

The Future of Petrochemicals in Europe

Continuous Retreat or Rising Profitability?



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Udo Jung, Jaime Ruiz-Cabrero, and Alex de Mur

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AT A GLANCE

Europe-based petrochemical companies will face a host of challenges in the near to intermediate future, including cost disadvantages relative to many of their international competitors, stagnant local demand, overcapacity, and aging plants. To successfully negotiate these challenges, these companies will have to deploy a range of operational and strategic levers simultaneously.

MAXIMIZING THE VALUE OF EXISTING ASSETS

To maximize the value of their existing assets, Europe-based companies should strive to enhance operational efficiencies; realize synergies—both upstream and downstream—available through improved integration; and optimize commercial strategies with regard to products, channels, and clients.

RESTRUCTURING THE PLANT PORTFOLIO

Europe-based players should also examine their plant portfolios to ensure that they are at appropriate scale, are making the right products, and have the right regional presence. They should consider consolidating and further integrating their European assets into advantaged networks.

EUROPE-BASED PETROCHEMICAL COMPANIES ARE finding themselves in a highly competitive environment that is likely to persist for at least the next several years. This situation is the result of a confluence of factors. In the sourcing of feedstock, Europe-based players are at a significant price disadvantage relative to many of their international competitors: margins for European ethane-fed steam crackers can be as much as \$900 lower than those for U.S. ethane crackers. Demand for petrochemicals, which is expanding at a healthy rate through much of the rest of the world, is essentially flat in Europe. (From 2008 through 2013, demand for polyethylene in Europe grew only 0.6 percent per year while the global average was 4.9 percent. From 2013 through 2022, European demand is expected to grow at about 0.3 percent annually and global growth is forecast at 4 percent.) European players collectively also have surplus production capacity: from 2008 through 2012, capacity utilization for ethylene in Europe hovered around 80 percent compared with a global average of 86 percent. And many European plants are outdated and inefficient.

European companies are thus being hit from both the demand and the supply sides. To negotiate the challenges, many of these businesses will need to make material moves on the strategic and operational fronts. Some players will need to close plants, for example—or, alternatively, engage in M&A to build scale. Others will need to rethink their product mix and customer targeting. Nearly all will need to maintain an unwavering focus on operational excellence.

For Europe-based petrochemical companies, this is obviously a tall order. But the risks of inaction are sizable.

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In a Recovering Industry, Europe Is Lagging

The global petrochemical sector has been under pressure since the start of the financial crisis in 2008. After 2008 and 2009, which were particularly tough, the sector began to recover slowly, albeit with some additional hiccups, such as in the first half of 2012, when the European sovereign-debt crisis increased in severity.

The effects of the ongoing recovery have been uneven by region, however. Most notably, Europe-based companies have experienced far less of a lift than their Asian and Middle Eastern peers and global players. This has extended Europe-based companies' protracted period of underperformance: from 2004 through 2012, Europe-based petrochemical companies had an average annual pretax return on capital employed (ROCE) of only 2 percent, compared with returns of 16 percent, 13 percent, and 17 percent for Asian, Middle Eastern, and global players, respectively. (See Exhibit 1.)

EXHIBIT 1 | Europe-Based Petrochemical Companies Have Underperformed Their Industry Peers



Sources: Orbis Asset Integrity; BCG analysis.

Note: Maximum and minimum data, where included, are based on the average company's performance. For oil and gas companies, we included the performance of their petrochemical units only.

There is much evidence suggesting that Europe-based companies' woes will persist. They face significant challenges on both the supply and the demand fronts.

- Europe is squeezed between feedstock-advantaged regions, including the Middle East and, now, the U.S.
- Europe-based players also face substantial cost challenges that are not feedstock related. Their plants are, in general, subscale and old. Furthermore, Europe's energy costs are well above those of both the U.S. and the Middle East. In 2013, for example, the price of natural gas in Europe was approximately \$10.60 per million British thermal units versus \$3.70 in the U.S. and \$0.75 in some countries in the Middle East.¹
- European demand for petrochemicals remains weak, weighed down by the lingering effects of the euro crisis. In western Europe, annual demand for polyethylene increased by less than 1 percent from 2008 through 2012, compared with 8 percent in Asia and 7 percent in the Middle East.

