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# Short-Term Outlook for Hydrocarbon Gas Liquids

March 2016



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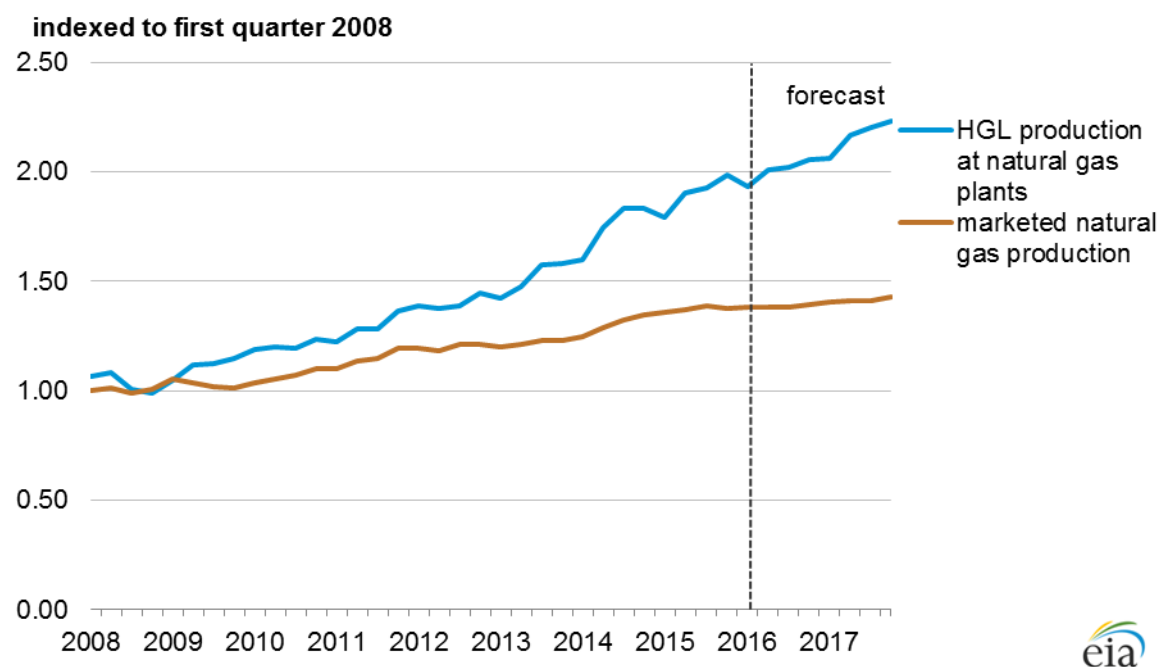
## Overview

U.S. liquid fuels production increased from 7.43 million barrels per day (b/d) in 2008 to 13.75 million b/d in 2015. However, the *Short-Term Energy Outlook* (STEO) expects liquid fuels production to decline to 12.99 million b/d in 2017, mainly as a result of prolonged low oil prices. The liquid fuels production forecast reflects a 1.24 million b/d decline in crude oil production by 2017 that is partially offset by a 450,000 b/d increase in the production of hydrocarbon gas liquids (HGL)—a group of products including ethane, propane, normal butane, isobutane, natural gasoline, and refinery olefins.

HGL production happens at natural gas processing plants and petroleum refineries, but between 2008 and 2015, almost all of the growth in HGL production occurred at natural gas processing plants as a by-product of the [growing supply of natural gas from shale gas](#) and tight oil formations. Investment projects that increased the capacity to produce, store, transport, export, and consume HGL enabled the supply of HGL to expand at a faster rate than natural gas production (Figure 1). STEO expects HGL production growth to continue to outpace natural gas production in 2016 and 2017, as more HGL infrastructure projects are completed.

Each HGL product serves a different market with a unique set of supply and demand drivers. Recently expanded export facilities have allowed excess propane, butane, and natural gasoline production to be shipped to foreign markets. Unlike the other HGL products, ethane production has been constrained by lack of demand and low prices. This analysis will discuss [the outlook for each of these four HGL streams](#) and related infrastructure projects through 2017. Learn more about the operations of the HGL market in [Hydrocarbon Gas Liquids: Recent Market Trends and Issues](#).

Figure 1. Growth in hydrocarbon gas liquids production (excluding rejection) at natural gas plants and marketed natural gas production, quarterly 2008-17

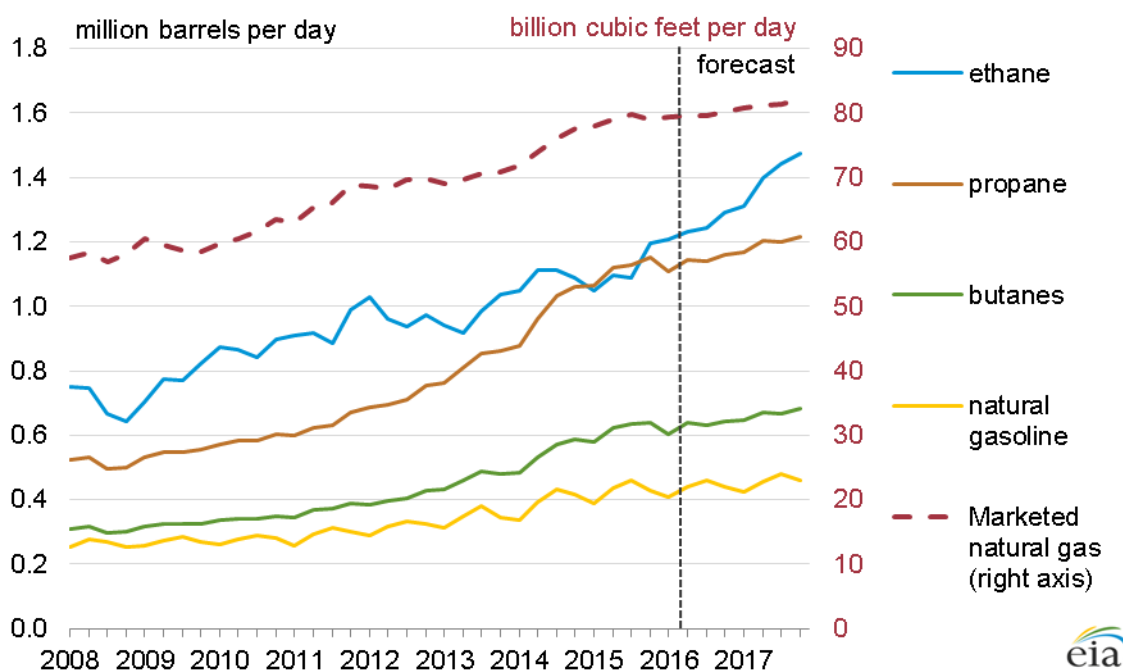


Source: U.S. Energy Information Administration, *Short-Term Energy Outlook*, March 2016

Key features of the outlook for HGL include:

- Forecast growth in marketed natural gas production slows from 5% in 2015 to 1% in 2016 and to 2% in 2017. Natural gas plant HGL production, or *natural gas plant liquids* (NGPL), which grew by 9% in 2015, is forecast to grow by 5% in 2016, and by 8% in 2017.
- From 2015 through 2017, natural gas plant production of HGL is forecast to grow 450,000 b/d, with increased ethane production accounting for 66% of this growth (Figure 2). Ethane production growth occurs as expanded petrochemical and export capacity provides new outlets for supply and allows more ethane to be recovered from raw natural gas. Ethane provides 140,000 b/d of the 180,000 b/d forecast HGL production growth in 2016, and 160,000 b/d of 280,000 b/d HGL production growth in 2017.
- Forecast HGL consumption in the United States increases more slowly than production, increasing by 1% in both 2016 and 2017. In 2016, increased ethane consumption offsets reduced consumption for other HGL. In 2017, the expected startup of six ethane-consuming petrochemical plants leads to an 80,000 b/d increase in ethane consumption, which more than offsets a 50,000 b/d decline in propane consumption.
- With HGL production outpacing consumption, forecast net exports of HGL increase by 38% (310,000 b/d) in 2016 and by 19% (220,000 b/d) in 2017. New export facilities allow net exports of HGL, which increased 260,000 b/d in 2015, to grow 310,000 b/d in 2016, and 220,000 b/d in 2017.

