Petrochemicals 2030: Reinventing the way to win in a changing industry

Location has been the key to success in petrochemicals: playing in emerging markets and accessing cheap feedstock. As the industry shifts, companies will have to work harder on core capabilities and strategy.

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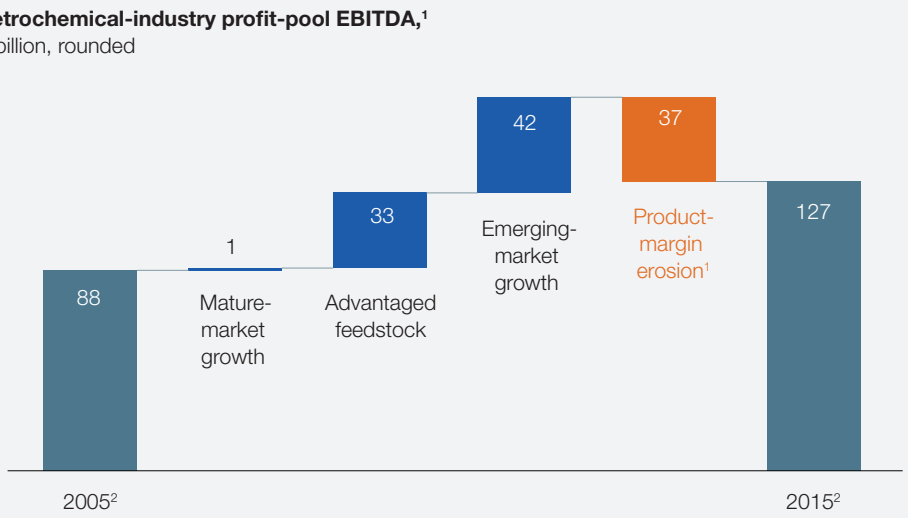
Below the surface of the record profits petrochemical companies have been reporting over the past few years, the industry is in a period of profound transition. Until the fall in oil prices, success in the industry had been based on stark regional asymmetries. Companies in fast-growing emerging markets such as China have thrived. So have companies in regions—in particular the Middle East and North America—with advantaged gas feedstock that they have made into petrochemicals and plastics and then exported to China and other growth markets. To put it bluntly, for the geography-blessed petrochemical players, it has been hard to go wrong.

Looking ahead to 2030, slower demand growth in emerging economies and less abundant advantaged feedstocks are likely to undermine these value-creation strategies. Companies will likely have to take a more disciplined approach to capacity additions, returns may be more modest, and all petrochemical players will need to work much harder on core capabilities and strategy. This will include using digital and advanced analytics to reach a new level of productivity, and attaining higher capital productivity on the industry's large-scale projects. Companies must also work on reinventing the interface with oil refining as the gas-driven era winds down. At the same time, they will need to manage the transition from an essentially linear economy, where plastics-based products get used once before disposal, to a circular economy.

Exhibit 1 **Windfalls in advantaged feedstock and emerging-market growth have been eroded by product commoditization in selected chains.**



[1] Earnings before interest, taxes, depreciation, and amortization.
[2] Based on 3-year trailing average.
[3] Netted for $4+ billion margin improvement in Western Europe.
Source: ICIS; IHS; McKinsey Chemical Insights; McKinsey analysis