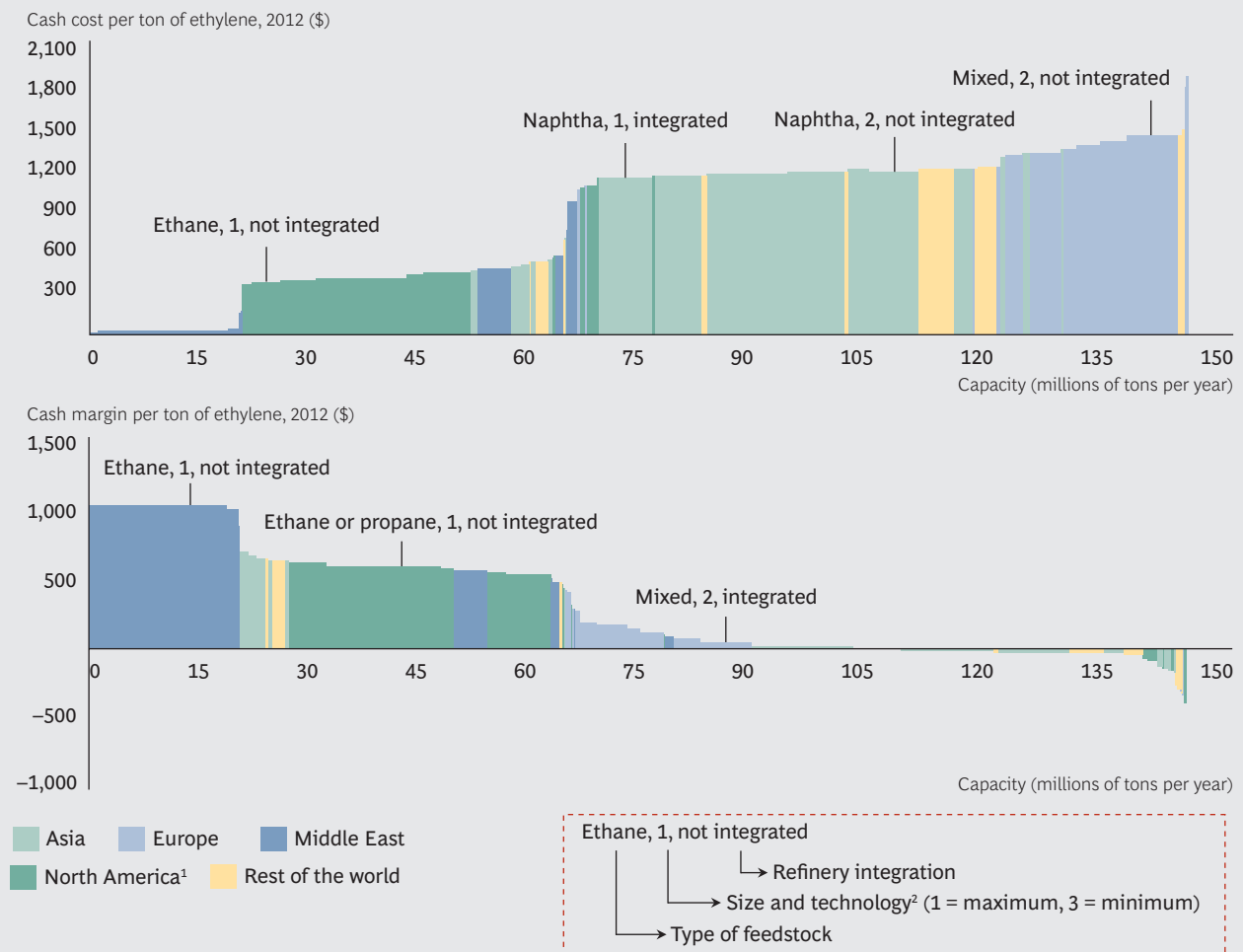
The challenges facing Europe-based players appear unlikely to ease through the medium term. Local demand will remain weak for the foreseeable future: BCG expects that demand for polyethylene, for example, will grow at an annual rate of only 0.6 to 0.9 percent from 2012 through 2022, depending on the scenario. Compounding these difficulties, additional production capacity is being built in the

U.S. Furthermore, other gas-producing countries—such as Russia, Kazakhstan, Azerbaijan, Colombia, and some West African nations—are stepping up their efforts to produce their own chemical industries, taking advantage of their abundant natural-gas supplies.

These forces place Europe’s petrochemical companies in a difficult position within the global supply curve. (See Exhibit 2, which depicts global supply curves for ethylene.) In fact, on the basis of these dynamics, BCG estimates that Europe currently has between 0.7 million and 2.5 million tons of excess ethylene capacity, which is equivalent to 3 to 10 percent of the region’s total ethylene capacity. Whether, and to

EXHIBIT 2 | Europe-Based Companies Are in a Difficult Position Within the Global Supply Curve

Cash cost and cash margin for ethylene, 2012



Sources: Nexant; BCG analysis.

