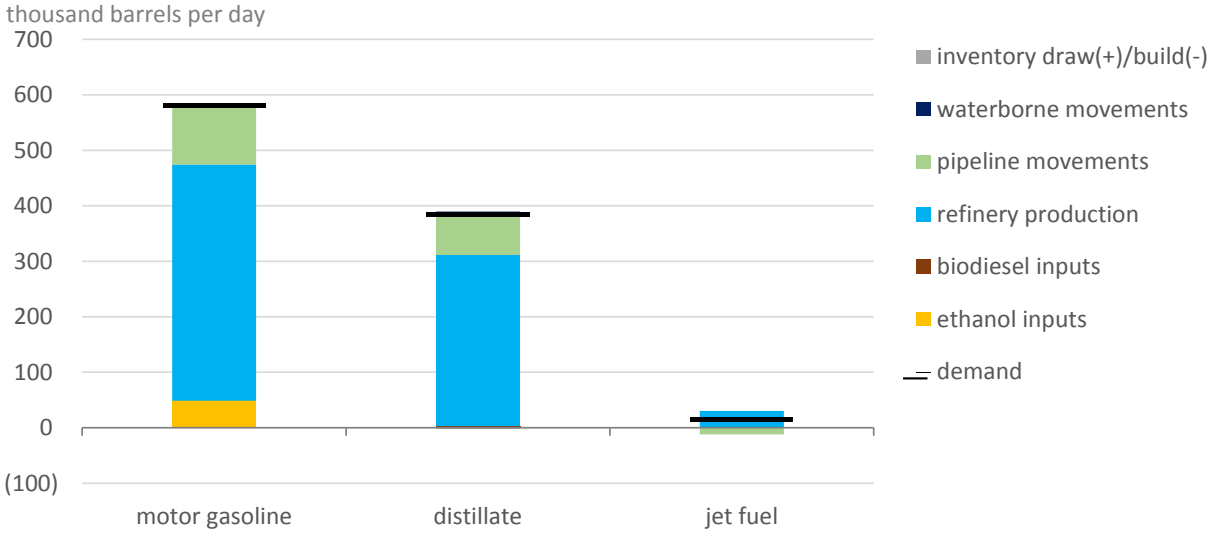
Southern Midwest

The Southern Midwest region includes five states: Iowa, Kansas, Missouri, Nebraska, and Oklahoma. Lying in the geographic center of the United States, this region is bounded by the Mississippi River to the east, the Rocky Mountain states to the west, Texas and Arkansas to the south, and the Northern Midwest states to the north. Estimated total demand for transportation fuels (motor gasoline, distillate fuel oil, and commercial jet fuel) in the Southern Midwest was 989,000 barrels per day (b/d) in 2015, or 24% of overall Midwest (Petroleum Administration for Defense District [PADD] 2) demand. Principal demand centers are geographically dispersed throughout the region with major metropolitan areas surrounding Saint Louis and Kansas City, Missouri, and Oklahoma City, Oklahoma.[154] Other major markets include Des Moines, Iowa; Wichita, Kansas; Springfield, Missouri; Omaha, Nebraska; and Tulsa, Oklahoma.

Supply/demand balances

The Southern Midwest has eight refineries, all located in Oklahoma and Kansas, which together produced 765,000 b/d of transportation fuels in 2015, enough to meet 77% of in-region demand (or 82% of demand net of ethanol and biodiesel inputs). In addition, St. Louis, the region's largest market, has direct access to supply from a 336,000 barrels per calendar day (b/cd) refinery in nearby Wood River, Illinois. Significant transportation fuel volumes—approximately 400,000 b/d in 2015—move into the Southern Midwest from the Gulf Coast via major pipeline systems. However, much of this volume is trans-shipped across the region for ultimate delivery to markets in the Eastern Midwest or Rocky Mountain (PADD 4) regions.

Figure 30. Southern Midwest supply/demand balances, 2015



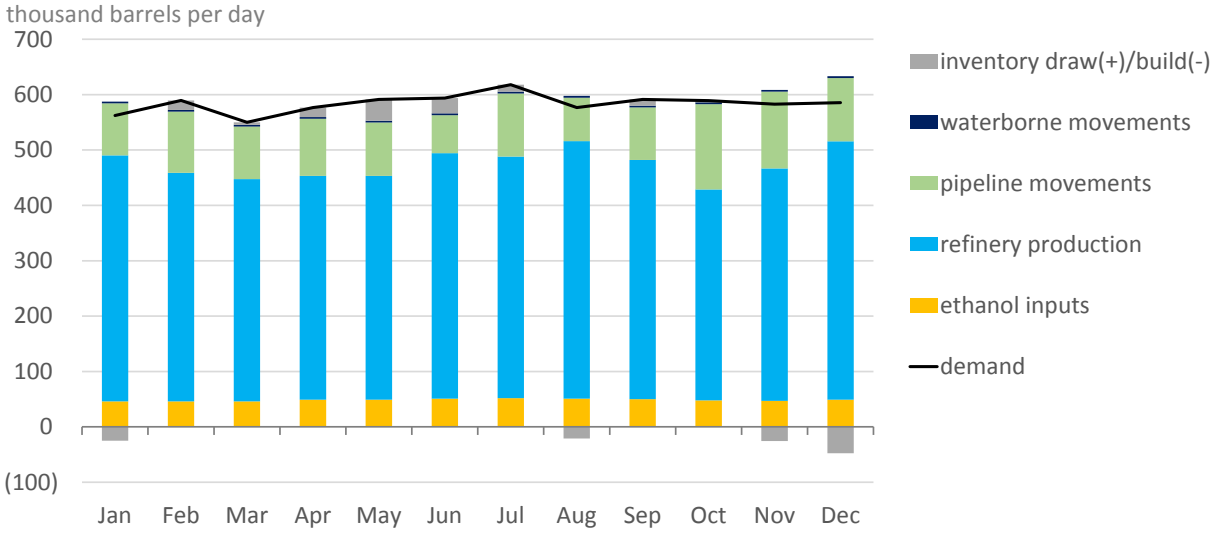
Note: All domestic movements and inventory changes are reported on a net basis.
Sources: ICF analysis of EIA, Airlines for America, USACE, FERC, and company 10-K data.

[154] Principal demand centers are defined as metropolitan statistical areas with 1 million or more people as of July 1, 2015. Population estimates are from the U.S. Census Bureau, "2015 Population Estimates" (accessed November 23, 2016), http://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?pid=PEP_2015_PEPANNRES&src=pt.

Gasoline

Figure 31 presents the 2015 monthly motor gasoline supply/demand balance in the Southern Midwest region. In 2015, in-region demand averaged 584,000 b/d, including approximately 49,000 b/d of ethanol. Demand is typically higher than average during the summer months. Peak demand for 2015 occurred in July at 618,000 b/d, up from the year's low of 550,000 b/d in March. In-region refinery production of gasoline averaged 426,000 b/d in 2015, enough to meet approximately 80% of annual demand (net of ethanol inputs). Net pipeline movements into the region from other U.S. markets made up most of the balance.

Figure 31. Southern Midwest motor gasoline supply/demand balance, 2015



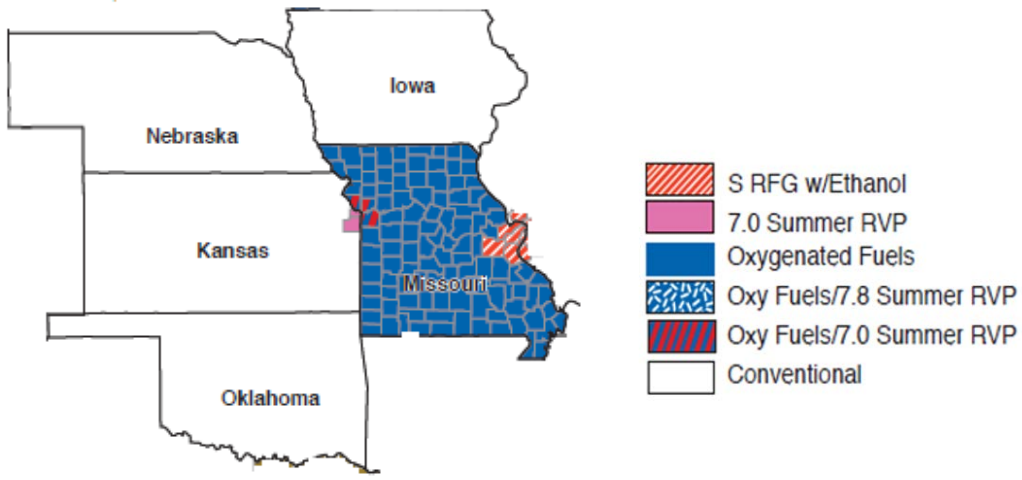
Note: All domestic movements and inventory changes are reported on a net basis.
Sources: ICF analysis of EIA, USACE, FERC, and company 10-K data.

The state of Missouri enforces a year-round, statewide oxygenated gasoline program.[155] Oxygenated gasoline is conventional gasoline that has been blended with ethanol in order for it to burn more completely, thus releasing fewer harmful chemicals into the atmosphere. Four Missouri counties that are included in the St. Louis metropolitan area are also reformulated gasoline "opt-in" areas where the U.S. Environmental Protection Agency (U.S. EPA) requires the sale of reformulated gasoline at the request of the state's Governor.[156] Reformulated gasoline is a special formulation of gasoline that is designed to reduce smog formation in urban areas. Reformulated gasoline is oxygenated through ethanol blending. In accordance with the Clean Air Act, the U.S. EPA also requires the adoption of summer Reid vapor pressure (RVP) standards that limit the volatility of conventional gasoline sold in parts of the Southern Midwest. From May 1 through September 15, all five Southern Midwest states enforce a statewide 9.0 RVP limit. In addition, counties in Kansas and Missouri that make up the Kansas City metropolitan area maintain a

[155] American Fuel and Petrochemical Manufacturers, "State Motor Fuel Specifications," updated 2015, https://www.afpm.org/State-Motor-Fuels-Specifications.
[156] U.S. Environmental Protection Agency, "Reformulated Gasoline" (accessed July 8, 2015), http://www2.epa.gov/gasoline-standards/reformulated-gasoline.

stricter RVP limit of 7.0 between June 1 and September 15. U.S. EPA and state-level motor gasoline regulations in the Southern Midwest region are mapped in Figure 32 and are listed in Table 28.

Figure 32. Map of Southern Midwest motor gasoline regulations



Source: ExxonMobil, as of June 2015.

Table 28. Schedule of Southern Midwest motor gasoline regulations

Regulation	Area(s)	Dates
Oxygenated Gasoline	All counties in Missouri	Year-round
Reformulated gasoline (Opt-in areas)	*Saint Louis metropolitan area:* Franklin, Jefferson, St. Charles, and St. Louis counties in Missouri	Year-round
Summer gasoline volatility <9.0 RVP	All counties in Iowa, Kansas, Missouri, Nebraska, and Oklahoma	May 1 – Sept. 15
Summer gasoline volatility <7.0 RVP	*Kansas City metropolitan area:* Johnson and Wyandotte counties in Kansas and Clay, Jackson, and Platte counties in Missouri	June 1 – Sept. 15

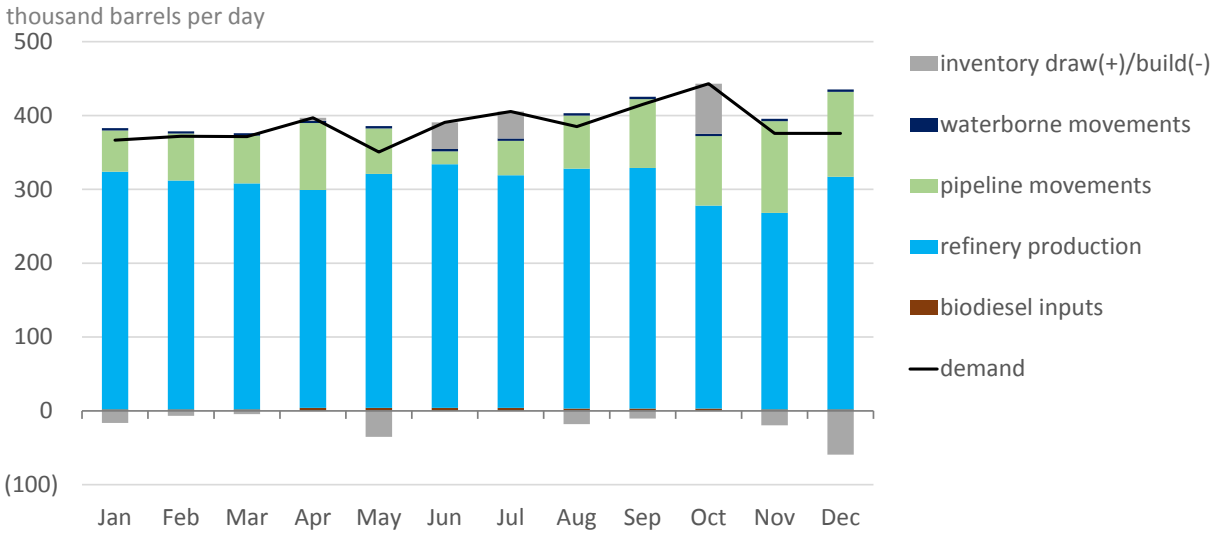
Sources: U.S. EPA Office of Transportation and Air Quality, American Fuel and Petrochemical Manufacturers.

Distillate

Figure 33 presents the 2015 monthly distillate supply/demand balance for the Southern Midwest region. In 2015, demand for distillate fuels averaged 387,000 b/d. Distillate fuel oil demand in the Southern Midwest is driven primarily by on-highway demand; however, distillate use in the farm and railroad sectors is also significant.[157] In 2014, farm use accounted for nearly 19% of the region's distillate sales, with farm use accounting for as much as 28% of sales in Kansas. These shares compare with a national average of 5%.[158] Distillate demand typically rises during the harvest season, peaking in the fall months. In 2015, consumption peaked in October at 443,000 b/d.

[157] U.S. Energy Information Administration, *Sales of Distillate Fuel Oil by End Use*, accessed June 26, 2016.
[158] Ibid.

Figure 33. Southern Midwest distillate supply/demand balance, 2015



Note: All domestic movements and inventory changes are reported on a net basis.
Sources: ICF analysis of EIA, USACE, FERC, and company 10-K data.

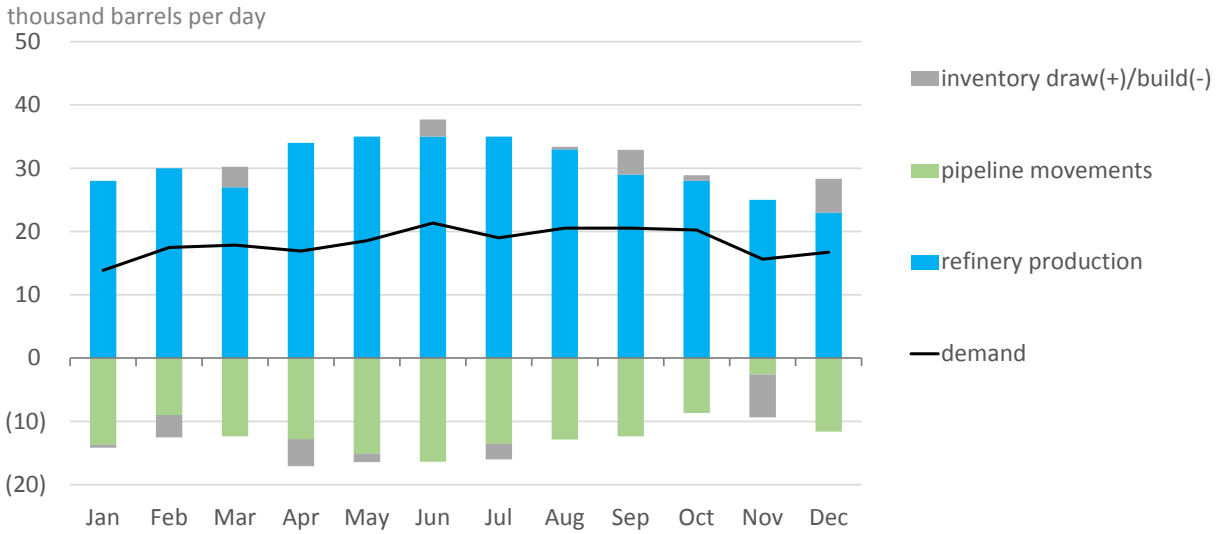
The Southern Midwest region, as with the rest of the country, is required by federal law to use ultra-low sulfur diesel (ULSD)—diesel fuel with a maximum sulfur content of 15 parts per million (ppm)—for all highway, non-road, locomotive, and marine diesel fuel. Although no states in the Southern Midwest have a biodiesel mandate, all five states provide incentives for its use, including retailer tax credits, producer tax refunds, and infrastructure grants.[159]

Jet fuel

Figure 34 presents the Southern Midwest region's 2015 monthly jet fuel supply/demand balance. Commercial jet fuel demand in the region averaged 18,000 b/d in 2015, while in-region refinery production averaged 30,000 b/d, exceeding demand by 67%. Surplus jet fuel produced in the Southern Midwest is transported to other regions via pipeline. Jet fuel demand in the Southern Midwest generally follows a seasonal pattern, with consumption rising in the summer months. In 2015, demand peaked at 21,000 b/d in June, August, and September, and was lowest in January, at 14,000 b/d.

[159] Alternative Fuels Data Center, "State Laws and Incentives," U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, updated June 4, 2014, available at http://www.afdc.energy.gov/laws/state.

Figure 34. Southern Midwest jet fuel supply/demand balance, 2015



Note: All domestic movements and inventory changes are reported on a net basis.
Sources: ICF analysis of EIA, Airlines for America, USACE, FERC, and company 10-K data.

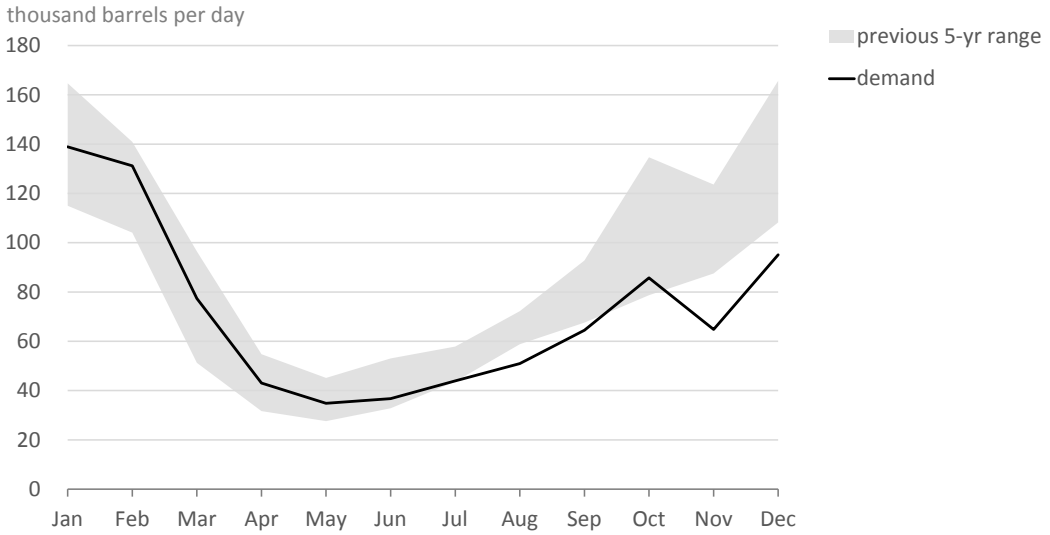
Three airports in the Southern Midwest region are designated as medium hubs by the Federal Aviation Administration: Lambert-St. Louis International, Kansas City International, and Eppley Airfield serving the greater Omaha metropolitan area. The Southern Midwest region also includes four small hubs serving Oklahoma City and Tulsa, Oklahoma; Wichita, Kansas; and Springfield, Missouri.[160] In addition to these hubs, 17 smaller commercial service airports operate in the region.

Propane

Figure 35 presents monthly prime supplier sales of consumer-grade propane in the Southern Midwest compared against the previous five-year range.[161] Propane sales in the Southern Midwest averaged just over 72,000 b/d in 2015, equal to roughly one-third of total Midwest (PADD 2) propane sales. Sales are highly seasonal, with volumes typically highest during the winter heating season and—under the right conditions—during the fall harvest season when propane is used for drying grain. In 2015, monthly sales peaked in January at 140,000 b/d, compared to sales volumes below 40,000 b/d in late spring and early summer.

