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Changing Trends in the Petrochemical Industry and their Impact on the Middle East

Petrochemicals are one of the key sources of future oil and gas demand, set to add 5 million bpd of oil and 14.6 Bcfd of gas demand worldwide by 2040. The Middle East, along with China, has been the leading area of petrochemical capacity growth in recent years. State-owned emerging market petrochemical and national oil companies have expanded at home and internationally to a leading global position, from 28% of the market in 2000 to over 48% now. But as feedstock preferences shift, North American output grows on the back of shale output, and environmental pressures intensify, Middle Eastern producers have to become more diversified and sophisticated in products, technology and marketing. Governments have an important part to play in supporting their most successful export manufacturing sector. This report explores the key global petrochemical trends and how Middle East firms and authorities are responding.

Executive Summary

- **Global petrochemical demand** is likely to show strong but slowing growth in emerging economies, outpacing GDP growth.
- **Emerging market producers,** often state-owned, have a large and growing role, and their entry is making some value chains more competitive and eroding margins.
- Strategies based purely on **advantaged low-cost feedstock** will become less successful due to US competition and the exhaustion of the available cheapest feedstock.
- **Oil-based petrochemicals** integrated with refining will make a comeback versus gas-based.
- **Environmental pressures** on petrochemical use in developed markets in particular grow as they put more stress on recycling, the 'circular economy' and biodegradability.
- **Threat of trade wars** is a concern for supply chains and overall demand growth.

Implications for Middle East Petrochemical Producers

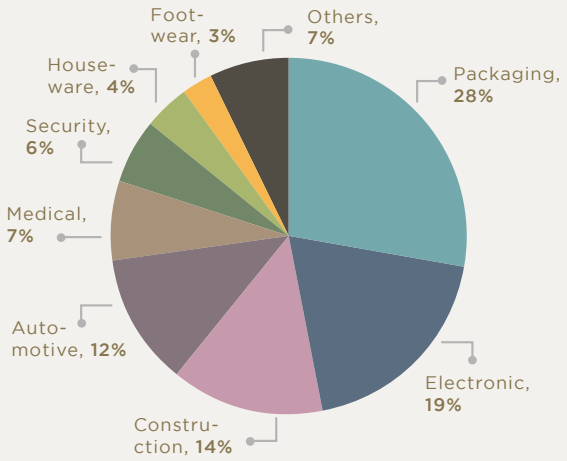
- **Countries with large low-cost gas resources** continue to have a competitive advantage but oil-based plants now have more room for value creation and sophistication.
- **Partnership decisions and M&A** are crucial, particularly for state-owned companies, to make the most of their geographic and feedstock advantages.
- **Trade barriers** are a threat to be monitored carefully; joint projects in target markets may provide some defence.
- **The more competitive market** requires more focus on operating efficiency, the downstream value chain, automation and analytics.
- The region has not yet developed a **diverse downstream petrochemical sector** comprised mostly of small and medium enterprises – it needs to do so to generate more employment, technological sophistication and exports.

Petrochemical demand continues to grow but shifts

Basic petrochemical output can be broadly divided into six categories: fertilisers, methanol, ethylene (which yields polyethylene and PVC used in packaging and construction, and polystyrene), propylene (which yields polypropylene used in packaging, vehicles and consumer goods), aromatics (which produce solvents, polyester, polystyrene, and polycarbonate) and butadiene (synthetic rubber). Of course, there are many other varieties of derived petrochemicals and applications.

FIGURE 1 shows petrochemical demand by end-use. Future growth in these sectors will be driven by the interaction of five megatrends: **rising incomes** (higher consumption of consumer goods, electronics and automotives), **demographics** (ageing populations which require less consumer goods and mobility but more medical services), **urbanisation** (driving overall higher consumption but particularly in construction), **environmental pressures** (particularly, reducing packaging use), and **new technologies** (expanding electronic, medical and security use in particular).