Note: Middle East prices assume netback to Asia. “Mixed” feedstock assumes 80 percent naphtha and 20 percent liquefied petroleum gas. In estimating integration synergies, we assumed reductions of 8 percent of energy costs, 9 percent of other variable costs, and 10 percent of fixed costs. Our calculation of synergies derived from the exchange of streams between sites assumes \$83 per ton of ethylene for naphtha and mixed-feed steam crackers.

¹The U.S. produces 80 percent of North American ethylene.

²Ethylene production size key: 1 = >700 kilotons per year; 2 = >200 kilotons per year; 3 = <200 kilotons per year. We assume that a company’s size and strength of technological capability are related.

what degree, Europe-based companies ultimately reduce capacity remains to be seen, however. In the past, quite a few forecasts that called for significant reductions in European capacity proved excessive. In fact, only 1 million tons of ethylene capacity has been taken off the European market since 2008, which is equivalent to 4 percent of total capacity.

Also, the reality is that even though Europe-based players have the highest ethylene-production costs in the world, Europe's product prices, which are higher than those in Asia, make Asian capacity, not European capacity, the marginal producer for ethylene and polyethylene supply, providing only a limited amount of protection to European plants. This rather counterintuitive situation is caused by the logistical costs of trade between the Middle East and Europe—costs that are higher than those between the Middle East and Asia—and reflects differences in the fluidity of the respective trade routes. Another contributing factor is the relative strength of Europe-based petrochemical companies' innovation capabilities and application technologies.

Within Europe, Distinct Starting Positions for Individual Plants

A close look at Europe's steam-cracker supply curve reveals significant differences among plants. In fact, for ethylene, the difference in production costs of the median first-quartile plant and the median fourth-quartile plant is well above \$300 per ton, a considerable spread.

The variation in the economic competitiveness of the plants is driven by a number of structural factors:

- *Scale.* Greater size can translate into significantly lower fixed costs. BCG research revealed that there is a 40 percent scale curve—that is, a 40 percent reduction in fixed costs for each doubling of capacity—for steam crackers.
- *Integration.* Integration—upstream (with a refinery) or downstream (with polyolefin or other petrochemical plants)—represents one of the most important levers for creating value and one that companies in Europe are now pursuing relentlessly. We believe that the total potential value of integration ranges from \$50 to \$150 per ton of ethylene, depending on the configuration of the refinery or petrochemical complex. Most of the value derived from integration comes from stream exchanges and the resulting increases in flexibility. However, there is also the potential for lower fixed and variable costs.
- *Feedstock Access and Cost.* Clearly, this is the single largest driver of European plants' lack of competitiveness compared with plants in other regions, especially those that enjoy access to cheap ethane. (Within Europe, only two plants—the Shell Chemicals-ExxonMobil Chemical Mossmorrان plant in the U.K. and the Ineos plant in Rafnes, Norway—utilize ethane feedstock.) Access to multiple types of feedstock, including liquefied petroleum gas and nontraditional intermediate streams, can also translate into significant advantage: companies capable of alternating feedstock types on the basis of economic signals can reap

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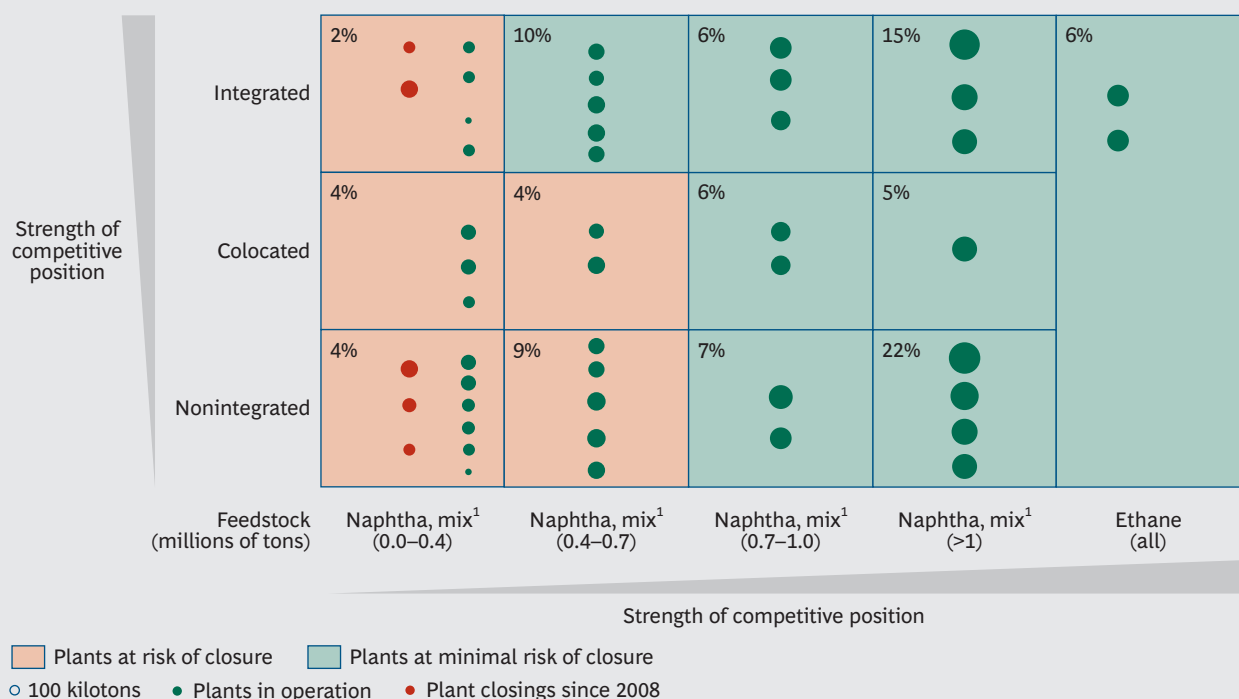
margin advantages ranging from \$30 to \$150 per ton for polyethylene.² Best-practice companies set specific annual targets for increasing their feedstock flexibility and their use of nontraditional feedstock.