[160] Federal Aviation Administration, "Passenger Boarding (Enplanement) and All-Cargo Data for U.S. Airports" (accessed November 23, 2016), https://www.faa.gov/airports/planning_capacity/passenger_allcargo_stats/passenger/.
[161] A prime supplier is a firm that produces, imports, or transports selected petroleum products across state boundaries and local marketing areas, and sells the product to local distributors, local retailers, or end users.

Figure 35. Monthly consumer-grade propane sales in the Southern Midwest, 2015



Source: U.S. Energy Information Administration, *Monthly Report of Prime Supplier Sales of Petroleum Products Sold for Local Consumption.*

Propane sales in the Southern Midwest are more equally distributed across consuming sectors than in other Midwest (PADD 2) regions where residential sales dominate. In 2014, the residential sector accounted for approximately 40% of total sales in the Southern Midwest, while the commercial and agricultural sectors accounted for roughly 20% and 25%, respectively, according to the American Petroleum Institute.[162] The total number of households using propane for primary space heating is just over 600,000, a 9% share of the residential heating market.[163] This share is higher than any other region in PADDs 2 or 4, aside from the Northern Midwest.

Extreme cold temperatures can drive demand for heating during the winter months, while heavy rainfall during the harvest season can lead to wetter corn crops, driving demand for propane use in grain-drying equipment. Fall demand for propane is also affected by the overall size of the harvest, with larger harvests contributing to increased propane use. Over the previous five years, fall sales peaked at more than 130,000 b/d in November 2013 due to a large and wet harvest, and winter sales peaked at more than 160,000 b/d in December 2013 and January 2014 amid near-record cold weather throughout much of the region. The size and timing of these two demand spikes, combined with concurrent infrastructure outages, led to a shortage of propane in the Northern Midwest in early 2014.[164] Weather conditions can also have the reverse effect on propane sales. In November and December 2015, states in the Northern Midwest

[162] American Petroleum Institute, *Sales of Natural Gas Liquids and Liquefied Refinery Gases Survey*, 2015 edition, http://www.api.org/products-and-services/statistics/reports-and-surveys.
[163] U.S. Census Bureau, *American Community Survey*, updated July 21, 2014, https://www.census.gov/programs-surveys/acs.
[164] U.S. Department of Energy, Office of Electricity Delivery and Energy Reliability, *An Assessment of Heating Fuels and Electricity Markets During the Winters of 2013–2014 and 2014–2015*, prepared for U.S. DOE by ICF, October 2015, http://energy.gov/sites/prod/files/2015/10/f27/DOE_OE_Two%20Winters%20Report_Final_10.19.15.pdf.

experienced temperatures much above average, driving sales below the previous seasonal five-year lows.[165]

Refineries

The Southern Midwest has eight small- to mid-sized refineries with a combined atmospheric crude distillation capacity of 850,300 b/cd.[166] Table 29 lists each refinery and its operable capacity as of January 1, 2016. All of this capacity is located in Oklahoma and Kansas—the so-called "Midcontinent." With the exception of HollyFrontier's Tulsa East and Tulsa West refineries—which operate as an integrated complex—the region's refineries are geographically dispersed within the Midcontinent.

Table 29. Southern Midwest refineries, 2016

Owner	Site	Operable capacity [a] (b/cd)
Oklahoma		
Phillips 66	Ponca City, OK	200,000
Valero Energy	Ardmore, OK	86,000
HollyFrontier	Tulsa West, OK	85,000 [b]
HollyFrontier	Tulsa East, OK	70,300 [b]
CVR Energy	Wynnewood, OK	70,000
	Total	**511,300**
Kansas		
HollyFrontier	El Dorado, KS	138,400
CVR Energy	Coffeyville, KS	115,000
CHS	McPherson, KS	86,000
	Total	**339,000**
	Southern Midwest Total	**850,300**

[a] Barrels per calendar day, as of January 1, 2016

[b] HollyFrontier Corporation's Tulsa refineries are integrated and have a combined crude processing rate of 125,000 barrels per stream day, which is lower than the sum of their individual capacities.

Sources: U.S. Energy Information Administration, *Refinery Capacity Report*; HollyFrontier Corporation, U.S. Securities and Exchange Commission Form 10-K, 2015.

Many of the Southern Midwest's refineries are connected to the nation's largest crude oil pipeline and storage hub in Cushing, Oklahoma, which gathers supply from numerous inland North American sources, including local Midcontinent production, the Permian Basin in West Texas and New Mexico, the Bakken Formation in North Dakota and Montana, and Western Canada. Access to diverse crude oil streams at the Cushing hub provides the flexibility for Southern Midwest refiners to optimize their crude slates. Crude

[165] National Oceanic and Atmospheric Administration, "National Temperature and Precipitation Maps," National Centers for Environmental Information: Temperature, Precipitation and Drought, March 6, 2015 release, https://www.ncdc.noaa.gov/temp-and-precip/us-maps/.

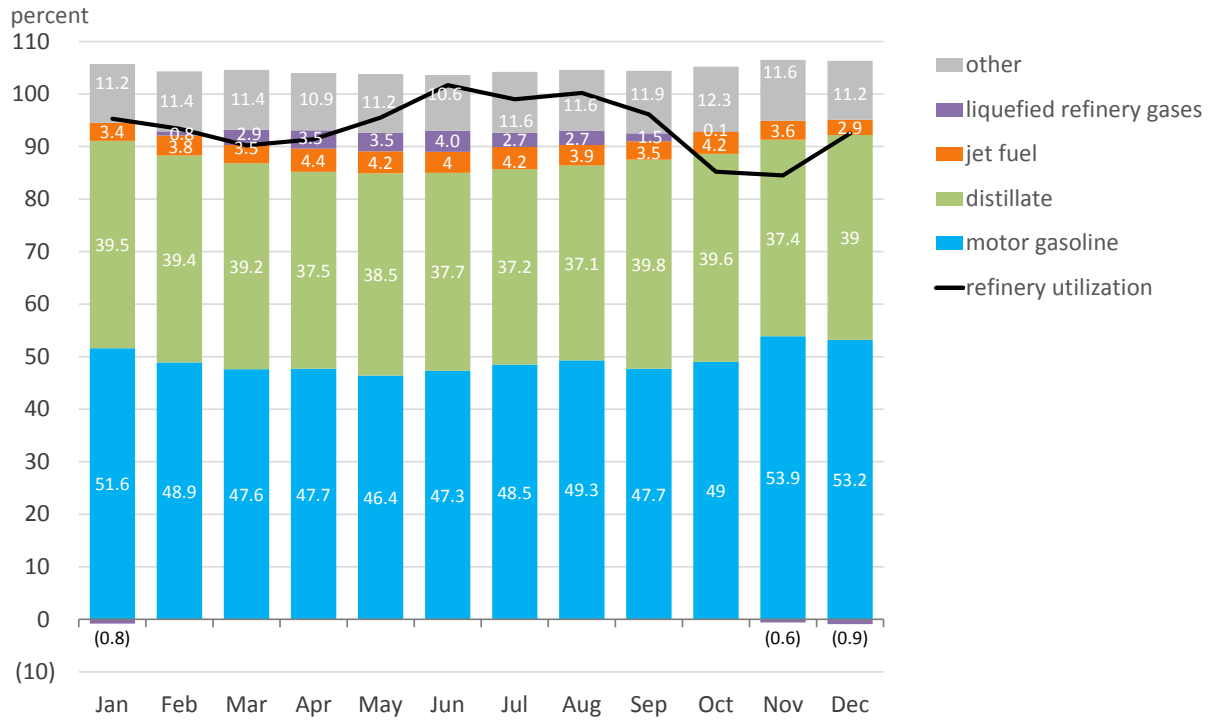
[166] Barrels per calendar day is a measure of the amount of input that a distillation unit can process in a 24-hour period under usual operating conditions. It takes into account both planned and unplanned maintenance. Stream day capacity is the maximum number of barrels of input that a distillation 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.

supply is sent to the region's refineries primarily by pipeline; however, in some cases, local production is delivered by truck. Southern Midwest refineries—like refineries elsewhere in the country—also process non-crude oil feedstocks, such as isobutane and natural gasoline. Southern Midwest refineries acquire these feedstocks from regional natural gas liquid (NGL) fractionation facilities, including a major NGL fractionation and storage hub in Conway, Kansas. Transportation fuels produced at Southern Midwest refineries are distributed by truck to local markets, and by pipeline to markets primarily in the Southern and Northern Midwest, but also to the Rocky Mountain and Eastern Midwest regions.

Refinery yields

Southern Midwest refineries are configured to yield high percentages of ground transportation fuels—motor gasoline and distillate fuels. Figure 36 shows monthly refinery utilization and yield percentages for motor gasoline (both finished gasoline and blendstocks), distillate fuel oil, liquefied refinery gases (LRGs), and other secondary products for the Southern Midwest refineries in 2015.[167]

Figure 36. Southern Midwest refinery yields, 2015



Note: Yield percentages sum to higher than 100% due to processing gains.
Source: U.S. Energy Information Administration, *Petroleum Supply Monthly*.

Production of transportation fuels (gasoline, distillate, and jet fuel) accounted for 91.6% of the region's annual yield in 2015, significantly higher than the national average of 84.8%, and one of the highest such yields of any refining region in the country. In particular, ground transportation fuel yields are significantly

[167] Liquefied petroleum gases are products fractionated from refinery or still gases; through compression and/or refrigeration, they are retained in the liquid state. The reported categories are ethane/ethylene, propane/propylene, normal butane/butylene, and isobutane/isobutylene. These exclude still gas.

higher than the national average: motor gasoline yield at 49.3% and distillate yield at 38.5% are higher than the national averages of 45.3% and 29.8%, respectively. This is primarily due to a very light refinery crude slate, the lowest residual fuel yield of any refining region in the country, and minimal petrochemical feedstock production. Meanwhile, jet fuel yield at 3.8% is lower than the national average of 9.7% as many refineries in the Southern Midwest are configured and operated to yield lower jet fuel volumes versus gasoline and diesel, due to relatively low demand in the region. Despite the region's low jet fuel yield, the Southern Midwest still produces more jet fuel than is consumed in the region, and it is therefore a net supplier to neighboring regions. Refinery utilization in 2015 averaged 93.8% for the year, with peak utilization as high as 101.7% in June. Utilization was lowest in October and November, at around 85%, due to planned refinery maintenance work, which typically occurs in the fall. Maintenance work also occurs in the spring, and March utilizations were the lowest over the first six months of the year.

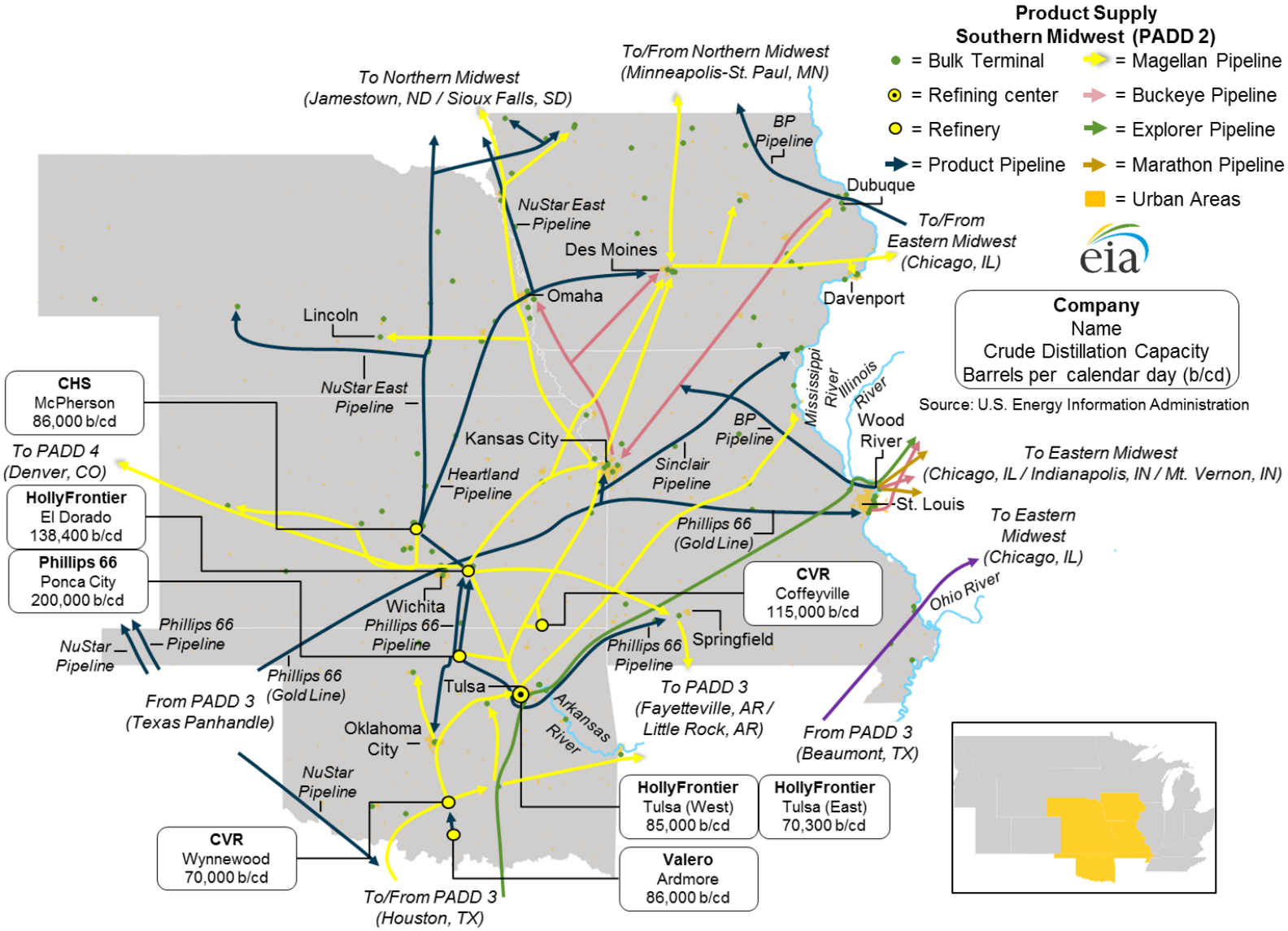
A particular characteristic of Southern Midwest refinery yields is the negative yield of LRGs during several winter months. In fall and winter, the region's refineries blend additional butane into supplies of winter-blend gasoline due to higher seasonal RVP limits and to control engine vapor lock. Supplies of butane are obtained through the distillation of crude oil at the refineries, but they are also brought in from outside sources, including regional NGL fractionators. Negative yields occur when inputs of butane from outside sources exceed production of all other LRGs (primarily propane/propylene) at the refineries. Proportionally, refineries in the Southern Midwest consume more butane from outside sources than the average U.S. refinery. In December 2015, Southern Midwest refinery inputs of normal butane from outside sources averaged 26,000 b/d, or 5.6% of total refinery gasoline production (excluding ethanol inputs), compared with a national average of 2.6% in the same month. [168] [169] Due to the impact of higher butane blending in winter gasoline, Southern Midwest motor gasoline yield is higher by about 3 to 5 percentage points in the fall and winter months than in the spring and summer months.

Supply and logistics

The Southern Midwest is primarily supplied by in-region refinery production but relies on product pipeline shipments from adjacent regions to meet demand for transportation fuels. The core of the region's supply system lies in Oklahoma and Kansas, sometimes referred to as the "Midcontinent," where eight small- to medium-sized refineries produce fuels from domestic U.S. and imported Canadian crude sources. From the Midcontinent, a web of product pipelines spreads throughout the Southern Midwest, delivering fuel to markets in Missouri, Iowa, Nebraska, and further north into the Northern Midwest. In-region refinery supply is supplemented by pipeline movements into the region from refining centers from the Gulf Coast, Eastern Midwest, and Northern Midwest. While Southern Midwest demand centers primarily receive fuel by pipeline, small volumes are also received at ports along the Mississippi River in Missouri. Figure 37 on page 88 presents the refineries, product pipelines, storage terminals, and inland waterways serving the Southern Midwest region.

[168] U.S. Energy Information Administration, *Refining District Oklahoma-Kansas-Missouri Refinery Net Production of Normal Butane*, accessed November 23, 2016.
[169] U.S. Energy Information Administration, *U.S. Refinery Net Production of Normal Butane*, accessed November 23, 2016.

Figure 37. Southern Midwest refined petroleum infrastructure



Pipelines

Pipelines transport virtually all of the transportation fuels that move into, out of, and within the Southern Midwest region. On a net basis, these pipeline systems deliver more transportation fuels into the region than they move out. The largest product flows into the Southern Midwest are from the Gulf Coast (PADD 3). In 2015, gross movements of transportation fuels from the Gulf Coast into the Southern Midwest averaged 400,000 b/d; however, much of the volume that enters the Southern Midwest from the Gulf Coast is trans-shipped across the region for ultimate delivery to markets in the Eastern Midwest or Rocky Mountain (PADD 4) regions.[170] Shipments from the Gulf Coast exhibit strong seasonal variation, with volumes typically highest in the summer months and during periods of planned and unplanned Midwest (PADD 2) refinery outages. In 2015, shipments into the Southern Midwest peaked at more than 600,000 b/d in October due to an usually high number of planned outages in the greater Midwest (PADD 2). In contrast, shipments from the Gulf Coast were approximately 270,000 b/d at their low point in February 2015.[171] The sections below describe refined product pipeline systems serving the Southern Midwest, including systems operated by the following companies: Magellan Pipeline, Explorer Pipeline, NuStar Energy, Phillips 66, BP North America Pipeline, Buckeye Partners, and Enterprise Product Partners.

Magellan Pipeline

Magellan Pipeline Company's refined products pipeline system is the longest common carrier pipeline system for refined products in the United States, extending approximately 9,500 miles from the Gulf Coast and covering a 15-state area across the central United States.[172] Magellan's system is designed as a hub-and-spoke system with key storage and distribution centers located in Oklahoma City, Tulsa, Kansas City, Des Moines, and Minneapolis. These hubs are connected to one another primarily via 12-inch pipelines with additional 8- and 6-inch pipeline spurs extending to primary and secondary terminal sites. Primary terminals in the Southern Midwest include Iowa City, Mason City, and Bettendorf, Iowa; Wichita, Kansas; Omaha, Nebraska; and Springfield, Missouri.[173] Table 30 shows select pipeline routes that make up the Magellan system within the Southern Midwest region, as well as their length and diameter if known.

[170] U.S. Energy Information Administration, *Movements by Pipeline between PAD Districts*, released August 31, 2016.
[171] Ibid.
[172] Magellan Midstream Partners, L.P., U.S. Securities and Exchange Commission Form 10-K, 2015.
[173] Magellan Midstream Partners, L.P., "Iowa Renewable Fuels Association: Pipeline & Terminal 101," presented by Tom Byers (Des Moines, IA, August 16, 2012), http://www.biodieselfoundation.org/docs/4th-annual-biofuels-science-sustainability-tour/magellanbiofuelstourpresentation.pdf?sfvrsn=2.

Table 30. Select Magellan Pipeline Company refined product pipelines in the Southern Midwest

Route	Line Number	Origin	Destination	Distance (mi.)	Diam. (in.)
N. Texas to Duncan	6920	Henrietta, TX	Duncan, OK	29	12
Duncan to Ft. Smith	6615	Duncan, OK	Allen, OK	96	10
	6595/6600	Allen, OK	Ft. Smith, AR	120	12
Wynnewood to Oklahoma City	6620	Wynnewood, OK	Oklahoma City (Reno), OK	67	12
Oklahoma City to Tulsa	6445	Oklahoma City, OK	Cushing, OK	55	8
	6100	Cushing, OK	Tulsa, OK	44	8
Tulsa to Kansas City	6045, 6050 (feeder)	Tulsa, OK	Barnsdall, OK	34	12, 12 [b]
	6005 (feeder)	Ponca City, OK	Barnsdall, OK	54	12
	6020, 6025, 6030	Barnsdall, OK	Kansas City, KS	174	8, 12, 12 [b]
Tulsa to Wichita	6060	Barnsdall, OK	El Dorado, KS	94	16
Tulsa to Columbia	6420/6425/6430	Tulsa, OK	Columbia, MO	276	12
	6355 (spur)	Columbia, MO	Palmyra, MO	89	6
Wichita to Springfield	6080	El Dorado, KS	Humboldt, KS	N/A [a]	8
	6365	Humboldt, KS	Springfield, MO	121	8
	6368 (spur)	Carthage Jct., MO	Carthage, MO	17	8
Razorback Pipeline [d]		Mt. Vernon, MO	Rogers, AR	67	8
Wichita to Kansas City	6110	El Dorado, KS	Kansas City, KS	167	10
Wichita to Des Moines	6380	El Dorado, KS	Wathena Jct., KS	181	16
	6395	Wathena Jct., KS	Des Moines, IA	151	16
Kansas City to Des Moines	6135	Kansas City, KS	Des Moines, IA	190	12
Des Moines to Chicago	6155/6165	Des Moines, IA	Chicago, IL	292	12
	6195 (spur)	Iowa City, IA	Dubuque, IA	70	6
Des Moines to Minneapolis	6185	Des Moines, IA	Minneapolis, MN	240	12
Kansas City to Sioux Falls	6225	Kansas City, KS	Irvington, NE	87	12
	6240	Irvington, NE	Sioux Falls, SD	166	12
	6230 (spur)	Irvington, NE	Omaha, NE	12	8
	6245 (spur)	Omaha, NE	Eppley Airfield (NE)	3	6
	6280 (spur)	Nebraska City, NE	Doniphan, NE	131	8
	6290 (spur)	Lincoln, NE	Lincoln AFB, NE	10	6
	6345 (spur)	Sioux City, IA	Milford, IA	81	6
Wichita to Denver (Chase Pipeline)	6912	El Dorado, KS	Aurora, CO	458	12/10 [c]
	6912	El Dorado, KS	Scott City, NE	249	10

[a] N/A = Not available

[b] Denotes parallel pipeline segments.

