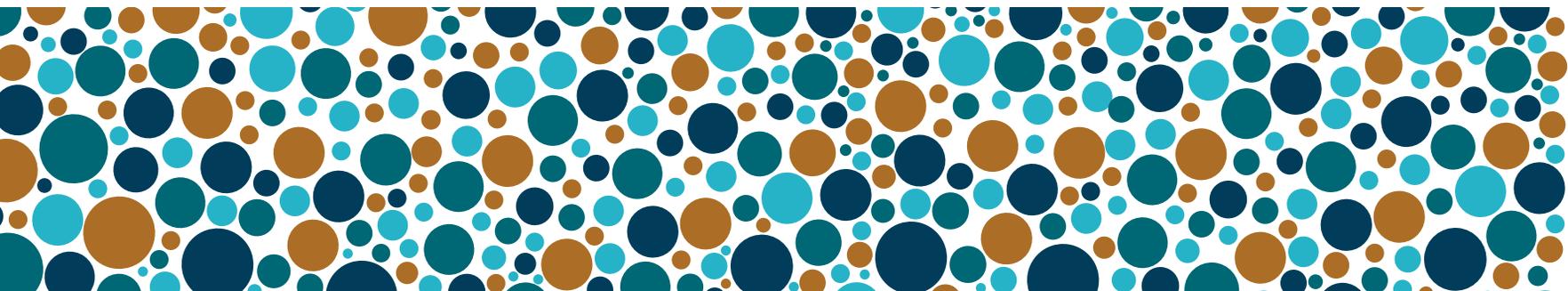


Executive Summary

ETHYLENE: A LITMUS TEST FOR THE CHEMICAL INDUSTRY

November 2019



World Ethylene End Markets Overview

- **Demand for ethylene derivatives from key end-user markets is expected to continue to grow.** The packaging industry drives about 45% of the global demand for plastics resins (Polyethylene, Polystyrenes, PVC, PET). The global packaging industry is expected to grow by 4% per year by 2025, driven by the increasing use of plastic packaging in food, beverages, personal care, healthcare and consumer electronics industries.
- **Demand from the construction industry represents almost 20% of ethylene derivatives consumption.** The global construction industry is expected to grow by 4.1% per year by 2030, driven by China, US and India. Plastic materials are increasingly replacing traditional materials in products like pipes, wires and insulation. As the world is becoming increasingly more urbanized, demand for building and construction plastics is expected to expand.

- **The automotive industry consumes about 6-10% of ethylene derivatives.** In the medium term, the global automotive industry is expected to remain stable, growing by 1.9% per year by 2025. With new innovative products application materials like steel, aluminum and glass. As the automotive industry continues to embrace new polymer products, demand for ethylene derivatives in this segment is expected to continue to grow.

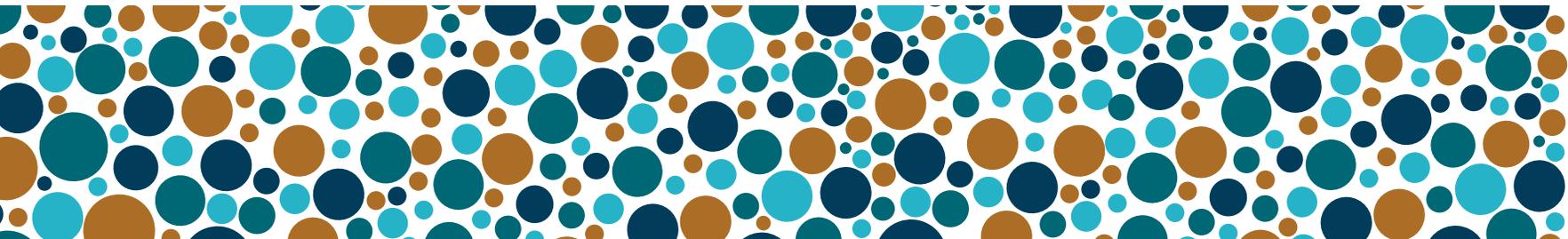
World Ethylene Market Overview

- **Driven by consumer demand, in packaging, construction and automotive, global ethylene capacity grew by 3% between 2012 and 2019.** In 2019, 183 million tons of ethylene was added worldwide. A healthy combination of strong global consumer demand and cheaper feedstocks created robust conditions during 2017 and 2018, when ethylene production capacity experienced its highest growth rate of 4.7% and 4.1% accordingly.

