IHS Markit™

Prospects to Enhance Pennsylvania's Opportunities in Petrochemical Manufacturing

Executive summary

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TEAM PENNSYLVANIA

Working. Together.

pennsylvania
DEPARTMENT OF COMMUNITY & ECONOMIC DEVELOPMENT

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IHS Markit is exclusively responsible for this report and all of the analysis and content contained herein. This report relies heavily on proprietary data collected on a regular basis by IHS Markit, by IHS Markit's proprietary models and analysis, and by secondary data provided by various US government agencies supported by interviews with industry representatives and other experts. The scope of research was limited to the two primary components of NGL (ethane and propane), and how these two products could be used to enhance manufacturing opportunities in the Commonwealth of Pennsylvania.

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Contents

Frequently used concepts and abbreviaions

Concept	Definition
Aromatics	The general term referring to benzene, toluene, and xylene-based chemicals
bbl	Barrels, a measure of liquid hydrocarbon products; 1 bbl = 42 gallons
Bcf	Billion cubic feet – the typical measurement unit for natrual gas
Btu	British thermal unit - the typical measurement unit for the heat content of fuel
Butanes	A hydrocarbon family consisting of normal-butane (n-butane) and iso-butane (i-butane)
EIA	Energy Information Administration (a division of the US Department of Energy)
FCC	Fluid catalytic cracking is one of the main conversion processes in a refinery
GSP	Gross State Product is a measure of the economic output of a state
HDPE	High-density polyethylene resin
kMT	Thousand metric tons
LDPE	Low-density polyethylene resin
LLDPE	Linear low-density polyethylene resin
LPG	Liquified Petroleum Gas (either propane or butane)
LQ	Location Quotient (LQ) is a measure of a region's industrial specialization relative to a larger geographical unit (usually the nation as a whole)
MMT	Million metric tons
NAICS	North American Industry Classification System is the standard method of classifying businesses by their industrial output
NGL	Natural Gas Liquids, a mixture of ethane, propane, butanes, natural gasoline, and higher order hydocarbons
Olefins	The general term referrring to ethylene, propylene, and C4 hydrocarbons (which include butanes, butylene, and butadiene)
PADD	Petroleum Administration for Defense District; the United States is divided into 5 districts for this purpose
PADD I	East Coast PADD includes Pennsylvania and West Virginia
PADD II	Midwest PADD includes Ohio
PADD III	Gulf Coast PADD includes Texas and Louisiana
PADD IV	Rocky Mountain PADD includes Colorado
PADD V	West Coast PADD includes California
PDH	Propane dehyrogenation; describes a technology that converts propane into propylene
PE	Polyethylene resins, includes LDPE, LLDPE, and HDPE
PP	Polypropylene resin
USGC	US Gulf Coast

Source: IHS Markit

Executive summary

Natural gas: Powering petrochemical and plastics manufacturing in Pennsylvania

"Prospects to Enhance Pennsylvania's Opportunities in Petrochemical Manufacturing" is an independent report by IHS Markit. Team Pennsylvania Foundation (Team PA) commissioned the report to identify and evaluate the opportunities for petrochemical and plastics manufacturing in Pennsylvania based on natural gas resources available in the Marcellus and Utica Shale plays. The Marcellus Shale resource alone represents the second largest natural gas field in the world and underlays two-thirds of Pennsylvania, extending into the neighboring states of New York, Ohio, and West Virginia. In 2015, the natural gas from the Marcellus and Utica Shale plays accounted for a quarter of all natural gas produced in the United States and is expected to account for more than 40% of the nation's natural gas production by 2030. A critical component of the natural gas produced in the region includes the abundant availability of ethane and propane—two important and high-value natural gas liquids (NGL) used in basic petrochemical production and plastics manufacturing.