- *Plant Age and Technology.* Newer, more advanced plants are generally more efficient in their energy use and provide better yields. We estimate that this advantage can represent up to \$100 per ton.
- *Location.* Given the potentially large differences (from \$10 to \$30 per ton) in logistics costs (for example the costs of integration into pipeline networks), location can have a sizable impact on a plant's cash position. Depending on location, energy and personnel costs can also differ materially across Europe. This was painfully demonstrated by the recent difficulties encountered by one of Europe's largest, most integrated plants, which faced significant profitability challenges that were driven by its high employee-related cost base.

In many cases, subscale, nonintegrated plants possess the least favorable economic profile and are at greatest risk of closure. In fact, all of the 1 million tons of European steam-cracker capacity taken offline since 2008 fall into this category. (See Exhibit 3.)

EXHIBIT 3 | Subscale, Nonintegrated Sites Are the Most Likely to Close

Share of total EU-27 production capacity of 26 million tons, 2012



Sources: Nexant; BCG analysis.

Note: In addition to scale and integration, other factors, including a plant's technology and efficiency, can influence its viability. The size estimates focus on ethylene production specifically.

¹"Naphtha, mix" includes plants that use naphtha or naphtha and mixed liquids as feedstock.

Denser plant networks allow petrochemical players to better balance specific-grade production across plants.

In addition to focusing on the five structural factors described above, best-practice companies worldwide actively strive to achieve operational excellence in an effort to significantly improve the economics of their plants. In the course of our extensive work with petrochemical companies, BCG has found that an industrial complex can increase its variable margin by more than \$100 per ton by tightening operations (including focus on yield improvement, maintenance, energy management, inventory management, procurement, plant optimization, and shared-services costs) and delivering commercial excellence programs (including price realization, product portfolio, channel mix, client, and regional strategies).

On top of the competitive advantages that can be gained through optimization at the individual- or integrated-plant level, competitive advantage can also be achieved at the corporate level. Possession of global scale and a global footprint can be a highly potent lever, as it permits companies with a larger client and revenue base to fund R&D efforts more easily and to participate in additional specialty and differentiated markets downstream. Furthermore, denser plant networks allow petrochemical players to better balance specific-grade production across plants. This provides companies the capacity to specialize certain plants, reducing operational complexity and bringing related operational advantages. It is important to note that global companies that have significant exposure to Europe have been able to generate very strong returns—returns that exceed those for plants in any single region—by leveraging their international footprint and global portfolio.

How Sustainable Is the Cost Advantage Driven by U.S. Shale Gas?

Much has been written about the U.S. shale-gas revolution and its impact on petrochemicals and other industrial sectors. The revolution has indeed completely transformed petrochemical dynamics in the U.S. (and ultimately worldwide), making the country one of the lowest-cost ethylene producers in the world.

U.S. shale-gas development and its peripheral effects—including the related surge in ethane production—have had, and will continue to have, a direct impact on C2 (ethylene), C3 (propylene), and C4 (including butadiene and butene) olefin value chains as well as on aromatics. Most notably, the sector's resulting shift to cheaper ethane feedstock is increasing the production of C2 and its derivatives while limiting the production of C3 and C4. Shale gas developments will also increase the production of aromatics through the build-up of new condensate splitters.³

Our purpose here is not to analyze the broader implications of the U.S. shale-gas revolution for the petrochemical industry—to gauge its impact on, for example, the various value chains or the relative attractiveness of different investment alternatives, such as propane dehydrogenation or on-purpose butadiene. Rather, our focus is on the pricing mechanism for U.S. natural-gas liquids (NGLs), including ethane, butane, and propane, and what it means for the competitiveness of European polyolefins.

