Booming Shale Gas Production Drives Texas Petrochemical Surge

By Jesse Thompson

A highly profitable petrochemical industry has reemerged in Texas from the boom in U.S. shale oil-and-gas exploration, creating an internationally competitive sector that can produce a variety of products including plastics at a lower cost.[1]

Advances in the exploration of shale, the source rock from which oil and gas have seeped for millions of years, have brought to market new supplies of oil, natural gas and natural gas liquids (NGLs) such as ethane, a key petrochemical feedstock or input. This modern-day gusher was made possible by hydraulic fracturing (also known as fracking) and horizontal drilling in the United States.

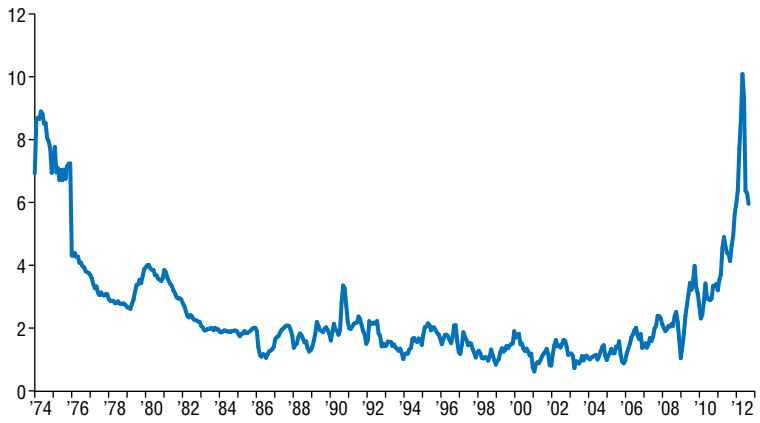
These technologies have helped reduce the price of natural gas, which was once in line with oil, and led to the production of lower-cost NGLs (*Chart 1*). Because U.S. petrochemical firms commonly use NGLs for feedstock, their input costs have fallen and they have gained an export advantage over competitors in other parts of the world that heavily rely on much pricier oil-based naphtha.

At the epicenter of the shale boom is Texas, a significant player in the U.S. petrochemical industry and home to some of the nation's most productive shale areas. The state is reaping economic gains from the petrochemical resurgence that include increases in construction, jobs and exports.

Changing Hydrocarbon Industry

Ethane and propane are key NGLs in ethylene—an intermediate petrochemical used in polyethylene, polyvinyl chloride, some polyesters and other substances. Those substances become components of products such as PVC pipe and an array of plastics and industrial products.

Chart 1 Oil Prices Rise, While Gas Falls on Higher Supplies



* Refiners' acquisition cost of imported crude relative to wellhead price of natural gas.
SOURCES: Energy Information Administration; author's calculations.

Globally, the growth rate for ethylene production slowed in the decade before the recent recession. After averaging 5 percent annually from 1990 to 2000, the rate declined, almost matching global gross domestic product growth of 2.5 percent from 2000 to 2009.[2] Demand for petrochemicals was increasingly concentrated in emerging markets where U.S. manufacturers couldn't overcome a strong dollar and international transportation costs. As a result, U.S. petrochemical firms confronted a steadily eroding outlook that left little justification for investment in new facilities.

The unlocking of hydrocarbons within shale and the resulting decline in natural gas prices—from $6.25 per thousand cubic feet (Mcf) in 2007 to $2.40 in the first half of 2012—changed the petrochemical industry.[3]

Shale fracking and horizontal drilling technologies in the early 2000s yielded discoveries in the Barnett Shale in North Central Texas before spreading to the Eagle Ford in South Texas; the Haynesville in Arkansas, Louisiana and East Texas; and the Marcellus in the Northeastern U.S.

These technologies not only led to the initial natural gas finds, but also proved successful at extracting oil and other liquids.