Figure 2. Natural gas plant production of hydrocarbon gas liquids, quarterly 2008-17



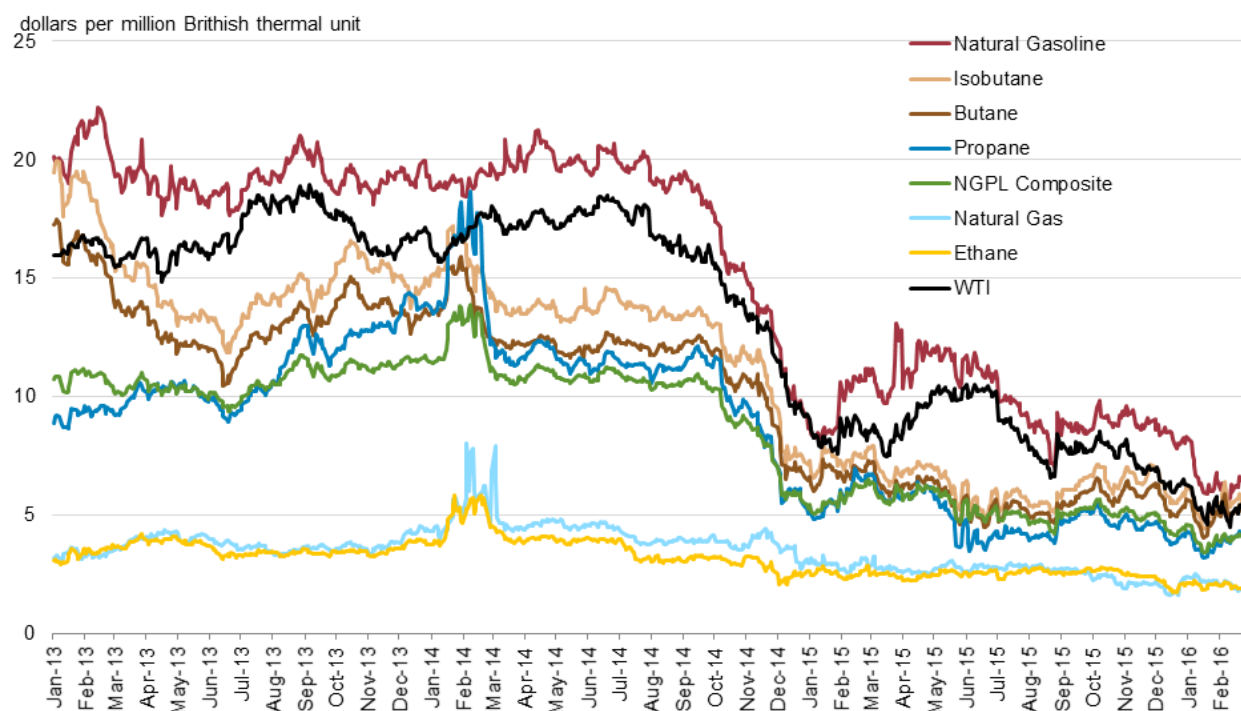
Source: U.S. Energy Information Administration, *Short-Term Energy Outlook*, March 2016

Much of the growth in HGL markets that occurred in 2015 and that is expected over the next two years is the result of infrastructure investment decisions made before the summer of 2014 when crude oil prices began to drop, changing the economics of crude oil, natural gas, and HGL. Domestic spot prices of HGL products generally fall between crude oil and natural gas spot prices

prices of HGL products generally fall between crude oil and natural gas spot prices on a heat-content basis, (\$/million British thermal units (MMBtu))(Figure 3). Propane, butane, and natural gasoline spot prices, which have historically moved with crude oil prices, have stayed consistently above the Henry Hub natural gas price since 2008, providing positive margins when these products were produced at natural gas plants. On the other hand, an oversupply of ethane kept ethane prices at or below the Henry Hub natural gas price from mid-2012 to late-2015. When ethane margins are negative, producers have an incentive to reject ethane, or leave it in the dry pipeline natural gas stream where it sells for its fuel value. However, ethane prices went above Henry Hub natural gas prices on September 22, 2015, and margins are assumed to be mainly positive through 2017, as new petrochemical demand and exports reduce the oversupply of ethane.

Except for ethane prices, HGL prices have remained higher than natural gas prices on an energy-content basis. Since mid-2014, crude oil prices have fallen, pulling down HGL prices. Natural gas prices have also declined since mid-2014, but by less than HGL prices, causing HGL processing margins to narrow. Despite lower processing margins throughout 2015, prior commitments by producers and midstream operators to process liquids and the continuing preference for liquids over natural gas contributed to estimated HGL production growth of 280,000 b/d (9%) between June 2014 and December 2015.

Figure 3. HGL prices relative to natural gas and crude oil, January 2013 – February 2016



Note: All prices are daily end-of-day spot prices, natural gas is Henry Hub, West Texas Intermediate (WTI) crude oil is at Cushing, OK, and NGL components are Mont Belvieu. NGPL composite calculated based on calorific contribution of each purity to total NGPL barrel heat value.

Source: U.S. Energy Information Administration, based on WTI spot prices from Thomson Reuters and all other spot prices from Bloomberg, L.P.

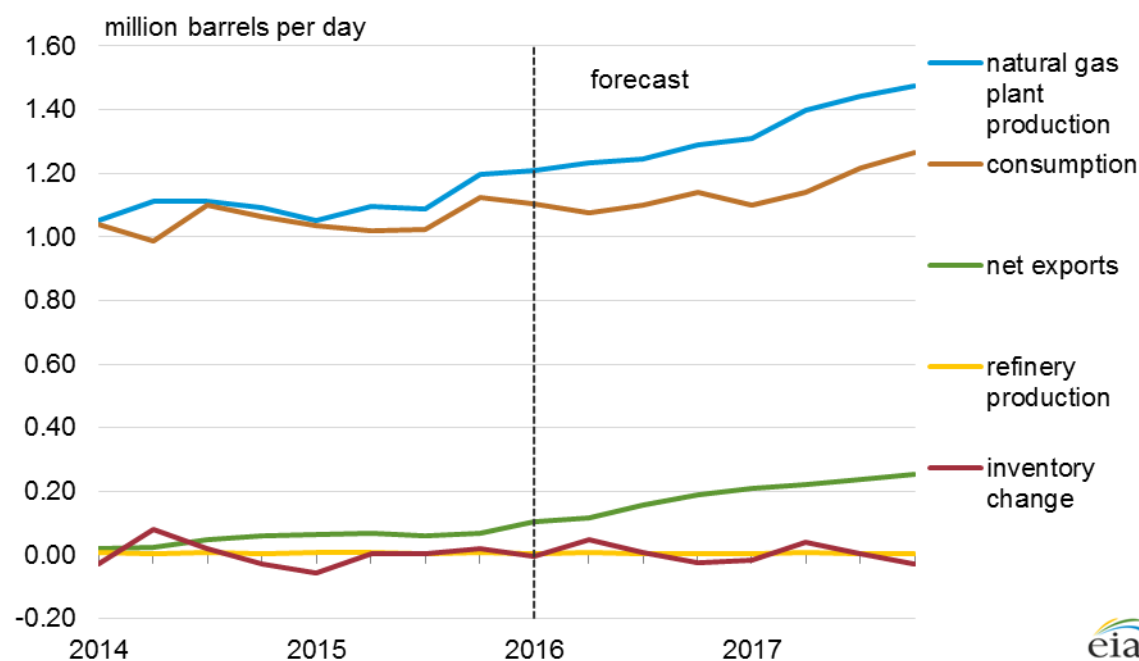


## Ethane Outlook

STEO projects ethane consumption, which was flat in 2015, to increase by 50,000 b/d in 2016 and by 80,000 b/d in 2017 (Figure 5). Ethane production at natural gas plants, which increased 20,000 b/d in 2015, is forecast to increase by 140,000 b/d in 2016 and by 160,000 b/d in 2017. Net exports are forecast to grow by 80,000 b/d in 2016 and 90,000 b/d in 2017, compared to growth of 30,000 b/d in 2015.