[c] Denotes continuous pipeline of varying diameter.

[d] Leased by Magellan Midstream Partners from TransMontaigne Partners; Interconnects with Magellan Pipeline Company system in Mt. Vernon, MO.

Sources: Magellan Pipeline Company, L.P., FERC Form No. 6, 2015/Q4.

Table 31 shows receipts into and deliveries out of the Magellan Pipeline system in each state in the Southern Midwest region. In 2015, approximately 558,000 b/d of refined products (including LPGs) originated on the Magellan Pipeline system in the Southern Midwest, either through direct receipts from refineries (447,000 b/d) or through receipts from connecting pipeline systems (111,000 b/d).[174] Magellan's system is directly connected to all eight refineries in the Southern Midwest. In 2015, Magellan's system delivered approximately 446,000 b/d of refined products (including LPGs) to receipt points in the Southern Midwest. According to Magellan, the company supplies 40% or more of gasoline and distillate demand in every state in the Southern Midwest region, including more than 80% in Iowa.[175]

Table 31. Magellan Pipeline receipts and deliveries of refined products in the Southern Midwest, 2015

State	Receipts (b/d) [a]	Deliveries (b/d) [a]
Iowa	15,000 [b]	124,000
Missouri	2,000 [b]	99,000
Oklahoma	295,000	99,000
Kansas	247,000	74,000
Nebraska	0	50,000
Total	**558,000**	**446,000**

[a] Includes gasoline, distillates, jet fuel, and LPGs.

[b] Originated entirely from pipeline interconnections.

Note: Volumes include LPG, which accounts for 6% of Magellan's total shipments in the Southern Midwest.

Sources: Magellan Pipeline Company, L.P., FERC Form No. 6, 2015/Q4; Magellan, 2016 Analyst Day Presentation.

Magellan's extensive system also ships significant volumes of fuel both into and out of the Southern Midwest region from adjacent regions. An analysis of pipeline receipt and delivery data indicates that between 70,000 b/d and 100,000 b/d entered the Southern Midwest from the Gulf Coast along Magellan's Houston, Texas to Duncan, Oklahoma pipeline segment in 2015. Other Magellan segments provide bidirectional flows to/from the Minneapolis hub in the Northern Midwest, and outbound flows to the Chicago market in the Eastern Midwest and Denver, Colorado in the Rocky Mountain (PADD 4) region.

While Magellan primarily provides transportation services for shippers, the company also contributes to the region's fuel supply through its butane blending and transmix (comingled products that result from batched pipeline shipments) fractionation activities. Magellan blends butane, a common gasoline blending component, into the gasoline pool, particularly during the fall and winter months when sales of higher RVP gasoline are allowed. According to Magellan, butane blending volumes account for approximately 2% of all gasoline it transports.[176] In addition, Magellan operates a fractionator in Des Moines, Iowa, that separates transmix back into useable gasoline and distillate fuels. Magellan processes transmix from its own system, as well as from third parties.

[174] Magellan Pipeline Company, L.P., FERC Form No. 6: Annual Report of Oil Pipeline Companies and Supplemental Form 6-Q: Quarterly Financial Report, 2015/Q4, April 18, 2016.
[175] Magellan Midstream Partners, L.P., "2016 Analyst Day" (New York City, March 31, 2016), https://www.magellanlp.com/~/media/2D007DDCD87F4E8DB62904A0C90D3946.ashx?db=master.
[176] Ibid.

Explorer Pipeline

The Explorer Pipeline is a 1,830-mile pipeline system carrying refined products from the Gulf Coast (PADD 3) to the Midwest (PADD 2). Table 32 lists the major segments and spurs that make up the Explorer Pipeline system, as well as their diameters and capacities.

Table 32. Select Explorer Pipeline refined product pipelines in the Southern Midwest

System	Line	Origin	Destination	Distance (mi.)	Diameter (in.)	Capacity (b/d)
Southern	Eastern Main	Houston, TX	Glenpool, OK	452	28	660,000
	Tulsa Spur	Glenpool, OK	West Tulsa, OK	13	28	
	Western Main	Houston, TX	Arlington, TX	258	10	
		Arlington, TX	Ardmore, OK [a]	106	8	
Northern	Eastern Main	Glenpool, OK	Wood River, IL	403	24	450,000
		Wood River, IL	Hammond, IN	249	24	
	St. Louis Spur	Wood River, IL	St. Louis, MO	23	14	

[a] Ardmore is not listed as an origin or destination point on the Explorer Pipeline tariff.

Source: Explorer Pipeline Company, FERC Form No. 6, 2015/Q4.

The Explorer Pipeline system has two primary lines that enter PADD 2 via the Southern Midwest from Texas. Explorer's eastern mainline consists of a 28-inch pipeline segment running from Houston, Texas to Glenpool, Oklahoma, and a 24-inch segment running from Glenpool to Hammond, Indiana (in the Chicago area). Explorer's western mainline consists of 10- and 8-inch segments running from Houston to Ardmore, Oklahoma; however, Explorer currently does not provide shipping services to or from Ardmore.[177] Explorer Pipeline's southern system, which includes both the eastern and western mainlines running from Houston to Glenpool and Ardmore, has a combined capacity of 660,000 b/d. Explorer's Northern System, which consists of the 24-inch segment from Glenpool to Hammond, has a capacity of 450,000 b/d.

In 2015, total flows on the Explorer system averaged approximately 610,000 b/d according to Federal Energy Regulatory Commission (FERC) filings. This volume includes shipments within Texas, primarily to the Dallas-Fort Worth area, as well as shipments of diluent into the Midwest for ultimate delivery to the Alberta Oil Sands via connecting carriers.[178] Within the Southern Midwest, Explorer has active receipt and delivery points in Tulsa, Oklahoma and St. Louis, Missouri. Only a small volume of Explorer's shipments—approximately 15,000 b/d—originated in Oklahoma in 2015, while another 28,000 b/d originated in Wood River, Illinois, just across the Mississippi River from St. Louis.

Phillips 66

Pipeline systems operated by Phillips 66 in the Southern Midwest region include the Gold Line system and the associated Standish system; the Cherokee system originating in Ponca City, Oklahoma; and the

[177] Explorer Pipeline, Inc., "About," updated 2016, http://www.expl.com/About.

[178] Explorer Pipeline Company, FERC Form No. 6: Annual Report of Oil Pipeline Companies and Supplemental Form 6-Q: Quarterly Financial Report, 2015/Q4, May 26, 2016.

joint venture Heartland Pipeline system. Table 33 lists the major Phillips 66 segments and spurs in the region, as well as their diameters and capacities, when available.

Table 33. Select Phillips 66 refined product pipelines in the Southern Midwest

System	Line	Origin	Destination	Distance (mi.)	Diameter (in.)	Capacity (b/d)
Gold Line	Mainline	Borger, TX	Wichita, KS	681	8-16 [c]	120,000
		Wichita, KS	Paola, KS			132,000
		Paola, KS	East St. Louis, IL			53,000
	Spur	Paola, KS	Kansas City, KS	53	8, 10 [d]	96,000
Standish		Ponca City, OK	Wichita, KS	92	18	72,000
Cherokee	North	Ponca City, OK	Arkansas City, KS	29	10	57,000
		Arkansas City, KS	Wichita, KS	N/A [b]	8	N/A [b]
	East	Ponca City, OK	Mt. Vernon, MO	287	10, 12 [d]	55,000
	South	Ponca City, OK	Oklahoma City, OK	90	8	46,000
Heartland [a]		McPherson, KS	Des Moines, IA	419	8, 6 [d]	30,000

[a] 50/50 joint venture with CHS, Inc.

[b] N/A = Not available

[c] Indicates continuous pipeline varying in diameter.

[d] Indicates parallel pipelines.

Sources: Phillips 66, U.S. Securities and Exchange Commission Form 10-K, 2015; Phillips 66 Carrier LLC, FERC Form No. 6, 2015/Q4; Phillips 66 Fact Sheet: Gold Line Product Pipeline System and Medford Spheres, 2014.

Phillips 66's largest system in the Southern Midwest is the 681-mile Gold Line, which originates at the company's refinery in Borger, Texas, and runs to the St. Louis area. The Gold Line also receives products from Phillips 66's Ponca City, Oklahoma refinery at a junction near Wichita via the company's 72,000 b/d Standish Pipeline. The Gold Line has a capacity of 120,000 b/d between Borger and Wichita, expanding to 132,000 b/d between Wichita and Paola, Kansas. From Paola, the Gold Line splits with the mainline' s capacity dropping to 53,000 b/d as it moves fuel east to the system's terminus in East St. Louis, Illinois, and a 53-mile, 96,000 b/d spur delivering fuel north into the Kansas City market.

Phillips 66's Cherokee Pipeline system primarily serves production from the company's 200,000 b/d Ponca City refinery. The 55,000 b/d Cherokee East pipeline runs 287 miles, delivering products to the Tulsa area before terminating near Springfield, Missouri. Meanwhile, the 57,000 b/d Cherokee North pipeline delivers products from Ponca City to Wichita, and the 46,000 b/d Cherokee South pipeline delivers products south to Oklahoma City.

In addition to its wholly owned Gold Line and Cherokee systems, Phillips 66 jointly owns the Heartland pipeline—a 419-mile, 30,000 b/d pipeline that ships products from the CHS Inc.'s McPherson, Kansas, refinery to Des Moines, Iowa. Phillips 66 also operates the Borger to Denver pipeline, which has no origin or destination points in the Southern Midwest but cuts through the Oklahoma Panhandle en route to markets in the Rocky Mountain (PADD 4) region.

According to FERC filings, approximately 163,000 b/d of transportation fuels originated on Phillips 66's wholly owned pipelines in the Southern Midwest in 2015. The vast majority of these shipments—158,000 b/d—originated at Phillips 66's 200,000 b/d Ponca City refinery, equal to nearly 80% of the refinery's crude distillation capacity.[179] These Ponca City volumes were either shipped on the Standish pipeline to the Gold Line system or distributed via the company's Cherokee pipelines. Meanwhile, approximately 27,000 b/d of transportation fuels originated on Phillips 66 lines in Borger, Texas. These volumes were either shipped on the Gold Line or the Borger to Denver line. The Heartland Pipeline, which Phillips 66 partially owns, shipped approximately 15,000 b/d from McPherson, Kansas to Iowa in 2015.[180]

NuStar Energy

NuStar Energy's East System covers 1,920 miles, moving refined products and natural gas liquids from origination points in southern Kansas to delivery points in Kansas, Nebraska, and South Dakota before terminating in Jamestown, North Dakota. Table 34 lists the major segments and spurs that make up NuStar's system in the Southern Midwest, as well as their lengths, diameters, and 2015 shipments of transportation fuels.

Table 34. Select NuStar Energy East System refined product pipelines in the Southern Midwest

System	Pipeline	Origin	Destination	Dist. (mi.)	Diam. (in.)	2015 Shipments [b] (b/d)
East Pipeline	**Mainline**	McPherson, KS	Geneva, NE	155	16	120,000
		Geneva, NE	Jamestown, ND	423	6	
		Geneva, NE	Wolsey, SD	202	8	
	Western Ext.	Geneva, NE	North Platte, NE	188	8	
	Eastern Ext.	Yankton, SD	Milford, IA	121	6	
		Sioux River Jct., SD	Rock Rapids, IA	41	6	
		Council Bluffs, IA [a]	Sioux Falls, SD	170	6	

[a] Interconnection with Buckeye's Lower V system

[b] Only includes transportation fuels (gasoline, distillates, and jet fuel).

Sources: NuStar Energy, L.P., U.S. Securities and Exchange Commission Form 10-K, 2015; NuStar Pipeline Operating Partnership, L.P., FERC Form No. 6, 2015/Q4.

A western extension of the East Pipeline system runs from Geneva to North Platte, Nebraska, and an eastern extension runs from Yankton, South Dakota to northeastern Iowa. The majority of the refined products transported through the East System are produced at the CHS McPherson, HollyFrontier El Dorado, and Phillips 66 Ponca City refineries. The East System also has access to Gulf Coast supplies of products through third-party connections in Kansas, and the system's eastern extension also is also capable of receiving supply from an interconnection with Buckeye's Lower V system in Council Bluffs, Iowa.

[179] Phillips 66 Carrier LLC, FERC Form No. 6: Annual Report of Oil Pipeline Companies and Supplemental Form 6-Q: Quarterly Financial Report, 2015/Q4, document filed April 8, 2016.

[180] Heartland Pipeline Company, FERC Form No. 6: Annual Report of Oil Pipeline Companies and Supplemental Form 6-Q: Quarterly Financial Report, 2015/Q4, document filed April 8, 2016.

In 2015, the East Pipeline shipped approximately 120,000 b/d of transportation fuels, with approximately 76,000 b/d originating at Kansas refineries.[181] A substantial share of the products delivered through the East System are ultimately used as railroad fuel; ethanol denaturant; or in agricultural operations, including fuel for farm equipment, irrigation systems, trucks used for transporting crops, and crop-drying facilities.[182]

Buckeye Pipe Line Transportation and BP Pipeline North America

Buckeye Pipe Line Transportation LLC, a subsidiary of Buckeye Partners, owns an approximately 650-mile refined product pipeline—the Lower V system—that originates in Dubuque, Iowa and runs southwest into Missouri and then northwest back into Iowa, serving terminals in Sugar Creek, Missouri (near Kansas City); Council Bluffs, Iowa (near Omaha, Nebraska); and Des Moines, Iowa. Table 35 lists the major segments and spurs that make up the Buckeye and BP systems in the Southern Midwest, as well as their lengths, diameters, and capacities, when available.

Table 35. Select Buckeye Pipe Line Transportation and BP Pipeline North America refined product pipelines in the Southern Midwest

System	Origin(s)	Destination(s)	Dist. (mi.)	Diam. (in.)	2015 Shipments (b/d)
Buckeye Pipe Line Transportation (Lower V system)	Dubuque, IA	Kansas City, MO	650	12	41,000
	Kansas City, MO	Council Bluffs, IA		8	
	Burlington Jct., MO	Des Moines, IA		6	
BP Pipeline North America	Whiting, IN	Dubuque, IA	196	10	24,000
	Dubuque, IA	Minneapolis, MN	237	10	N/A [a]
	Wood River, IL	Milan, MO	N/A [a]	N/A [a]	17,000

[a] N/A = Not available

Sources: Buckeye Partners system map; Buckeye Pipe Line Company, L.P., FERC Form No. 6, 2015/Q4; BP Pipelines (North America) Inc., FERC Form No. 6, 2015/Q4.

The Lower V system receives product in Dubuque, Iowa, and Milan, Missouri, via interconnections with two pipelines operated by BP Pipeline North America. BP's Whiting-Dubuque-Twin Cities pipeline delivers fuel to the Lower V system from BP's Whiting, Indiana refinery to Dubuque before extending from Dubuque to the Twin Cities area in Minnesota, while BP's Wood River-Milan line delivers product to the Lower V system in Milan from the refining and pipeline hub in Wood River, Illinois. In 2015, the Lower V system received 24,000 b/d from BP in Dubuque and 17,000 b/d from BP in Milan, according to data filed with FERC.

Enterprise TEPPCO

The Enterprise TEPPCO pipeline system is a 3,396-mile pipeline system that carries transportation fuels, propane, and diluent from the Gulf Coast (PADD 3) to destination points across the Midwest (PADD 2) and

[181] NuStar Pipeline Operating Partnership, L.P., FERC Form No. 6: Annual Report of Oil Pipeline Companies and Supplemental Form 6-Q: Quarterly Financial Report, 2015/Q4, document filed April 14, 2016.
[182] NuStar Energy, L.P., U.S. Securities and Exchange Commission Form 10-K, 2015.

East Coast (PADD 1). Table 36 lists the major segments and spurs that make up the TEPPCO system in the Southern Midwest, as well as their lengths, diameters, and capacities, when available.

Table 36. Select Enterprise TEPPCO refined product pipelines in the Southern Midwest

Pipeline	Origin	Destination	Distance (mi.)	Diameter (in.)	Capacity (b/d)
TEPPCO Mainline (P-2)	Beaumont, TX	Seymour, IN	921	20	330,000 [a]
Chicago Spur (P-35)	Seymour, IN	Chicago, IL	234	14	N/A [b]

[a] Estimated

[b] N/A = Not available

Sources: Enterprise Product Partners, U.S. Securities and Exchange Commission Form 10-K, 2015; Enterprise TE Products Pipeline Company LLC, FERC Form No. 6, 2015/Q4.

In 2015, the TEPPCO system transported 440,000 b/d of refined products, according to the company's annual report; however, this number includes volumes shipped within PADD 3 only and shipments of propane, and may include some northbound movements of diluent for ultimate delivery to the Alberta Oil Sands. Northbound flows of transportation fuels on the TEPPCO pipeline have declined significantly in recent years, and Enterprise reversed and repurposed one of TEPPCO's two mainline pipelines to carry ethane from the Marcellus/Utica Shale region in the Northeast to destinations in the Gulf Coast. In addition, TEPPCO no longer ships distillates or jet fuel on its remaining mainline pipeline into the Midwest, and no longer ships gasoline further east than Seymour, Indiana (although a spur of the system allows gasoline to be delivered from Seymour into the Chicago market). TEPPCO supplies only one receipt point in the Southern Midwest—Cape Girardeau in southeastern Missouri—before passing into the Eastern Midwest.

Other Pipelines

Several other companies transport products within the Southern Midwest, including several systems that serve individual refineries or terminals. Table 37 lists select pipeline systems and their lengths, diameters, and capacities, if available.

Table 37. Select other refined product pipelines in the Southern Midwest

Pipeline	Origin	Destination	Distance (mi.)	Diameter (in.)	Capacity (b/d)
Valero - Wynnewood Products System	Ardmore, OK	Wynnewood, OK	30	12	90,000
CHS Council Bluffs Pipeline	McPherson, KS	Council Bluffs, IA	227	N/A [a]	43,000 [b]
Holly Energy Partners	Wichita Falls, TX	Duncan, OK	47	6	21,000
Sinclair Transportation	Olathe, KS	Carrollton, MO	N/A [a]	8	15,600 [c]
	Carrollton, MO	Montrose, IA	N/A [a]	8	9,600 [c]

[a] N/A = Not available

[b] Average volumes transported in 2015; May include intermediary products delivered from McPherson, KS, to Conway, KS.

[c] Average volumes transported as of December 2013

Sources: Company websites, 10-K reports, FERC Form 6, Pipeline and Hazardous Materials Safety Administration spill response plans.

Valero's proprietary 90,000 b/d Wynnewood Products system is the primary distribution outlet for the company's refinery in Ardmore, Oklahoma, delivering products to an interconnection with the Magellan pipeline system in Wynnewood, Oklahoma. Similarly, CHS McPherson operates a proprietary pipeline from the company's McPherson refinery to Council Bluffs, Iowa, in the Omaha metropolitan area. Holly Energy Partners delivers up to 21,000 b/d via a common-carrier line from Wichita Falls, Texas, to a Magellan interconnection in Duncan, Oklahoma. The line is part of Holly's 510-mile refined product system that distributes products from Alon's Big Spring refinery in western Texas. Sinclair Transportation operates a proprietary line, which ships products from a Magellan inter-connection in Olathe, Kansas, south of Kansas City, to the company's terminals in Carrollton, Missouri and the Fort Madison, Iowa area. In 2013, the pipeline reportedly shipped 15,600 b/d of products.