FIGURE 01: **PETROCHEMICAL DEMAND BY END-USE**



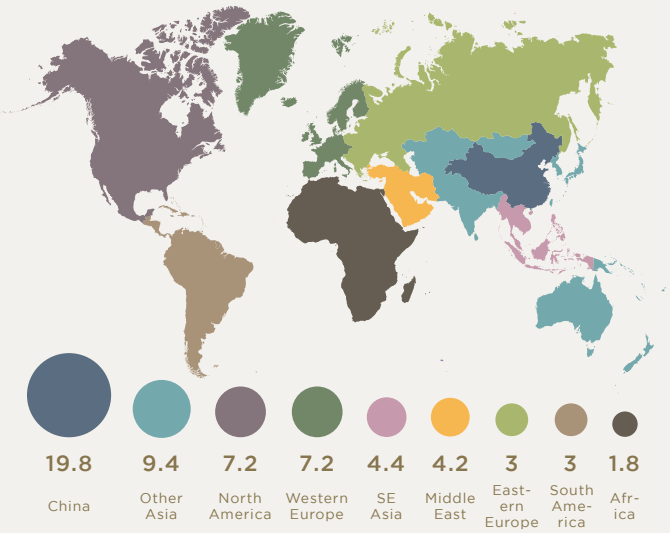
Strong recent economic growth worldwide has supported rising consumption of petrochemicals and their derivatives.

Petrochemical demand growth strongly tracks GDP growth in emerging markets: benzene grows as fast as GDP, xylene, high-density polyethylene (HDPE), polypropylene (PP) and ethylene about 1.5x GDP, and propylene and low-density polypropylene (LDPE) about 2x GDP[1]. This growth is driven by the different end-user segments.

However, globally the elasticity of petrochemical demand has been falling, from 2x GDP in the early 1990s to around 1.5x currently and 1x by 2025. Economic growth in China is slowing and the country is moving to a more service-led model, slowing petrochemical growth here. Demand growth will have to be picked up by India, Pakistan, some south-east Asian and African countries. If this is delayed, world petrochemical demand growth will slow in the 2020s.

Demand is concentrated in Asia (FIGURE 2 shows the example of polypropylene) and this is likely to intensify.

FIGURE 02: **POLYPROPYLENE DEMAND BY REGION (MILLION TONNES, 2015)**



The International Energy Agency (IEA) sees petrochemicals as the single largest sector of growth in oil demand to 2040, rising from 10.7 to 15.7 million barrels per day. Anchoring future demand in emerging markets is key for major oil exporters as other sources of demand growth slow or reverse.

Similarly, BP's World Energy Outlook shows industrial feedstock as one of the fastest sources of gas demand growth to 2040, from 18.6 Bcf/day (192 BCM/year) in 2016 to 33.2 Bcf/day (343 BCM/year) in 2040.

Emerging-market producers have changed the industry structure

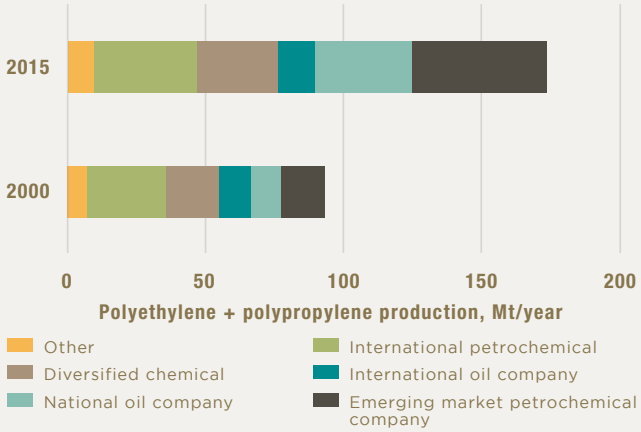
In 2000, two-thirds of the basic petrochemical industry was controlled by international oil companies, specialist petrochemical firms and diversified chemical companies. By 2015, almost half of this industry was represented by national oil companies and emerging-market petrochemical firms, such as SABIC and Reliance (FIGURE 3).

Some of these emerging-market players have been aggressive in acquisitions and expansions beyond their home base (TABLE 1).

They have also been looking at international organic expansion due to limited domestic opportunities as advantaged feedstocks are allocated. The focus is on growth markets in East Asia, and on leveraging cheap shale gas in North America. For instance, SABIC is discussing a polycarbonate plant with Sinopec in China and a 1.8 million tonnes per year (Mta) cracker with ExxonMobil in Texas[2]. Kuwait's Petrochemical Industries Company formed a polypropylene joint venture in Canada in May 2017[3], while Wanhua Chemical is to build an isocyanates plant in Louisiana[4].

These ventures are often coordinated with refining: in April 2018, Saudi Aramco agreed to build a $44 billion refining and petrochemical complex in western India, in partnership with three Indian state firms.