STEO projects annual average gas plant production of HGL to grow 450,000 b/d by 2017, with increased ethane production accounting for two-thirds of this growth (Figure 2). Over the past several years, the amount of ethane contained in raw natural gas has exceeded the U.S. capacity to consume and export it. This oversupply kept ethane prices relatively low, hovering at or below the price of natural gas on a heat-content basis (\$/million British thermal units (MMBtu)) (Figure 3). The lower prices created an incentive for producers to reject ethane into pipeline natural gas to capture its value as a fuel, as opposed to recovering it at gas plants and marketing it as a separate product for use in the petrochemical manufacturing. As new ethane-consuming petrochemical and export capacity reduces the ethane oversupply in 2016-17, ethane prices are expected to generally remain above natural gas prices in \$/MMBtu, and ethane recovery is expected to rise to meet demand and export growth.

Figure 4. Ethane supply and disposition, quarterly 2014-17



Note: Consumption, refinery production, and inventories include refinery-sourced ethylene. EIA uses product supplied as a proxy for consumption.

Source: U.S. Energy Information Administration, *Short-Term Energy Outlook, March 2016*

In 2016-17, EIA expects the completion of several infrastructure projects to contribute to higher consumption, net exports, and gas plant production of ethane. New and expanded petrochemical plant capacity and new export terminal capacity will provide new outlets for a market that has been over supplied. At the same time, new pipelines, de-ethanization plants, and storage capacity will allow more ethane to be separated from natural gas and transported to demand centers.

### Natural gas plant production of ethane

Raw natural gas has a higher content of ethane than of the other HGL components, but since 2012 natural gas plant recovery of ethane has grown more slowly and sporadically than propane, butane, and natural gasoline. Although the ethane was produced alongside the other HGL streams, persistently weak ethane demand and prices provided a disincentive for ethane recovery at natural gas plants and encouraged producers to reject some ethane into the pipeline gas to capture its value as a fuel at natural gas prices (Figure 3, Table 1).

Ethane recovery is expected to increase as expanded infrastructure allows it to reach new markets, where it can fetch a higher price. In recent years, the availability of inexpensive ethane feedstock led to a wave of investments in ethane-consuming petrochemical plants, export facilities, and the infrastructure required to recover it from raw natural gas and transport it to market. Many of these projects are under construction and will come online in the next few years. Among these projects are new de-ethanization facilities, ethane pipelines, and ethane export facilities. These projects increase take-away capacity for ethane, especially in the Marcellus and Utica shale regions, where market outlets for rapidly growing supplies were previously limited to pipeline natural gas.

Increased ethane recovery is expected to result in ethane production (excluding rejection) growth that is much stronger than natural gas production growth, with annual ethane production rising 27% between 2015 and 2017 and marketed natural gas production rising 3%. STEO projects ethane production to increase by 140,000 b/d in 2016 and by 160,000 b/d in 2017, compared with annual average growth of 50,000 b/d between 2008 and 2015.

**Table 1. Ethane supply and disposition, 2013-17**

million barrels per day	Annual Average					Year-over-year change		
						Forecast		
	2013	2014	2015	2016	2017	2015	2016	2017
Gas Plant Production	0.97	1.09	1.11	1.24	1.41	0.02	0.14	0.16
Refinery and Blender Net Production	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00
Net Imports	0.00	-0.04	-0.06	-0.14	-0.23	-0.03	-0.08	-0.09
Stock Build (Draw)	-0.01	0.01	0.00	0.00	0.00	-0.01	0.00	0.00
Consumption	0.99	1.05	1.05	1.11	1.18	0.00	0.05	0.08

Note: Consumption, refinery production, and inventories include refinery-sourced ethylene. EIA uses product supplied as a proxy for consumption.

Source: U.S. Energy Information Administration, *Short-Term Energy Outlook, March 2016*

## Domestic consumption of ethane

STEO forecasts ethane consumption to rise from 1.05 million b/d in 2015 to 1.18 million b/d in 2017. Ethane is used almost exclusively as a feedstock for [ethylene](#) production at petrochemical plants, a use that is expected to expand as [new ethylene plant capacity](#) comes online. Ethylene plants can process feedstocks including ethane, propane, butane, naphtha, and heavier liquids to produce ethylene, an important component for manufacturing plastics and other industrial materials. Depending on plant configuration and feedstocks consumed, ethylene production also results in the coproduction of other petrochemicals including propylene, butylene, and other aromatics. The relatively low cost of U.S. ethane led to a wave of investment in ethylene plant projects, including plant restarts, capacity expansion and feedstock conversions at existing plants, and new ethylene plants, expected to increase the ethane throughput capacity by 440,000 b/d by the end of 2017 (Table 2), with most of this at the end of 2017.

**Table 2. Additional capacity of ethylene plants to consume ethane feedstock and projected growth in ethane consumption, 2013-17**

million barrels per day	2013	2014	2015	Forecast	
				2016	2017
Capacity expansions (including restarts and debottlenecking)	0.04	0.04	0.04	0.03	0.04
New ethylene plants	--	--	--	--	0.37
Feedstock conversions	0.00	0.01	0.01	0.01	--
Total annual throughput capacity additions (end-of-year)	0.04	0.05	0.05	0.04	0.40
Annual consumption growth	0.11	0.06	0.00	0.05	0.08

-- = Not applicable

Source: U.S. Energy Information Administration, capacities are end-of year estimates based on various company announcements and trade-press articles. See Table A1 for assumed timeline of projects. Consumption (product supplied) growth is from *Short-Term Energy Outlook, March 2016*

A number of projects to restart or expand the capacity of ethylene-producing plants to use ethane as their feedstock increased ethane throughput capacity by about 140,000 b/d between 2013 and 2015 (Table 2). Most of this new capacity was from expansion projects scheduled to come online late in 2015, which may not impact feedstock demand until the first or second quarter of 2016, depending on plant ramp up schedules. Two more expansion projects and a feedstock conversion project, capable of using another 40,000 b/d of ethane, are expected in 2016 (See Appendix Table A1 for a complete list of projects). Some existing plants have the flexibility to switch feedstocks and may choose to increase their ethane throughput or use alternative feedstocks, such as naphtha or propane, when prices are competitive.

Five new ethylene crackers (from Dow, Formosa, ExxonMobil, Chevron Philips, and OxyChem/Mexichem) and two expansion projects (Lyondell Bassell and Westlake) are under construction and are expected to begin operating in 2017. In addition, Indorama Ventures recently acquired a mothballed plant and has proposed restarting the plant by the end of 2017. These projects

are expected to expand ethane throughput capacity by more than 400,000 b/d in 2017, with the bulk of the capacity coming on at the end of the year. The new plants are designed to consume predominantly light feedstock, and EIA expects ethane to constitute most of their feed. However, the amount of ethane used in these plants will be determined mainly by the ethylene production margins (cracking margins), which will be driven by the demand for and price of ethylene and propylene compared with ethane and other feedstocks.

