THE OXFORD INSTITUTE FOR ENERGY STUDIES

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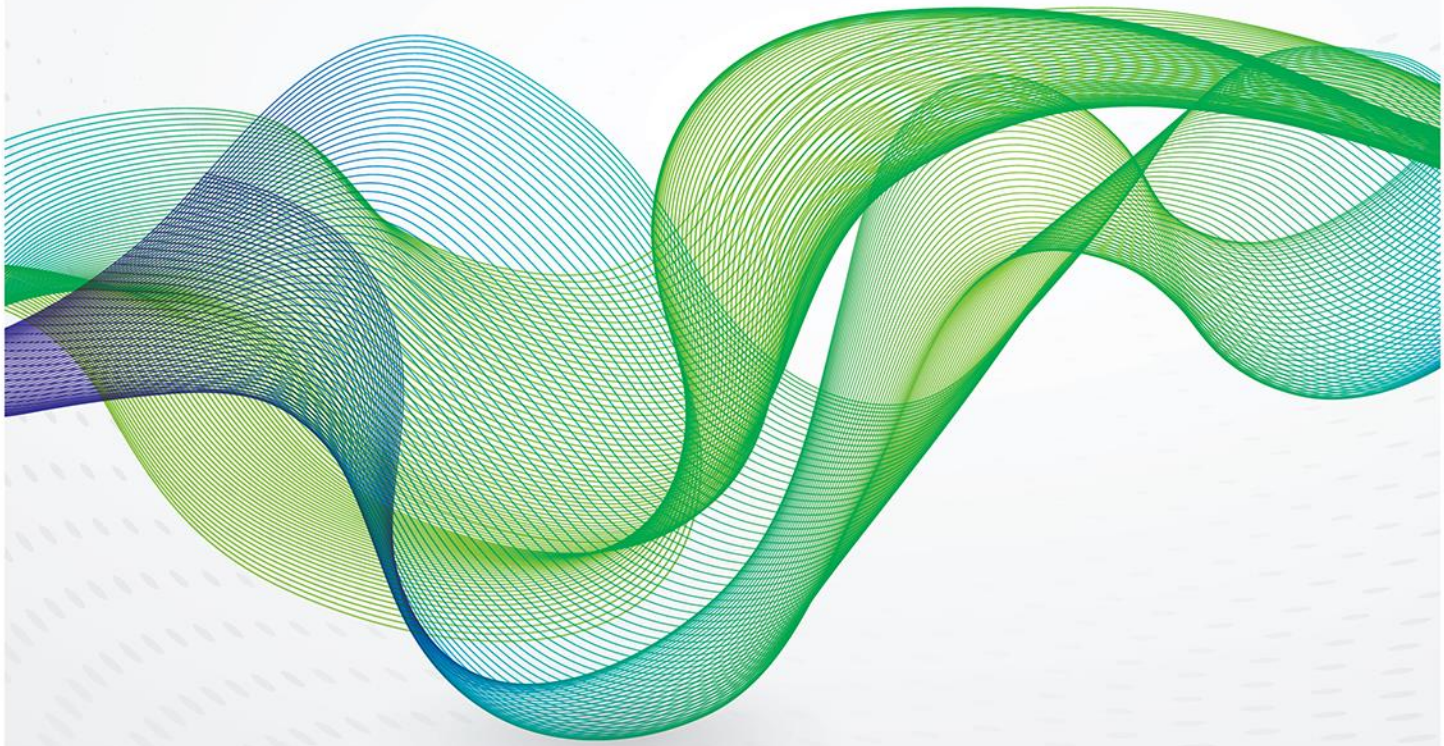
# The US Shale Revolution and the changes in LPG Trade Dynamics:

## A Threat to the GCC?



OXFORD ENERGY COMMENT

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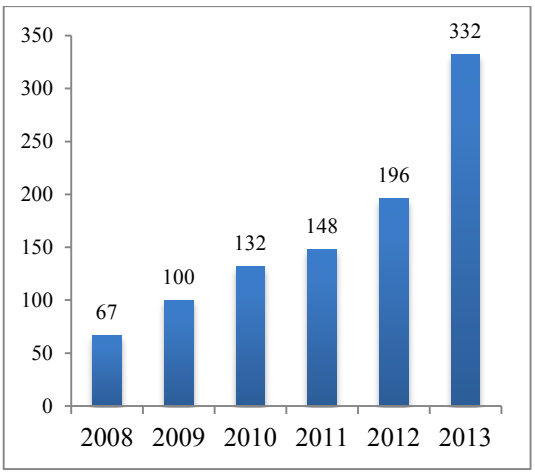
## 1. Introduction

One of the major developments associated with the US shale revolution and that has attracted little attention from market analysts is the sharp expansion in US liquefied petroleum gas (LPG) exports.[1] Substantial increase in domestic supply has not only meant that US imports of LPG, which mainly come from Canada, have dwindled, but the US has now become one of the world's biggest exporters of LPG. From 67 thousand b/d in 2008 (2.1 million tonnes per annum (mtpa)), LPG exports increased to more than 0.33 million b/d (10.4 mtpa) in 2013. Just between 2012 and 2013 alone, LPG exports rose by more than two-thirds, from 0.20 to 0.33 million b/d (see Fig. 1). According to the EIA, US LPG exports are expected to persist well into the next decade as natural gas liquids (NGL) output in the US continues on its upward trend.[2]

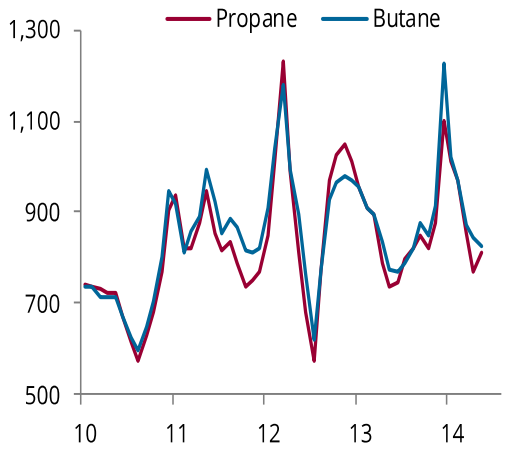
The sharp rise in US LPG exports is already having wide repercussions on global LPG market dynamics and trade flows.[3] While the bulk of US exports are currently destined for Latin America, it is widely believed that the impact of higher US LPG exports will undermine the position of traditional exporters, mainly those in the Gulf Cooperation Council (GCC). First, as Asian consumers increase their purchase of US LPG in an attempt to diversify their sources of supply and gain access to cheaper LPG, GCC's share of LPG exports to Asia is expected to fall. Second, LPG prices and the existing pricing mechanism may come under pressure from intense competition from US supplies. In mid-2012 and earlier this year, propane and butane prices came under pressure of this sort, although price data show no clear trend, with prices being highly cyclical (see Fig. 2).

**Fig. 1: US exports of LPG, Thousand b/d**




Source: EIA

**Fig. 2: Saudi Aramco contract price, $/tonne**




Source: MEES

In this paper we argue that while US exports are a powerful force shaping LPG markets, it is also important to examine some of the internal dynamics within the key GCC producers, especially the rapid growth in domestic demand for LPG driven by the petrochemical sector. Lower LPG prices may also accelerate some of the existing policies within the GCC such as diversifying the feedstock for their domestic petrochemicals sector to capture