Ports

The Southern Midwest region receives small volumes of transportation fuels at terminals along the Mississippi River. According to data from the U.S Army Corps of Engineers (USACE), approximately 8,000 b/d were received as inbound shipments to terminals along the Mississippi River between Minneapolis, Minnesota, and the mouth of the Ohio River in 2014. This volume includes receipts at the Port of St. Louis, and may include some receipts on the Illinois side of the Mississippi River. An additional 1,000 b/d of distillates was received at Caruthersville Harbor in Missouri, south of the mouth of the Ohio River.[183]

Markets

The Midcontinent

Oklahoma and Kansas—collectively referred to as the Midcontinent—are primarily supplied by local refinery production. All eight of the Southern Midwest's refineries, with a combined refining capacity of 850,000 b/cd, are located in the Midcontinent. A vast web of pipelines—primarily operated by Magellan, NuStar, and Phillips 66—extends from these refineries, supplying markets throughout the Southern Midwest and moving fuel to adjacent regions. The Magellan pipeline system transports 44% and 47% of the gasoline and distillate consumed in Oklahoma and Kansas, respectively, according to the company.[184] Additional pipeline systems, including Explorer, Phillips 66's Gold Line, and a segment of the Magellan system originating in Houston, enter the Midcontinent from Texas, in some cases picking up additional supply from Midcontinent refineries before delivering products to final destination markets. Within the Midcontinent, transportation fuel supply is distributed to local markets directly from refinery truck racks or shipped by pipeline short distances to distribution terminals near area population centers, including Oklahoma City and Tulsa in Oklahoma, and Wichita, Topeka, and the Kansas City metropolitan area in Kansas. Phillips 66 operates short-distance jet fuel pipelines that move fuel from local terminals to Oklahoma City's Will Rogers Airport, Wichita's Mid-Con International Airport, and the McDonnell Airforce Base near Wichita.

[183] U.S. Army Corps of Engineers, "2014 Waterborne Commerce of the United States (WCUS) Manuscript Cargo File: Part 2 Gulf Coast, Mississippi River System, Puerto Rico, and Virgin Islands," USACE Navigation Data Center, http://www.navigationdatacenter.us/data/datawcus.htm.
[184] Magellan Midstream Partners, L.P., "2016 Analyst Day" (New York City, March 31, 2016), https://www.magellanlp.com/~/media/2D007DDCD87F4E8DB62904A0C90D3946.ashx?db=master.

Kansas City

The Kansas City metropolitan area, which straddles the border between Missouri and Kansas, is supplied by a number of pipeline systems. Kansas City is a Magellan system hub: Two 12-inch lines and an 8-inch line supply the area from Tulsa, Oklahoma, and a 10-inch line provides supply from Wichita, Kansas. From Kansas City, refined products are shipped on separate 12-inch Magellan lines north to Nebraska and Iowa. A 6-inch Magellan line supplies jet fuel to the Kansas City International Airport. The Kansas City area also receives supply from Phillips 66's 96,000 b/d Paola to Kansas City system, which is composed of 10-inch and 8-inch laterals off of the company's Gold Line, which sources product from refineries in the Midcontinent and Texas Panhandle. In addition, Buckeye's Lower V system, which originates in Dubuque, Iowa, supplies fuels into Kansas City via a 10-inch line before the system turns back north into western Iowa. Fuels shipped on the Lower V system are originally sourced from supply hubs in the Eastern Midwest.

Springfield

Springfield, Missouri, is supplied off an 8-inch Magellan line from Wichita, Kansas, and from Phillips 66's 55,000 b/d Cherokee East line, which originates at the company's refinery in Ponca City, Oklahoma and terminates in Mount Vernon, Missouri, just west of Springfield. From Mt. Vernon, Magellan's system extends south into Rogers, Arkansas (near Fayetteville) via the 30,000 b/d Razorback pipeline, which Magellan leases from TransMontaigne Partners.

Omaha

Several pipeline systems supply the Omaha, Nebraska metropolitan area, which includes Council Bluffs on the Iowa side of the Missouri River. The Magellan system supplies products produced in the Midcontinent and Gulf Coast to Omaha via an 8-inch spur off the company's line running from Kansas City to Sioux Falls. Short-distance Magellan pipelines supply jet fuel from the company's Omaha terminal to Eppley Airfield and Offutt Air Force Base, located to the north and south of the city, respectively. Buckeye's Lower V system, which ships fuel produced in the Eastern Midwest, accesses the Omaha market via an 8-inch line from Kansas City to Council Bluffs. From Council Bluffs, Buckeye's system interconnects with the eastern extension of NuStar Energy's East System, which supplies markets further north in western Iowa. Two additional pipelines provide supply into Council Bluffs from the CHS McPherson refinery—Phillips 66's 30,000 b/d joint-venture Heartland Pipeline, which passes through Council Bluffs en route to Des Moines, and CHS's proprietary pipeline that terminates in Council Bluffs. Heartland shipped approximately 15,000 b/d to markets in Iowa in 2015, according to FERC data.

Des Moines

According to Magellan, the company's pipeline system transports more than 80% of the gasoline and distillate fuels consumed in Iowa.[185] Des Moines, Iowa, is a major hub for the Magellan pipeline system: a 16-inch line and a 12-inch line supplies the city from Wichita and Kansas City, respectively, while a 12-inch line provides a bidirectional connection between Des Moines and Minneapolis to the north. From the Des

[185] Magellan Midstream Partners, L.P., "2016 Analyst Day" (New York City, March 31, 2016), https://www.magellanlp.com/~/media/2D007DDCD87F4E8DB62904A0C90D3946.ashx?db=master.

Moines hub, the Magellan system pushes products east via a 12-inch line to Davenport, Iowa, and allows products to be shipped further into the Chicago market. Des Moines is a balancing point on Magellan's system between the Midcontinent and Minneapolis area refiners. While normal flow on the Magellan segment between Minneapolis and Des Moines is from north to south, the system is bidirectional, allowing Midcontinent supply to flow into the Northern Midwest to compensate when there are refinery outages in that region. Des Moines is also home to one of Magellan's three fractionators, which separate pipeline transmix (comingled products that result at the interface between pipeline batches) into useable gasoline and distillate fuels. Two other refined product pipeline systems terminate in Des Moines: the 30,000 b/d Heartland Pipeline, a joint venture between Phillips 66 and Oneok, ships unleaded gasoline from the CHS McPherson refinery, and Buckeye's Lower V system delivers fuels produced in the Eastern Midwest via a 6-inch spur.

St. Louis

The St. Louis metropolitan area, which straddles the Mississippi River between Missouri and Illinois, is primarily supplied from Phillips 66 and Cenovus Energy's 336,000 b/d joint venture refinery in Wood River, Illinois (WRB Refining). The St. Louis area is also a major pipeline hub, serving as both an origin and destination point for numerous pipeline systems. From the west, Explorer Pipeline delivers supply from the Gulf Coast via its 450,000 b/d Northern system, which passes through Wood River before continuing northeast to the Chicago market, and Phillips 66's Gold Line from refineries in the Texas Panhandle and Midcontinent delivers up to 53,000 b/d via a segment of its system running from Paola, Kansas to East St. Louis, Illinois, just across the Mississippi River from St. Louis.

From the Wood River area, Buckeye pipelines move fuel to the Chicago market (14-inch line), to Indianapolis and an interconnection with Buckeye's system in Lima, Ohio (12-inch line), and to destination points in southeastern Illinois (12-inch line), while Marathon lines ship gasoline and distillates to Chicago (12-inch line) and Indianapolis (10-inch line). These Buckeye and Marathon lines are discussed in greater detail in the chapter on the Eastern Midwest sub-PADD region. In addition, BP Pipeline North America ships products from Wood River to an interconnection with Buckeye's Lower V system in Milan, Missouri. Shipments along this line averaged 18,000 b/d in 2015, according to FERC fillings.

Within the St. Louis area, several short-distance pipelines operated by Explorer, Buckeye, and Marathon move gasoline and distillates from the Wood River hub to terminals in St. Louis and East St. Louis. Two pipelines from Wood River—a 10-inch Buckeye line and Allied Aviation's St. Louis Pipeline—supply jet fuel to Lambert-St. Louis International Airport, which is the busiest airport in the Southern Midwest region.[186] Although several terminals in the St. Louis area have barge docks, receipts of transportation fuels are minimal—only 4,000 b/d were received into the Port of St. Louis in 2014, including approximately 1,500 b/d shipped locally within the port, most likely from the Wood River refinery. Meanwhile, approximately 8,000 b/d were loaded onto barges for outbound shipment, primarily from Wood River.[187]

[186] Allied Aviation, "Pipelines," 2016, http://www.alliedaviation.com/locations/pipeline/pipeline.html.
[187] Cited volumes do not include ethanol.

Supply vulnerability

The Southern Midwest has both strong in-region refinery production and significant ability to draw supply from adjacent regions, particularly the Gulf Coast. In 2015, in-region refinery production of 765,000 b/d was equal to 82% of the region's total demand for transportation fuels (net of ethanol and biodiesel inputs), and, if production from the 336,000 b/cd Wood River, Illinois refinery were included in the sum, supply and demand in the Southern Midwest fuel market would be almost perfectly balanced. (Note: the Wood River refinery is located in the St. Louis metropolitan area but is in Illinois, so it is included with Eastern Midwest production). The Southern Midwest also has significant capacity to bring in supplemental supplies from the Gulf Coast when needed to compensate for in-region refinery outages, primarily through the Explorer and Magellan pipeline systems that extend from Houston.

The Southern Midwest is heavily reliant on the Magellan pipeline system, which—according to the company—transports 40% or more of the gasoline and distillate fuels consumed in each of the region's five states, including as high as 86% in Iowa.[188] Despite this dependence, the Magellan system is highly resilient due to the system's hub-and-spoke configuration, which draws supply from multiple, geographically dispersed sources, and can often deliver products to major demand centers from multiple directions. The Des Moines market, for instance, can be supplied by separate Magellan lines from Wichita, Kansas City, or Minneapolis. The redundancy within the Magellan system—and the presence of competing pipeline systems, such as NuStar Energy and Phillips 66, in most of the region's major markets—means that no one pipeline segment is critical to the region's supply.

Despite the strengths of the Southern Midwest's pipeline network, it can be difficult for supplemental volumes to quickly move to where they are needed. The region's pipeline network primarily consists of small-diameter pipelines, and the system's web-like nature means that it can take significant time for product to move through the network in response to supply imbalances in specific markets. In addition, these shipments would need to be arranged without displacing volumes from other shippers on the region's pipeline systems.

In addition to these logistical challenges, the Southern Midwest, due to the dispersed nature of its refined product infrastructure, lacks a massive, centralized refined product storage hub similar to those found in New York Harbor or the Gulf Coast. As a result, the suppliers in the Southern Midwest have a limited ability to draw down near-market inventories to make up for temporary supply system outages.

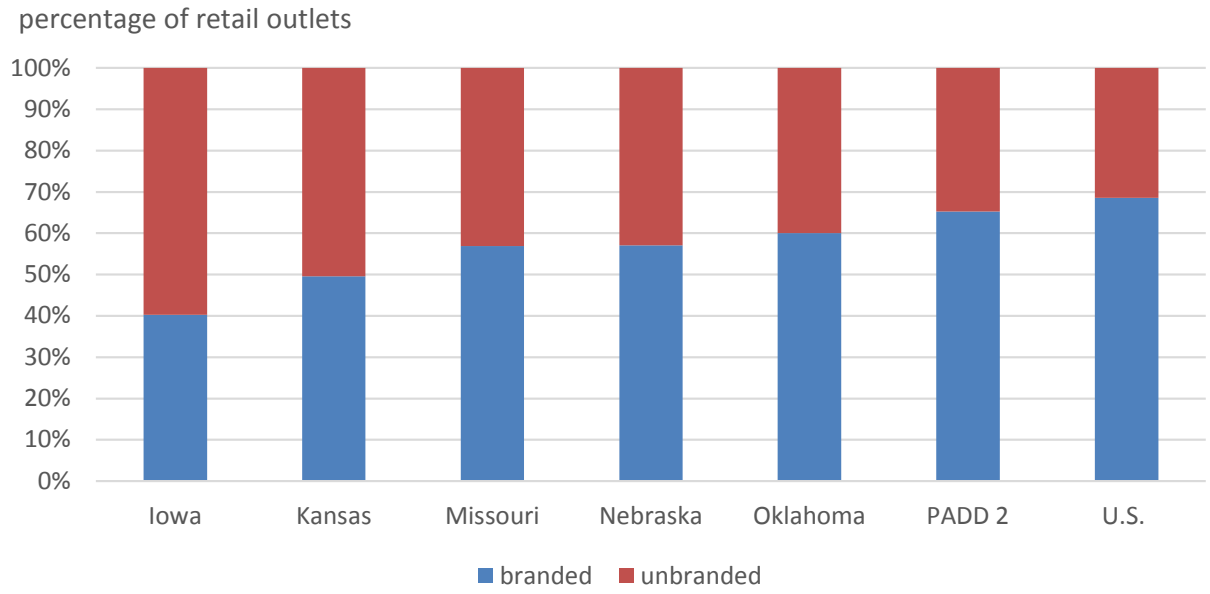
Retail markets

There are 8,115 retail service outlets in the Southern Midwest. Figure 38 shows the share of these outlets that are branded versus unbranded by state and compares those shares to overall PADD 2 and national shares. Stations were assigned to the branded versus unbranded designations according to their ownership. If a station is owned by, or affiliated with, a major oil company, it is categorized as "branded." Fifty-three percent of the Southern Midwest's retail stations are branded (less than the national average

[188] Magellan Midstream Partners, L.P., "2016 Analyst Day" (New York City, March 31, 2016), https://www.magellanlp.com/~/media/2D007DDCD87F4E8DB62904A0C90D3946.ashx?db=master.

of 69%). The share of branded outlets varies substantially within the region; Oklahoma is the highest with 60% branded, while Iowa's 40% is lowest. The top five brands in the Southern Midwest are Phillips 66, Conoco, Shell, Sinclair, and BP, and these brands together account for 43% of the region's retail outlets. Fifty-six percent of the region's stations offer diesel fuel, compared to a national average of 53%. As of June 2015, there were 420 public and 21 private filling stations in the Southern Midwest region offering E85 and 14 public and 11 private filling stations offering biodiesel (B20 and above).[189] Iowa is home to the largest number of E85 stations in the region, with 212, and also leads the region with 19 total biodiesel stations.

Figure 38. Southern Midwest retail market structure



Source: Homeland Security Infrastructure Program, 2015.

Recent and future changes

Refineries

Although Southern Midwest refineries already produce high yields (greater than 90%) of transportation fuels, expansions are underway or have been announced to further enhance the production of "clean products"—a trend that will incrementally increase transportation fuels supply in the region. Projects are also underway to enhance the ability of refineries to process cost-advantaged crude varieties, including light oil from the Bakken Shale region and heavy crude oil from Western Canada. Notable projects are listed below:

- **CHS Inc.:** CHS Inc. completed a multi-year delayed coker project at its McPherson refinery in February 2016. The new coker and other modifications enable the refinery to process higher

[189] U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, "Alternative Fuels Data Center," accessed July 26, 2016, http://www.afdc.energy.gov/states/.

quantities of heavy Canadian crude oil.[190] A separate multi-year expansion project, expected to be completed in 2016, will increase the refinery's capacity from approximately 85,000 b/d to 100,000 b/d. The added refinery production will be equally divided between diesel and gasoline and is intended to meet the needs of agricultural customers.[191]

- **HollyFrontier:** HollyFrontier is considering a project to debottleneck operations to increase processing rates by as much as 6,000 b/d at its El Dorado refinery. HollyFrontier is also evaluating a project to improve light product yields from the refinery's coker unit, while a separate upgrade project would improve reformer operation, yield, and reliability. To help meet Tier 3 low-sulfur gasoline requirements, the company has an ongoing project to add a fluid catalytic cracking (FCC) gasoline hydrotreater.[192] At HollyFrontier's integrated Tulsa refineries, projects are underway to expand gasoline production. The first project, completed in spring 2016, modernizes their fluid catalytic cracking (FCC) units, increasing the FCC capacity by as much as 4,000 b/d, and enhancing gasoline conversion rates and yield by 1%. The second project, scheduled to be completed in early 2017, is designed to address Tier 3 low-sulfur gasoline compliance by expanding naphtha splitter capabilities to improve gasoline octane levels, and allow the refineries to upgrade 2,000 b/d of light naphtha to gasoline.[193]
- **Phillips 66:** Phillips 66 has a project underway at its Ponca City refinery to install facilities to further improve clean product yield. The refinery currently has a clean product yield of 93%.[194] In 2015, the Ponca City refinery completed a tight oil processing flexibility project, which involved the construction of a 30,000 b/d naphtha splitter tower to allow the refinery to process greater quantities of lighter crude oil.[195]

Pipelines

Existing pipeline infrastructure in the Southern Midwest is extensive. New projects are primarily designed to enhance connections between existing systems.

[190] CHS, Inc., "New coker now operating at CHS Refinery in McPherson, Kansas," Our Company: News & Media, February 16, 2016, http://www.chsinc.com/our-company/news-and-media/news/2016/02/17/new-coker-now-operating-at-chs-refinery-at-mcpherson-kansas.
[191] CHS, Inc., "CHS announces plans to boost McPherson, Kan., refinery production," Our Company: News & Media, March 12, 2013, http://www.chsinc.com/our-company/news-and-media/news/2013/03/12/chs-announces-plans-to-boost-mcpherson-kan-refinery-production.
[192] Brelsford, Robert, "HollyFrontier updates refinery projects," *Oil and Gas Journal*, September 8, 2015, http://www.ogj.com/articles/2015/09/hollyfrontier-updates-refinery-projects.html, and HollyFrontier Corporation, Form 10-Q, filed with the U.S. Securities and Exchange Commission on May 4, 2016, http://investor.hollyfrontier.com/secfiling.cfm?filingID=48039-16-113&CIK=48039.
[193] Ibid.
[194] Philips 66, *2015 Annual Report*, accessed July 29, 2016, http://s1.q4cdn.com/175206842/files/doc_financials/annual/2015/P66_Annual_Report_2016.pdf.
[195] Burns & McDonnell, "Tight Oil Processing Flexibility Project," project completed 2015 for Phillips 66, description http://www.burnsmcd.com/projects/tight-oil-processing-flexibility-project.

- **CHS Inc. and NuStar Energy:** CHS and NuStar are developing a project to interconnect their pipeline systems in Council Bluffs, Iowa.[196] CHS operates a proprietary pipeline that supplies fuels from its McPherson refinery to Council Bluffs. NuStar's East System has an origination point in Council Bluffs that supplies products into northwestern Iowa.
- **NuStar Energy:** NuStar Energy has projects under development with a key customer to increase distillate and propane supply on its Mid-Continent pipeline and terminal network, which includes its East and North pipeline systems. The propane supply project has already been completed, with construction on remaining projects expected to be complete by the fourth quarter of 2017.[197]
- **Magellan Pipeline Company:** In August, Magellan completed a 210-mile, 75,000 b/d project that extends the company's system from Fort Smith, Arkansas to the Little Rock, Arkansas market. The new pipeline supplies transportation fuels into central Arkansas from Southern Midwest refineries, as well as products trans-shipped through the Southern Midwest from the Texas Gulf Coast. A project is now underway to interconnect the Magellan system in Little Rock with a segment of the TEPPCO pipeline system supplying West Memphis, Arkansas.[198, 199]

[196] CHS, Inc., "CHS grows refined fuels supply capabilities through NuStar agreement and continued investments," Our Company: News & Media, March 8, 2016, http://www.chsinc.com/our-company/news-and-media/news/2016/03/08/chs-grows-refined-fuels-supply-capabilities-through-nustar-agreement-and-continued-investments.
[197] NuStar Energy, "2016 MLPA: Master Limited Partnership Investor Conference," (Orlando, Florida, June 2016), http://www.mlpassociation.org/wp-content/uploads/2016/06/Nustar_MLPA-Conference-053116.pdf.
[198] Magellan Midstream, "Master Limited Partnership Association Annual Investor Conference," (Orlando, Florida, June 2016), http://www.mlpassociation.org/wp-content/uploads/2016/06/MMP_mlpa-6-16.pdf.
[199] Lyon, John, "Pipeline expansion increases fuel flow to central Arkansas," PulaskiNews.Net, August 11, 2016, http://www.pulaskinews.net/news/20160811/pipeline-expansion-increases-fuel-flow-to-central-arkansas.