### Net exports of ethane

In 2014, the United States switched from being a net importer of ethane to a net exporter after the opening of [two new ethane pipelines](#) that began transporting ethane from North Dakota and southwestern Pennsylvania to Canada. STEO expects annual average ethane net exports (gross exports minus gross imports) to increase from 60,000 b/d in 2015 to 230,000 b/d in 2017, as new export facilities allow ethane to reach foreign markets (Table A3).

Table 3. Ethane export capacity and net exports

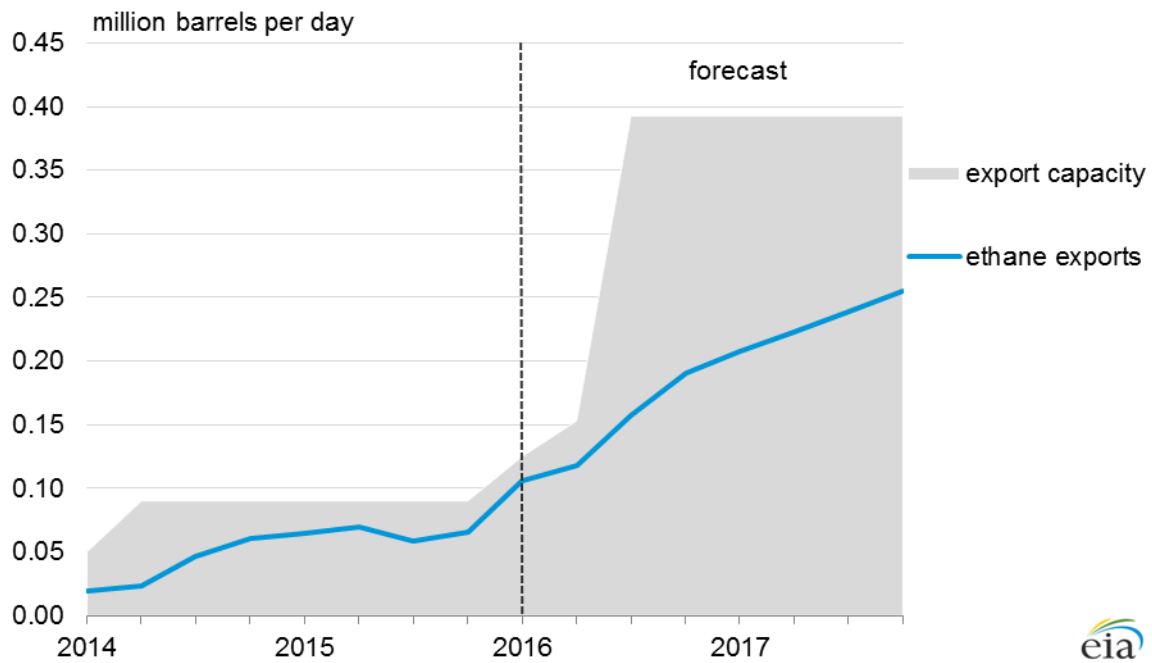
	Annual average					Year-over-year change		
	2013	2014	2015	Forecast		Forecast		
million barrels per day				2016	2017	2015	2016	2017
Net exports (annual average)	0.00	0.04	0.06	0.14	0.23	0.03	0.08	0.09
Ethane export capacity	0.05	0.09	0.09	0.39	0.39	0.00	0.30	0.00

Note: Reflects end-of-year export capacity.

Source: U.S. Energy Information Administration, *Short Term Energy Outlook*, March 2016, and EIA analysis of announced export projects. See Appendix Table A3 for list of projects.

Early in 2016, the United States is expected to begin exporting ethane to Europe from Sunoco's Marcus Hook facility near Philadelphia, Pennsylvania. Under a 15-year contract, new purpose-built tankers will move the ethane from Marcus Hook to Scotland and Norway for use in INEOS petrochemical plants. In the third quarter of 2016, Enterprise is expected to open a new ethane export facility at Morgan's Point, Texas, which will eventually be capable of exporting 240,000 b/d. This new terminal is expected to support exports to Europe and to India. Reliance Industries, a refiner and petrochemical producer, is building terminal and pipeline infrastructure and has [ordered six very large ethane carriers](#) to transport ethane to India. The first of Reliance's ethane carriers is expected to be completed by the end of 2016.

Figure 5. Ethane export capacity and net exports, quarterly 2014-17



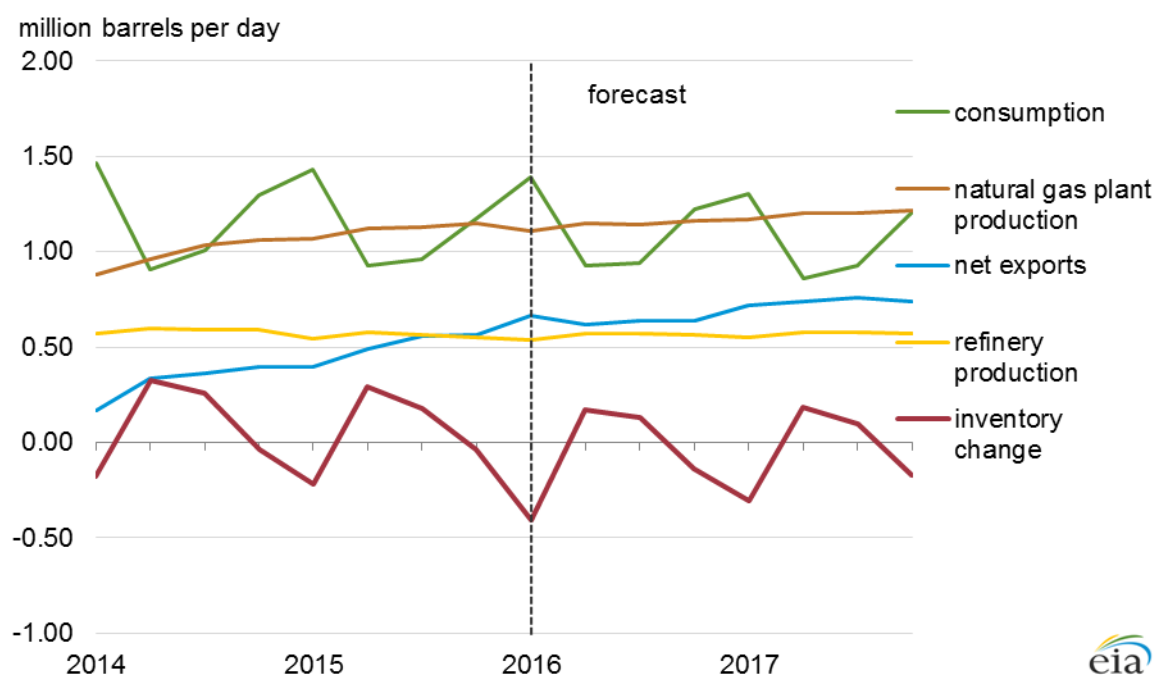
Source: U.S. Energy Information Administration, *Short-Term Energy Outlook*, March 2016, and EIA analysis of announced export projects. See Appendix Table A3 for list of projects



## Propane Outlook

The outlook for propane is marked by continued growth in gas plant production, albeit at a slower pace than in recent years, relatively flat domestic consumption levels, and continued growth in net exports (Figure 5). STEO projects natural gas plant production of propane to increase by 20,000 b/d in 2016 and by 60,000 b/d in 2017, compared with estimated annual growth of 130,000 b/d in 2015. After a 50,000 b/d annual decline in 2015, propane consumption, which includes refinery grade propylene, is forecast to remain flat in 2016 and decline by 50,000 b/d in 2017. Net exports, which grew by an estimated 190,000 b/d in 2015, are forecast to grow by 140,000 b/d in 2016 and by 100,000 b/d in 2017.

