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# When gas gets tight: Next steps for the Middle East petrochemical industry

**The region's producers are entering a world of limited new gas supply. To continue to grow at home and remain competitive, big changes will be required.**

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The Middle East petrochemical industry has seen spectacular growth over the past 30 years based on the availability of low-price gas feedstocks. But with advantaged new gas supply expected to end in most countries in the region over the next few years, petrochemical producers that want to expand domestically face major challenges. They can continue to build up their export industry using naphtha feedstock instead, but companies will have to find new ways to offset the handicap of their geographical location far from major growth markets. While obtaining naphtha at advantaged prices would help their position, the region's petrochemical producers should become leaders in operating and functional efficiency. This will in turn require a broad mobilization to

build the managerial and technical capabilities needed to develop and further grow their businesses.

## **Petrochemicals' child prodigy grows up**

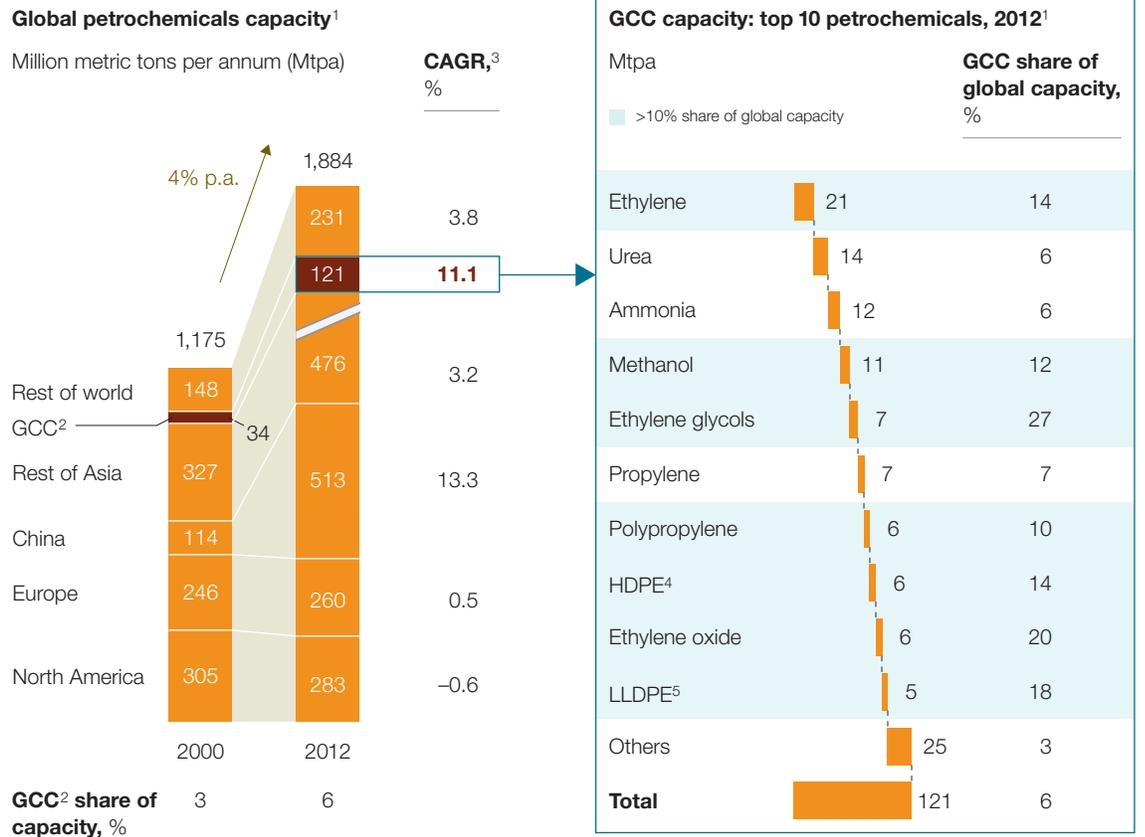
The Middle East petrochemical industry has come very far, very fast. From the first joint-venture plant in 1981, the industry has expanded to a total annual petrochemical production of 121 million tons in 2012. Capturing the gas flows associated with oil production that were previously flared and instead channeling those flows as very low-priced feedstock for chemical production has made it possible to build an immense and highly profitable industry. The Gulf Cooperation Council (GCC) countries contributed 11 percent

of global petrochemical-capacity growth over the past ten years and are now a leading global producer and supplier to world markets of ethylene and derivatives and methanol (Exhibit 1).