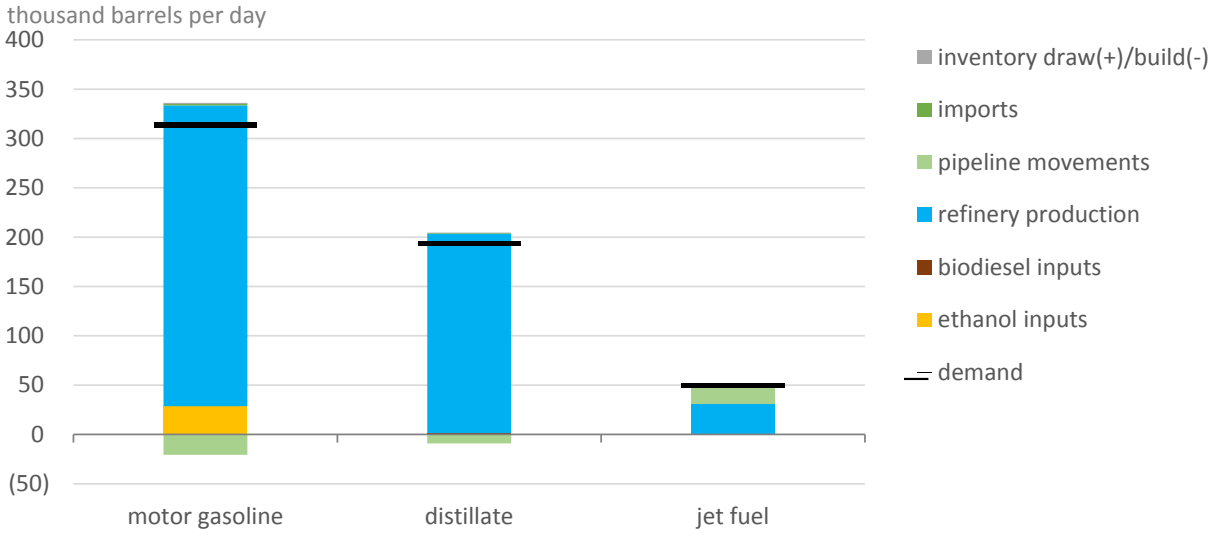
Rocky Mountain

The Rocky Mountain (Petroleum Administration for Defense District [PADD 4]) region includes five states: Colorado, Idaho, Montana, Utah, and Wyoming. The region is defined by the Rocky Mountain range and is bounded by the Midwest (PADD 2) to the east, the West Coast (PADD 5) to the west and south, the Gulf Coast (PADD 3) to the south, and Canada to the north. Estimated total demand for transportation fuels (motor gasoline, distillate fuel oil, and commercial jet fuel) in the Rocky Mountain region was 562,000 barrels per day (b/d) in 2015. The region's population centers are geographically dispersed and are separated by mountain ranges and large expanses of wilderness and rural lands. Principal demand centers are located in the Front Range Urban Corridor, which runs from Cheyenne, Wyoming, to Pueblo, Colorado, and includes the Colorado cities of Denver, Colorado Springs, Fort Collins, Boulder, and Greely; and the Wasatch Front in north-central Utah, which includes Salt Lake City, Ogden, and Provo.[200] Other demand centers include Boise City, Idaho, and Billings, Montana.

Supply/demand balances

Figure 39 below presents the Rocky Mountain region's 2015 annual supply and demand balances for motor gasoline, distillate, and jet fuel.

Figure 39. Rocky Mountain supply/demand balances, 2015



Note: All domestic movements and inventory changes are reported on a net basis.
Sources: ICF analysis of EIA, Airlines for America, USACE, FERC, and company 10-K data.

The Rocky Mountain region has 17 small refineries, which together produced 538,000 b/d of transportation fuels in 2015, enough to meet nearly 96% of in-region demand (or 101% of demand net of ethanol and biodiesel inputs). Despite this balance in supply and demand, significant product movements take place into and out of the region. In 2015, the Rocky Mountain region received approximately 83,000 b/d of transportation fuels from Kansas in the Midwest (PADD 2) and from the Texas Panhandle on the

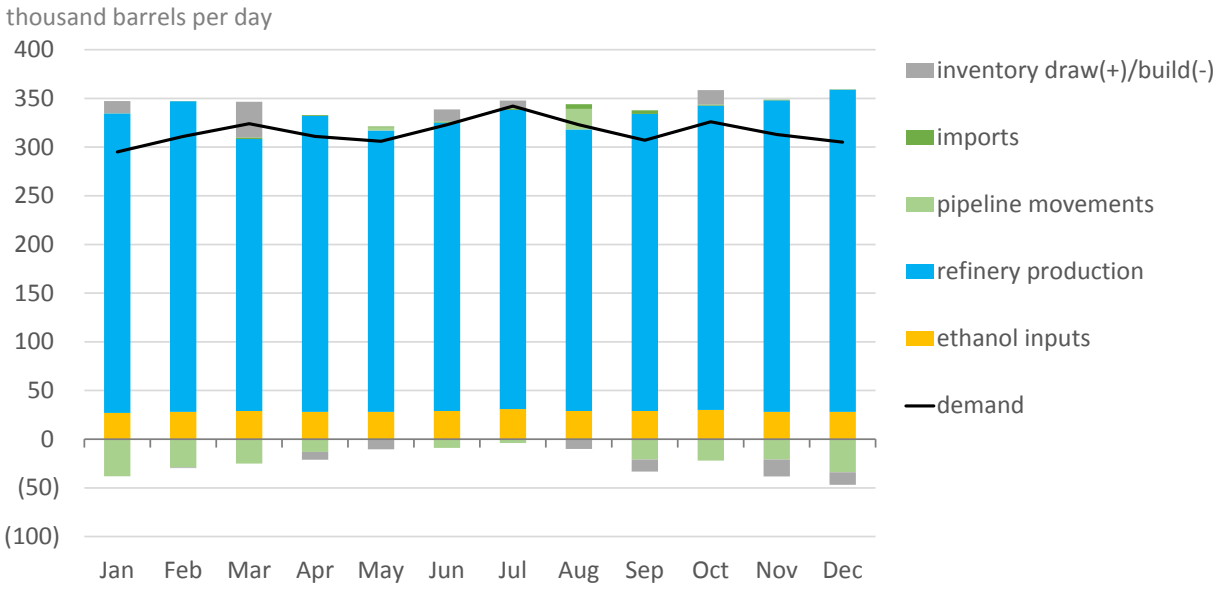
[200] Principal demand centers defined as metropolitan statistical areas with 1 million or more people as of July 1, 2015.

Gulf Coast (PADD 3), and shipped 57,000 b/d into eastern Washington state and the Las Vegas, Nevada, market on the West Coast (PADD 5) and 31,000 b/d into North Dakota and South Dakota in the Midwest (PADD 2).[201] On balance, the Rocky Mountain region is a net shipper of gasoline and distillates to other regions, but it is a net receiver of jet fuel. Minimal imports of gasoline and distillates are trucked across the Canadian border into Idaho and Montana.

Gasoline

Figure 40 presents the 2015 monthly motor gasoline supply/demand balance in the Rocky Mountain region. In 2015, in-region demand averaged 316,000 b/d, including approximately 29,000 b/d of ethanol. Peak demand in 2015 occurred in July at 342,000 b/d, up from the year's low of 295,000 b/d in January. In-region refinery production of gasoline averaged 305,000 b/d in 2015, exceeding average demand (net of ethanol inputs) by 6%. In 2015, inbound pipeline shipments to the Rocky Mountain region from other regions averaged 46,000 b/d, with volumes as high as 74,000 b/d in August, while outbound pipeline shipments averaged 62,000 b/d, with volumes as high as 83,000 b/d in December.[202] In 2015, the Rocky Mountain region shipped 16,000 b/d more gasoline to other regions than it received; however, these movements are highly seasonal; in May and August 2015, the region was a net receiver of gasoline.

Figure 40. Rocky Mountain motor gasoline supply/demand balance, 2015



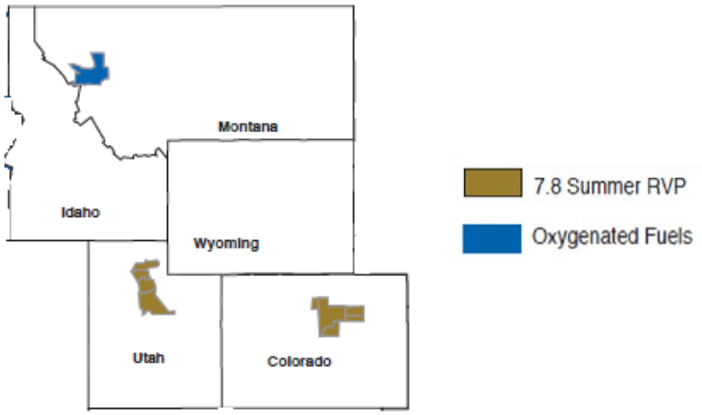
Notes: All domestic movements and inventory changes are reported on a net basis. Supply and demand do not perfectly balance in some months due to PADD-level adjustments.
Sources: ICF analysis of EIA, USACE, FERC, and company 10-K data.

The U.S. Environmental Protection Agency (U.S. EPA) does not require the use of reformulated gasoline anywhere in the Rocky Mountain region; however, the state of Montana requires that all motor gasoline

[201] U.S. Energy Information Administration, *Movements by Tanker, Pipeline, Barge and Rail between PAD Districts*, accessed November 17, 2016.
[202] U.S. Energy Information Administration, *Rocky Mountain (PADD 4) Receipts by Pipeline from Midwest (PADD 2) of Kerosene-Type Jet Fuel*, accessed November 17, 2016.

sold in the state include 10% ethanol by volume.[203] In accordance with the Clean Air Act, U.S. EPA requires the adoption of a summer Reid vapor pressure (RVP) standard that limits the volatility of conventional gasoline sold in certain areas of the country. From May 1 through September 15, the states of Colorado, Idaho, Montana, Utah, and Wyoming enforce a statewide 9.0 RVP limit. A stricter RVP limit of 7.8 is enforced in the Denver and Salt Lake City metropolitan areas between June 1 and September 15. Within the Rocky Mountain region, only the Missoula, Montana, metropolitan area maintains a winter oxygenated fuels program to limit carbon monoxide emissions.[204] EPA and state-level motor gasoline regulations in the Rocky Mountain region are mapped in Figure 41 and enforcement schedules are provided in Table 38.

Figure 41. Map of Rocky Mountain motor gasoline regulations



Source: ExxonMobil, as of June 2015.

Table 38. Rocky Mountain motor gasoline regulations

Regulation	Area(s)	Dates
Ethanol blend (10%)	Montana (entire state)	Year-round
Summer gasoline volatility <9.0 RVP	All counties in Colorado, Idaho, Montana, Utah, and Wyoming	May 1 – Sept. 15
Summer gasoline volatility <7.8 RVP	*Denver metropolitan area:* Adams, Arapahoe, Boulder, Broomfield, Denver, Douglas, and Jefferson counties, as well as parts of Larimer and Weld counties in Colorado *Salt Lake City metropolitan area:* Davis and Salt Lake counties in Utah	June 1 – Sept. 15
Winter oxygenated fuel (2.7%)	*Missoula metropolitan area:* Missoula County in Montana	Nov. 1 – Feb. 29

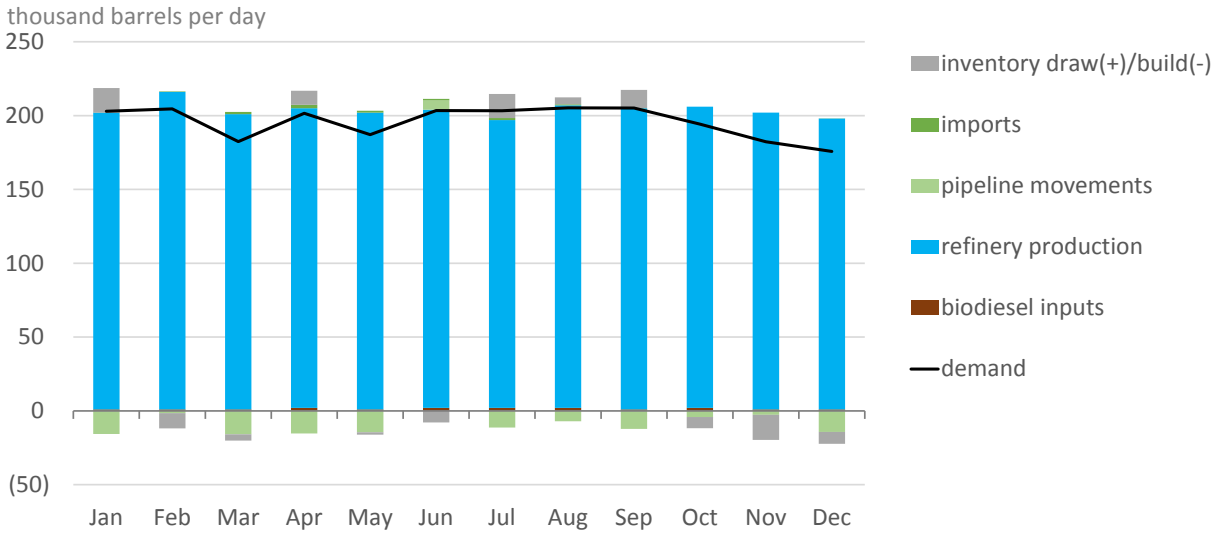
Sources: U.S. EPA Office of Transportation and Air Quality, American Fuel and Petrochemical Manufacturers.

[203] American Fuel and Petrochemical Manufacturers, "Montana State Motor Fuels Specifications" (accessed September 9, 2016), https://www.afpm.org/content.aspx?id=1447.
[204] U.S. Environmental Protection Agency, *State Winter Oxygenated Fuel Program Requirements for Attainment or Maintenance of CO NAAQS*, accessed November 17, 2016, https://www.epa.gov/sites/production/files/2015-09/documents/420b08006.pdf.

Distillate

Figure 42 presents the 2015 monthly distillate supply/demand balance for the Rocky Mountain region. In 2015, demand for distillate fuels averaged 196,000 b/d. Distillate fuel oil demand in the Rocky Mountain region is driven primarily by on-highway use, which made up approximately 63% of total distillate sales in 2014. Other demand drivers include the industrial and railroad sectors, which accounted for 11% and 8% of 2014 sales, respectively.[205] The bulk of the region's industrial sector demand is in Wyoming, where distillate fuels are used to power mining equipment in the state's coal-producing Powder River Basin. Sales to industrial users in Wyoming accounted for 24% of the state's total distillate sales in 2014. Distillate production in the Rocky Mountain region was enough to satisfy 103% of demand in 2015. Inbound pipeline shipments of distillates to the Rocky Mountain region averaged 16,000 b/d in 2015, while outbound shipments averaged 24,000 b/d.[206]

Figure 42. Rocky Mountain distillate supply/demand balance, 2015



Note: All domestic movements and inventory changes are reported on a net basis.
Sources: ICF analysis of EIA, USACE, FERC, and company 10-K data.

The Rocky Mountain region, as with the rest of the country, is required by federal law to use ultra-low sulfur diesel (ULSD)—diesel fuel with a maximum sulfur content of 15 parts per million (ppm)—for all highway, non-road, locomotive, and marine diesel fuel.

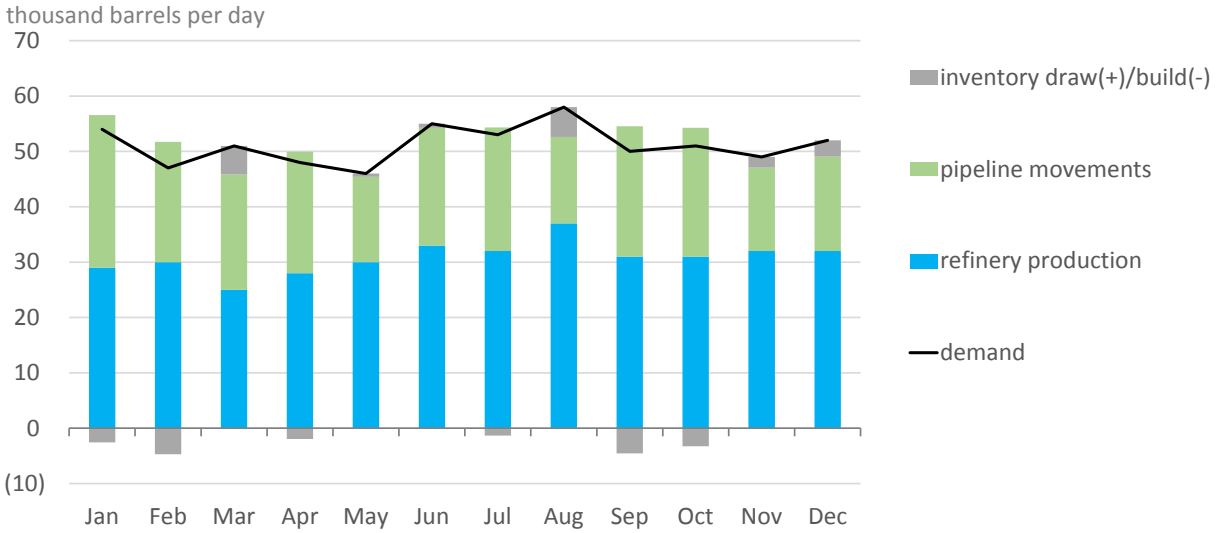
Jet fuel

Figure 43 presents the Rocky Mountain region's monthly 2015 jet fuel supply/demand balance. Commercial jet fuel demand in the region averaged 51,000 b/d in 2015, while in-region refinery production averaged 31,000 b/d, enough to meet 60% of demand. The balance of demand (20,000 b/d) was delivered via pipeline to the Denver metropolitan area from refineries in Kansas and on the Texas

[205] U.S. Energy Information Administration, *Sales of Distillate Fuel Oil by End Use*, (accessed June 29, 2016).
[206] U.S. Energy Information Administration, *Rocky Mountain (PADD 4) Receipts by Pipeline from Midwest (PADD 2) of Kerosene-Type Jet Fuel*, accessed November 17, 2016.

Panhandle.[207] In 2015, Rocky Mountain jet fuel demand was highest during the summer, with demand peaking at 58,000 b/d in August, up from a low of 46,000 b/d in May.

Figure 43. Rocky Mountain jet fuel supply/demand balance, 2015



Sources: ICF analysis of EIA, Airlines for America, FERC, and company 10-K data.

Two airports in the Rocky Mountain region are designated as large hubs by the Federal Aviation Administration: Denver International Airport and Salt Lake City International Airport. These two airports account for 86% of the total Rocky Mountain jet fuel demand. The region also includes four small hubs serving Boise, Idaho; Colorado Springs, Colorado; Bozeman, Montana; and Billings, Montana.[208] In addition, 37 smaller commercial service airports and several air force installations operate in the region, including Buckley Air Force Base (AFB), Cheyenne Mountain AFB, Peterson AFB, and Schriever AFB, and the U.S. Air Force Academy in Colorado; Mountain Home AFB in Idaho; Malmstrom AFB in Montana; Hill AFB in Utah; and F.E. Warren AFB in Wyoming.[209]

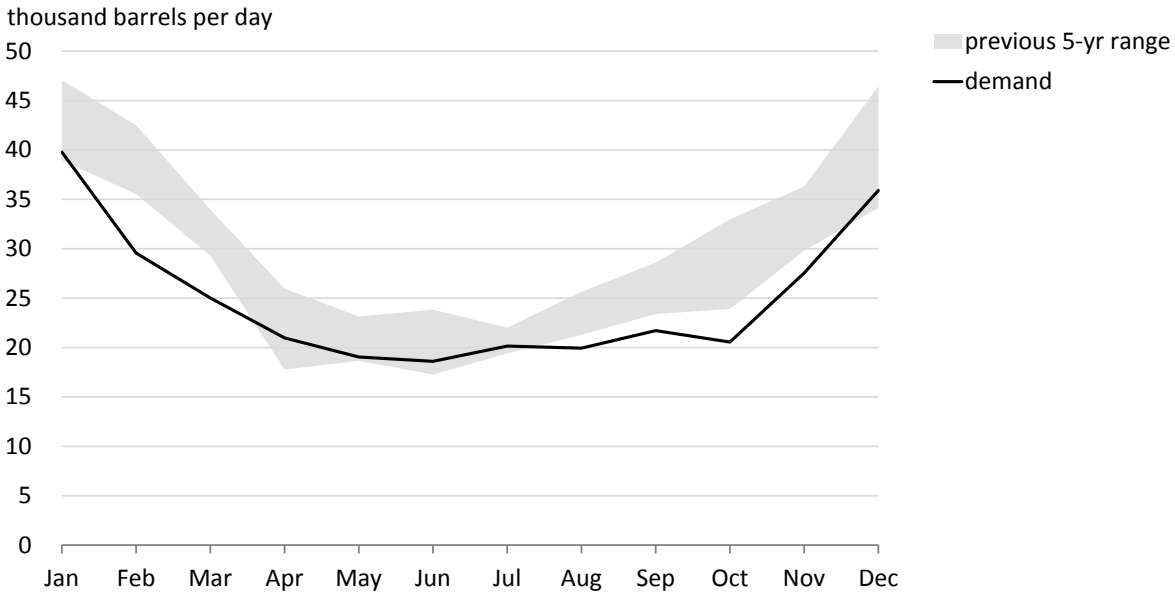
Propane

Approximately 218,000 households in PADD 4, or 5% of all households, use propane as their primary space heating fuel.[210] Demand from the residential and commercial sectors, which use propane for space heating, accounted for 74% of propane sales in 2015, while demand from the agricultural sector as minimal, according to data from the American Petroleum Institute.[211] Figure 44 presents PADD 4 prime supplier sales of propane by month in 2015 compared with the range of sales over the previous five

[207] Ibid.
[208] Federal Aviation Administration, "Passenger Boarding (Enplanement) and All-Cargo Data for U.S. Airports" (accessed November 23, 2016), https://www.faa.gov/airports/planning_capacity/passenger_allcargo_stats/passenger/.
[209] MilitaryBases.com, "State Military Bases" (accessed August 10, 2016), http://militarybases.com.
[210] [210] U.S. Census Bureau, *American Community Survey*, updated July 21, 2014, https://www.census.gov/programs-surveys/acs.
[211] American Petroleum Institute, *Sales of Natural Gas Liquids and Liquefied Refinery Gases Survey*, 2015 edition, http://www.api.org/products-and-services/statistics/reports-and-surveys.

years.[212] Prime supplier sales in 2015 averaged 25,000 b/d. Due to heavy use for space heating, propane sales are highly seasonal, with sales in 2015 peaking above 40,000 b/d in January. Warmer-than-average temperatures in 2015 led to propane sales consistently at or below the lower end of the previous five-year range.