In the U.S., the significant growth in NGL production associated with both shale gas and shale oil development has led to a surplus of such products and an increasing

decoupling of NGL prices from prices for crude oil and its derivatives. Exhibit 4 shows the price decoupling of different NGLs versus naphtha (a heavy feedstock from oil refining)—a very relevant comparison, as these are all potential feedstocks for steam crackers.

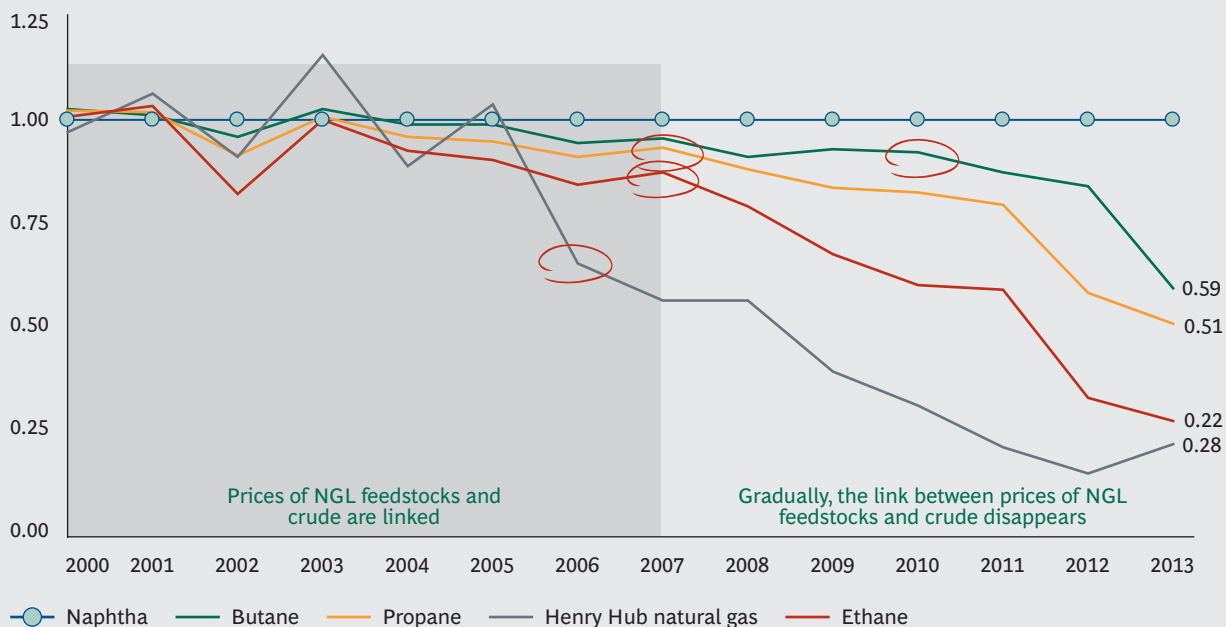
We can readily observe the gradual decoupling of NGLs, starting with natural gas as early as 2006, followed by ethane and propane in 2008 and, more recently, butane. At the beginning of this century, ethane and naphtha were priced almost at parity, but by 2012, ethane's price was only 33 percent of the price of naphtha (on a weight basis).

The rise in U.S. ethane production—annual production climbed from 250 million barrels in 2008 to 350 million barrels in 2012—has been too large to be absorbed by the country's existing steam-cracker capacity. Production thus exceeds demand from the U.S. petrochemical industry. As a result, ethane, which was priced as an alternative to a feedstock product such as naphtha prior to the shale oil revolution, is today priced for its alternative usage. That is, it is now priced as an alternative or supplement to natural gas. In fact, significant amounts of ethane are “rejected” into the natural-gas pool, because ethane's processing economics remain negative.

The surplus of NGLs—and the cost advantage that surplus provides the U.S. in the global supply curve—is, thus, the key driver behind the U.S. petrochemical-industry renaissance. The question is: How long will this last? To answer the question, we

EXHIBIT 4 | U.S. Petrochemical-Feedstock Prices Have Lost Their Link to Crude Oil

U.S. feedstock prices as a percentage of naphtha's price



Source: BCG analysis.