FIGURE 03: **BASIC PETROCHEMICAL MARKET STRUCTURE[5]**



Finally, they have sought to gain expertise via joint ventures, such as Saudi Aramco's $1.37 billion investment into elastomers with Lanxess AG of Germany[6], and its integrated refining and petrochemical JVs with Sumitomo (PetroRabigh), Dow (Sadara) and Satorp (Total).

TABLE 01: **SELECT INTERNATIONAL ACQUISITIONS BY EMERGING-MARKET PETROCHEMICAL COMPANIES[7]**

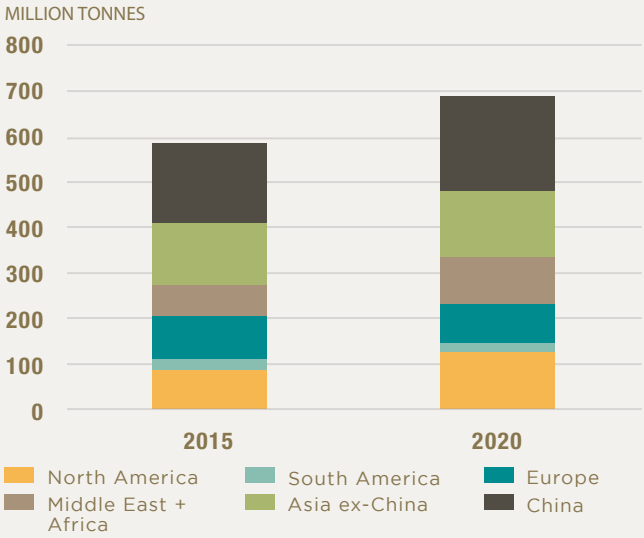
Acquirer	Target	Date
SABIC (Saudi Arabia)	24.99% of Swiss speciality chemical maker Clariant for ~$2.4 billion.	24-1-2018
	50% of SADAF from Shell.	August 2017
	GE Plastics for $11.6 billion.	21-5-2007
IPIC (now Mubadala) – Nova Chemicals (Abu Dhabi)	Williams Partners' Louisiana olefins plant for $2.1 billion.	2017
Equate (Kuwait)	MEGlobal (ethylene glycol).	2015
Wanhua (China)	BorsodChem (Hungary) for $1.7 billion.	February 2011
Honam Petrochemical (South Korea)	Titan Chemical (Malaysia).	2010
ChemChina	Elkem AS for $2.17 billion.	January 2011
	Makhteshim Agan Industries (Israel) for $2.19 billion.	October 2011
	Syngenta (Switzerland) for $43 billion.	May 2017

National oil companies have sought to increase their petrochemical businesses to retain value within their company rather than losing it via subsidised feedstock sales, capture markets, and to realise growth at a time when upstream expansion is constrained by low oil prices and the OPEC pact. Abu Dhabi National Oil Company (ADNOC) recently followed Aramco by planning to expand from 4.5 Mta to 14.4 Mta of petrochemical capacity by 2025.

Though still a net importer of petrochemicals by value, China has become a net exporter by volume, and is moving into more sophisticated products, while seeking to reduce over-capacity in basic products. Private companies are gaining market share, and the government is pushing consolidation to improve efficiency and reduce pollution. Consequently, overseas investment will increase – meaning more competition for acquisitions and joint ventures between Chinese, Middle Eastern and other firms.

Along with the growth in the Middle East and North America, capacity in Europe and Japan has had to reduce (FIGURE 4). Up to 2020, basic chemicals capacity in Europe and South America is expectedly hardly to change; North America will grow by 31 Mta, China by 41 Mta, and other Asia and Middle East/Africa by 16 Mta each.

FIGURE 04: **BASIC CHEMICALS OUTPUT BY REGION, 2015 AND 2020**[8]



The emergence of new players has increased competitiveness in some parts of the industry, particularly in the C4 and aromatics (paraxylene, phenol, polyamide and purified terephthalic acid) chains, which were historically dominated by a few firms. This has reduced margins in these sectors. Some intermediate and speciality chemicals sectors, particularly adhesives and sealants, look ripe for consolidation[9].

Preferred feedstocks shift again

From 2000 to about 2011, Middle East and particularly GCC petrochemical production rose rapidly based on low-cost feedstocks – supplies of methane, ethane, NGLs and in some cases oil at low prices. This was due to a combination of available cheap gas (often associated with oil production) with no easy export outlet, and due to government policies of providing feedstock at low, regulated prices to encourage industrial development as a partial form of economic diversification.