Figure 44. Monthly consumer grade propane sales in PADD 4, 2015



Source: U.S. Energy Information Administration, *Monthly Report of Prime Supplier Sales of Petroleum Products Sold for Local Consumption.*

Refineries

The Rocky Mountain region has 17 refineries with a combined atmospheric crude distillation capacity of nearly 679,000 barrels per calendar day (b/cd).[213] While the number of Rocky Mountain refineries is relatively high, most of the refineries are small, with an average capacity of 40,000 b/cd. Refineries are distributed throughout the region, with significant capacity clustered around the Salt Lake City, Billings, and Denver metropolitan areas. Table 39 lists each refinery and its operable capacity as of January 1, 2016.

[212] A prime supplier is a firm that produces, imports, or transports selected petroleum products across state boundaries and local marketing areas, and sells the product to local distributors, local retailers, or end users.

[213] 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 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.

Table 39. Rocky Mountain refineries, 2016

Owner	Site	Operable capacity (b/cd) [c]
Colorado		
Suncor Energy	Commerce City [b]	67,000
Suncor Energy	Commerce City [b]	36,000
	Total	**103,000**
Utah		
Tesoro	Salt Lake City	57,500
Chevron	Salt Lake City	53,000
Big West Oil	North Salt Lake	30,500
HollyFrontier	Woods Cross	25,050 [d]
Silver Eagle Refining	Woods Cross	15,000
	Total	**181,050**
Wyoming		
Sinclair Oil	Sinclair	85,000
HollyFrontier	Cheyenne	47,000
Sinclair Oil	Evansville	24,500
Par Pacific [a]	Newcastle	18,000
Genesis Energy	Douglas	3,800
Silver Eagle Refining	Evanston	3,000
	Total	**181,300**
Montana		
ExxonMobil	Billings	60,000
Phillips 66	Billings	60,000
CHS	Laurel	59,600
Calumet	Great Falls	33,600 [e]
	Total	**213,200**
	Rocky Mountain Total	**678,550**

[a] Par Pacific Holdings, Inc. acquired the refinery and related assets from Wyoming Refining Company in July 2016.
[b] Suncor operates these refineries as a single integrated refinery.
[c] Barrels per calendar day, as of January 1, 2016.
[d] Expansion completed in 2016/Q1; increases refining capacity from 31,000 to 45,000 barrels per stream day.
[e] Includes 9,600 b/cd of idle capacity.
Source: U.S. Energy Information Administration, *Refinery Capacity Report*, 2016.

Refineries in the Rocky Mountain region primarily process locally produced crude oils, light Bakken crude from North Dakota and eastern Montana, and imported heavy crude oil and light synthetic crude oil from Western Canada. Colorado has two refineries in Commerce City, just outside of Denver, which Suncor operates as a single integrated refining system. The refineries produce fuels for local consumption in Colorado and Wyoming.[214] Utah has five refineries, which total 181,050 b/cd of capacity, all of which are

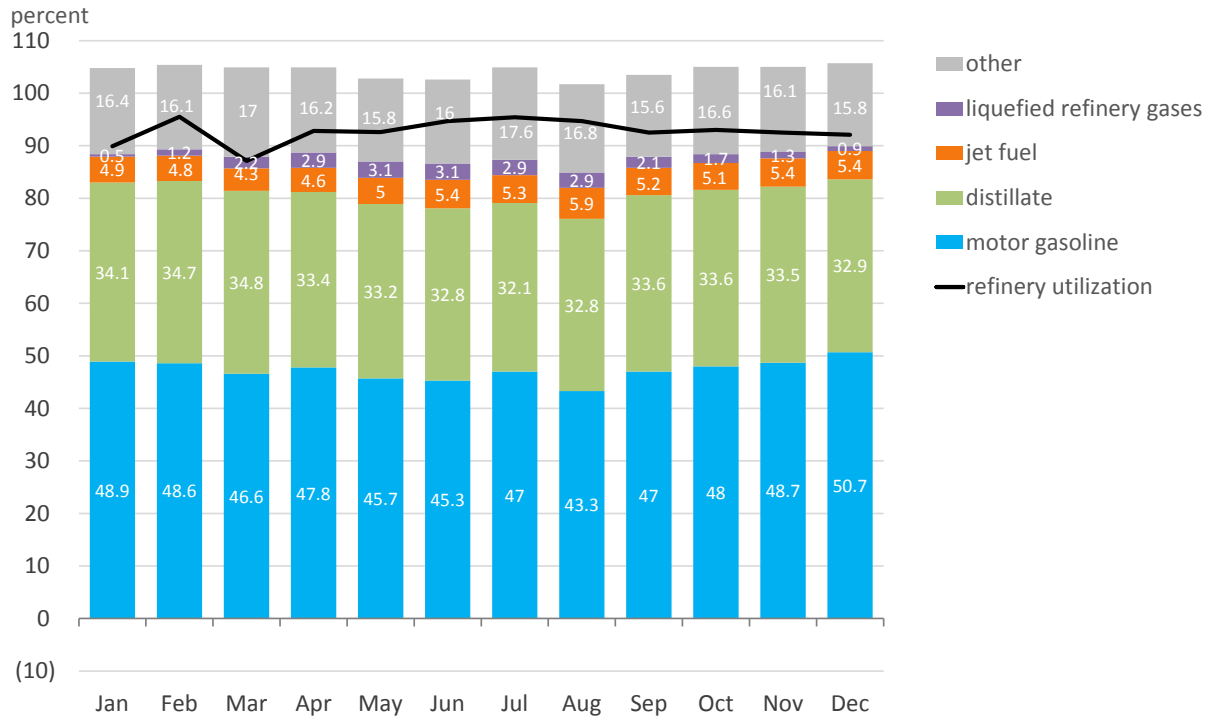
[214] Suncor Energy Inc., *Annual Information Form*, February 25, 2016, http://sustainability.suncor.com/2016/pdf/AIF_2015_EN_FINAL_Suncor.pdf.

located in the Salt Lake City area. These refineries produce fuels for local consumption and also ship fuel by pipeline to Idaho, eastern Washington state, and Las Vegas, Nevada. Wyoming's six refineries, which total 181,300 b/cd of capacity, are geographically spread out throughout the state. In-state demand for fuels is low, and much of the production from Wyoming's refineries is shipped to markets in neighboring states, or is trans-shipped to further destinations through pipeline interconnections at the Salt Lake City supply and logistics hub. Montana has four refineries. Three of those refineries, which total 179,000 b/cd of capacity, are clustered in and around Billings. These refineries supply local Montana markets and also push fuels by pipeline into North Dakota and to the eastern Washington state market. The fourth refinery, located in Great Falls, Montana, primarily supplies fuels to local markets by tank truck and rail car.

Refinery yields

Figure 45 shows monthly refinery utilization and yield percentages for motor gasoline (both finished gasoline and blendstocks), distillate fuel oil, jet fuel, residual fuel oil, liquefied refinery gases (LRGs),[215] and other secondary products (e.g., asphalt, petroleum coke) for the Rocky Mountain refineries in 2015.

Figure 45. Rocky Mountain refinery yields, 2015



Note: Yield percentages sum to higher than 100% due to processing gains.
Source: U.S. Energy Information Administration, *Petroleum Supply Monthly*, 2016.

Refinery utilization averaged 92.7% in 2015, and it was fairly stable over the course of the year. Production of transportation fuels (gasoline, distillate, and jet fuel) accounted for 85.7% of the region's annual

[215] Liquefied petroleum gases are products fractionated from refinery or still gases; through compression and/or refrigeration, they are retained in the liquid state. The reported categories are ethane/ethylene, propane/propylene, normal butane/butylene, and isobutane/isobutylene. These exclude still gas.

refinery yield in 2015, slightly higher than the national average of 84.8%. The region's motor gasoline yield with 46.3% was slightly higher than the national average of 45.3%; distillate yield with 33.5% was higher than the national average of 29.8%; and jet fuel with 5.1% was lower than the national average of 9.7%. Yields of gasoline typically increase by about 3 to 5 percentage points during the fall and winter months as butane is blended into the gasoline pool due to higher seasonal RVP limits. The removal of butane from the gasoline pool in the spring and summer results in higher yields of LRGs in those months.

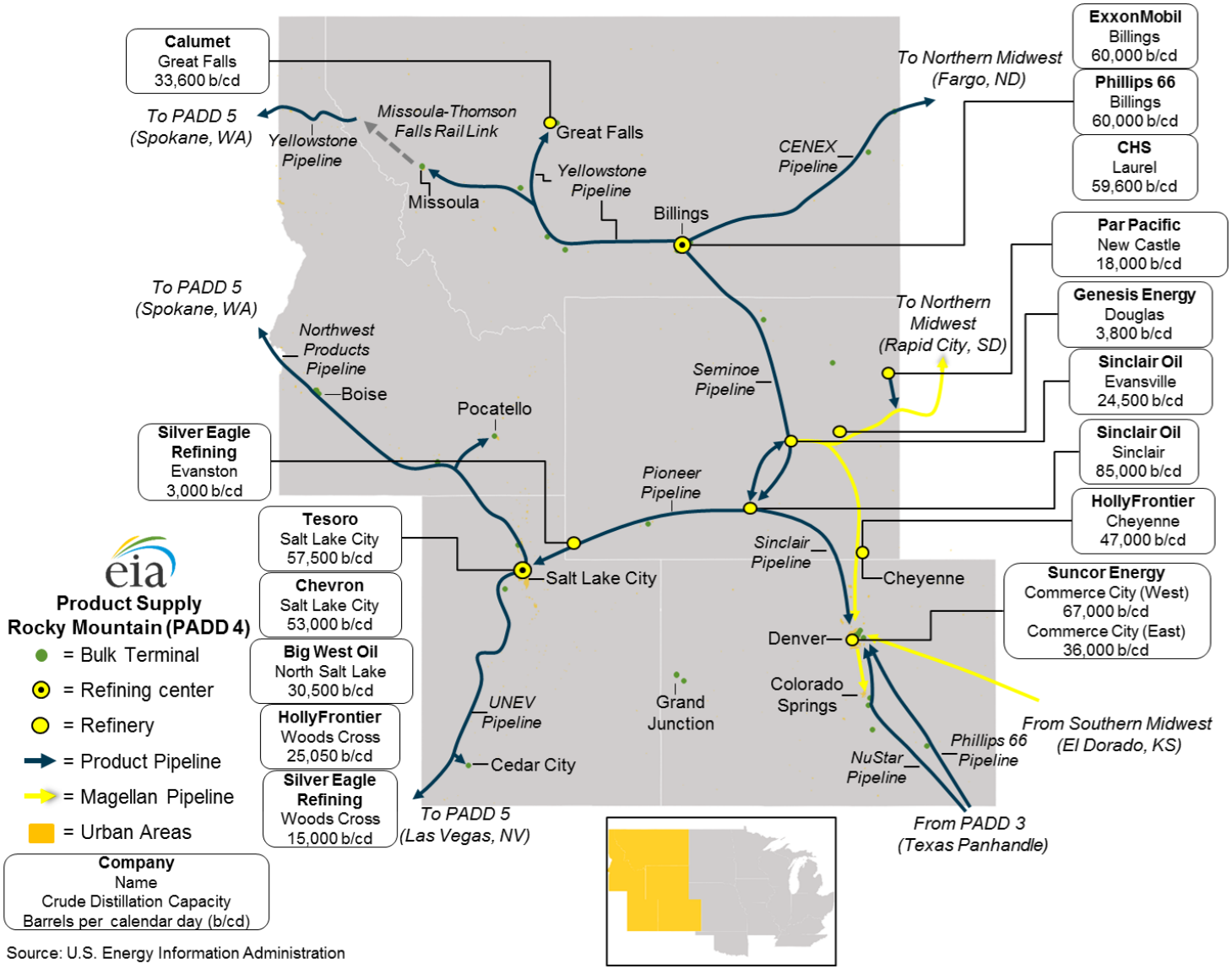
Supply and logistics

Supply and demand centers are geographically distributed throughout the Rocky Mountain region, with supply moving to end-use markets primarily by pipeline, and to a lesser extent by rail. Major supply centers include clusters of refineries located in the Salt Lake City, Billings, and Denver metropolitan areas, and a number of refineries spread out geographically in Wyoming, primarily in the eastern portion of the state. The Front Range Urban Corridor (which includes Denver) in Colorado and Wyoming, and the Wasatch Front (which includes Salt Lake City) in north-central Utah are the region's largest demand centers. Although supply and demand in the Rocky Mountain region is largely balanced on a macro level, significant volumes of transportation fuels are shipped into and out of the region by pipeline. Fuels move into the Denver area from refineries in Kansas (in PADD 2) and on the Texas Panhandle (in PADD 3), while the Salt Lake City supply hub ships fuels to eastern Washington state and the Las Vegas, Nevada, market (in PADD 5), and the Billings supply hub ships fuel to North Dakota (in PADD 2) and eastern Washington state (in PADD 5). The Wyoming refineries are connected by pipeline to the Denver, Salt Lake City, and Billings hubs, and Wyoming production acts to balance supply across the major Rocky Mountain markets. Figure 46 on 113 presents the refineries, product pipelines, and storage terminals serving the Rocky Mountain region.

Pipelines

Several long-distance pipeline systems move fuels into, out of, and within the Rocky Mountain region. The Denver market receives supply via Phillips 66's Borger-Denver system and NuStar Energy's Central West system from refineries on the Texas Panhandle, and via the Magellan's Chase Pipeline system from Kansas. Shipments of transportation fuels into Denver on these systems averaged 83,000 b/d in 2015, with movements peaking at approximately 108,000 b/d in August. Three pipeline systems move products from Rocky Mountain supply centers to markets within the region before supplying fuel to the West Coast (PADD 5) region. From the Salt Lake City supply hub, fuels move on the UNEV Pipeline to southwestern Utah and Las Vegas, Nevada, and via the Northwest Products Pipeline to markets in Idaho and eastern Washington state. From Billings, the Yellowstone Pipeline system pushes fuel west to markets in western Montana before terminating in eastern Washington state. In 2015, approximately 57,000 b/d of transportation fuels moved from the Rocky Mountain region into West Coast markets (eastern Washington state and Las Vegas) via these systems, with movements peaking at 83,000 b/d in December. Two pipeline systems move fuels from the Rocky Mountain region into the Midwest (PADD 2) region: The Cenex Pipeline system ships fuel east from the Billings refining hub to markets in North Dakota, while a spur of the Magellan Pipeline system ships fuel from Wyoming refineries east into Rapid City, South Dakota. In 2015, these pipelines shipped an average of 31,000 b/d from PADD 4 to PADD 2.

Figure 46. Rocky Mountain refined petroleum infrastructure



Source: U.S. Energy Information Administration

Several pipeline systems also move products within the Rocky Mountain region, including pipelines operated by Phillips 66 (Seminoe and Pioneer), Sinclair Oil, and Magellan. These pipelines connect the refinery hubs and provide supply flexibility within the Rocky Mountain region to cover planned and unplanned downtime.

Phillips 66 Pipeline

Phillips 66 wholly or partially owns four common-carrier pipeline systems serving the Rocky Mountain region: Yellowstone, Seminoe, Pioneer, and Borger-Denver. In 2015, the Yellowstone, Seminoe, and Pioneer systems collectively shipped nearly 200,000 b/d of transportation fuels, according to FERC filings.[216] Table 40 lists select Phillips 66 pipeline systems serving the Rocky Mountain region, including their origin and destination points, distances, diameters, and 2015 shipments.

Table 40. Select Phillips 66 refined product pipelines in the Rocky Mountain region

System	Origin	Destination	Dist. (mi.)	Diam. (in.)	2015 Shipments (b/d) [d]
Yellowstone	Billings, MT	Helena/Missoula, [b] MT	389	10	101,000 [e]
	Helena, MT	Great Falls, MT	82	6	
	Thompson Falls, [b] MT	Spokane, WA	98	10	
Seminoe	Billings, MT	Casper/Sinclair, WY	342	8	31,000
Pioneer	Sinclair, WY	Salt Lake City, UT	264	8, 12 [c]	66,000
Borger-Denver [a]	Borger, TX	Denver, CO	405	12	N/A [f]

[a] Phillips 66 operates the system, which is jointly owned with NuStar Energy. System is cross-listed in Table 43.

[b] Due to an idle pipeline segment, products are moved via rail between Missoula and Thompson Falls, MT.

[c] Denotes parallel pipeline segments.

[d] Only includes shipments of transportation fuels (motor gasoline, distillates, and jet fuel).

[e] Only includes volumes from Montana origins. In 2015, approximately 10,000 b/d originated on this system in Washington state.

[f] N/A = Not available. System capacity is 38,000 b/d.

Sources: Phillips 66 Pipeline, LLC, and Phillips 66 Midstream Partners websites; Phillips 66 Pipeline, LLC, FERC Form No. 6, 2015/Q4; Yellowstone Pipe Line Co., FERC Form No. 6, 2015/Q4; Pioneer Pipe Line Co., FERC Form No. 6, 2015/Q4.

The 710-mile Yellowstone Pipeline system, which is a joint venture between Phillips 66 and ExxonMobil, originates at the Billings refining center (where both companies operate refineries) and supplies markets across western Montana before terminating in eastern Washington state. In 2015, approximately 101,000 b/d of transportation fuels originated on the Yellowstone system in Montana, according to the FERC filings, equal to more than 55% of the aggregate crude distillation capacity of the three refineries in the Billings area. In Montana, the system consists of a 10-inch mainline that extends west from Billings to markets in Bozeman, Helena, and Missoula, and a 6-inch spur that delivers products to Great Falls from a junction off the mainline near Helena. A segment of the mainline between Missoula and Thompson Falls, Montana, has been idle since 1996, when the pipeline's former owners were unable to renew a land easement on a 21-mile section of the line that runs through an Indian reservation.[217] Since that time,

[216] This sum includes approximately 12,000 b/d of transfers between the Seminoe and Pioneer systems and are thus double-counted.

[217] Selden, Ron, "Tribes beat back oil giants," *High Country News*, March 4, 1996, http://www.hcn.org/issues/54/1688.

Yellowstone has off-loaded products from the mainline in Missoula and shipped them by rail to Thompson Falls, where they are reinjected into the mainline. This rail link currently operates two trains per day, loading as many as 30 tank cars per train.[218] From Thompson Falls, the 10-inch pipeline continues through Idaho before terminating in Spokane, Washington. An 8-inch extension of the system runs from Spokane to Moses Lake, Washington. In 2015, approximately 10,000 b/d of transportation fuels were received into the Yellowstone system in Washington state via connecting carriers.

Phillips 66's wholly owned Seminoe pipeline extends 342 miles south from the Billings refining center to an interconnection with the Magellan Pipeline system near Casper, Wyoming, and an interconnection with the Pioneer Pipeline system near Sinclair, Wyoming. According to FERC filings, the 8-inch Seminoe pipeline shipped approximately 31,000 b/d of transportation fuels in 2015, with more than 27,000 b/d originating at the Billings refining center, equal to about 15% of the aggregate crude distillation capacity of the three refineries in the Billings area.