The Eagle Ford is expected to produce more than 90 million barrels of oil and 51 million oil-equivalent barrels of natural gas in 2012 after yielding less than 10 million barrels of both in 2009. Total annual Texas oil production, which fell steadily for decades and bottomed out in 2007 at 391 million barrels, may reach 712 million barrels this year—an 82 percent increase over five years.[4]

When global commodity prices spiked in 2008, natural gas prices soared to $10.79 per Mcf and oil reached a high of $127.77 per barrel. Both tumbled amid the global

economic recession, with natural gas falling to $3.70 per Mcf and oil sliding to $36.84 per barrel in early 2009. Gas prices rebounded to $5.69 per Mcf by January 2010, only to begin a sustained decline that just recently showed signs of abating. Oil, meanwhile, hovered between $70 and $80 per barrel in 2010 and has stood at around $100 since March 2011.

Fracking expanded the U.S. production of natural gas and NGLs far more rapidly than the market could absorb them or export them, unwinding more than a decade of rising input costs for U.S. petrochemical firms. Natural gas prices this year reached their lowest levels since 1975, adjusted for inflation. Ethane and propane tumbled 40 percent to their lowest prices in at least two decades.[5]

The Eagle Ford, with its significant amounts of oil and NGLs and a network of pipelines and plants, feeds Texas refining and petrochemical facilities.[6] Overall, Texas accounts for 72 percent of U.S. ethylene capacity.

A Boon to U.S. Competitiveness

While the U.S. petrochemical industry primarily uses NGLs (mostly ethane) to make ethylene, other areas of the world (outside the Middle East) heavily rely on naphtha (*Table 1*). Naphtha has followed oil prices higher.

Underscoring the impact of diverging oil and natural gas prices, it cost 60 cents to produce a pound of ethylene with nearly 12 cents worth of ethane in September 2012; alternatively, one pound of ethylene required $1.37 of naphtha. While the NGL-based product was clearly profitable, the oil-based version was not (*Chart 2*).

From May 2011 to September 2012, the difference in the feedstock costs rose fivefold.

Investing in New Capacity

The U.S.—with Texas at the forefront—has become a highly cost-effective place to invest in new petrochemical plants, even if the market for that new production is in emerging economies.[7] Ethylene capacity is poised to increase almost 33 percent by 2017, pending completion of all new plants, expansions, enhancements and restarts of shutdown facilities that have been announced in the U.S. (*Table 2*).[8]

Obtaining permits for these new projects can take more than two years, with individual facilities representing an investment of $350 million to $1.7 billion. The regional economic impact of the construction alone should be significant, with Gulf Coast crews earning from $25 an hour for experienced personnel to $40 an hour for the slightly more than 10 percent of the workforce with specialized skills. Machining and fabrication of pipes, fittings, valves and other specialty components for these facilities could provide more work for U.S. firms. Moreover, these new and revamped facilities

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Table 1 U.S. Favors Natural Gas Liquids in Ethylene Production; Other Nations Use Oil-Based Naphtha

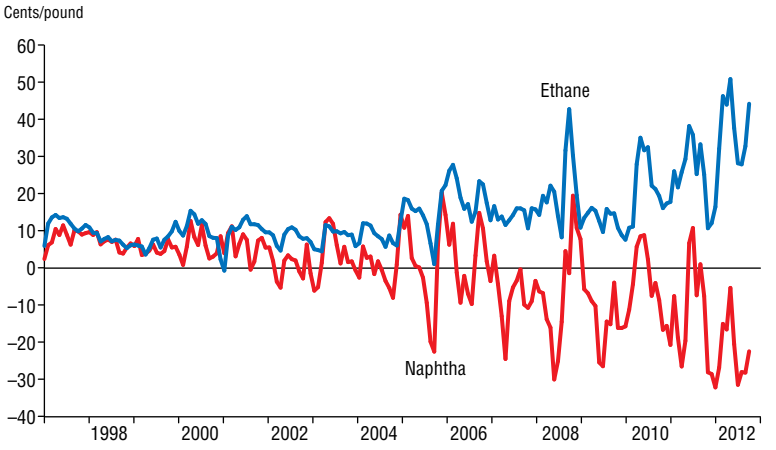
	Nameplate capacity, 2011*	Feedstock mix, 2011 (percent)**		
Area	Million tons/year	NGL	Naphtha	Other
Asia Pacific	29.2	21	76	3
Middle East	24.1	75	21	4
United States	27.6	59	30	11
Western Europe	24.4	20	71	9
Rest of the world	38.9	47	45	8

*Nameplate capacity refers to the theoretical maximum output in a given year under ideal conditions.