Figure 6. Propane supply and disposition, quarterly 2014-17



Note: Consumption, refinery production, and inventories include refinery-sourced propylene. EIA uses product supplied as a proxy for consumption.

Source: U.S. Energy Information Administration, *Short-Term Energy Outlook, March 2016*

### Natural gas plant production of propane

Gas plant production of propane more than doubled between 2008 and 2015, with most of the growth occurring since 2011. The rate of growth in gas plant propane production outpaced that of natural gas (Figure 2), as increased natural gas processing and fractionation capacity allowed producers to separate more liquids from raw natural gas production. Growth in both natural gas and propane production slowed in 2015, with marketed natural gas increasing by an estimated 5% and propane increasing by an estimated 13%. STEO projects growth in marketed natural gas will slow to about 1% in 2016 and 2% in 2017, while propane production at natural gas processing plants growth slows to 2% in 2016 and 5% in 2017.

Table 4. Propane supply and disposition, 2013-17

million barrels/day

	Annual average					Year-over-year change		
	2013	2014	2015	Forecast		2015	Forecast	
				2016	2017		2016	2017
Gas Plant Production	0.82	0.98	1.12	1.14	1.20	0.13	0.02	0.06
Refinery and Blender Net Production	0.56	0.59	0.56	0.56	0.57	-0.03	0.00	0.01
Net Imports	-0.18	-0.32	-0.50	-0.64	-0.74	-0.19	-0.14	-0.10
Stock Build (Draw)	-0.06	0.09	0.05	-0.06	-0.05	-0.04	-0.11	0.01
Consumption	1.28	1.17	1.12	1.12	1.07	-0.05	0.00	-0.05

Note: Consumption, refinery production, and inventories include refinery-sourced propylene. EIA uses product supplied as a proxy for consumption.

Source: U.S. Energy Information Administration, *Short-Term Energy Outlook, March 2016*

## Domestic consumption of propane

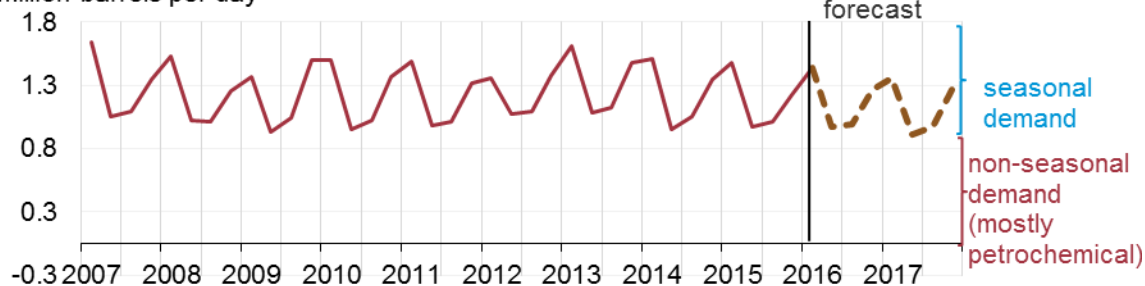
In 2015, the United States consumed 1.12 million b/d of propane (including 280,000 b/d of refinery-sourced propylene) for a combination of uses. In the United States, propane is used mainly for space heating and as a feedstock for petrochemical plants, and to a lesser extent for agricultural applications and transportation. Propane's use as a heating fuel is mainly responsible for the seasonal pattern in its consumption, which peaks in the winter (fourth and first quarters) (Figure 6). In the fourth quarter of 2015, the warm weather resulted in heating demand, measured by population-weighted heating degree days (HDD) that was 16% lower than the fourth-quarter average over the previous five years. Mild weather continued into the first quarter of 2016, and is expected to result in heating demand that is 7% lower than the first-quarter average over the previous five years. Despite lower than average heating demand in 2016, STEO projects propane consumption will remain flat because of increased petrochemical use. Although more typical heating demand is expected in 2017, forecast propane consumption declines by 50,000 b/d, as petrochemical consumption declines.

Propane is a feedstock used by the [petrochemical industry](#) to produce ethylene and propylene for chemicals and plastics. Some ethylene-producing plants can process propane into ethylene, propylene, and a slate of other olefins. As these plants become more reliant on ethane feedstock, propylene production at ethylene plants is expected to decline. To offset the decline in ethylene cracker propylene production, petrochemical companies have invested in propane dehydrogenation (PDH) plants that are dedicated to producing propylene from propane feedstock.

Figure 7. U.S. propane consumption and population-weighted heating degree days, quarterly 2014-17

**U.S. propane consumption, quarterly 2007 - 17**

million barrels per day

**U.S. population-weighted heating degree days, quarterly 2007-17**

Note: Propane consumption include refinery-sourced propylene. EIA uses product supplied as a proxy for consumption.

Source: U.S. Energy Information Administration, *Short-Term Energy Outlook, March 2016*

The United States currently has two PDH plants (Table A2). The first plant, with an estimated propane feedstock capacity of 30,000 b/d, was opened by Petrologistics in 2010, and has since been sold to Flint Hills. A second plant, owned by Dow Chemical, with a propane feedstock capacity of 35,000 b/d, began commercial operation in December 2015. One additional plant is expected to start up in the forecast period, Enterprise's 35,000 b/d feed capacity plant expected to start in the first quarter of 2017. The amount of propane feedstock consumed depends on plant economics. However, the construction of new PDH plants may result in a net reduction in petrochemical propane consumption, because a PDH plant produces more propylene per barrel of propane feedstock than an ethylene plant.

### Net exports of propane

STEO forecasts imports and exports together as *net imports* (gross imports minus gross exports). Annual average net propane exports increased from 10,000 b/d in 2011 to an estimated 500,000 b/d in 2015, as the capacity to export liquefied petroleum gas (LPG), including propane and butanes, increased by almost 1 million b/d. Three notable infrastructure changes occurred during this period. In 2014, Kinder Morgan's Cochin Pipeline was converted from a pipeline that carried propane imports from Canada to one that carries natural gasoline exports to Canada. Second, the Marcus Hook terminal near Philadelphia, Pennsylvania, began exporting propane in the fourth quarter of 2014. Additionally, the number of vessels designed to carry LPG grew by 185, in anticipation of greater shipping demand. More



growth in the LPG vessel fleet is expected, according to Bloomberg. As of December 11, 2015, 123 tankers designed to carry LPG were on order, with 60 under construction.<sup>1</sup>

STEO projects propane net exports to increase to 640,000 b/d in 2016 (Table 5) and to 740,000 b/d in 2017 as exports ramp up at two Gulf Coast terminal projects that began operating in the second half of 2015, and as Phillips66 opens its new terminal at Freeport, Texas, in the second half of 2016. See Appendix Table A4 for a list of projects.

**Table 5. U.S. propane/butane export capacity and net exports**

million barrels/day

	Annual average					Year-over-year change		
	2013	2014	2015	Forecast		2015	Forecast	
				2016	2017		2016	2017
Net Exports								
Butanes	0.01	0.06	0.08	0.15	0.16	0.03	0.06	0.02
Propane/propylene	0.18	0.32	0.50	0.64	0.74	0.19	0.14	0.10
Propane/butane export capacity	0.43	0.62	1.17	1.32	1.32	0.55	0.15	0.00

Note: Reflects end-of-year export capacity.

Source: U.S. Energy Information Administration, *Short-Term Energy Outlook*, March 2016 and EIA estimates of export capacity. See Appendix Table A4 for list of projects.

The relatively low cost of U.S. propane spurred [international demand and changed international trade patterns](#). Growth in propane exports is expected to be mainly driven by petrochemical demand in Asia and to a lesser extent Europe.