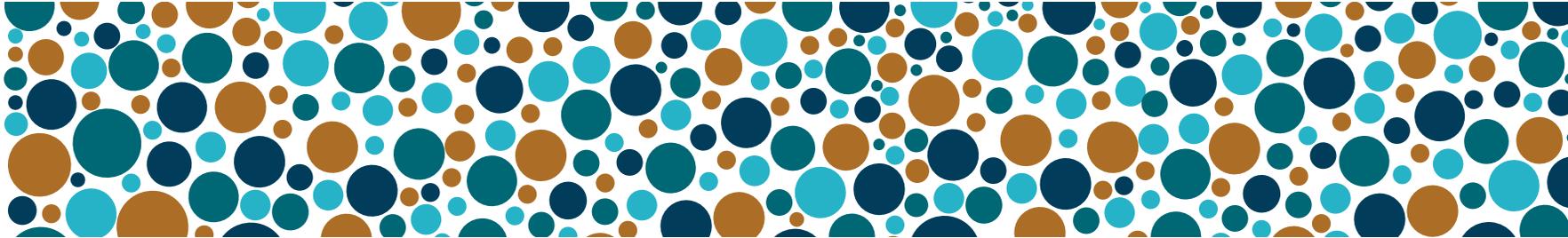
- **About 60% of incremental ethylene supply between 2012-2018 came from ethane.** Globally, 40% of ethylene produced in 2018 was ethane based, up from 35% in 2012. Together with naphtha, they are responsible for 80% of global ethylene production. The balance of 20% is shared between other feedstock types, namely propane, butane, coal to olefins, methanol to olefins and methanol to propylene.
- **Ethylene steam crackers based on ethane are the most profitable.** In the Middle East, which is predominantly ethane based, ethylene cash cost has been lower compared to other regions globally. In 2017, Middle East ethylene production cost was 30% lower than the world average. While it may look like a significant advantage, if we consider the recent past, we see that Middle Eastern producers have been losing their market positions quite rapidly. In 2013, Middle Eastern ethylene cash cost was 60% lower than global average, twice higher than Middle Eastern cash cost in 2018.
- **Looking ahead, assuming oil will remain at USD 60/ barrel, Middle Eastern ethane-based ethylene producers are expected to be at the bottom of the cost curve followed by North American ethane-based producers.** However, low cost supply sources can only cover part of future ethylene demand. Naphtha crackers will need to be built to meet demand, with China being the most cost-effective location for new naphtha crackers.
- **Global ethylene operating rates remained stable in 2017 and 2018 at 90%, driven by limited amount of ethylene capacity additions relative to demand.** Tight ethylene supply is driven by project delays and cancellations, changes in ethylene demand and feed availability.
- **Over the coming years, the global rate of ethylene capacity expansion is significantly higher than the forecast demand growth,** resulting in the possibility of an ethylene over supply and subsequently, an operating rate decline. Therefore, the forecast for global operating rates is 88%, which is slightly lower than the historical average of 89%.

GCC Ethylene Market Overview

- **Over the past three decades, the GCC region has emerged as a leading ethylene production hub,** growing by 9.8% per annum since 2000 and reaching 25.8 million tons of production capacity in 2018. This translates to 1.2 million metric tons of ethylene added each year between 2000 and 2018. The GCC has a significant competitive cost advantage compared to other parts of the world, as most ethylene production is ethane based.
- **Over the next ten years, the GCC ethylene capacity is forecasted to increase by 53% reaching 39.4 million tons in 2029.** This translates to about 1.5 million tons of ethylene capacity addition every year, compared to 1.2 million tons during the 2010-2018 period. Saudi Arabia will account for half of incremental capacity additions and grow by 3.4% per year over the 2019-2028 period. While market share of ethylene capacity in Saudi Arabia is not expected to change much in volume terms, we expect to see feedstock mix changes and ownership restructuring. Feedstock mix change will be driven by refinery and petrochemical integration and SABIC - Saudi Aramco's Crude-To-Chemicals technology development.



- **Ethane is a dominant feedstock in the GCC due to its availability and relative lower costs compared to feedstocks in other regions.** About 70.7% of ethylene produced in 2018 by GCC producers was based on ethane. Historically, crackers in the GCC have been predominantly ethane based, however, with constraints in the supply of ethane, crackers are now being fed with heavier feedstocks. This led to a more balanced product mix at the basic petrochemical building block, which in turn resulted in a more diversified product portfolio. While the economics of heavier feedstocks cracking are different, several new crackers in the region that are mixed feed are being built. Nevertheless, the ethane content in feedstock will remain high over the next ten years. In 2028, it is expected to represent a 67.3% share, compared with 70.7% in 2018.
- **GCC companies are investing in ethylene production in key growth markets around the world, particularly in Asia and North America.** With China striving for self-sufficiency, ethylene supply is expected to increase by 3.7% per year between 2019-2027. GCC chemical producers are also setting up ethylene production facilities in this key growth market, including petrochemical plants in Zhejiang, Panjin and Fujian. North America is another key growth market for global ethylene supply and GCC producers are investing in projects in this region. They include the Texas Ethane Cracker by SABIC and ExxonMobil, Port Arthur Petrochemical plant integrated refinery by Saudi Aramco and Texas Petrochemical Plant developed by a consortium of players including Nova Chemicals (UAE)/ Borealis and Total.
- **GPCA estimates that by 2029 about one third of total ethylene production by the GCC producers will be located overseas.** Taking into consideration the increase in overseas projects by GCC producers, the region's share in global ethylene supply will reach 25% by 2027, up from 20% in 2018.