**Percent of capacity reporting feedstock usage in each region: Asia Pacific, 82 percent; Middle East, 46 percent; U.S., 99 percent; Western Europe, 89 percent; rest of the world, 56 percent.

SOURCES: 2012 International Survey of Ethylene Steam Crackers; author's calculations.

Chart 2 Profit Margins Grow for Ethylene Made from Ethane



SOURCES: Muse, Stancil and Co.; author's calculations.

Texas is a leading exporter, accounting for 17 percent of all U.S. exports in 2011, including 24 percent of chemicals and 12 percent of plastics and rubber products—categories that include resins for pipes, toys, plastic cups and antifreeze.

Table 2 Shale Gas Spurs Investment in Ethylene Capacity

Company	Project	Capacity	Location	Cost	Start-up
ExxonMobil Chemical	New cracker	1.5m tons	Baytown, TX	n.a.	2016
Chevron Phillips Chemical	New cracker	1.5m tons	Cedar Bayou, TX	n.a.	1Q 2017
Dow Chemical	New cracker	>800,000 tons	U.S. Gulf Coast	n.a.	2016-17
Shell	New cracker	>800,000 tons	U.S. Northeast	n.a.	2016-17
Formosa Plastics	New cracker	800,000 tons	Point Comfort, TX	$1.7bn	2016
Dow Chemical	Restart	390,000 tons	St. Charles Parish, LA	n.a.	End 2012
LyondellBasell	Expansion	386,000 tons	La Porte, TX	n.a.	2014
Williams	Expansion	272,158 tons	Geismar, LA	$350m–$400m	3Q 2012
Westlake Chemical	Expansion	113,399 tons	Lake Charles, LA	n.a.	2014
Westlake Chemical	Expansion	108,863 tons	Lake Charles, LA	n.a.	Midyear 2012
INEOS	Debottleneck	115,000 tons	Chocolate Bayou, TX	n.a.	End 2013

NOTES Crackers are plants that refine ethane into ethylene. The entry "n.a." denotes that the project cost was not available.
SOURCE: ICIS.

will require highly skilled personnel to monitor and maintain plant systems.

To take advantage of export opportunities, ethylene must be sent to other new or expanded chemical facilities that will transform it and other intermediate products into consumer goods and components for further manufacturing. The construction and expansion at this stage is similarly valuable. For example, Chevron Phillips has announced two polyethylene facilities in addition to a new ethylene plant in Southeast Texas, representing an estimated $5 billion total investment.[9]

Building Export Trade

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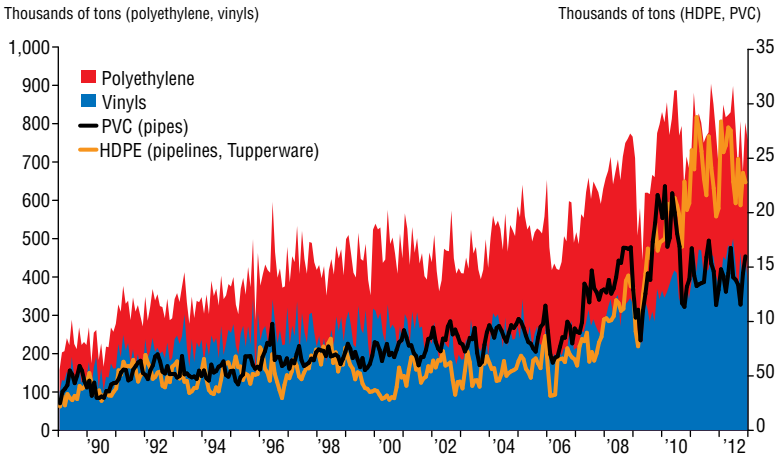
The value and tonnage of Texas petrochemical exports have grown over the last decade on strong global activity. More recently, shipments have soared on cost advantages and foreign markets' relative attractiveness. This is particularly true for two ethylene-based products—polyethylene and vinyls. Polyethylene has been an increasingly important export over the last 20 years, doubling its share to nearly half of all ethylene-related chemicals and resins sent abroad (*Chart 3*).[10] Polyethylene is used for such items as plastic lids and containers, packaging for consumer products, televisions and