More recently, the North American shale gas boom has also encouraged a wave of new petrochemical investment, with ethylene output set to rise strongly in 2017 and succeeding years.

But attention in the Middle East, primarily the GCC and Egypt, has shifted back towards naphtha and mixed feeds. This is because of rising costs and/or shortages of methane and ethane in most of the regional countries. The fall in oil prices during 2014-16 helped made oil/NGL-based feedstocks more competitive against natural gas, although this has partly been undone by rising oil prices under the OPEC deal on production cuts in 2017-18. It is also driven by the broader product slate available from mixed-feed crackers[10].

As exceptions, Qatar continues to have available low-cost feedstock while Iran is completing a large number of ethylene and other plants, but is constrained by finance and technology availability because of sanctions concerns.

Conversely China has been a leader in coal-to-chemicals, particularly coal-to-olefins via methanol, coal to monoethylene glycol, and coal/methanol to aromatics areas in which it has developed proprietary technology[11]. Even SABIC is seeking to develop a coal-to-chemicals project with Shenhua Ningxia[12].

Refinery integration is increasingly seen as a route to increased efficiency and value creation[13], combining two very competitive and cost-sensitive industries. Refineries provide surplus ethane, LPG, off-gases and aromatics to the petrochemical plant and receive in return C4s, pyrolysis gas/oil and hydrogen. Utilities and storage can be larger-scale and more efficient, and thermal losses reduced. Control rooms and support functions such as maintenance, human resources, finance and security can be combined.

Integrated facilities can also boost value creation by their ability to vary feedstocks and outputs in response to market conditions. Artificial intelligence approaches can optimise operations accordingly.

The ultimate logic of the integrated refinery-petrochemical model is the crude-to-chemicals plant. ExxonMobil opened the world's first in Singapore in 2014, a 1 Mta steam cracker that is flexible on feedstock from crude oil to light gases[14]. Saudi Aramco and SABIC are now moving ahead with a $20 billion integrated complex at Yanbu which would process 400,000 bpd of Arab Light crude into 9 million tonnes of chemicals (polyethylene, polypropylene, xylene, benzene) and base oils, and 200,000 bpd of diesel. This is intended to give higher rates of crude conversion to chemicals and reduce capital costs by 30%.

Such plants could be a game-changer for the petrochemicals industry. But engineering, operations and the overall investment size and project complexity are greater, putting more emphasis on corporate capability and execution.

Middle East attention is turning to speciality chemicals

The attention of Middle East petrochemical industries is turning to intermediate and speciality chemicals (TABLE 2) because of the declining availability of advantaged feedstocks for basic chemicals; and the potential for more downstream value creation, economic development and employment.

The move to such products is favoured by the creation of 'petrochemical parks' or special industrial zones which share logistics, utilities and ready availability of intermediate feedstocks. The expiry of patents is increasing access to some required technologies, which otherwise can be obtained by

licensing and joint ventures.

However, these speciality chemicals require more in capabilities of cost-effective operations, logistics and marketing. The development of the SME chemical sector in the GCC still lags behind.

TABLE 02: **SPECIALTY CHEMICALS**

Historical	
Polyethylene	Ethylene glycol
Polypropylene	Styrene
Polystyrene	
Future	
Specialty chemicals	**Performance polymers**
Glycol ethers	C8 PE/ elastomers
Acrylate monomers	Nylon 6
Epichlorohydrin	Polyacetal resins
MDI/TDI	Polycarbonate
Polyols	ABS
EO/PO	Synthetic rubber
Amines	

The petrochemical industry can expect tougher environmental pressures

The pressures come in four main areas:

- Continuing demand for energy- and resource efficiency and pollution and emissions reductions.
- Bans on packaging and plastic bags (which represented 28% of end-user demand in 2015[15]).
- Moves towards the 'circular economy', encouraging re-use and recycling.
- Competition from alternative non-fossil feedstocks, including bioplastics (from sugar-cane, palm and cassava), and possibly in future engineered life-forms such as algae, and synthetic materials made directly from carbon dioxide with renewable energy.

Concerns over greenhouse gas emissions and water use are negative particularly for coal-to-chemicals processes. Pressure to reduce disposable plastics use (such as bans on plastic bags) threatens demand growth.

On the other hand, the use of new non-metallic materials, driven by pressure for light-weighting in transport, the take-up of additive manufacturing, and attempts to reduce energy and greenhouse gas intensive materials such as steel and cement, can be positive for the petrochemical industry. Development of more biodegradable plastics, and industry support for re-use and recycling, would ease concerns over plastic waste.