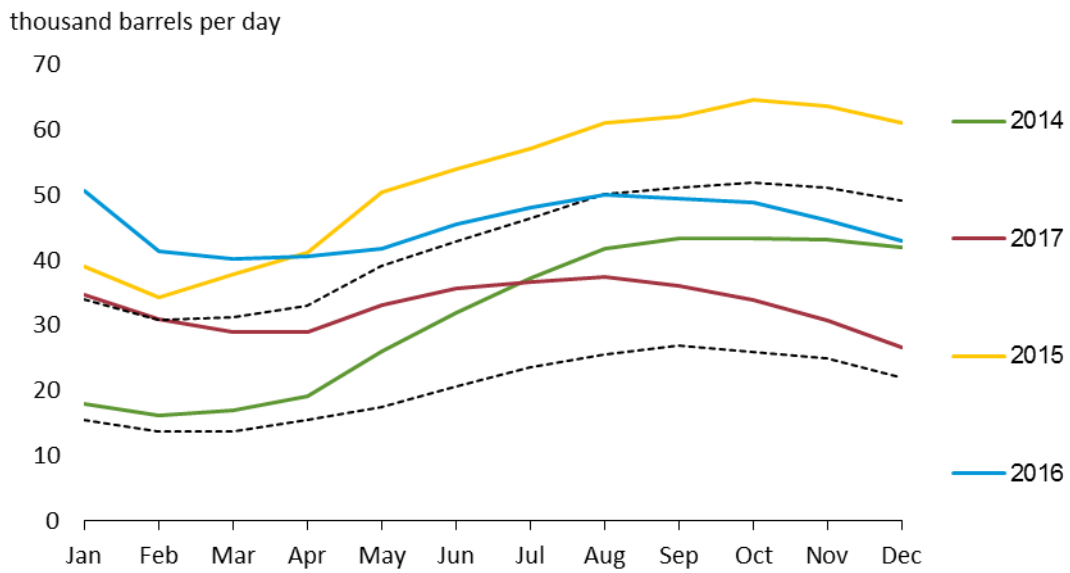
## Propane inventories

Inventories of propane, which include 3-4 million barrels of non-fuel use propylene, have remained well above the five-year range since May 2014, as U.S. production increased more rapidly than domestic consumption and net exports. Inventories expanded the most in the Gulf Coast region (PADD3), the location of most petrochemical plants and propane export facilities. In 2015, Gulf Coast propane inventories exceeded the previous five-year average by nearly 21 million barrels, or by 65%.

Gulf Coast inventories, which reached a record-high of 64.9 million barrels on November 20, 2015, were drawn down to 41.8 million barrel by February 26, 2016. This unusually strong, 23.1 million barrel, draw on inventories was mainly the result of higher utilization rates and expanded capacity at export terminals, in addition to seasonal heating demand, which was actually below normal for most of the winter. Following the strong drawdown, STEO expects inventories to return to the normal range in the second quarter of 2016, where they will remain through the end of 2017. STEO projects Gulf Coast inventories to draw 18.1 million barrels in 2016 and 16.4 million barrels in 2017.

<sup>1</sup> Based on Bloomberg's Vessel Fleet Status LPG Tanker, December 11, 2015, Total in Service (VESLLPIS Index), Total On Order (VESLLPOO Index), Total Under Construction (VESLLPUC Index).

Figure 8. Propane inventories on the Gulf Coast (PADD 3), monthly 2014-17



Note: Includes non-fuel use propylene.

Source: U.S. Energy Information Administration, *Short-Term Energy Outlook, March 2016*

## Butanes Outlook

STEO projections for butanes include normal butane and isobutane, as well as refinery-produced olefins butylene and isobutylene. STEO projects natural gas plant production to increase by 10,000 b/d in 2016 and by 40,000 b/d in 2017, compared with annual growth of 70,000 b/d in 2015. After growth of 20,000 b/d in 2015, butane consumption is forecast to remain flat in 2016 and increase by 10,000 b/d in 2017. Net exports, which grew by 30,000 b/d in 2015, are forecast to grow by 60,000 b/d in 2016 and by 20,000 b/d in 2017.

### Natural gas plant production of butanes

Gas plant production of butanes (normal and iso-), which doubled between 2008 and 2015, accounts for most of the growth in butanes production. Gas plant production of butanes (normal and iso-) increased from an annual average of 310,000 b/d in 2008 to an estimated 620,000 b/d in 2015, with about half this growth occurring since 2013. STEO projects gas plant production to grow to 630,000 b/d in 2016 and to 670,000 b/d in 2017.

The rate of growth of gas plant butanes production exceeded that of natural gas, as increased natural gas processing and fractionation capacity allowed producers to focus more on wet natural gas, which has a higher concentration of liquids. Between 2013 and 2015, annual growth in marketed natural gas production averaged an estimated 6%, and growth in gas plant production of butanes averaged 15%. STEO projects annual growth in marketed natural gas will slow to 1% in 2016, then rise to 2% in 2017. Continued expansion of natural gas processing and fractionation capacity, in addition to the changing composition of recovered natural gas, is expected to lead to 2% growth in butanes production in 2016 and 6% growth in 2017.

**Table 6. Butanes supply and disposition, 2013-17**

million barrels/day

	Annual average					Year-over-year change		
	2013	2014	2015	2016	2017	2015	2016	2017
Gas Plant Production	0.47	0.54	0.62	0.63	0.67	0.07	0.01	0.04
Refinery and Blender Net Production	0.05	0.06	0.05	0.05	0.05	-0.01	0.00	0.00
Net Imports	-0.01	-0.06	-0.08	-0.15	-0.16	-0.03	-0.06	-0.02
Refinery and Blender Net Inputs	0.33	0.36	0.37	0.34	0.34	0.01	-0.03	0.00
Stock Build (Draw)	0.00	0.01	0.01	-0.01	0.00	0.00	-0.02	0.01
Consumption	0.17	0.18	0.20	0.20	0.21	0.02	0.00	0.01

Note: Butanes includes normal butane/butylene and isobutane/isobutylene. EIA uses product supplied as a proxy for consumption.

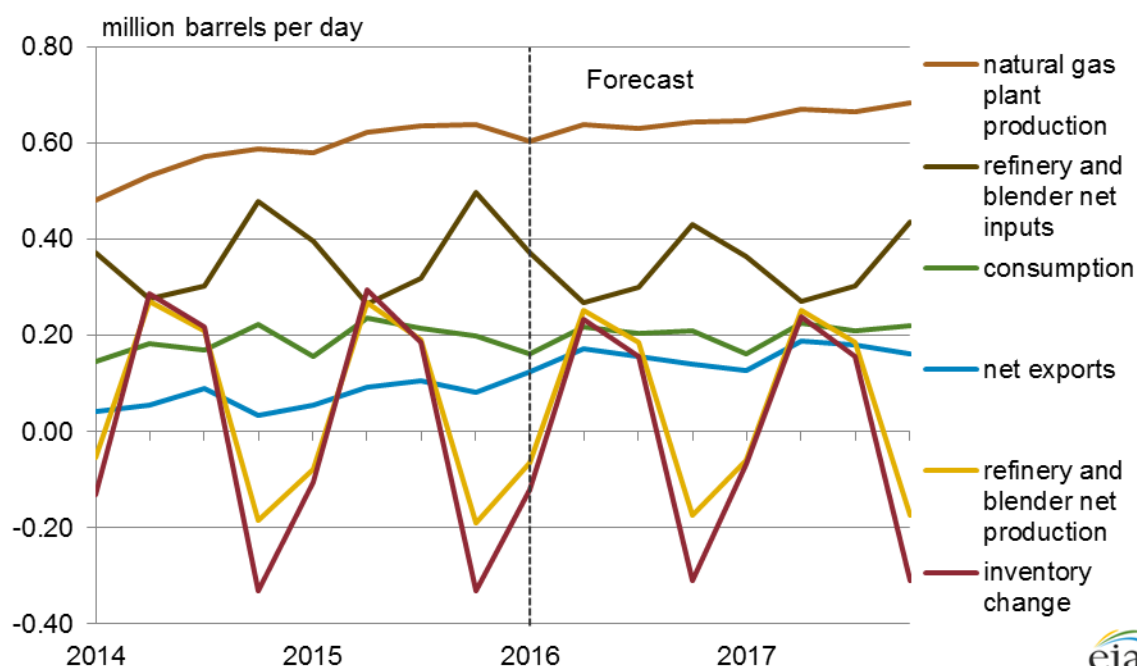
Source: U.S. Energy Information Administration, *Short-Term Energy Outlook, March 2016*