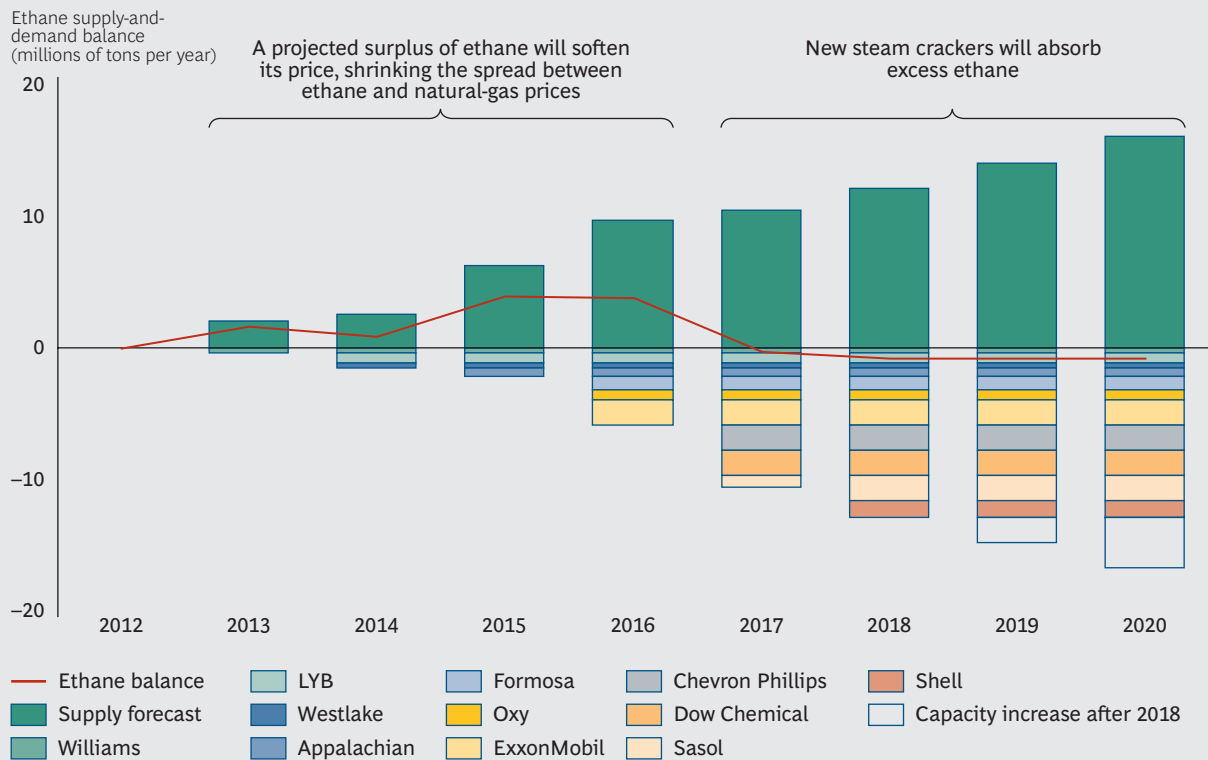
Note: NGLs = natural-gas liquids.

first need to answer another: When (if ever) will all U.S. ethane production again be absorbed by U.S. steam crackers?⁴

Exhibit 5 gives a clear view of the situation. According to our research, growth in U.S. ethane production, which, by 2020, we believe will reach roughly 15.5 million tons per year, will be compensated for by an increase in domestic demand from newly built petrochemical plants and expansion of existing plants by 2017. At that point, ethane will no longer be in surplus, and the pricing mechanism will have changed. In our view, the new price-setting mechanism for ethane will be the polyethylene netback from China and the required ethane price. Our analysis shows that this price will likely be around 60 percent of the U.S. naphtha price, compared with 33 percent in 2012. Ethane will, therefore, remain a price-advantaged feedstock.

Similar analysis can be done for propane and butane, for which price adjustment will come as export parity prices are reached following the development of the requisite export infrastructure. We believe that this will take place in 2014 or 2015. Propane's price will rise to approximately 70 to 75 percent of naphtha's price (versus 55 percent in 2012), and the price of butane will rise to about 90 percent (versus 84 percent in 2012).

EXHIBIT 5 | By 2017, New Plants in the U.S. Will Absorb Surplus Ethane



Sources: Deutsche Bank; BCG analysis.

Note: LYB = LyondellBasell Industries; Westlake = Westlake Chemical; Appalachian = Appalachian Resins; Formosa = Formosa Petrochemical; Oxy = Occidental Petroleum; Chevron Phillips = Chevron Phillips Chemical.