The expansion in petrochemicals has made an important contribution to the region's economies, diversifying them away from their dependence on oil production. The region's chemical industry

Exhibit 1

**The GCC's petrochemicals output has grown 11% a year since 2000, capturing significant global share.**



<sup>1</sup>Figures may not sum to total, because of rounding.

<sup>2</sup>Gulf Cooperation Council.

<sup>3</sup>Compound annual growth rate.

<sup>4</sup>High-density polyethylene.

<sup>5</sup>Linear low-density polyethylene.

Source: ICIS; IHS; International Fertilizer Development Center; Italia ATEC; McKinsey analysis

## As job creation and economic diversification has become a more pressing issue in the past decade, the industry's contribution has increasingly been recognized by national governments.

currently supports an estimated 840,000 jobs: 110,000 in chemical production, and, indirectly, a further 730,000 jobs, including suppliers and contractors involved in areas such as gas production, outsourced maintenance, transportation services, and other logistics services. In Saudi Arabia, chemicals represented 4.5 percent of non-oil and gas GDP in 2011—a share that increases to 11 percent if indirect and induced contributions are included.

As job creation and economic diversification has become a more pressing issue in the past decade, the industry's contribution has increasingly been recognized by national governments. Of course, 840,000 jobs can only go so far in meeting the employment needs of a working-age population of around 20 million across the GCC countries, but it represents an important step toward diversification.

While progress to date in building up industries such as plastics processing that could consume some of the region's petrochemicals has so far lagged behind expectations, this largely untapped opportunity offers promise for the future. Chemical production more than three or four processing steps beyond the cracker or aromatics plant—"downstream activities" in chemical-industry parlance—accounted for 3 percent of capacity and 4 percent of chemical revenues in the region in 2010, compared with 15 percent of capacity on average worldwide.

As the Middle East's petrochemical industry has grown, a number of companies have emerged as leading global players. Sabic has acquired a petrochemical base in Europe, bought GE Plastics, and made production investments in China that it continues to expand. The portfolio of Abu Dhabi's International Petroleum Investment Company includes Nova Chemicals and Cepsa as well as majority ownership of Borealis.