## Refinery and blender net inputs and net production, inventory change, and domestic consumption

Normal butane is predominantly used by refiners and blenders as a gasoline blendstock and isobutane is used to produce alkylate, which boosts octane and reduces vapor pressure in gasoline. Refineries and blenders use both purchased butanes, referred to as *net inputs*, and refinery-produced butanes.

Refinery and blender net inputs of butane are highly seasonal because they are a function of gasoline production and gasoline Reid vapor pressure (RVP) specifications (Figure 9). Because normal butane has a high RVP relative to other blendstock, and gasoline is permitted to have a higher RVP during the winter, net inputs of gas plant-sourced butane peak in the winter (fourth and first quarters). Net inputs of butane are lowest in the spring (second quarter), as blenders produce lower RVP gasoline for the summer. STEO projects annual net inputs in 2016 and 2017 will be 340,000 b/d, which is the same as the five-year (2011-15) average, but 30,000 b/d lower than the 2015 level.

Figure 9. Butanes supply and disposition, quarterly 2014-17



Note: Butanes includes normal butane/butylene and isobutane/isobutylene. EIA uses product supplied as a proxy for consumption.

\*Refining industry net inputs equals refinery and blender net inputs minus refinery and blender net production (see Table 6).

Source: U.S. Energy Information Administration, *Short-Term Energy Outlook*, March 2016

In addition to net butane inputs, which are purchased, refineries produce much of the butane used for gasoline production. In the summer, when less butane is needed for gasoline blending, refineries produce more butane than is needed, and *net refinery and blender* production peaks, and inventories build. During the winter, refinery and blender net production is negative and inventories draw down, because refineries use more butane for producing gasoline than they produce internally. STEO projects

net refinery and blender production will average 50,000 b/d annually in 2016 and 2017, which is the same as the five-year average (2011-15).

Outside of refining, butane is also consumed as a feedstock in petrochemical plants, and a relatively small amount is consumed as lighter fluid. STEO projects butane consumption, which was an estimated 200,000 b/d in 2015, to remain relatively flat in 2016 and 2017.

### **Net exports of butanes**

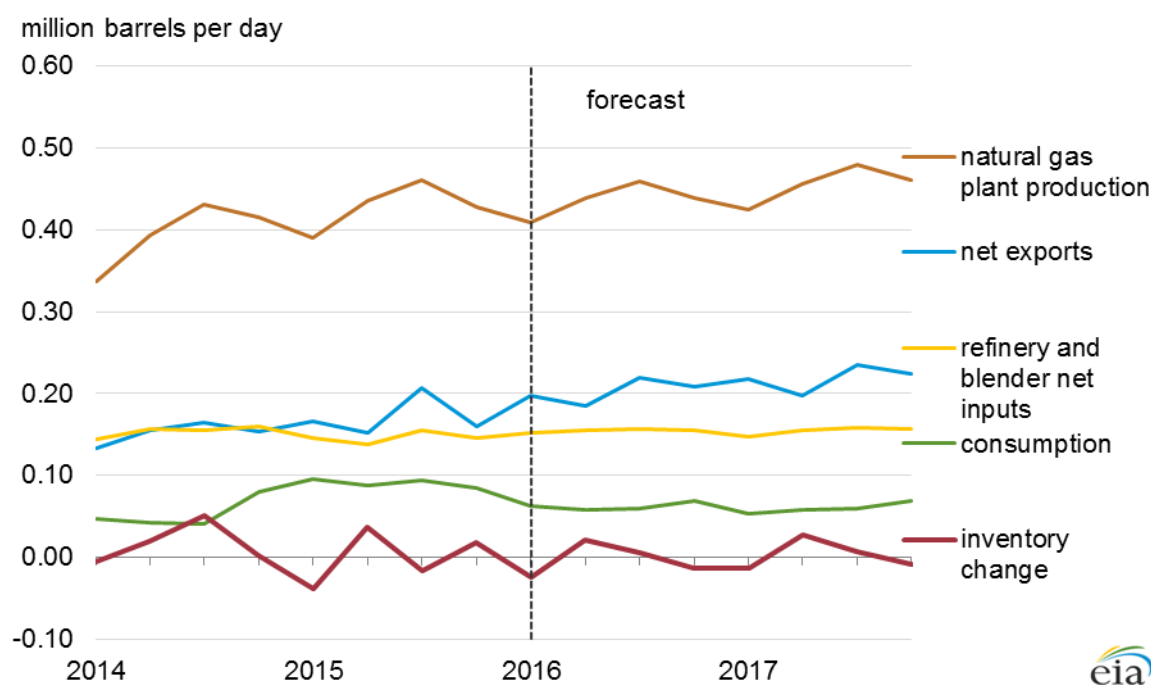
Annual average net exports of butanes increased from 10,000 b/d in 2013 to 80,000 b/d in 2015, as the capacity to export liquefied petroleum gas (propane and butane) increased by almost 1 million b/d. Nearly all of these exports were normal butane. STEO projects butane net exports to increase to 150,000 b/d in 2016 (Table 5) as exports ramp up at two Gulf Coast terminal projects that began operating in the second half of 2015, and as Phillips66 opens its new Freeport terminal in the second half of 2016. Forecast net exports increase to 160,000 b/d in 2017. See Appendix Table A4 for a list of projects.

## Natural gasoline (pentanes plus)

Natural gasoline, also known as pentanes plus, is produced at natural gas plants and mainly used in the United States by refiners and blenders to produce finished motor gasoline or as a [denaturant](#) for fuel ethanol. Natural gasoline is also used by some ethanol producers to make [E85](#). Over 40% of the natural gasoline produced in the United States is exported to Canada, where it is used as a diluent to reduce the viscosity (increase API gravity) of the heavy crude oil produced in Alberta's oil sands.

STEO projects production of natural gasoline to increase by 10,000 b/d in 2016 and by 20,000 b/d in 2017, compared to estimated annual growth of 30,000 b/d in 2015. After high natural gasoline consumption in 2015, forecast consumption declines by 30,000 b/d in 2016, and it remains flat in 2017. Net exports, which increased by 20,000 b/d in 2015, are forecast to grow by 30,000 b/d in 2016 and by 20,000 b/d in 2017.

Figure 10. Natural gasoline supply and disposition, quarterly 2014-17



Note: EIA uses product supplied as a proxy for consumption.

Source: U.S. Energy Information Administration, *Short-Term Energy Outlook*, March 2016

### Natural gas plant production of natural gasoline

STEO forecasts the annual growth of natural gasoline production to slow from an estimated 9% in 2015 to 2% in 2016 and rise to 4% in 2017. The slowdown in natural gasoline production is expected as a result of a lower growth rate for marketed natural gas production from an estimated 5% in 2015 to 1% in 2016 and 2% in 2017.