The analysis conducted by IHS Markit highlights the economic opportunities for Pennsylvania based on predicted growth of both natural gas and NGL production in the Marcellus and Utica Shale plays. The findings of this report conclude that there will be significant potential for driving economic development and job creation across the state thanks to a variety of existing and future competitive advantages. Pennsylvania's advantages for petrochemical processing and plastics manufacturing include cost and freight advantages driven by the availability and abundance of natural gas and NGL, proximity to high-demand North American end use markets, existing and planned infrastructure investments, a skilled workforce and specialized talent pipeline, and a well-established plastics manufacturing industry.

Pennsylvania's NGL resource base

The abundance of natural gas from the Marcellus and Utica Shale plays has resulted in significant economic benefits for Pennsylvania over the past decade, even during periods when natural gas prices are low. A significant factor that continues to drive natural gas development in Pennsylvania is the fact that up to 40% of natural gas produced in the Marcellus and Utica Shale plays is rich in NGL, more than 70% of which is ethane and propane. This has important economic consequences for existing and potential petrochemical manufacturing companies in the region as ethane and propane are important raw materials for petrochemical production.

IHS Markit predicts continued upward production trends for both natural gas and NGL through at least 2030, with the Marcellus and Utica Shale plays acting as a key contributor to ongoing growth. Between 2026 and 2030, NGL production to meet US demand is expected to reach nearly 6.3 million barrels per day (b/d), of which more than 1 million b/d of NGL is expected to be produced in the Marcellus and Utica Shale plays. The high-value of the NGL contained in the natural gas stream—specifically ethane and propane—is responsible for driving ongoing production increases. The substantial increase in NGL production from US tight oil and shale gas plays, including from the Marcellus and Utica Shales, has resulted in a remarkable shift in the US refining and petrochemical industries.

Opportunities for ethane

There is an abundance of ethane available in the Marcellus and Utica Shale plays. Ethane contained in natural gas can either be recovered as a purity product for petrochemical feedstock to produce ethylene (a key petrochemical building block), which is used to manufacture polyethylene (PE)—a plastics resin—or it can simply be left in the natural gas stream. As of the end of 2016, 100% of the ethane produced in Pennsylvania and recovered as a petrochemical feedstock is being shipped out of the state to other end use markets for petrochemical processing. This is largely because of the low cost of ethane produced in the Marcellus and Utica Shale plays compared to ethane produced from the US Gulf Coast (USGC) and other global locations. The IHS Markit forecast shows that between 2026 and 2030, the expected ethane

production from the Marcellus and Utica Shale plays will be enough to support up to four additional world-scale ethane steam crackers in the region, even after meeting the demand from the future Shell Pennsylvania Chemicals ethane steam cracker in Southwestern Pennsylvania. This is also in addition to meeting the demand for ethane from pipelines currently shipping it out of the region and future pipeline projects that will do the same.

Opportunities for propane

As with ethane, propane production is expected to increase in the Marcellus and Utica Shale plays through at least 2030 and is expected to be priced lower than propane from the USGC. While IHS Markit predicts ethane will primarily be used as a petrochemical feedstock with opportunities for additional steam crackers locating in the footprint of the Marcellus and Utica Shale plays, propane has multiple competing end uses that may result in NGL being used for other purposes.

Propane can be used as a heating fuel source or as a petrochemical feedstock to produce propylene—through a process known as propane dehydrogenation (PDH)—or by steam cracking a mixture of ethane and propane. Propylene can be converted into polypropylene (PP), a versatile and high-growth plastic resin. IHS Markit predicts propane will continue to be used primarily in residential, commercial, industrial, and utility sectors as a fuel because of strong demand in both domestic and international markets. In addition to determining the fuel market as the most likely and viable economic opportunity for propane, IHS Markit also reviewed the competitiveness of the two types of propane petrochemical processing as second and third-tier opportunities. Based on its evaluation, IHS Markit identifies a stronger potential for demand for propane as a petrochemical feedstock for PDH rather than for steam cracking. The analysis concludes that this is because petrochemical steam crackers have a less expensive feedstock readily available in abundance, namely ethane.