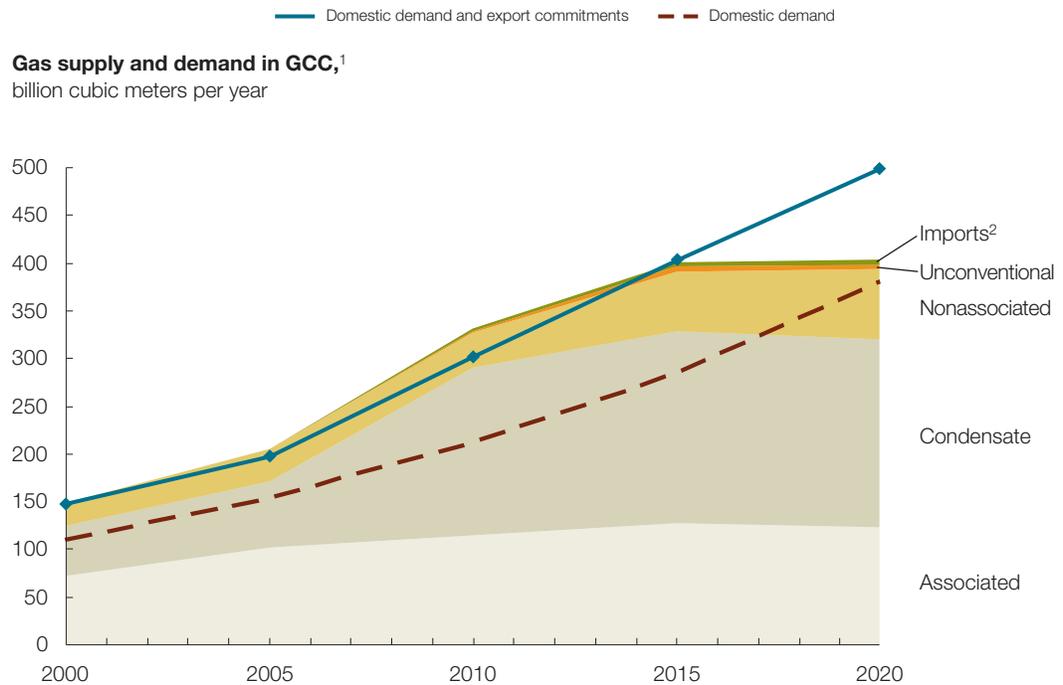
This internationalization trend has gained a further dimension over the past decade as Middle East oil producers have increasingly invested directly in emerging markets; some of these investments include petrochemicals as well as refinery units. Such moves clearly help to assure outlets for these Middle Eastern countries' hydrocarbons in the markets that are the key drivers of oil-consumption growth. But to further the economic diversification and employment growth that most Middle Eastern countries are looking for at home, expansion of the domestic petrochemical sector would remain an important instrument. Superficially, the Middle East petrochemical industry is still in a good position: petrochemical production requires feedstocks, and the region sits on immense reserves of oil and gas, which could potentially feed continued global growth in petrochemical demand.

### **New hurdles on the development path**

However, producers in the GCC face a number of challenges, and perhaps surprisingly, the most significant of these is in feedstocks. The scale

## Exhibit 2

## GCC petrochemicals growth will be gas-supply constrained by around 2015.



<sup>1</sup>Gulf Cooperation Council; demand includes long-term gas export agreements of Oman, Qatar, and United Arab Emirates.

<sup>2</sup>Includes liquefied natural gas imports of Dubai and Kuwait.

Source: Company websites; Rystaad; McKinsey analysis

of expansion in the GCC region in petrochemicals, energy-intensive industries, and in gas-fired power generation has been such that the region will move from a gas surplus to a shortage around 2015, according to current estimates. The expectation is that there will simply not be enough gas available to sustain further petrochemical expansion across the region beyond 2015 (Exhibit 2). Should any new gas become available, allocations are likely to be supplied at a higher price.

This is already presenting a challenge to the large wave of new capacity that is currently getting

under way. Projects under construction or at the planning stage in Saudi Arabia, Kuwait, Abu Dhabi, and Oman would add a further 34 million tons of annual capacity by 2018 and would increase the GCC's share of global ethylene capacity from 14 percent to 16 percent. Because of a lack of ethane, some of the recent projects have had to use a different feedstock slate. For example, Saudi Kayan uses butane for 65 percent of its feedstock (with the balance ethane), and the Sadara JV of Saudi Aramco and Dow Chemical will use naphtha for approximately half its feedstock, with the balance again ethane. Butane

and propane are seeing the same supply limitations as ethane, however. These constraints are likely to force the industry to increasingly look at naphtha from local refineries for additional feedstock.

Shifting to naphtha from low-priced ethane represents a major challenge to the cost position and competitiveness of the Middle East petrochemical industry, which has grown accustomed to operating at the favorable end of the cost curve. Most national oil companies will want to transfer their naphtha at international market prices. Our analysis suggests, however, that crackers in the Middle East getting naphtha at market price will be among the highest cost producers in the world.

Our modeling identifies two main factors underlying this cost disadvantage. First, the transportation costs of shipping GCC petrochemicals to market—typically in Asia—put them at a disadvantage not only to naphtha crackers in those Asian markets but also to traditionally high-cost producers such as Europe and Japan, which have large domestic markets to serve. GCC naphtha-based production would also be at a significant disadvantage to planned new North American capacity based on new shale-gas supply. Second, by-product streams at GCC petrochemical plants that are used for fuel have low value given the low price of gas in the GCC countries, thus increasing the plants' costs.