GCC Ethylene Derivatives Market Overview

- **GCC domestic ethylene derivatives production reached 33 million tons in 2018 accounting for 21% of global ethylene derivatives production.** PE and EG are the leading ethylene derivatives in terms of market size. Aggregated growth for ethylene derivatives in the GCC during 2008-2018 was 5.8%. This trend is higher than the global of 4% CAGR during the same period and higher than the GCC GDP growth of 3.3% per annum.
- **In the next ten years, the largest contribution to the ethylene derivatives growth in the GCC is expected to come from PE and EG, which will account for 91% in incremental capacity.** The GCC EG capacity growth forecast is 1.5% per year, in line with ethylene derivatives growth in the region between 2019 and 2029. Most of the ethylene producers in the GCC region adopt flexibility to switch between PE and EG depending on the prices in the global market to achieve higher margin. In contrast, demand from EDC production is forecast to stagnate until 2029, as a result of less favorable economics.

- **The GCC accounted for a 21% share of global ethylene derivatives output in 2018.** The GCC produces all major ethylene derivatives, namely LLDPE, LDPE, HDPE, EG, EDC, Ethyl Benzene, EVA and Ethanol.

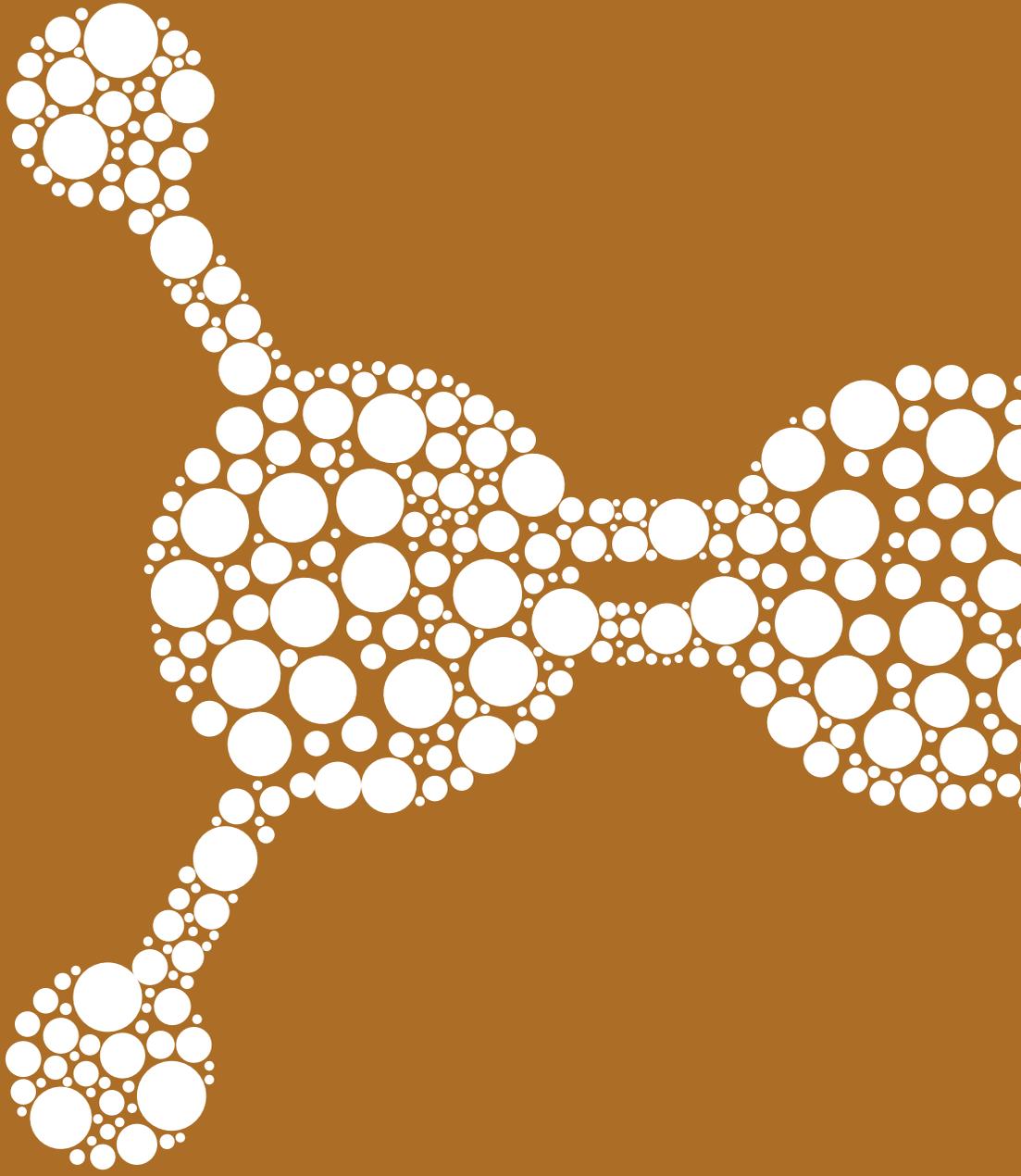
Strategic Considerations for GCC Ethylene Producers