A look back at what's been creating value for the industry

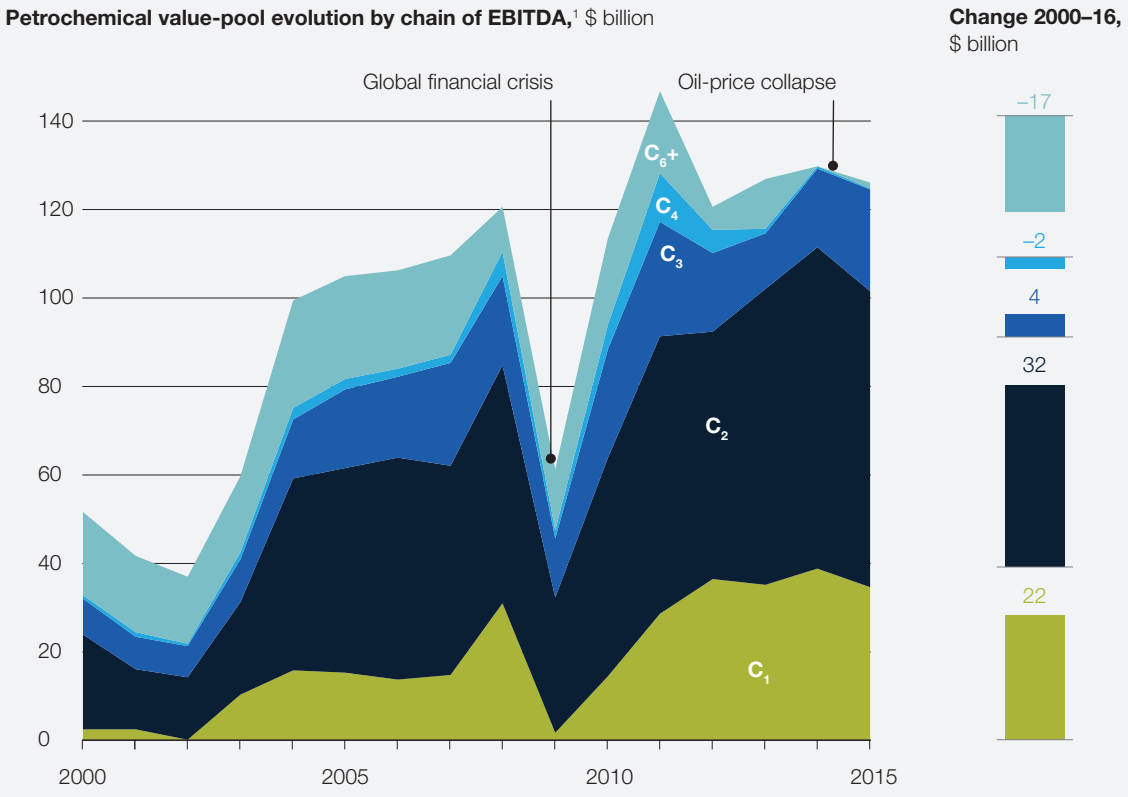
The global petrochemical industry has experienced more than 15 years of strong volume growth: annual ethylene production has risen from around 100 million metric tons in 2000 to almost 150 million metric tons in 2016. In conjunction with this volume growth, value creation has also risen at a 4 percent compound annual growth rate since 2005. Petrochemical company stocks have performed strongly compared with other chemical sectors and the overall market over the period.

In the past three years, petrochemical companies worldwide have been showing buoyant margins, as healthy demand growth, particularly from Asia, has led to high operating rates, especially in the ethylene and C_2 derivatives chain and propylene and C_3 derivatives chain. This has enabled companies to hold on to the higher margins stemming from lower oil prices, instead of the industry's more typical practice of passing falls in feedstock costs through to customers.

To better understand the industry's possible development path, we can look back over the past decade and a half at the more complex dynamics at play. There have been two main drivers of value creation (Exhibit 1).

The petrochemical industry has ridden high on emerging-market demand growth since the start of the century, just like producers of metals and other commodities. On top of this, many petrochemical companies have benefited from manufacturing using low-cost gas feedstocks instead of oil-based feedstocks, putting them in a highly cost-advantaged position. This has particularly been the case for

Exhibit 2 **The producers with access to advantaged gas have captured the majority of value created in the industry from 2000 to 2015.**



[1] Earnings before taxes, interest, depreciation, and amortization.

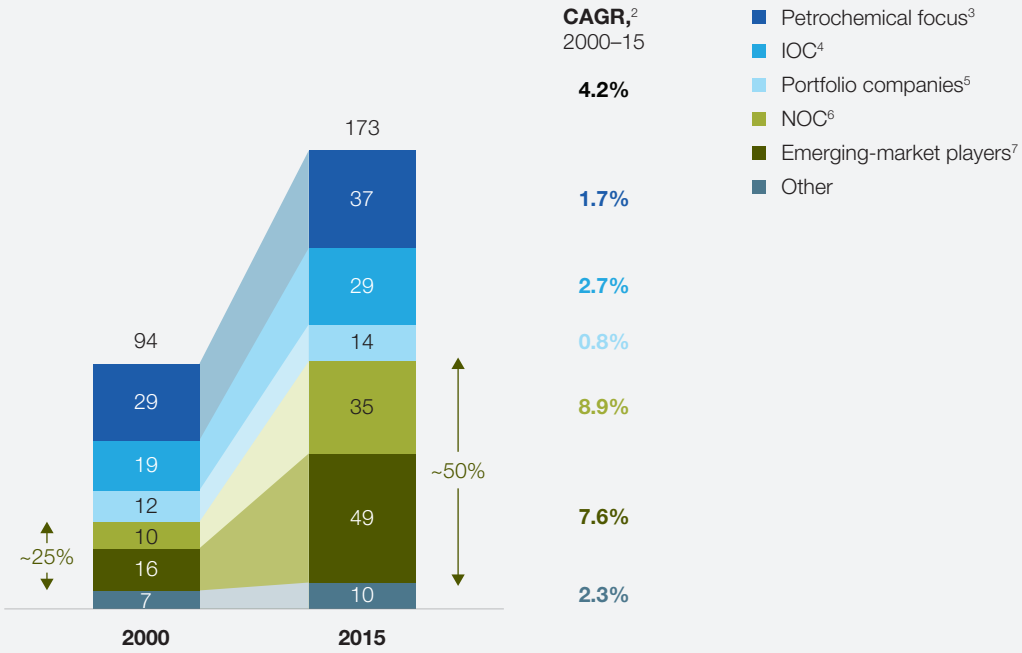
Source: ICIS; IHS; McKinsey Chemical Insights; McKinsey analysis