Clearly, given the region's hydrocarbon wealth, there is potential to develop new gas production. Initiatives are already under way to develop nonassociated gas production in the region, notably in Saudi Arabia. But the typically long lead times on such projects mean that Middle East

petrochemical makers face a gas-supply squeeze for at least the next several years.

On top of this, Middle East producers have historically tended to depend on their joint-venture partners for technology and for marketing; joint ventures account for 60 percent of today's capacity. At this point, it is unclear to what extent international partners will be interested in participating in ventures that do not have an advantaged feedstock position.

The prospect of having to fend for themselves would take many Middle East-based companies into new territory. Put simply, while the companies have built up their capacity over the past 30 years, many have not built up their functional capabilities in parallel. Companies across the region also confront a gap in the area of management and technical capabilities. Moreover, companies must cope with a severe shortage of both qualified graduates and of experienced candidates for promotion in the workforce that could constrain the industry's ability to grow.

Take the example of chemical engineers: Saudi Arabia is currently expected to train at most around 3,000 chemical engineers in the next seven years, while Germany will train around 10,000. This is mismatched with Saudi Arabia's ambition to build around 15 million tons of new capacity, while Germany expects to build 1.5 million tons over the same time period.

### **Adapting to the new feedstocks landscape**

The Middle East petrochemical industry faces some important choices under these new circumstances. If the only feedstock available is market-priced naphtha, the only new production that could compete on costs with other regions would be plants that supply the immediate

region—a very limited opportunity. But if the region’s governments decide that they want to expand petrochemical production in order to continue to diversify and grow their economies, then one option could be to make naphtha available at a cost advantage relative to global prices. This could make Middle East production competitive again, and large-scale expansion could continue.

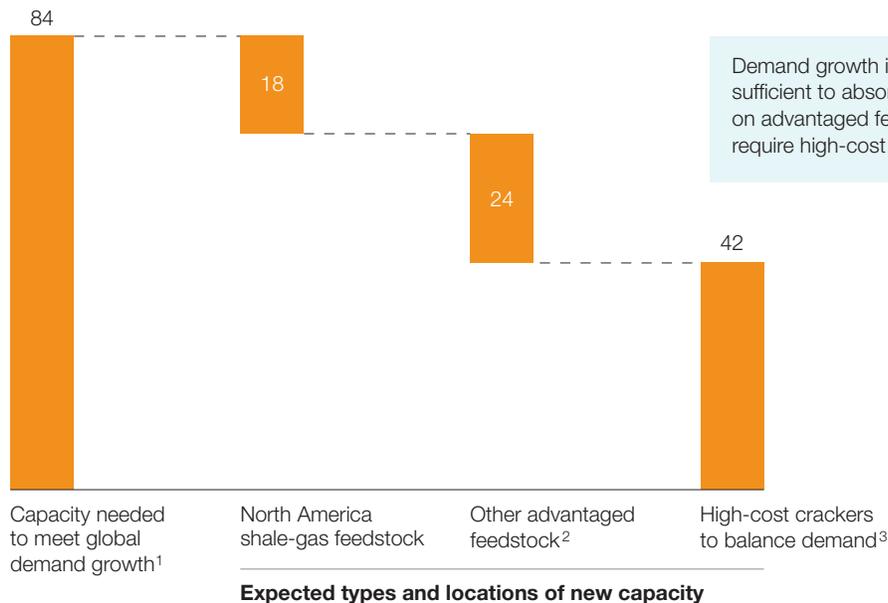
The demand is there: total worldwide ethylene demand is projected to increase by more than 40 million tons per year to around 175 million tons by 2020, and to nearly 210 million tons by 2025, with most of the end-use demand growth coming from China and other emerging economies. New North American capacity and other advantaged feedstock-based producers will cover only around half of new demand,

### Exhibit 3

## Global petrochemical demand growth will exceed new capacity based on advantaged feedstocks.

Million metric tons per annum, ethylene, estimated, 2013–25

### Expected mix of new ethylene capacity to meet demand growth



<sup>1</sup> Assumes annual demand will grow by about 75 million tons by 2025, with capacity added to get to long-term average industry utilization of about 88%.