It is possible that after 2017, the market will experience alternating periods of ethane surplus and deficit. When the ethane supply again becomes inadequate and its price increases, exploration and production companies will have significant incentive to increase drilling in ethane-rich regions. Establishing new processing and fractionation facilities takes some time—although not nearly as long as building a new steam cracker. Hence, we might see rapid ethane-supply responses that would put the market back in an oversupply situation in as little as 18 months, given the right economic incentives.

In every scenario, despite the incremental production from NGLs, naphtha will remain the main and marginal petrochemical feedstock and hence the olefins price setter. We estimate that, by 2020, slightly less than 70 percent of global ethylene capacity will still be naphtha based.

Implications for European Olefin Production and Capacity

What will all of this mean for Europe-based petrochemical players? We have defined two possible scenarios.

Base Scenario. In our base scenario, U.S. ethane prices resume their link to U.S. naphtha prices from 2017 onward, diminishing the price advantage of U.S. imports into Europe. The U.S. price advantage remains significant, however, as ethane is priced at around 60 percent of naphtha's price. This scenario is consistent with our views expressed in the section above.

Alternative Scenario. In our alternative scenario, U.S. growth of ethane production outpaces new petrochemical developments in the U.S., and, thus, ethane prices remain linked to U.S. prices for natural gas.⁵ In parallel, there are short ethane-deficit cycles that are quickly “corrected” by exploration and production companies through drilling campaigns in ethane-rich regions, as discussed above. In any case, U.S. plants retain a significant cost advantage over their European counterparts, though the difference is much larger in the alternative scenario (\$600 per ton) than in the base scenario (\$380 per ton).

In both scenarios, U.S. and Middle Eastern companies would increase their exports to Europe. Coupled with expected lackluster growth in European demand—we anticipate aggregate demand growth, from 2012 through 2022, of 1.1 million tons and 0.8 million tons for polyethylene in our base and alternative scenarios, respectively—this will place growing pressure on margins for European steam crackers and will likely force additional plant closures. As noted above, we estimate that European steam-cracker capacity at risk of closure ranges from 0.7 million tons (in the base scenario) to 2.5 million tons (in the alternative scenario). The U.S. ethane-pricing mechanism will play a key role, because it will significantly change the economics of the country's ethylene production and therefore significantly influence the volume of U.S. exports to Europe.

The challenge that imports from other countries pose for European players could intensify greatly depending on Asia's degree of self-sustainability: that is, the extent to which Asian producers meet Asian demand. In the alternative case of China's in-

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creased self-sustainability, Middle Eastern producers would increase their exports to Europe in an effort to compensate for the market lost in China.

Weathering the Storm and Moving Toward a Profitable Future

The environment for Europe-based petrochemical companies will remain challenging for the next several years. Indeed, it may become more challenging, as competitive pressure from the U.S. and the Middle East will not only persist but could also rise, set against a backdrop of ongoing moderate growth in local demand.

However, as they have done in the past, well-run companies operating in Europe will still be able to differentiate themselves and improve their financial returns. Consider, for instance, the period from 2004 through 2012, when the average pretax ROCE for petrochemical companies focused solely on Europe was a meager 2 percent. If we de-average the numbers, we find significant differences by company: the top performer had an annual pretax ROCE of 8 percent, while the bottom player's was –6 percent. Furthermore, as we have noted, global companies that have a very relevant asset base in Europe have also been able to reap significant returns, reaching a median pretax ROCE of 17 percent for that period. In short: good performance has been, and will continue to be, rewarded by higher returns.

There are a number of levers that Europe-based companies can deploy to increase their chances of success in this environment. We group these into two main buckets: maximizing the value of existing assets and restructuring the plant portfolio.

Maximizing the Value of Existing Assets. To maximize the value of their existing assets, companies can undertake, or continue to support, a number of key actions:

- *Operational Excellence.* Some companies are launching comprehensive operational-excellence programs, including efforts directed at cost reduction (focused on fixed costs such as maintenance, energy management, and procurement), inventory reduction, and margin enhancement (by, for example, increasing feedstock flexibility and optimizing unit performance and yields). In our experience, petrochemical companies can realize value ranging from \$60 to \$150 per ton through the combination of such efforts, depending on the company's starting position and its specific configuration of assets.
- *Integration.* Integration—both upstream and downstream—offers considerable opportunity for enhanced operational efficiencies and higher returns on existing assets through increased stream integration and flexibility, coupled with organizational and cultural improvements. Working with our clients, we have observed in several instances that, beyond the obvious streams (for example, C3s from a fluid catalytic-cracking plant), refining and petrochemicals do not necessarily maximize the value of intermediate streams exchanged. This is especially true of intermediate streams whose disposition value changes over time, depending on external economic signals (for example, the value of a raffinate stream from a continuous catalytic-reforming plant that is exported or routed to the gasoline pool or steam-cracker feedstock). Coordination mechanisms and simple and

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shared analytical tools can help recoup this value for the integrated site. We estimate that companies can achieve savings of \$20 to \$40 per ton by strategically leveraging these less obvious integration opportunities.⁶

- *Commercial Excellence.* Many petrochemical companies will find that by rethinking their price realization, product portfolio, channel mix, client, and regional strategies, they have substantial opportunity to improve returns on existing assets. In our experience, the typical value at stake can change significantly, depending on the starting position.