producers based in the Middle East and, more recently, in North America, based on new shale-gas supply. This advantage was most pronounced during the period of high crude oil prices that ended in 2014, and has predominantly benefitted the C_1 derivatives chain and C_2 chain, and to a lesser extent the C_3 chain.

Over the same period, however, the industry suffered margin erosion across many of its products, cancelling out roughly half the value created. This margin erosion mainly affected the C_4 and aromatics chains, and was primarily a result of overbuilding by newer industry participants in emerging markets.

We also need to recognize just how small a part of the industry is represented by the companies that have captured such a large share of the value up to 2014: it has mainly been producers with access to low-cost gas, which account for around 20 percent of the industry's output, but were responsible for well over 80 percent of the industry's total value pool in the early part of this decade (Exhibit 2).

Exhibit 3 **National oil companies and emerging-market players have grown much faster than market and doubled their market share.**



[1] Polyethylene and polypropylene production capacity, millions of metric tons per year.
[2] Compound annual growth rate.
[3] Business portfolio focused on petrochemicals.
[4] Petrochemical activities within oil and gas companies.
[5] Petrochemical activities within broad portfolio chemical companies.
[6] Petrochemical business of national oil companies.
[7] Petrochemical businesses of emerging-market players, other than national oil companies.

Source: ICIS; McKinsey Chemical Insights; McKinsey analysis

For petrochemical producers that are not part of the advantaged gas-based cohort, the years up to the fall in oil prices had been challenging. This group includes players in Europe, Japan, Latin America, South Korea, and Taiwan. While they are enjoying the rebound now, their earlier difficulties have been highlighted by significant capacity closures in Japan and Western Europe in the early 2010s.

At the same time, a structural shift in the industry has taken place: further consolidation in mature markets and a rapid rise of emerging-market players. Four main families of producers make up the global petrochemical industry: national oil companies (NOCs) and other emerging-market players; international oil companies; pure-play petrochemical producers; and diversified chemical companies with large petrochemical-production assets. NOCs and other producers in emerging markets have been the biggest investors in new capacity as they have been aiming to meet demand growth in their home markets, and have grown at about four times the rate

of Western players (Exhibit 3). A number of these companies, such as PetroChina, Reliance, SABIC, Sinopec, and Wanhua are now among the leading companies by capacity in some petrochemical-industry segments—or will become so in the near future.

In a nutshell, most of the history of the petrochemical industry in the new millennium has been one of regional asymmetry—where the key to success has simply come down to being in the right place. Emerging-market-based companies have risen as leaders in the industry, and companies in locations with access to cheap gas have earned the majority of profits.

The old models for value creation are losing traction

New trends are emerging in the industry that are changing the rules for success.

The advantaged-feedstock-opportunity window is closing

Production based on advantaged feedstocks has been a cornerstone of value creation in the industry, but the potential for investments based on such feedstocks is likely to become much more constrained after 2020.

The Middle East and North America have been the two main sources of advantaged feedstocks in the industry's recent history, but in both locations, medium- and long-term opportunities are becoming limited. In the Middle East, new petrochemical investments are increasingly based on liquid feedstocks such as naphtha and gasoil, or mixed gas/liquid feedstock, instead of exclusively on gas. In North America, the feedstock advantage is expected to start to erode in the next decade as new ethylene cracking capacity and export opportunities increase demand for ethane and propane, which could drive prices up.