- **Ethane availability for new projects in the GCC is limited. Therefore, future petrochemical growth in the region will require liquid feedstocks from refinery petrochemical integration.** Integration can offer numerous benefits. Integrating an ethylene cracker with a refinery will lead to a range of new building blocks for the petrochemicals industry, which in turn, provides opportunities for diversification of product portfolios within the chemical industry. This is a crucial element for the GCC and long-term national visions as diversification of the industry will bring more value addition and job creation.

- **With technology advancements, future plants are likely to be configured to convert light crude oil directly to chemical feedstocks instead of transport fuels.** By 2025, Saudi Aramco and SABIC plan to bring on board a COTC plant in Saudi Arabia, targeting a 70-80% conversion rate, by eliminating intermediate refining steps in conventional crude oil conversion.
- **Currently, on a global level only about 8-10% of crude oil can be converted to chemicals.** Even in well integrated complexes, such as Petro-Rabigh, the conversion rate is 17-20%. By leveraging feedstock advantage and reconfiguring the conventional refining approach, COTC technology can achieve a higher conversion rate to generate greater value across the hydrocarbon value chain. If a COTC complex is built based on this technology, 20 million tons of crude oil would produce 14-16 million tons of chemicals per year, instead of the currently known 9 million tons. This demonstrates that technology will be an important competitive factor in the future COTC projects. It is estimated that every 1% integration improves EBITDA by about 3%.
- **Driven by sustainability efforts, companies are studying the use of renewable electricity for ethylene production.** In August 2019, six companies including SABIC, BP, BASF, Borealis, Total and LyondellBasell have formed a “Cracker of the Future Consortium”, with the objective of studying the use of renewable electricity as a substitute to fossil fuels in operating steam crackers. The consortium will invest in R&D and knowledge-sharing to assess the possibility of

transitioning from base chemical production to renewable electricity. “Cracker of the Future Consortium” is a direct result of a Trilateral Strategy of the European chemical industry, developed by ministries of economic affairs and industry associations in Germany, Belgium and the Netherlands. The *Trilateral Strategy* targets the improvement of sustainability in the chemical sector. Going forward, we may see more legislation driving technology developments in the chemical industry.

- **GCC regional ethylene network has potential, however there are hurdles related to multi-country developments.** On a global level, only 50% of ethylene capacity is interconnected. Currently, there are no regional ethylene pipeline networks in the GCC. Each country in the region has been developing its petrochemicals industry independently. Regional pipelines typically require large investments in land and infrastructure and have a long payback period. Additionally, constraints in the supply of ethylene throughout the GCC States combined with legal frameworks and access to land for regional pipelines make such a project difficult to materialize in the foreseeable future.



The Gulf Petrochemicals and Chemicals Association (GPCA) represents the downstream hydrocarbon industry in the Arabian Gulf. Established in 2006, the association voices the common interests of more than 250 member companies from the chemical and allied industries, accounting for over 95% of chemical output in the Gulf region. The industry makes up the second largest manufacturing sector in the region, producing over USD 108 billion worth of products a year.

The association supports the region's petrochemical and chemical industry through advocacy, networking and thought leadership initiatives that help member companies to connect, to share and advance knowledge, to contribute to international dialogue, and to become prime influencers in shaping the future of the global petrochemicals industry.

Committed to providing a regional platform for stakeholders from across the industry, the GPCA manages six working committees - Plastics, Supply Chain, Fertilizers, International Trade, Research and Innovation, and Responsible Care - and organizes five world-class events each year. The association also publishes an annual report, regular newsletters and reports.

For more information, please visit www.gpca.org.ae

Gulf Petrochemicals & Chemicals Association (GPCA)

P.O. Box 123055

1601, 1602

Vision Tower, Business Bay

Dubai, United Arab Emirates

T +971 4 451 0666

F +971 4 451 0777

Email: info@gpca.org.ae