The Pioneer Pipeline system, which is majority owned and operated by Phillips 66 through a business agreement with Sinclair Oil, receives products from Sinclair's 85,000 b/cd refinery in Sinclair and from the Seminoe Pipeline system, and ships them west to Salt Lake City. [219] Pioneer shipped approximately 66,000 b/d of transportation fuels in 2015, according to FERC filings. Of these shipments, approximately 36,000 b/d originated at the Sinclair refinery, equal to about 42% of its crude distillation capacity. An additional 12,000 b/d was received by Pioneer in Wyoming via an interconnection with the Seminoe system. The remaining volumes on the Pioneer system, approximately 18,000 b/d, consist of local shipments from refineries in the Salt Lake City area.[220]

Finally, Phillips 66 operates the 405-mile Borger-Denver system, which gathers products from refineries on the Texas Panhandle (WRB Borger and Valero McKee) and delivers them into the Denver market. The pipeline system, which Phillips 66 jointly owns with NuStar Energy, has a gross capacity of 38,000 b/d.[221]

[218] Montana Rail Link, PNWARS Conference slides, September 19, 2013, https://www.pnrailshippers.com/pnwars_pdfs/2013_lewis_presentation.pdf.
[219] Pioneer Pipe Line Co., FERC Form No. 6: Annual Report of Oil Pipeline Companies, 2015/Q4.
[220] Ibid.
[221] Phillips 66, U.S. Securities and Exchange Commission Form 10-K, 2015.

Tesoro Logistics

Tesoro Logistics Northwest Pipeline, LLC, is the owner and operator of two pipeline systems that originate at the Salt Lake City supply hub: The Northwest Products system ships supply to markets in Idaho and eastern Washington state, and the Salt Lake City system supplies jet fuel to the Salt Lake City International Airport and Hill Air Force Base AFB located near Ogden, about 30 miles north of the city. Tesoro Corp., the parent company of Tesoro Logistics, operates a 57,500 b/cd refinery in Salt Lake City. Table 41 lists select Tesoro Logistics pipelines in the Rocky Mountain region, as well as their origins, destinations, lengths, diameters, and 2015 shipments of transportation fuels.

Table 41. Select Tesoro Logistics refined product pipelines in the Rocky Mountain region

System	Origin	Destination	Distance (mi.)	Diameter (in.)	2015 Shipments [a] (b/d)
Northwest Products	Salt Lake City, UT	Spokane, WA (Line 1)	706	8	62,000 [b]
	Salt Lake City, UT	Boise, ID (Line 2)	329	8	
	Idahome, ID (Jct.)	Pocatello, ID	56	8	
Salt Lake City	Salt Lake City, UT	Salt Lake City Intl Airport	6	6	600
	Salt Lake City, UT	Hill AFB	1	4	

[a] Only includes shipments of transportation fuels (motor gasoline, distillates, and jet fuel).

[b] Only includes volumes from Utah origins. In 2015, approximately 10,000 b/d originated on this system in Washington state.

Sources: Tesoro Logistics Northwest Pipeline LLC, FERC Form No. 6, 2015/Q4; Tesoro Logistics website.

Tesoro's Northwest Products mainline system consists of two parallel 8-inch pipelines: Line 1 transports distillate fuel oil and jet fuel more than 700 miles from Salt Lake City to as far north as eastern Washington state, while Line 2 runs parallel to Line 1 for more than 320 miles, transporting gasoline as far as Boise, Idaho.[222] In addition, an 8-inch spur extends east off the mainline system into Pocatello (near Idaho Falls) in southeast Idaho. In eastern Washington state, Line 1 is connected to terminals in Pasco and Spokane, as well as Fairchild AFB.

According to information filed with FERC, the Northwest Products system shipped approximately 62,000 b/d of transportation fuels from its Salt Lake City origin in 2015, equal to approximately 34% of the refining capacity in the Salt Lake City area. An additional 10,000 b/d was shipped on the system from Tesoro's barge-receiving terminal on the Columbia River in Pasco, Washington. In 2015, the majority of supply on the Northwest Products system was delivered to markets in Idaho (53,000 b/d), with the remainder going to Washington state (18,000 b/d). Tesoro's Salt Lake City Pipeline system shipped approximately 600 b/d of jet fuel to Salt Lake City International Airport and Hill AFB in 2015.[223]

[222] Federal Energy Regulatory Commission, "Response of Tesoro Logistics Northwest Pipeline LLC to Protests of Chevron Products Company and Sinclair Oil Corporation: Exhibit A," October 13, 2015.

[223] Tesoro Logistics Northwest Pipeline LLC, FERC Form No. 6: Annual Report of Oil Pipeline Companies and Supplemental Form 6-Q: Quarterly Financial Report, 2015/Q4.

Magellan Pipeline

Magellan Pipeline Company operates two refined product systems in the Rocky Mountain region. Magellan's Rocky Mountain system, which the company purchased from Plains All American Pipeline in 2013, ships fuels from Wyoming refineries to markets in Colorado and South Dakota. Meanwhile, Magellan's Chase Pipeline system ships fuel from Kansas to the Denver market. Table 42 lists these systems, as well as their origins, destinations, lengths, diameters, and 2015 shipments of transportation fuels, if available.

Table 42. Select Magellan Pipeline Company refined product pipelines in the Rocky Mountain region

System	Line Number	Origin	Destination	Dist. (mi.)	Diam. (in.)	2015 Shipments [b] (b/d)
Rocky Mountain	7175/7164	Casper, WY	Dupont, CO	262	8	66,000
	7165	Denver, CO	Fountain, CO	90	6	
	7170 (lateral)	Casper, WY	Rapid City, SD	190	6	
Chase Pipeline	6912	El Dorado, KS	Aurora, CO	458	10/12 [a]	N/A [c]
	6917	Aurora, CO	Denver Intl Airport	17	10	

[a] Denotes continuous pipeline of varying diameters.

[b] Only includes shipments of transportation fuels (motor gasoline, distillates, and jet fuel).

[c] N/A = Not available. Capacity on the segment from El Dorado to Aurora is 60,000 b/d.

Sources: Magellan Pipeline Company, L.P., FERC Form No. 6, 2015/Q4; Magellan Midstream Partners, L.P., U.S. Securities and Exchange Commission Form 8-K, October 1, 2004.

Magellan's Rocky Mountain system originates in Casper, Wyoming, where it receives supply from Sinclair Oil's Evansville refinery and from an interconnection with the Pioneer Pipeline system from the Billings refining center. From Casper, an 8-inch line supplies products 350 miles south to the Denver area (Dupont, Colorado), with a 6-inch line extending 90 miles farther south to Colorado City (Fountain, Colorado). These lines also receive product from HollyFrontier's Cheyenne, Wyoming, refinery; from Suncor Energy's refineries in Commerce City, Colorado; and from interconnections with other pipeline systems in the Denver area. A separate 6-inch lateral runs 190 miles east from Casper to Rapid City, South Dakota, and receives additional supply from Par Pacific's refinery in New Castle, Wyoming, via a pipeline interconnection near the Wyoming-South Dakota border. In 2015, approximately 66,000 b/d of transportation fuels were shipped on Magellan's Rocky Mountain system, including approximately 37,000 b/d originating in Wyoming and 29,000 b/d originating in Colorado.

Magellan operates the 458-mile Chase Pipeline, a 10- and 12-inch pipeline that supplies product into the Denver metropolitan area (Aurora, Colorado) from refineries in Kansas. The Chase Pipeline is the only pipeline system transporting fuel into the Rocky Mountain (PADD 4) region from Midwest (PADD 2) supply sources. The pipeline had a capacity of 60,000 b/d from El Dorado, Kansas, to Aurora in 2004, according to U.S. Securities and Exchange Commission filings.[224] A 17-mile extension of the pipeline carries jet fuel from Aurora to Denver International Airport.

[224] Magellan Midstream Partners, L.P., U.S. Securities and Exchange Commission Form 8-K, October 1, 2004, https://www.sec.gov/Archives/edgar/data/1126975/000119312504165631/d8k.htm.

NuStar Energy

NuStar Energy's Central West Refined Products system includes two pipeline systems that run more than 350 miles from refineries on the Texas Panhandle to the Denver metropolitan area. NuStar's wholly owned 32,500 b/d McKee-Denver system originates at Valero's McKee refinery in Sunray, Texas, and delivers fuels north to Colorado Springs and Denver. A 6-inch spur off the McKee-Denver line supplies jet fuel to the Colorado Springs Municipal Airport. In addition, NuStar owns a share in the 38,000 b/d Borger-Denver pipeline system operated by Phillips 66. Table 43 lists select segments of NuStar's Central West Refined Products system, including their origins, destinations, distances, diameters, and capacities.

Table 43. Select NuStar Energy refined product pipelines in the Rocky Mountain region

System	Origin	Destination	Dist. (mi.)	Diam. (in.)	Capacity (b/d)
McKee-Denver	McKee refinery (Sunray, TX)	Denver, CO	357	10	32,500
	Colorado Springs, CO	Colorado Springs Airport	2	6	20,000
Borger-Denver [a]	McKee refinery (Sunray, TX)	Denver, CO	356	12	38,000

[a] Phillips 66 operates the system, which originates in Borger, Texas. Origin and distance listed in this table reflect only the portion of the line that NuStar shares. Capacity listed here reflects gross capacity. System is cross-listed in Table 40.

Sources: NuStar Logistics, L.P., FERC Form No. 6, 2015/Q4; NuStar Energy website.

Other Pipelines

Other pipeline systems in the Rocky Mountain region include the Cenex and UNEV common-carrier systems and proprietary systems operated by Sinclair Transportation Co. and Par Pacific. Table 44 lists these systems, including their origins, destinations, distances, diameters, capacities, and 2015 shipments of transportation fuels, if available.

Table 44. Select other refined product pipelines in the Rocky Mountain region

System	Origin	Destination	Dist. (mi.)	Diam. (in.)	Capacity (b/d)	2015 Shipments [e] (b/d)
Cenex Pipeline	Laurel, MT	Fargo, ND	683	8/10 [d]	N/A [c]	46,000
UNEV Pipeline	Woods Cross, UT	Las Vegas, NV	417	12	62,000	22,000
	Cedar City Jct.	Cedar City, UT	10	8		
Sinclair	Casper, WY [a]	Sinclair, WY [a]	N/A [c]	8/12 [d]	21,600	N/A [c]
Transportation	Sinclair, WY	Denver, CO	204	6/10 [d]	27,600	N/A [c]
Par Pacific	New Castle, WY	Mule Creek Jct., WY [b]	40	N/A [c]	N/A [c]	N/A [c]

[a] Bidirectional segment

[b] Interconnects with Magellan's Rocky Mountain system at Mule Creek Junction, WY, for further delivery to Rapid City, SD.

[c] N/A = Not available

[d] Denotes continuous pipeline of varying diameters.

[e] Only includes shipments of transportation fuels (motor gasoline, distillates, and jet fuel).

Sources: Cenex Pipeline, LLC, FERC Form No. 6, 2015/Q4; UNEV Pipeline, LLC, FERC Form No. 6, 2015/Q4; Sinclair Transportation Company, *Emergency Response and Management Manual*; Holly Energy Partners, L.P., UNEV Pipeline Transaction presentation, July 2012.

Cenex Pipeline, LLC, a wholly owned subsidiary of CHS Inc., operates a 683-mile pipeline system that moves fuel east from CHS's Laurel, Montana, refinery and other refineries in the Billings area to delivery points in eastern Montana, including Billings, Glendive, and Sidney, before supplying fuels into North Dakota, as far east as Fargo. In 2015, this system shipped approximately 46,000 b/d of gasoline and distillates, equal to more than 25% of the aggregate crude distillation capacity of the three refineries in the Billings area.

The 62,000 b/d UNEV Pipeline system, which is jointly owned by Holly Energy Partners and Sinclair Oil Corp., originates in the Salt Lake City refining center and moves fuel more than 400 miles southwest to Las Vegas, Nevada. An 8-inch spur off the 12-inch UNEV mainline also delivers products into Cedar City in southwest Utah. Shipments of transportation fuels on the UNEV system averaged approximately 22,000 b/d in 2015, according to FERC filings.[225]

Sinclair Transportation Co. and Par Pacific also operate proprietary systems that ship transportation fuels out of refineries in Wyoming. Sinclair Transportation's pipeline network consists of a 21,600 b/d bidirectional segment connecting refineries owned by its parent company (Sinclair Oil) in Sinclair and Casper, Wyoming, and a 27,600 b/d segment known as the Medicine Bow Pipeline, which ships fuel from Sinclair approximately 200 miles south into the Denver market.[226] Meanwhile, Par Pacific, which purchased the 18,000 b/cd New Castle, Wyoming, refinery and related assets from Wyoming Refining Company in July 2016, operates a pipeline that delivers products 40 miles from the refinery to a Magellan Pipeline lateral for further delivery into Rapid City, South Dakota. Par Petroleum operates a jet fuel terminal in Rapid City and a proprietary pipeline supplying Ellsworth AFB just outside the city.[227]

Markets

The Front Range

The Front Range Urban Corridor, which runs from Cheyenne, Wyoming, to Pueblo, Colorado, and includes the Colorado cities of Denver, Colorado Springs, Fort Collins, Boulder, and Greely, is the Rocky Mountain region's largest demand market. The Front Range market has three refineries: Suncor Energy operates two refineries in Commerce City, Colorado (which are operated as an integrated refining system) with an aggregate atmospheric crude distillation capacity of 103,000 b/cd, and HollyFrontier operates a 47,000 b/cd refinery in Cheyenne, Wyoming. Transportation fuels demand in the Front Range market exceeds production from these refineries, and the market is dependent upon pipeline deliveries from Kansas (in PADD 2), the Texas Panhandle (in PADD 3), and from other Rocky Mountain (PADD 4) refineries in Wyoming and Montana. Inbound pipelines from the Texas Panhandle include Phillips 66 and NuStar Energy's jointly owned 38,000 b/d Borger-Denver system and a 32,500 b/d segment of NuStar's Central West Refined Products system. The only inbound system from Kansas is Magellan's 60,000 b/d Chase

[225] UNEV Pipeline, LLC, FERC Form No. 6: Annual Report of Oil Pipeline Companies, 2015/Q4.
[226] Pipeline Hazardous Materials Safety Administration, "Sinclair Transportation Company Response Zones 1–6 FRP" (accessed November 17, 2016), http://www.phmsa.dot.gov/staticfiles/PHMSA/ERR/PHMSA000112309-000113126_SINCLAIR_TRANSPORTATION_COMPANY.pdf.
[227] PR Newswire, "Par Pacific Holdings Successfully Closes Acquisition of Wyoming Refining Company and Related Logistics Assets," July 14, 2016, http://www.prnewswire.com/news-releases/par-pacific-holdings-successfully-closes-acquisition-of-wyoming-refining-company-and-related-logistics-assets-300299123.html.

Pipeline. Movements of transportation fuels on these systems from PADD 3 and PADD 2 into the Front Range market averaged approximately 83,000 b/d in 2015, with shipments reaching as much as 108,000 b/d in August 2015. Shipments of jet fuel on these systems averaged 21,000 b/d in 2015, or 25% of total shipments, with a high of 29,000 b/d in January 2015. Pipelines supplying the Front Range market from origins in Wyoming include an 8-inch Magellan Pipeline from Casper, Wyoming, to Denver, which extends to Colorado City as a 6-inch line, and Sinclair Transportation's 27,600 b/d Medicine Bow Pipeline from Sinclair, Wyoming, to Denver. These lines primarily deliver fuels produced at Wyoming refineries, but they may also transport fuels shipped into Wyoming from the Billings refining center via the Seminoe Pipeline.

Salt Lake City

The Wasatch Front urban area in north-central Utah includes the cities of Salt Lake City, Ogden, and Provo. The Wasatch Front is both a major demand center in the Rocky Mountain region and a major refining and logistics hub supplying Idaho, southern Nevada, and eastern Washington state markets. Salt Lake City supply infrastructure is concentrated in the North Salt Lake-Woods Cross industrial corridor just north of Salt Lake City. The hub gathers supply from five local refineries with a combined atmospheric crude distillation capacity of 181,050 b/cd, and from Wyoming and Montana refineries via the Pioneer Pipeline. According to FERC filings, the Pioneer system delivered approximately 48,000 b/d into the Salt Lake hub from Wyoming in 2015. From the Salt Lake supply hub, outbound pipelines move fuels to isolated markets within the Rocky Mountain (PADD 4) region before extending to markets in the West Coast (PADD 5) region. Tesoro's Northwest Products system ships fuel from the Salt Lake hub to terminals across southern Idaho, including Boise, Burley (near Twin Falls), and Pocatello (near Idaho Falls), before extending into eastern Washington state. The Northwest Products system shipped approximately 62,000 b/d from Salt Lake City origins in 2015, of which about 53,000 b/d were delivered to Idaho, with the balance delivered into eastern Washington state. Meanwhile, HollyFrontier and Sinclair Oil's southbound UNEV Pipeline supplies a terminal in Cedar City (near St. George) in southwest Utah before extending into the Las Vegas market. Shipments of transportation fuels on the UNEV Pipeline averaged approximately 22,000 b/d in 2015.

Billings

Billings is Montana's largest demand market; however, transportation fuels production in the Billings area exceeds demand, and Billings area refineries ship supply by pipeline to other markets in Montana, and into eastern Washington state (in PADD 5) and North Dakota (in PADD 2). The Billings supply hub has three refineries (including the CHS refinery in Laurel), with an aggregate crude distillation capacity of 179,000 b/cd, or more than 30% of total Rocky Mountain (PADD 4) refining capacity. Major pipeline systems originating in Billings include Phillips 66's Yellowstone and Seminoe systems, and CHS's Cenex Pipeline system. The Yellowstone Pipeline supplies markets in western Montana, including Bozeman, Helena, Missoula, and Great Falls, before extending farther west to supply Spokane and Moses Lake in eastern Washington state.[228] According to FERC filings, the Yellowstone system shipped approximately 101,000

[228] A segment of the Yellowstone mainline between Missoula and Thompson Falls, Montana, has been idle since 1996, when the pipeline's former owners were unable to renew a land easement on a 21-mile section of the line that runs through an

b/d from Billings in 2015, of which approximately 71,000 b/d were delivered to markets in Montana, with the balance delivered into eastern Washington state.[229] Some supply delivered to Spokane is trucked back into markets in northern Idaho, including Coeur d'Alene. Meanwhile, the Seminoe Pipeline extends south from the Billings refining center to an interconnection with the Magellan Pipeline system near Casper, Wyoming, and an interconnection with the Pioneer Pipeline system near Sinclair, Wyoming. Products received into the Magellan and Pioneer systems from Seminoe are shipped further into the Denver and Salt Lake City markets, respectively. Shipments of transportation fuels originating on the Seminoe system at the Billings hub averaged approximately 27,000 b/d in 2015, according to FERC filings. Finally, the Cenex Pipeline sources fuel from CHS's Laurel refinery and other refineries in the Billings area, and ships them to delivery locations in eastern Montana, including Billings, Glendive, and Sidney, before supplying markets in North Dakota as far east as Fargo. The Cenex system shipped approximately 46,000 b/d of transportation fuels in 2015.

Wyoming

Wyoming is sparsely populated and has relatively low demand for transportation fuels but is home to six refineries with a combined atmospheric crude distillation capacity of 181,030 b/cd (including the 47,000 b/cd Cheyenne refinery, which was previously counted as part of the Front Range market). Wyoming's small-scale refining industry is driven by access to low-cost, indigenous crude oil supply. The three largest refineries—making up more than 86% of the state's operable refining capacity—are located in Sinclair, Cheyenne, and Casper (Evansville). The Sinclair and Casper supply centers are connected to each other through an 8- and 12-inch bidirectional pipeline. The Sinclair hub gathers supply from Sinclair Oil's 85,000 b/cd refinery and from the Seminoe Pipeline from Billings, and then ships fuels into Salt Lake City through the Pioneer Pipeline system and to Denver via Sinclair Transportation's 27,60 0 b/d Medicine Bow Pipeline. The Casper hub gathers supply from Sinclair Oil's 24,500 b/cd Evansville refinery and from Seminoe, and ships fuels south on an 8-inch Magellan line to the Front Range market where it picks up additional supply from the Cheyenne and Commerce City refineries, and east via a Magellan 6-inch lateral to Rapid City, South Dakota. The eastbound 6-inch lateral picks up additional supply from Par Pacific's 18,000 b/d Newcastle refinery at a pipeline interconnection near the Wyoming-South Dakota border.

Supply vulnerability

Demand centers in the Rocky Mountain region are largely isolated from major supply centers in the Midwest (PADD 2), Gulf Coast (PADD 3), and West Coast (PADD 5) regions, and supply and demand of transportation fuels within the region are tightly balanced. In 2015, the region's 17 small-scale refineries produced 538,000 b/d of transportation fuels, enough to meet 101% of demand net of ethanol and biodiesel inputs. However, supply and demand centers in the Rocky Mountain region are geographically dispersed, and supply-demand balances vary from market to market within the region. In the Salt Lake

Indian reservation. Since that time, Yellowstone has off-loaded products from the mainline in Missoula and shipped them by rail to Thompson Falls, where they are reinjected into the mainline for further delivery into eastern Washington state.