Clearly, there are new possible sources of advantaged-price gas supply in the world, for example in Iraq and Kazakhstan, and there is also the prospect that shale-gas production could take off in countries such as Argentina. However, the size of these opportunities, their degree of cost advantage, and their access to downstream markets may be more modest than what has been provided by the Middle East and North America in recent years.

Petrochemical growth will slow down as economies mature

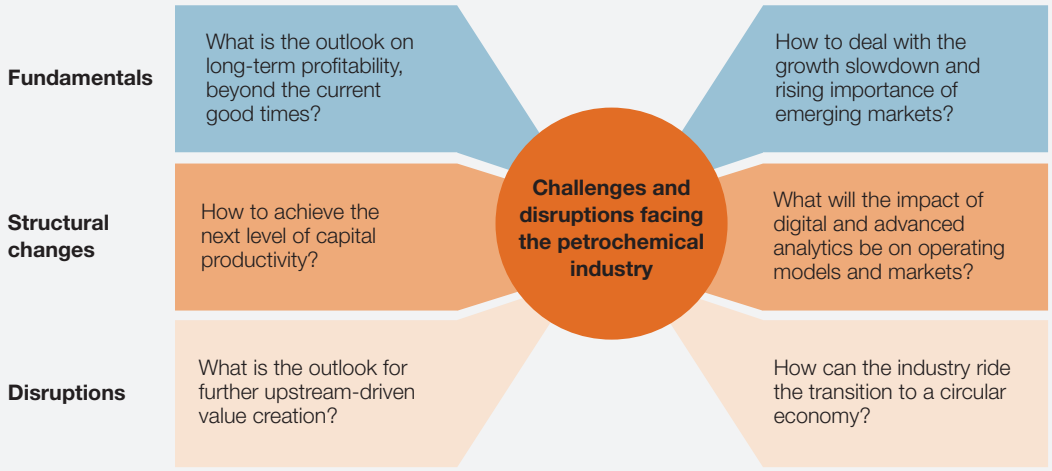
The GDP growth rate of the important Chinese market has slowed and may slow further.[1] In parallel, per capita chemical consumption in China appears to be at the point where it may start to grow more slowly than the country's GDP growth rate. This development is associated with macroeconomic trends in China, which is moving from the investment stage of development with spending on infrastructure, along with expanded purchases of new houses, consumer durables, and autos, to an economy more focused on services and upgrade-type purchases. The latter generate much less additional demand for chemicals.

We estimate that the last decade's 3.6 percent growth rate for global petrochemicals demand may slow to 2.0 percent to 3.0 percent through 2030. Growth may accelerate again as a new group of economies—for example, India, Indonesia, Pakistan, and countries in Africa—contribute more significantly to expanding demand, but this may take another five to ten years.

Margin erosion in selected chains seems likely to be a constant

The margin erosion observed in certain chains of products is unlikely to be reversed. The greatest erosion has been seen in chains based on aromatics, such as *para*-xylene and purified terephthalic acid, phenol, and polyamide. Over the past decade, participation in these markets has broadened

Exhibit 4 **Petrochemical companies face challenges and disruptions.**



beyond its historically limited number of players, and the structure of these markets is unlikely to revert to what it was. Even if demand growth and greater investment discipline among producers could improve the situation, we do not expect the underlying trend to reverse.

Today's petrochemical paradigm: Finding a new balance between strategy and performance

As these different trends come to bear on the petrochemical sector, the industry will be facing a new set of challenges. To thrive in the next decade, petrochemical companies will need to move beyond advantaged feedstock and emerging markets, and focus on a broader set of strategic priorities (Exhibit 4).