<sup>2</sup> Includes advantaged ethane in former Soviet Union countries and North Africa, as well as methanol to olefins in China. Limited by amount of low-cost feedstock supply and other resources (eg, water), and expected gradual pace of building new capacity based on new technologies.

<sup>3</sup> Includes naphtha crackers in China, India, Southeast Asian countries, and the Middle East.

Source: Tecnon; McKinsey analysis

leaving extensive scope for companies in other regions (Exhibit 3).

However this plays out, there is one clear no-regrets move for Middle East producers to make: since margins are likely to be lower than companies have enjoyed in the past, they will want to embrace functional-excellence initiatives that can help boost returns. In addition, producers in the region will want to build up their organizational strengths in order to sustain growth. It is also important that downstream investment be prioritized.

#### 1. Drive functional excellence.

Consider first the no-regrets move. Historically, profit levels for Middle East petrochemical

producers have been so high that producers have not taken the time to ask, “What opportunities do we have to increase our profits further?” Given the anticipated squeeze on margins as “easy” gas supply dries up, now is the time for producers to ask a different question: “How much margin could we make if we optimized all our costs and operations?”

A range of opportunities under the heading of “functional excellence” can be exploited to build a new kind of cost advantage. Manufacturing, capital projects, and pricing are especially important. The largest gains in return on invested capital (ROIC) tend to occur through manufacturing-excellence efforts; in Europe and North America, gains of three to four percentage points are

Exhibit 4

### Functional excellence can significantly improve ROIC performance.



often achieved (Exhibit 4). Other areas are nearly as rich with potential, though there is some overlap among them. In our experience, these improvements in ROIC tend to be even higher in Middle East companies. An essential ingredient in all functional-improvement efforts is talent management, which we will discuss below.

In manufacturing, many top-performing companies are increasingly shifting their focus from fixed costs (such as labor) to variable costs, the much larger portion of their cost base. Improvements achieved in energy, yield, and throughput have been substantial—especially since, in petrochemicals, these not only reduce cost but also increase production volumes