Conclusions: Implications for the Middle East

Middle Eastern petrochemical producers need to adapt to a world of still strong, but slower growth in demand, while low-cost feedstocks at home become less available. Those who still have access to competitive natural gas and ethane can continue to expand in basic chemicals. But for most, a turn to mixed feed and refinery-integrated projects will be essential to remain competitive.

To support broader-based economic development and employment creation, a broader product slate is required. The more advanced Middle Eastern petrochemical industries are already well advanced on this path, with moves into intermediate and speciality chemicals. So far, though, this remains dominated by largely state-owned firms, and a diverse SME sector has not emerged.

Big state-owned Middle Eastern companies are attractive partners for two classes of petrochemical investors: those bringing primarily technological expertise; and those bringing market access in developing Asia. Projects located in Asian markets provide an outlet for the region's NGL and crude oil exports, helping anchor demand, but they do not assist domestic job creation.

Governments can assist by:

- Coordinating the activities of national oil companies and state petrochemical firms;
- Promoting energy and resource efficiency alongside graduated subsidy reform, to help the industry make the transition from reliance on cheap feedstock;
- Ensuring both state and private companies have ready access to feedstock;
- Encouraging strong commercial and competitive cultures within state petrochemical firms, including by restructuring, IPOs and joint ventures;
- Strengthening science and engineering oriented education, skills development and research;
- Supporting their companies against the threat of 'trade wars' and tariffs;
- Catalysing the creation of special industrial zones, so lowering the barrier to entry for SMEs;
- Promoting clustering of petrochemical industries with downstream users, to save costs (sharing utilities, warehousing, ports, marketing, back-office), gain synergies (transfers of byproducts, use of waste heat) and promote innovation and business creation.

References

1. Deutsche Bank; https://www.krungsri.com/bank/getmedia/b826b347-1f14-41ec-804e-8acad1778b65/IO_Petrochemicals_2017_EN.aspx

2. https://www.reuters.com/article/us-saudi-sabic-m-a/saudis-sabic-to-spend-3-10-billion-in-acquisitions-over-next-five-yrs-idUSKBN1DS1SX

3. http://refiningandpetrochemicals.energy-business-review.com/news/pembina-petrochemical-form-jv-for-polypropylene-project-in-canada-160517-5814857

4. https://cen.acs.org/content/cen/articles/95/web/2017/04/Wanhua-Chemical-build-isocyanates-plant.html

5. McKinsey, 'Petrochemicals 2030', https://www.mckinsey.com/industries/chemicals/our-insights/petrochemicals-2030-reinventing-the-way-to-win-in-a-changing-industry

6. https://www.bloomberg.com/news/articles/2017-07-02/from-oil-gushers-to-golf-balls-saudi-aramco-bets-on-chemicals

7. https://www.reuters.com/article/us-syngenta-ag-m-a-chemchina/chemchina-clinches-landmark-43-billion-takeover-of-syngenta-idUSKBN1810CU; media reports

8. Ethylene, propylene, methanol, benzene, paraxylene and chlorine. IHS Markit, http://c.ymcdn.com/sites/www.vma.org/resource/resmgr/2016_mow_presentations/MOW_2016_-_Eramco.pdf

9. https://www2.deloitte.com/content/dam/Deloitte/global/Documents/consumer-industrial-products/gx-manu-2017-chemical-multiverse-report.pdf

10. Khalid Al Falih, Gulf Petrochemical Association, http://www.gpcaforum.net/wp-content/uploads/2016/04/d1p3.pdf

11. https://ihsmarkit.com/pdf/IHS-China-Coal-Chemical-Prospectus_223213110913044932.pdf

12. https://www.reuters.com/article/us-sabic-china/saudi-sabic-says-chemicals-project-in-china-to-cost-3-4-billion-tv-idUSKCN1174PI

13. C-P. Hälsig and F. Baars, Fluor, http://www.wraconferences.com/wp-content/uploads/2016/02/Claus-Peter-Halsig-FLUOR.pdf

14. https://uk.reuters.com/article/exxon-singapore-petrochemical/interview-exxon-starts-worlds-1st-crude-cracking-petrochemical-unit-idUKL3N0KH2VU20140108

15. Nexant, https://www.krungsri.com/bank/getmedia/b826b347-1f14-41ec-804e-8acad1778b65/IO_Petrochemicals_2017_EN.aspx