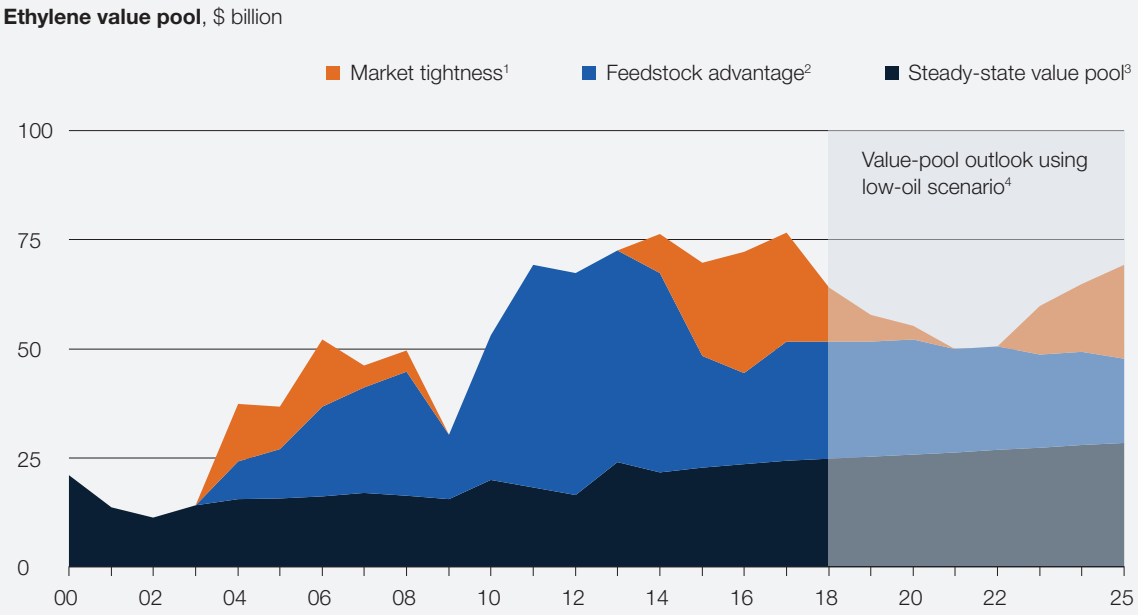
1. Harness the new sources of industry profitability

For the period 2020 to 2030, we anticipate fewer truly advantaged investments and a step change in industry conduct. Since the early 2000s, over half of petrochemical investments have been based on advantaged feedstock, in particular in the C_1 and C_2 chains. Companies have not been concerned about the impact this new capacity would have on the industry's supply-demand balance, because they knew they were investing with such decisively low costs that they would be far below the marginal cost of production.

By 2020, most of the world's advantaged feedstock projects will have come onstream, and for the period from 2020 to 2025, we anticipate fewer truly advantaged investments. To meet demand growth, the industry will rely on ethylene cracker investments based on liquids feedstocks—naphtha, gasoil, and heavier feeds. Cost-curve logic dictates that these investments will generate a return that is close to cost-of-capital returns across the cycle, and significantly below that of the earlier advantaged-feedstock projects.

As a result, we expect tighter investment discipline to be shown by most industry participants, and a higher average level of capacity utilization industry-wide, which would help industry-wide returns. There is also likely to be greater industry margin volatility, because the industry's steeper cost curve resulting from these trends would mean that outages and

Exhibit 5 **Market tightness has reemerged as an important contributor to value creation.**



[1] Market tightness is estimated based on the difference between total value pool minus feedstock advantage and steady-state value pool.
[2] Estimated based on the surplus value generated in regions with strongly advantaged feedstock.
[3] Steady-state value pool is calculated as historical margins before either of structural or market factors.
[4] Expected value pool calculated for a low-oil scenario (~$60/barrel) and global growth at 3% per annum; assumes a cyclical market, returning to marginal producer economics by 2021, and then a demand-driven fly-up by 2022. Gas prices in the Middle East and North America are assumed to be at the same levels as 2017, and growth in the steady-state value pool is assumed at 2% per annum.

Source: IHS; McKinsey analysis

small shifts in the demand-supply balance would have greater impact on prices and therefore margins (Exhibit 5).

2. Take a more strategic approach to growth

As discussed above, we expect that end-market growth rates for petrochemical products will slow down as high-growth emerging-market economies mature and shift from manufacturing products to providing services.

To offset this slowdown, the petrochemical industry needs to rediscover one of the roots of its original success—its ability to substitute for traditional materials, such as paper, wood, and metal. But in the past 15 years we have seen this substitution come to a standstill—and even reverse. The industry should double down in its innovation efforts on areas where new growth can be unlocked through substitution and not just focus on end-market growth. We also expect that petrochemical companies will start to pursue opportunities for inter-material competition between different plastics to capture additional growth.

Major projects have been a signature of the industry, but the closing of the advantaged-feedstock window combined with lower growth will result in fewer attractive large investment opportunities, and the ones that remain will involve potentially higher risks.

We expect to see more large-scale partnerships emerge in response, combining resource/feedstock supply; technology and product application know-how; and growth-market access. Companies bringing a strong position in one or more of these areas will have a better negotiating position relative to the few remaining opportunities in coming years.