From NGL to plastics

IHS Markit estimates that 73% of United States and Canada's PE demand and 67% of PP demand falls within a 700-mile region of Southwestern Pennsylvania. These percentages are well above relative capacities to meet the demand within the target region, meaning that producers within this region will enjoy a location advantage over suppliers outside the region. New regional petrochemical producers will be well positioned to compete for a respectable share of this domestic demand because of a shorter supply chain. Additionally, petrochemical producers operating in the region will also be in a strong position to take advantage of export opportunities as well.

The first large scale NGL-based petrochemical investment in Pennsylvania will be the Shell Pennsylvania Chemicals ethane cracker in Southwestern Pennsylvania. It is slated to be a world-scale, ethane-fed steam cracker that will produce 1.5 million metric tons per year of ethylene, which will be converted to more than 1 million metric tons per year of high-density polyethylene (HDPE) and 550,000 metric tons per year of linear low-density polyethylene (LLDPE). HDPE and LLDPE are two of the fastest growing and largest volume plastic resins globally. IHS Markit expects construction to be completed by 2021–22, including the significant feedstock and transportation infrastructure required. The infrastructure needed to meet the demands of the project is expected to exceed what is typically required for a similar facility built in the USGC.

Despite higher capital and developmental costs than the USGC, which has an established and mature petrochemical industry, Southwestern Pennsylvania's PE and PP production is forecast to be highly competitive on a cash cost basis relative to existing production centers. This includes not only the USGC, but also Alberta, Canada; Sarnia, Canada; and the Middle East. The cost advantages over these global existing industry hubs are driven by low-priced ethane and propane (the main feedstocks for production), proximity to major North American demand centers (resulting in reduced freight and transportation costs), and a significant base of plastics manufacturers in Pennsylvania and the Northeastern United States.

With the growth of a regional supply of PE and PP, Pennsylvania's plastics companies may see significant cost savings and advantages over competitors located outside of the region. IHS Markit identified an industry cluster of plastics manufacturers in Pennsylvania that use PE and PP to produce products such as plastic films, containers, housewares, food-grade packaging, and bottles for industrial and consumer markets. The development of PE and PP production in-state will benefit Pennsylvania's plastic manufacturers that use these resins as the foundational building blocks for their respective plastics products.

Economic development opportunities for the future

Pennsylvania currently has a sufficient supply of NGL to support a world-class petrochemical industry. Its major competitive advantage is access to an expanding supply of low-cost natural gas and NGL (particularly ethane and propane) capable of supplying up to four additional world-scale, integrated ethane crackers similar in size to Shell Pennsylvania Chemicals.

In addition, Pennsylvania has a significant locational advantage. Over two-thirds of US and Canadian PE and PP demand is located within 700 miles of Southwestern Pennsylvania, and the state already has a large installed base of plastics manufacturers available to purchase some of the output of Shell Pennsylvania Chemicals. The cost of doing business for manufacturing operations in Southwestern Pennsylvania is comparable to costs across the Marcellus and Utica basins, and these costs are also competitive compared to those in the petrochemical hub along the USGC.

IHS Markit notes that Pennsylvania is currently only using a limited portion of the available Marcellus and Utica Shale natural gas and NGL in-state. As such, it must begin taking immediate steps to support a long-term strategy that will maximize in-state economic development—as other US states and regions are also competing for the resources.

To maximize the potential economic development benefits of increasing NGL production volumes and related investment, including both attracting additional petrochemical companies and expanding the plastics manufacturing sector, IHS Markit recommends that Pennsylvania take aggressive action to address potential developmental and infrastructure constraints proactively. This includes investing in suitable sites to accelerate pad-ready development and supporting NGL pipeline infrastructure and storage capacity. These actions are critical to ensuring that Pennsylvania is positioned to develop long-term, job-creating manufacturing opportunities.

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