Chart 3 Exports of Major Ethylene Products Soar



SOURCES: International Trade Commission; author's calculations.

cell phones. Vinyls make up a similar share of ethylene-related chemical exports and are overwhelmingly tied to construction-related products such as the large pipes used in municipal water operations. As U.S. construction tumbled at the outset of the recent recession, sales abroad of polyvinyl chloride pipe, also known as PVC, increased.

Overall, greater domestic ethylene production capacity will significantly outstrip projected domestic demand growth over the next several years. As a result, U.S. petrochemical exports, particularly from Texas, will expand significantly.

Robust Outlook for U.S. Firms

U.S. producers of ethylene-based petrochemicals have gained a significant cost advantage and greater global competitiveness because of relatively inexpensive and plentiful NGLs from hydraulic fracturing of shale. Projects capitalizing on the shale boom will drive a wave of construction as plants are built and pipeline infrastructure and storage capacity are expanded along the Gulf Coast over the next five years.

The extent of the construction depends on several factors, including regulatory constraints.[11] Whatever the outcome, cheaper raw material inputs are likely to uniquely benefit Texas firms for some time, and petrochemicals will become an increasingly important component of already expanding Texas exports.[12]

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Notes

[1] "Petrochemical" refers to a group of substances that are ultimately derived from oil or natural gas. The term is usually applied to substances such as ethylene, propylene and their byproducts, which are used to make plastics, among other things. "Petroleum product" usually refers to substances with molecular properties such as those of gasoline and diesel.

[2] See "Petrochemicals: Preparing for a Supercycle," Morgan Stanley Blue Paper, Oct. 18, 2010, www.morganstanley.com/views/perspectives/preparingfor_supercycle.pdf.

[3] See "Oil Boom in Eagle Ford Shale Brings New Wealth to South Texas," by Bill Gilmer, Raúl Hernandez and Keith R. Phillips, Federal Reserve Bank of Dallas *Southwest Economy*, Second Quarter 2012.

[4] Projection based on the average monthly increase in Texas production in 2012 through August.

[5] Mont Belvieu and Conway NGL spot prices from Bloomberg.

[6] Data from the 2012 International Survey of Ethylene from Steam Crackers.

[7] Ethylene plants are also referred to as "crackers," a term that describes the process of breaking up—or cracking—feedstock into smaller units such as ethylene.

[8] "ExxonMobil Brings Total U.S. C2 Expansions to over 33 Percent of Capacity," by Joseph Chang, ICIS, June 1, 2012, www.icis.com/Articles/2012/06/01/9566472/exxonmobil-brings-total-us-c2-expansions-to-over-33-of.html.

[9] "Chevron Phillips Chemical Chooses Old Ocean, Texas, Site for New Polyethylene Plants," by Bernardo Fallas, Platts, April 30, 2012, www.platts.com/RSSFeedDetailedNews/RSSFeed/Petrochemicals/6243222.

[10] The data presented were limited to resins and chemicals within the ethylene chain that make up the bulk of export tonnage, and largely excluded end products. Examples of included substances are vinyl chloride (chloroethylene), ethylene dichloride, trichlorethylene, vinyl acetate and polymers, PVC and polymers, HDPE (high-density polyethylene), linear low-density polyethylene, low-density polyethylene, other polymers of ethylene, ethylene copolymers, etc.

[11] Many considerations are not addressed in this article, including the potential environmental impact of these facilities and of hydraulic fracturing, the effects on property taxes and the potential impact of a capacity overbuild.

[12] See "U.S. LNG Exports Truth and Consequence," by Kenneth B. Medlock, James A Baker III Institute for Public Policy, Rice University, Aug. 10, 2012, http://bakerinstitute.org/publications/US%20LNG%20Exports%20-%20Truth%20and%20Consequence%20Final_Aug12-1.pdf.

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