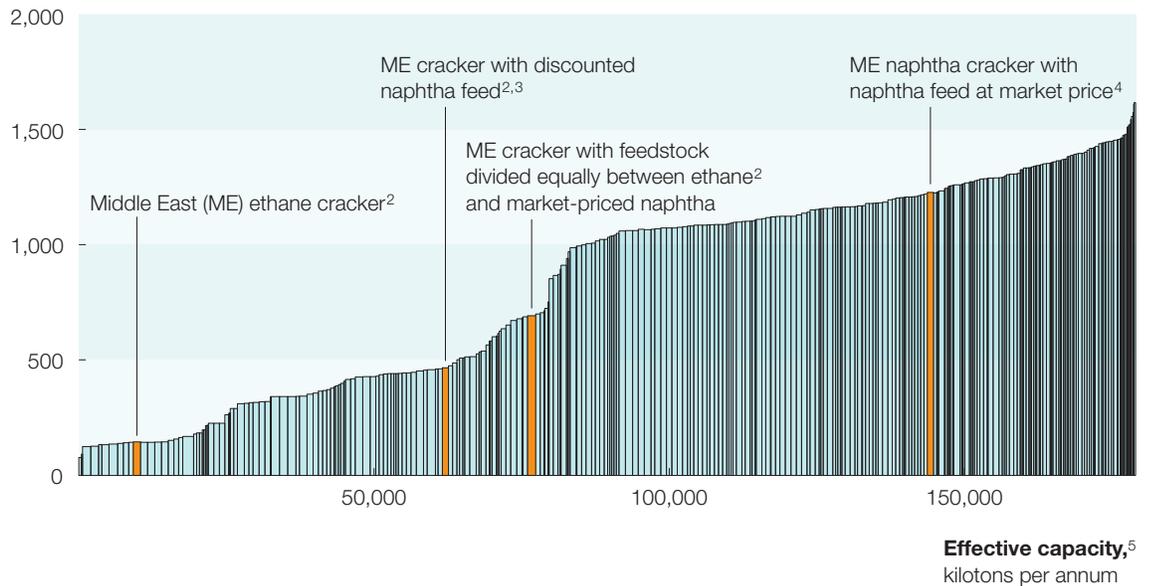
## Exhibit 5

### The competitive position of Middle East ethylene production would vary sharply depending on feedstock.

Global ethylene cost curve (plant gate): 2020 capacities, 2012 prices, and cash costs<sup>1</sup>

#### Cash cost

\$ per metric ton



<sup>1</sup>Plant-gate costs; based on prices in United States, Western Europe, Northeast Asia, Southeast Asia, and Middle East netbacks (South America costs based primarily on US prices); each cracker's cost based on estimated feed mix, scale, and estimated yield-efficiency estimate.

<sup>2</sup>Middle East ethane is valued at fuel value with gas at 75 cents per million British thermal units; discounts on naphtha are assumed at 25% for the curve.

<sup>3</sup>Assumes the naphtha cracker has discounted feedstock and integrated operations.

<sup>4</sup>Assumes naphtha, butadiene, propylene, and other by-products are at export netback.

<sup>5</sup>Effective capacity assumes 93% of nameplate capacity.

Source: CMAI; ICIS; Tecnon; McKinsey analysis

## A broad mobilization is going to be needed to build the functional capabilities that will be required to run operations more efficiently and to grow the business.

without consuming more feedstock. This latter consideration is clearly important in the tight feedstock environment that Middle East producers are now entering.

Companies pursuing this route often set targets based on a “theoretical limit”—that is, the minimum amount of energy or feedstock that the thermodynamics or stoichiometry requires—and then analyze losses based on a profit/hour equation. They employ a range of tools, from load curves to advanced analytics, to identify improvement opportunities and relentlessly go after them. By focusing on manufacturing in this new way, leading operators can achieve an additional impact of 3 to 5 percent on the overall cost baseline, and it is not unusual to achieve energy-cost savings of as much as 15 percent.

### 2. Tailor the growth path.

We see three development scenarios that could play out.

*Restoring a cost advantage to capture a share of worldwide demand growth.* Our modeling suggests that ethylene producers that receive a discount of around 25 percent on their naphtha supply would have an attractive cost position that would enable them to profitably export into Asian growth markets (Exhibit 5). This advantaged position could also be attractive to

international joint-venture partners that frequently own the process technology needed to make higher-margin products.

Middle East hydrocarbon producers are likely to continue to invest in refining and in petrochemical plants in emerging markets that will also help capture a greater share of global demand growth. But clearly for domestic economic development, investments in petrochemical production at home will be the priority.

### *The “economically rational” minimal growth path.*

At the opposite extreme is a scenario where naphtha would only be available at market price. As discussed above, this would put Middle East ethylene derivatives production in an uncompetitive position for export. The only hope for new petrochemical production earning a respectable return based on this feedstock position will be a very limited number—perhaps only one or two—of petrochemical complexes that make a range of more targeted products that can displace imports in the Middle East region.

Our analysis suggests that such a plant—one that uses market-priced naphtha but is able to optimize operations, use all its by-products and off-gases, and sell its production in the region—would move its position enough down the cost curve to where it could expect to make acceptable returns. If it developed the required derivatives slate,

it could also possibly form the basis for a cluster of more elaborate, smaller-scale specialty polymers and specialty-chemical production plants.

However, it is important to underline that there is only a limited opportunity here given the small size of the Middle East market, and such a plant could be facing competition from the “hybrid” plants described below.