3. Attack rising capex costs

Since 2000, we have seen a rush to build new facilities to capture the benefits of advantaged feedstock and strong market growth. However, investment costs measured in terms of capital expenditures per ton of chemicals output are creeping up. This has resulted from higher input costs, tighter construction-market conditions, higher costs related to the locations where plants have been built, and the fact the industry is reaching the limits of the cost reductions that can be gained from building on an ever-larger scale.

In response, leading players are taking a more disciplined approach to capital allocation, as well as approvals and decision-making processes. They are more aggressively managing the concept evaluation, scope and design of projects, and introducing lean principles into all stages of the engineering, procurement, and construction process.

4. Embed digital and advanced analytics

As the advantaged-feedstock window of opportunity is closing, petrochemical companies should step up their efforts to search elsewhere for ways to boost profitability and improve returns. The industry's complex and integrated operations, where variable costs make up a high share of total costs, are well suited to benefit from the improvements digital and advanced analytics have to offer.[2]

We are starting to see a step change in operational performance, as companies boost yield, energy, and throughput; reduce down time; and improve commercial margins by applying advanced analytics to operations, maintenance, and commercial processes. We also see efficiency improvements through digitization of work processes, which can at the same time help improve safety performance.

5. Identify new opportunities for upstream value creation

As gas became the feedstock of choice for petrochemicals, many producers have all but severed the historic ties between refining and petrochemicals. That may change: the slowdown in opportunities for chemical companies to use gas feedstock may have them looking at petroleum-based feedstocks again. The attraction is likely to be mutual: oil companies are frantically interested in the higher demand-growth promise that petrochemicals hold compared with fuel markets for heating and transportation. These fuel markets are expected to grow below 1 percent a year; petrochemicals, in contrast, are expected to grow at between 2 and 3 percent through 2030. Based on these projections, petrochemicals could be responsible for 70 percent of new oil-demand growth.

We expect deeper integration between refining and petrochemicals to emerge in response, and larger-scale future investments to become fully integrated refining and olefins sites, or even crude-to-chemicals units, and not just colocated refining and petrochemical plants. On a like-for-like basis, these units may have capital-investment costs that are 10 to 20 percent lower and cash costs that are 5 to 15 percent lower than simple colocated units, by capturing synergies on raw-material integration and optimization, energy efficiency, and sharing of common infrastructure. NOCs are likely to be well positioned here, combining their financial strength to fund new technology development with their need to tap into the relatively high-growth petrochemical market.

6. Build the business case for embracing a more circular economy

The petrochemical industry is inextricably caught up in the circular-economy debate. Eighty percent of

petrochemical building blocks are used to produce plastics, in what today is essentially a once-through value chain where the products are thrown away after use. The push across society for a more circular approach is real, in particular with respect to managing the waste streams. A plethora of potential solutions is being applied or tested, which includes the introduction of renewable and bio-based materials, mechanical plastics recycling,[3] recovery of hydrocarbon content through chemical recycling, and incineration combined with energy recovery. But these efforts are generally not at scale and are not yet presenting attractive economics.

We expect to see that forward-looking petrochemical companies will start to direct a significant share of innovation budgets, capital investments, and strategic thinking toward circular approaches. This will include not only adapting to how demand reduction and plastics reuse will substantially cut growth for conventional products, but also to developing a credible portfolio of options that includes recycling, energy recovery, and end-market and application offerings that are inherently more circular.

The global petrochemical industry is starting to move on from its development phase of cheap gas-feedstock windfalls and emerging-market demand take-off. Petrochemical companies around the world need to get ready for a more challenging playing field. An important ingredient for success is going to be a renewed focus on operations excellence, this time enhanced by digital and advanced analytics. But future winners will also need to back that up with significant strategic moves to capture the new round of value-creating opportunities coming into view.

[1] See Florian Budde, Obi Ezekoye, Thomas Hundertmark, Manuel Prieto, and Theo Jan Simons, "Chemicals 2025: Will the industry be dancing to a very different tune?," March 2017, McKinsey.com.

[2] See Valerio Dilda, Lapo Mori, Olivier Noterdaeme, and Joris Van Niel, "Using advanced analytics to boost productivity and profitability in chemical manufacturing," February 2018, McKinsey.com.

[3] Mechanical plastics recycling refers to mechanical processes such as separating and regranulating to produce recycled material that can be converted into new products.

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