Restructuring the Plant Portfolio. Measures to restructure the plant portfolio to ensure that it is optimized in terms of products, scale, and regional exposure include the following:

- *Plant Closures.* Less efficient plants can be closed in order to maximize the value of the company's best plants. Closing a plant is not always simple, however, given the associated costs—both financial and political.
- *Expansion of European Production Networks.* To grow their market footprint and maximize the value of their overall plant portfolio (for example, by rebalancing production and market concentration), companies can increase their overall network scale through joint ventures or M&A. An enlarged network provides more freedom to deploy the operational levers described above. (A larger network affords greater scope for individual sites to take on different roles, for example.)
- *Participation in Cross-Regional Networks.* To mitigate the growing challenges that European asset networks are likely to face in the future, Europe-based companies can integrate those asset networks into cross-regional asset networks through alliances, joint ventures, and M&A.
- *Changes to the Product Portfolio.* To increase their share of (higher-margin) specialty products, some companies are leveraging their innovation capabilities and retooling some of their downstream plants. Note that a shift to higher-end products requires not just plant-specific changes but also strong R&D capabilities, sufficient budget, and a sales force capable of selling specialty products and engaging with clients over the long term.

For most Europe-based players, the required consolidation of their European steam-cracker and petrochemical capacities will entail joining forces (through joint ventures, for example) with other companies. The resulting enlarged-site networks will expand the number of options companies have both for allocating advantaged products to advantaged sites and for closing plants.

We conclude our analysis of the European petrochemical landscape with a key question that remains open and whose answer could have very different effects on companies based in Europe and the Middle East: Will Europe's ethylene price remain higher than prices in other regions? The difference between the prices for European and Asian polyethylene, for example, stood at approximately \$300 per ton

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in 2012, a gap largely explained by the difference in transport costs (\$230 per ton) and import duties (\$84 per ton). If price differentials stay the same, some European companies—those that have Middle Eastern, or even U.S., petrochemical assets that are capable of improving their supply chains to reduce export costs—could gain a significant advantage by exploiting Europe’s prices, which are higher than prices in Asia. A general erosion of the price difference, however, would put further pressure on Europe-based petrochemical companies.

EUROPE-BASED PETROCHEMICAL COMPANIES are in a highly challenging situation. But most have considerable scope to withstand the challenges, strengthen their financial performance, and create defensible positions. It will take the willingness and ability to be flexible, make bold moves, and think long term. Inaction is not an option.

NOTES

1. The source for the European gas price is the National Balancing Point.
2. Among European plants, there is a wide range of capabilities regarding feedstock flexibility. In best-practice and advanced sites, liquefied petroleum gas can account for as much as 50 percent of utilized feedstock, while in some other plants, it accounts for no more than 10 percent.
3. For more details, see “Natural-Gas Liquids: The Implications of the Next Energy Tsunami,” BCG article, October 2012.
4. One might argue that exporting ethane could help reduce the gap. However, we believe that exporting ethane will not take place on a large scale since, given the characteristics of the ethane value chain, it is much more feasible for companies to process ethane and export ethylene, especially polyethylene. In addition, exporting ethane would involve, among other things, building ad hoc infrastructure (for example, pressurized and refrigerated tanks), whereas polyethylene has much lower logistical needs, most of them indistinguishable from those for other types of wares.
5. Prices for natural gas itself will also remain decoupled from oil prices.
6. This assumes that basic intermediate streams among sites are already exchanged (for example, C3s from a fluid catalytic-cracking plant to a polypropylene plant or hydrogen gas from a steam cracker to a refinery). Otherwise, the value of integration would be much higher (up to \$150 per ton).

About the Authors

Udo Jung is a senior partner and managing director in the Frankfurt office of The Boston Consulting Group. He is the global leader of the petrochemical sector of BCG's Energy practice. You may contact him by e-mail at jung.udo@bcg.com.

Jaime Ruiz-Cabrero is a partner and managing director in the firm's European regional office. You may contact him by e-mail at ruiz-cabrero.jaime@bcg.com.

Alex de Mur is a project leader in BCG's Madrid office. You may contact him by e-mail at demur.alex@bcg.com.

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