*Hybrid route: Building on past cost advantages.*

A third scenario would comprise companies with grandfathered low-price supplies combining that profitable base business with expansion into naphtha feedstock-based plants.

The combination of low-priced ethane and market-priced naphtha could still add up to a competitive position, particularly if these plants embraced functional-excellence programs. Such programs would improve the already high profitability of their cheap-gas plants and could help establish well-run operations at new market-priced feedstock plants, to compete against similar plants in the West that can look back over decades of continuous optimization efforts. This approach, which combines low-priced and market-priced feedstocks, is already starting to take shape at some projects in the region.

**3. Develop new models to build organizational strength.**

A broad mobilization is going to be needed to build the functional capabilities that will be required to run operations more efficiently and to grow the business. The following three areas represent the top priorities.

*Focus on workforce development and talent management.*

The industry must assure a sufficient supply of qualified recruits to meet its growing requirements. Companies should

assess how many people they will need at all levels, and with what skills, as the industry expands. They should then liaise with education providers—governments and training institutions—to ensure the provision of vocational training that will create the skilled manpower needed.

Here, industry can play an important role in defining the standards of occupational skills for apprentices, on which technical- and vocational-training providers can base their programs. In some countries, such as Saudi Arabia, progress has already been made in piloting such initiatives, but programs will have to be scaled quickly to prevent a talent shortage from blocking growth. In addition, larger companies should expand their own on-the-job training curricula for fresh graduates. In time, this will generate a cadre of skilled employees.

*Build management and technical capabilities.*

Most Middle East petrochemical companies do not have world-class organizational and continuous-performance-improvement capabilities. Internal capability-building initiatives and functional-excellence programs can help to move them to the top rank.

There are a number of proven approaches that companies can embrace. These include programs based on adult-learning principles that combine conceptual training with on-the-job learning and the creation of continuous-improvement training teams to enable a company to constantly upgrade its capabilities.

In addition, a number of successful companies have invested in corporate academies to help build up a cadre of management trainees. Such academies often include the use of model factories, where management trainees along with all company employees—from top managers to plant

operators—can learn better ways to operate based on actual in-factory experience.

*Develop new models for growth partnerships.*

As noted, most Middle East companies have formed close partnerships with Western players (in some cases including equity investments); some of these partnerships aim not only to develop and execute joint projects in the region but also to transfer capabilities. Employee exchange and secondment programs, consulting agreements, and knowledge transfer on functional-excellence topics are all a part of the mix. We have observed that cultural differences and a lack of defined common objectives can handicap such initiatives, but if the transference of skills can be made an explicit part of the partnership agreement, these initiatives can be successful.

**4. Make downstream investment a priority—and a strength.**

Most Middle East producers have so far been hesitant in pushing downstream investment, as we discussed above. Downstream chemical production and processing is on track to reach 5 percent of capacity and 8 percent of revenues in 2015, far behind international averages.

We see the scope for downstream investment growth comprising two stages. The first is in capturing existing opportunities, such as replacing imports, and represents a no-regrets move. For example, companies should identify niches for derivatives production that can meet local demand, in particular, derivatives where feedstock

and energy-cost advantages make an important contribution to final-product profitability. In a number of product areas, such as construction chemicals, demand across the region is already substantial. Related to this is the processing of chemical end products such as polymers to meet local demand. Significant opportunities might be found in plastics processing to make articles such as plastic bags.

The second stage consists of further expansion where a company can identify a viable venture or where regional governments create conditions that could make new ventures viable. Plastics processing (to make products such as vinyl siding or automobile components) has the potential to create a substantial number of jobs, and thus a case could be made for government backing in this area. Both stages of downstream investment could help assure the success of expanded petrochemical production in the region.



The petrochemical industry in the Middle East is approaching a watershed. The changes under way in feedstock availability are creating a much more challenging environment. To continue to grow profitably at home, Middle East companies will need to become leaders in operating and functional excellence. They will also need to build up managerial and technical capabilities across their workforces to underpin that performance. ○

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