Table 7. Natural gasoline supply and disposition, 2013-17

million barrels/day

	Annual average					Year-over-year change		
	2013	2014	2015	2016	2017	2015	2016	2017
Gas Plant Production	0.35	0.39	0.43	0.44	0.46	0.03	0.01	0.02
Net Imports	-0.10	-0.15	-0.17	-0.20	-0.22	-0.02	-0.03	-0.02
Refinery and Blender Net Inputs	0.17	0.15	0.15	0.15	0.15	-0.01	0.01	0.00
Ethanol Denaturant	0.02	0.02	0.02	0.02	0.02	0.00	0.00	0.00
Stock Build (Draw)	0.00	0.02	0.00	0.00	0.00	-0.02	0.00	0.01
Consumption	0.06	0.05	0.09	0.06	0.06	0.04	-0.03	0.00

Source: U.S. Energy Information Administration, *Short-Term Energy Outlook*, March 2016

### Domestic consumption and refinery net inputs of natural gasoline

Refineries and blenders used nearly 150,000 b/d of natural gasoline in 2015 for blending into gasoline and 20,000 b/d for blending into ethanol, and they are projected to use roughly the same amounts in both 2016 and 2017. In addition, STEO projects 60,000 b/d of natural gasoline will be consumed for other purposes in 2016 and 2017, mainly marketed as light naphtha and used as ethylene plant feedstock. In 2015, petrochemical consumption was relatively high at an estimated 90,000 b/d, which was 30,000 b/d above the average of the previous five years (2010-14).

### Net exports of natural gasoline

In 2015, 40% of the natural gasoline produced in the United States was exported. Almost all natural gasoline exports went to Canada for use as a diluent for heavy crude oil to make the oil flow more easily in pipelines. In 2014, the capacity to export natural gasoline to Canada expanded when the Cochin Pipeline, which previously carried propane from Canada to the U.S. Midwest, was converted to export natural gasoline and other light petroleum liquids from the United States to Canada. STEO forecasts net exports of natural gasoline, which were 170,000 b/d in 2015, to increase by about 30,000 b/d in 2016 and by 20,000 in 2017.

## Appendix

Table A1. Assumed timeline for additions to ethane feedstock capacity at ethylene cracking plants, quarterly 2013-17

Assumed startup	Company	Location	Project Type	Additional Ethylene nameplate capacity (thousand metric tons/year)	Additional Ethane input (thousand barrels/day)
Pre-2013				28,814	
2013Q1*	Dow Chemical Co.	Hahnville, LA	restart	380	23
2013Q2	Westlake Chemical Corp.	Lake Charles, LA	capacity expansion	109	7
2013Q2	BASF Fina Petrochemicals	Port Arthur, TX	feedstock conversion	0	4
2013Q2	LyondellBasell	Morris, IL	capacity expansion	54	3
2013Q3	INEOS Olefins and Polymers USA	Chocolate Bayou, TX	capacity expansion	115	7
2014Q2	BASF Fina Petrochemicals	Port Arthur, TX	capacity expansion	141	4
2014Q2	Westlake Chemical Corp.	Calvert City, TX	feedstock conversion	0	12
2014Q2	Westlake Chemical Corp.	Calvert City, TX	capacity expansion	82	5
2014Q4	Chevron Phillips Chemical Co.	Sweeny, TX	capacity expansion	91	5
2014Q4	LyondellBasell	LaPorte, TX	capacity expansion	363	22
2015Q2	LyondellBasell	Channelview, TX	capacity expansion	113	14
2015Q2	Williams Olefins	Geismar, LA	capacity expansion	272	16
2015Q4	Huntsman Corp.	Port Neches, TX	capacity expansion	13	1
2015Q4	Flint Hills Corp.	Port Arthur, TX	capacity expansion	100	6
2015Q4	Dow Chemical Co.	Plaquemine, LA	feedstock conversion	200	12
2016Q1	Dow Chemical Co.	Freeport, TX	feedstock conversion	0	12
2016Q2	Westlake Chemical Corp.	Lake Charles, LA	capacity expansion	113	7
2016Q4	LyondellBasell	Corpus Christi, TX	capacity expansion	363	22
2017Q1	LyondellBasell	Channelview, TX	capacity expansion	249	15
2017Q2	Westlake Chemical Corp.	Calvert City, TX	capacity expansion	32	2
2017Q2	Dow Chemical Co.	Freeport, TX	new plant	1,500	90
2017Q2	OxyChem/Mexichem JV	Ingleside, TX	new plant	544	33
2017 Q3	Chevron Phillips Chemical	Baytown, TX	new plant	1,500	90
2017 Q4	ExxonMobil Chemical Co.	Baytown, TX	new plant	1,500	90
2017Q4	Formosa Plastics Corp. USA	Point Comfort, TX	new plant	1,043	63
2017Q4	Indorama Ventures Olefins, LLC	Carlyss, LA	restart	370	19
2013-17	Total	United States	capacity growth	9,248	583

\*Plant restarted at the end of December 2012.

Source: U.S. Energy Information Administration. Ethane throughput capacity is calculated based on announced additions to ethylene nameplate capacity from various company announcements and trade press articles. Total pre-2013 nameplate capacity is based on the Oil and Gas Journal, International Survey of Ethylene from Steam Crackers for January 1, 2013.



Table A2. Assumed timeline for startup of U.S. propane dehydrogenation (PDH) plants with related propane feedstock capacity, quarterly 2010-17

Assumed startup	Company	Location	Propylene nameplate capacity (thousand metric tons/year)	Propane feedstock capacity (thousand barrels per day)
2010	Flint Hills (from PetroLogistics)	Houston, TX	659	30
2015Q4	Dow Chemical	Freeport, TX	750	35
2017Q1	Enterprise Products	Mt. Belvieu, TX	750	35
2013-17	Total	United States	1,500	70

Source: U.S. Energy Information Administration estimates based on various company announcements and trade press articles.

Table A3. Assumed timeline for U.S. ethane export pipelines and terminals with related capacities, quarterly 2013-2017

Assumed startup	Project	Location*	Type	Pipeline/terminal capacity (thousand barrels per day)
2013Q4	Mariner West pipeline to Canada	Marysville, MI	new pipeline	50
2014Q2	Vantage pipeline to Canada	Elkhorn, ND	new pipeline	40
2016Q1	Sunoco Logistics LP terminal	Marcus Hook, PA	new terminal**	35
2016Q2	Vantage pipeline to Canada	Elkhorn, ND	pipeline expansion	28
2016Q3	Enterprise terminal	Morgan's Point, TX	new terminal	240
2013-17	Total	United States	capacity growth	393

\*Locations cited for pipelines are at U.S. exit points.

\*\* Existing terminal that did not previously handle ethane.

Source: U.S. Energy Information Administration estimates based on various company announcements and trade press articles.

Table A4. Assumed timeline for U.S. propane/butane export terminals with related capacities, quarterly 2013-17

Assumed startup	Company	Location	Type	Terminal capacity additions (thousand barrels per day)
pre-2013	Total	United States	existing	196
2013Q1	Enterprise	Channelview, TX	new	115
2013Q3	Targa Resources	Galena Park, TX	expansion	120
2014Q2	Petrogas Energy	Ferndale, WA	conversion	30
2014Q3	Targa Resources	Galena Park, TX	expansion	120
2014Q3	Sunoco Logistics	Marcus Hook, PA	new	40
2014Q4	DCP Midstream	Chesapeake, VA	new (butane only)	8
2015Q1	Sunoco Logistics	Nederland, TX	new	197
2015Q2	Enterprise	Channelview, TX	expansion	49
2015Q3	Occidental	Ingleside, TX	new	66
2015Q4	Enterprise	Channelview, TX	expansion	230
2016Q3	Phillips66	Freeport, TX	new	150
2013-2017	Total	United States	capacity growth	1,125

Source: U.S. EIA estimates based on various company announcements and trade press articles.