[229] Yellowstone Pipe Line Co., FERC Form No. 6: Annual Report of Oil Pipeline Companies, 2015/Q4.

City and Billings areas, and in Wyoming, refinery production exceeds demand, while the Front Range Urban Corridor in Colorado and Wyoming is in deficit.

Despite its remoteness, the Front Range Urban Corridor, which is the Rocky Mountain region's largest market, has connections to several supply sources. The Front Range receives the majority of its supply from Colorado and Wyoming refineries, but it is also connected by pipeline to refineries on the Texas Panhandle (in PADD 3) and in Kansas (in PADD 2). Capacity on pipelines from Texas and Kansas total more than 130,000 b/d, but flows averaged 83,000 b/d in 2015, meaning that significant excess capacity is available for incremental shipments into the market, if needed.

The Salt Lake City and Billings markets also have considerable flexibility because they send a significant portion of their production to out-of-region markets that have access to alternate supply sources. From Salt Lake City, products are shipped to eastern Washington state and southern Nevada, and from Billings, products are shipped as far away as eastern Washington state and eastern North Dakota. The southern Nevada market is primarily supplied by pipeline from the Southern California refining center; the eastern North Dakota market is primarily supplied from in-state refineries and by pipeline from the Minneapolis refining center; and eastern Washington state can receive supply via barge in Pasco, Washington, from tank farms in the Portland, Oregon/Vancouver, Washington area. These alternate supply sources allow external markets to shift supply away from Rocky Mountain sources in the event of unplanned supply outages in Salt Lake City or Billings.

The most vulnerable markets in the Rocky Mountain region are smaller markets that rely on a single pipeline for supply. In particular, Boise and other southern Idaho markets are entirely dependent upon shipments via Tesoro's Northwest Product Pipeline system from Salt Lake City, and many markets in western Montana are solely dependent upon the Yellowstone Pipeline system from Billings. Long-distance truck deliveries would be needed to supply these markets in the event of an extended outage on these pipelines systems.

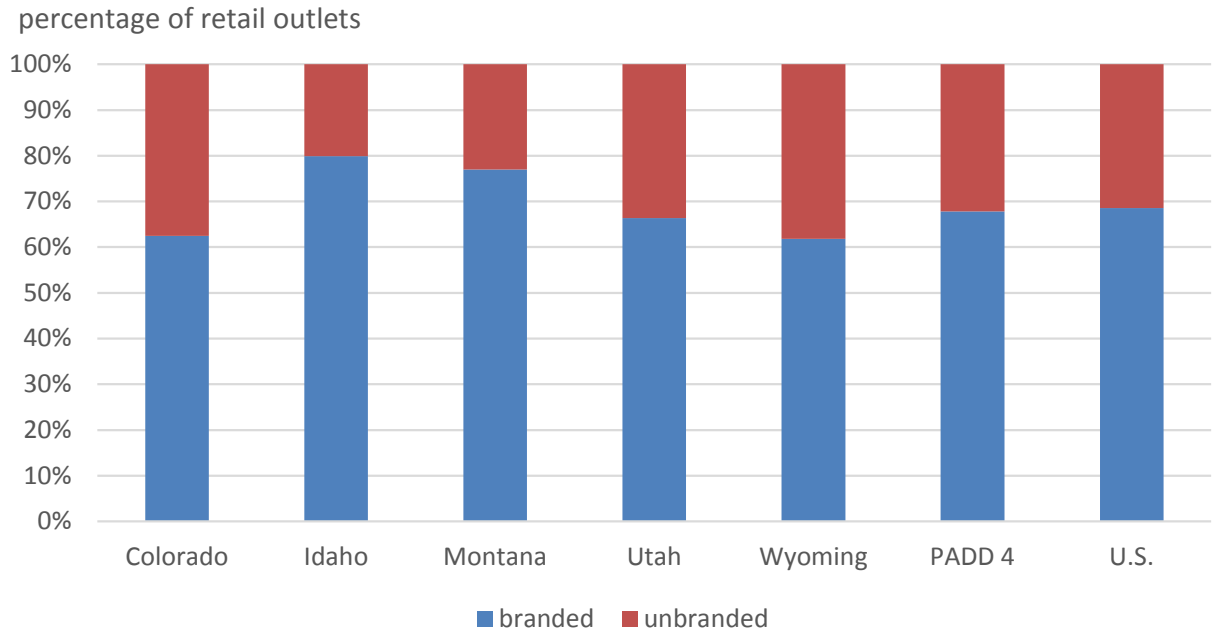
Retail markets

According to the U.S. Department of Energy's Alternative Fuels Data Center, there are 4,268 retail service outlets in the Rocky Mountain region. Figure 47 shows the share of these outlets that are branded versus unbranded by state. Stations were assigned to the branded versus unbranded designations according to their ownership. If a station is owned by or affiliated with a major oil company, it is categorized as branded. Sixty-eight percent of the Rocky Mountain region's retail stations are branded, almost exactly equal to the national average of 69%. The share of branded outlets varies around this figure within the region; Idaho is the highest with 80% branded, while Wyoming is lowest with 62%. The top five brands in the region are BP, CENEX, Mobil, Shell, and Citgo, and these brands together account for nearly 45% of the region's retail outlets. Sixty-two percent of the region's stations offer diesel fuel, well above the national average of 53%. As of June 2015, there were 88 public and 21 private filling stations in the Rocky Mountain region offering E85, and 11 public and 30 private filling stations offering biodiesel (B20 and above).[230] Colorado

[230] U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, "Alternative Fuels Data Center," accessed November 17, 2016, http://www.afdc.energy.gov/states.

is home to the largest number of E85 stations in the region, with 88, and the state also leads the region with 16 total biodiesel stations.

Figure 47. Rocky Mountain retail market structure



Source: Homeland Security Infrastructure Program 2015.

Recent and future changes

Refineries

Several projects have been recently completed or are underway at Rocky Mountain refineries. These projects primarily involve expansions to crude oil processing capacity, improvements to crude slate flexibility, or the addition of environmental equipment to reduce emissions.

- **HollyFrontier Corp.:** HollyFrontier has invested in processing upgrades at its Cheyenne and Woods Cross refineries. At the 47,000 b/cd Cheyenne refinery, HollyFrontier completed the installation of a new hydrogen plant during the fourth quarter of 2015 to decrease the benzene content of motor gasoline production in conjunction with the startup of a previously completed naphtha fractionation project, while simultaneously improving the refinery's overall liquid yields and ability to process higher volumes of heavy Canadian crude oil. In 2016, HollyFrontier implemented a project to improve fluid catalytic cracking unit yield and reliability at the Cheyenne refinery. Meanwhile, HollyFrontier put into operation the initial phase of an expansion project at its 25,050 b/cd Woods Cross refinery during the first quarter of 2016. The project included an increase in the refinery's crude oil processing capacity from 31,000 to 45,000 barrels per stream day (b/sd), as well as a new rail loading rack for intermediates and finished products associated with refining

waxy crude oil. An additional investment was also made to allow for greater crude slate flexibility, which will increase capacity utilization during periods when waxy crudes are in short supply.[231]

- **Tesoro Corp.:** In the second quarter of 2015, Tesoro completed the second phase of a conversion project at its 57,500 b/cd Salt Lake City refinery. The project was designed to improve yields of gasoline and diesel, improve the flexibility of processing crude feedstocks, and increase total throughput capacity by 4,000 b/sd to 63,000 b/sd. The project also increased the refinery's capacity to process waxy crude to 26,000 b/sd.[232] In addition, in 2016, Tesoro said that it would begin implementing equipment upgrades over the next three years to produce lower sulfur motor gasoline to meet U.S. EPA's Tier 3 requirements by 2020.[233]
- **Calumet Specialty Products Partners, L.P.:** In February 2016, Calumet completed an expansion project at its Great Falls refinery that included the installation of a new crude unit that can process up to 25,000 b/sd of crude oil and other feedstocks, a hydrogen plant, and a 20,000 b/sd mild hydrocracker. The project allows the refinery to process more local Bow River crude oil, while producing additional fuels and refined products for delivery into the regional market. As part of the project, Calumet idled the refinery's existing 10,000 b/sd crude unit.[234]
- **CHS, Inc.:** CHS is undertaking a series of related projects to increase distillate fuel oil production and boost efficiency at its 59,600 b/cd refinery in Laurel, Montana. The projects include construction of a new hydrogen plant and modifications to a crude oil distillation unit to increase crude oil throughput and increase diesel production, and hydrocracker modifications to increase diesel production, reduce production interruptions, and allow the refinery to process additional crudes. The project, which began in fall 2014, is being completed in phases through 2019 and is aimed at meeting growth in diesel demand in the Upper Midwest.[235]
- **Phillips 66:** Phillips 66 is investing in a Vacuum Improvements Project at its 60,000 b/cd Billings refinery that will allow the refinery to process up to 100% heavy Canadian crudes and facilitate higher total acid number (High-TAN) crudes. The project, which is also expected to increase clean product yield by 2,000 b/d, is expected to be completed during a planned turnaround in 2017.[236]
- **Par Pacific Holdings, Inc.:** In July 2016, Par completed a deal with Black Elk Refining, LLC to purchase Wyoming Refining Company, which operates the Newcastle refinery and associated crude oil and refined product logistics assets. In November 2015, prior to the acquisition,

[231] HollyFrontier Corp., U.S. Securities and Exchange Commission Form 10-K, 2015, pp. 44–45, http://investor.hollyfrontier.com/secfiling.cfm?filingID=48039-16-90&CIK=48039.
[232] Tesoro Corporation, "Tesoro Corporation Reports 2015 Second Quarter Record Results," August 5, 2016, http://phx.corporate-ir.net/phoenix.zhtml?c=79122&p=irol-newsArticle&ID=2076298.
[233] Kuer, "Tesoro Refinery Volunteers to Make Cleaner Fuel," February 8, 2016, http://kuer.org/post/tesoro-refinery-volunteers-make-cleaner-fuel#stream/0.
[234] Calumet Specialty Products Partners, L.P., FERC Form 10-K, 2015, pp. 10, 57.
[235] PR Newswire, "CHS will boost diesel production with $406 million Montana refinery investment," September 4, 2014, http://www.prnewswire.com/news-releases/chs-will-boost-diesel-production-with-406-million-montana-refinery-investment-273960581.html.
[236] Phillips 66, *Billings Refinery Citizens Advisory Council Minutes*, November 10, 2015, http://www.phillips66.com/EN/susdev/social/transparency/billings/Documents/nov-mins-2015.pdf.

Wyoming Refining increased the refinery's processing capacity from 15,000 to 18,000 b/cd with the addition of new pre-fractionation and crude units. [237]

- **Sinclair Oil Corp.:** Sinclair completed a major overhaul at its 24,500 b/cd Evansville refinery in 2016. The project included replacements or renovations to nearly all major equipment, oil storage tanks, and crude distillation units in order to reduce environmental impacts and improve the refinery's operations. In addition, the refinery's new boilers will burn natural gas instead of fuel oil produced from the refinery. The company says that the upgrades will add 100 years to the life of the refinery, which was built in 1923.[238]

Pipelines

CENEX Pipeline and NuStar Energy are constructing an interconnection between their two systems near Fargo, North Dakota. The CENEX Pipeline, which is owned by CHS Inc., spans from CHS Inc.'s refinery in Laurel, Montana, to Fargo, North Dakota. NuStar's North Pipeline system originates at Tesoro's Mandan, North Dakota, refinery and runs to the Twin Cities supply hub. The interconnection project, which is slated for completion in spring 2017, will enable product flows between the Billings, Montana, and Twin Cities supply hubs. In addition, CENEX plans to upgrade portions of its system to expand distribution capacity.

[237] PR Newswire, "Par Pacific Holdings to Acquire Wyoming Refining and Related Logistics Assets," June 14, 2016, http://www.prnewswire.com/news-releases/par-pacific-holdings-to-acquire-wyoming-refining-and-related-logistics-assets-300284236.html.

[238] Fladager, Greg, "Casper's Sinclair Refinery hires hundreds of workers for massive overhaul," Casper Star Tribune, accessed July 27, 2016, http://trib.com/news/local/casper/casper-s-sinclair-refinery-hires-hundreds-of-workers-for-massive/article_b07deda2-fece-544d-a6b8-c7a064eaaecb.html.

Appendix A. Data methodology

Demand and supply volumes presented in this report are based on an analysis of publically available data sources, including data from the following sources:

- The U.S. Energy Information Administration (EIA)
- The Federal Energy Regulatory Commission (FERC)
- The U.S. International Trade Commission (USITC)
- The Federal Aviation Administration (FAA)
- Airlines for America (A4A)
- The U.S. Army Corps of Engineers (USACE)
- Various company websites, 10-K reports, and investor presentations
- Trade press and other publically available data

Demand

EIA uses *Product Supplied* as an approximation for consumption/demand of petroleum products because it measures the disappearance of these products from primary sources, i.e., refineries, natural gas processing plants, blending plants, pipelines, and bulk terminals. EIA provides Product Supplied values for each PADD but not for each sub-PADD region. EIA's Prime Supplier Sales Volumes and data from Airlines for America were utilized to estimate demand for sub-PADD regions in the Midwest (PADD 2).

Motor gasoline

EIA compiles Prime Supplier Sales Volumes (PSSV) for motor gasoline based on prime supplier sales of selected petroleum products into the local markets of ultimate consumption, as defined by the instructions for *Form EIA-782C*. Sales volumes are reported by refiners, gas plant operators, importers, petroleum product resellers, and petroleum product retailers that produce, import, or transport product across state boundaries and local marketing areas and sell the product to local distributors, local retailers, or end users. To estimate each state's share of gasoline demand, each state's Total Motor Gasoline PSSV was divided by Total Motor Gasoline PSSV at the PADD level. This quotient was multiplied by PADD-level motor gasoline Product Supplied to estimate each state's motor gasoline Product Supplied. These state-level estimates were then aggregated to produce estimates of Product Supplied at the sub-PADD level.

Equation 1. Distillate demand estimation formula

$$Motor\ Gasoline\ Demand_{State} = \left(\frac{Motor\ Gasoline\ PSSV_{State}}{Motor\ Gasoline_{PADD}}\right) \times \left(Motor\ Gasoline\ Product\ Supplied_{PADD}\right)$$

This calculation was done for each month in 2015. Note that state-level demand estimates are forced to sum to PADD-level product supplied when aggregated.

Distillate

To estimate each state's share of gasoline demand, each state's Total Motor Gasoline PSSV was divided by Total Motor Gasoline PSSV at the PADD level. This quotient was multiplied by PADD-level motor

gasoline Product Supplied to estimate each state's motor gasoline Product Supplied. These state-level estimates were then aggregated to produce an estimates of Product Supplied at the sub-PADD level.

To estimate each state's share of distillate demand, each state's Total Distillate and Kerosene PSSV was divided by Total Distillate and Kerosene PSSV at the PADD level. This quotient was multiplied by PADD-level distillate Product Supplied to estimate each state's distillate Product Supplied. These state-level estimates were then aggregated to produce estimates of Product Supplied at the sub-PADD level.

Equation 2. Distillate demand estimation formula

$$Distillate\ Demand_{State} = \left(\frac{Distillate\ and\ Kerosene\ PSSV_{State}}{Distillate\ and\ Kerosene\ PSSV_{PADD}}\right) \times \left(Distillate\ Product\ Supplied_{PADD}\right)$$

This calculation was done for each month in 2015. Note that state-level demand estimates are forced to sum to PADD-level product supplied when aggregated.

Jet fuel

Airlines for America (A4A), an industry group representing U.S. airlines, provided ICF and EIA non-public data on commercial jet fuel consumption in 2014 and 2015 for around 80 of the largest airports in the country. 2015 jet fuel consumption reported by A4A covered 80% of EIA's total 2015 U.S. jet fuel Product Supplied. To estimate jet fuel consumption at airports not covered by A4A data, a multivariate regression analysis was conducted to establish a statistical relationship between jet fuel consumption at individual airports, and reported enplanements (passenger boardings) and cargo volumes (by landed weight) at those airports, as reported by FAA. Because the airports not included in the A4A dataset were smaller airports, the relationship was only estimated using data from similarly sized airports. Outlier airports in Hawaii and Alaska were removed from the regression data. The multivariate regression calculated with data from these airports achieved a multiple R squared value of 0.99297. The resulting correlation equation is expressed in Equation 3.

Equation 3. Jet fuel correlation equation

$$Jet\ Fuel\ Demand_{Airport} = \left(0.33559 \times Enplanements_{Airport}\right) + \left(0.00027 \times Landed\ Cargo_{Airport}\right)$$

In Equation 2, Demand is expressed in annual barrels of jet fuel consumption, enplanements are expressed as an annual count of passenger boardings, and cargo landed weight is expressed in annual tons. Equation 2 was used to estimate jet fuel demand at airports not included in the A4A dataset. Combining reported airport jet fuel consumption from the A4A dataset with estimated demand from non-reporting airports produced a comprehensive demand dataset for all the airports in PADDs 2 and 4. Data for each airport was then adjusted so that the sum of all airports would equal EIA's PADD-level jet fuel Product Supplied. The annual demand numbers for each airport were then apportioned to each month in 2015, using monthly shares of *state-level PSSV of jet fuel*. For each month, jet fuel demand estimates for each airport were rolled up to the sub-PADD level.

Supply

Supply data include refinery production, imports, exports, inventory changes, domestic pipeline movements, and domestic marine movements. Ethanol and biodiesel are also treated as supply elements but the source of these fuels are not broken out at the sub-PADD level.

Refinery production

Refinery production volumes for motor gasoline, distillate, and jet fuel were taken from EIA's Monthly Refinery Report. Calculating refinery production of motor gasoline and distillate required adjustments to subtract renewable fuel additives (fuel ethanol and biodiesel), which are sometimes blended into finished fuels that are distributed via the refinery's truck rack. Motor gasoline refinery production was calculated as the sum of two components: finished motor gasoline from EIA's *net refinery production* data and motor gasoline blending components from EIA's *refinery net input* data. From this sum, net *refinery input* of ethanol was subtracted to arrive at the petroleum-only component of refinery motor gasoline production. Similarly, for distillate, refinery inputs of *renewable diesel fuel* were subtracted from EIA's *net refinery production* of distillates to arrive at the petroleum-only component of refinery distillate production. Jet fuel *net refinery production* did not require any adjustments for renewable fuels.

Imports

Import of motor gasoline, motor gasoline blending components, distillates, and jet fuel were sourced from EIA's 2015 *company level imports* data.

Exports

Exports of transportation fuels were sourced from the USITC's Interactive Tariff and Trade Dataweb.

Inventories

Inventory changes to transportation fuels were calculated as the sum of changes to refinery and blender stocks using EIA's *Refinery, Bulk Terminal, and Natural Gas Plant Stocks by State*.

Ethanol and Biodiesel

Ethanol and biodiesel supplies were calculated as the sum of refinery and blender inputs of those products. These data are publicly available for sub-PADD regions in PADD 2 (which correspond with EIA's refinery districts), as well as PADD 4, a study region in and of itself. Non-public EIA data was ethanol and biodiesel supply used for these sub-PADDs. In order to calculate nameplate capacity for ethanol and biodiesel production at the PADD and sub-PADD region levels, EIA's state-level data from the U.S. Fuel Ethanol Plant Production Capacity report and the Monthly Biodiesel Production Report were used.

Domestic Movements

Pipeline and *tanker/barge* movements between PADD regions were sourced from EIA's Monthly Tanker and Barge Movements Report. Movements between sub-PADD regions are not publicly available, so analyst judgement was used to estimate the volumes of fuel moving into and out of these regions based on an analysis of inter-PADD movements; sub-PADD regional demands; reported supply sources within, into, and out of each sub-PADD region; and data on specific waterborne and pipeline receipts reported by other sources, including:

- USACE's Waterborne Commerce of the United States (2014 data) provided domestic inbound and outbound movements of gasoline, distillate, and jet fuel to U.S. ports. UASCE data are reported in tons and were converted to barrels using product-specific conversion factors.
- FERC's Form 6/6-Q – Annual/Quarterly Report of Oil Pipeline Companies (2015) provided quarterly receipts of gasoline, distillates, and jet fuel into interstate pipeline systems by state.

Retail Markets

Data on the number of service stations and their branding in each region were obtained from the Homeland Security Infrastructure Program. Data on the number of renewable fuel service stations were obtained from the Department of Energy's Alternative Fuel Data Center. Locational data were from the National Renewable Energy Laboratory (NREL)'s Biofuels Atlas.