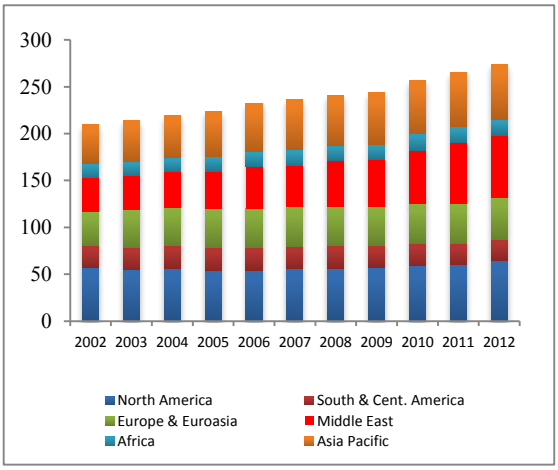
[1] The bulk of US LPG exports consist of propane, with butane representing a much smaller proportion of the total. Both are produced by passing natural gas through a gas processing plant and as a by-product of refining crude oil. Propane produced from natural gas has been the fastest-growing component of overall US LPG supply.
[2] EIA (2013), 'U.S. exports of liquefied petroleum gases projected to continue through 2040', *Today in Energy*, May.
[3] See for instance, K. Koyama (2013), 'LPG Market under Shale Revolution', *IEEJ*, August; F. Leija and R.L. Gist (2013), 'Shale gas development altering LPG demand, trade', *Oil & Gas Journal*, 6 March 2013.

more value added down the petrochemical chain and to reduce reliance on less attractive propane exports. These internal dynamics would lower the volumes of LPG available for exports from the region, and along with the expected growth in Asian demand for LPG, will moderate the impact of higher US LPG exports on prices. Furthermore, the cost of arbitrage between the US and Asia is likely to limit the impact on regional LPG prices, as prices in the US will have to fall substantially before the impact is felt in Asia.[4] Thus, the expansion of the Panama Canal is expected to have a big impact on the dynamics of LPG trade.

## 2. The Traditional Pillars of the LPG Market in the East of Suez: Middle East Supply, Asian Demand and Trade flows

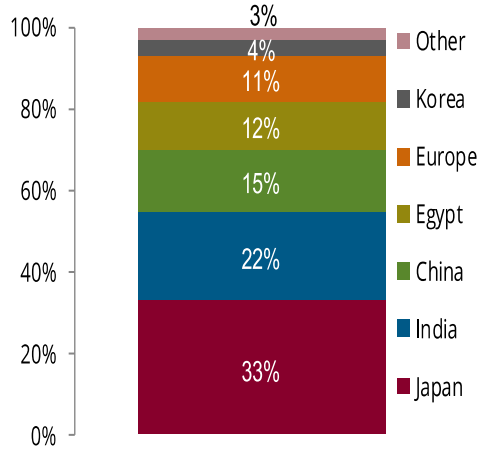
While the Middle East's share in global LPG production is relatively small, production from the region has been growing fast (see Fig. 3). Between 2002 and 2012, LPG production in the Middle East increased by 31 mtpa, taking the region's share to 24.5 per cent of global production, up from 17 per cent. As in the US, most of the region's production comes from gas fields.[5] Despite delays in some of the projects, Middle East producers (mainly Saudi Arabia, Qatar, UAE, Kuwait, and possibly Iran) are expected to continue to grow their LPG output in the coming years to 70 mtpa in 2015.[6] In addition to its growth potential, what gives the region a special position in LPG market is its dominance in LPG trade. Of the 81 mtpa of LPG exported in 2012, the Middle East accounts for around 40 per cent of global LPG exports.[7] Most of the LPG exports from the Middle East are destined for Asia. For instance, in 2012, Saudi Arabian exports to Japan, China, India, and South Korea accounted for almost three-quarters of its total exports, while exports to Europe accounted for only 11 per cent (see Fig. 4).

**Fig. 3: LPG production by region 2002–12, million tonnes**




Source: Argus, *Statistical Review of Global LP Gas*

**Fig. 4: Saudi LPG exports by destination, %**




Source: Saudi Aramco

[4] For instance, in February this year a total of six US Gulf Coast LPG cargoes, totalling over 3 million barrels, were cancelled due to unfavourable price spreads as propane prices in the US rose sharply, closing the arbitrage window. See Platts (2014), 'USGC LPG cargo cancellations total 3 million barrels in February', 26 February 2014. http://www.platts.com/latest-news/shipping/houston/usgc-lpg-cargo-cancellations-total-3-million-21273356.

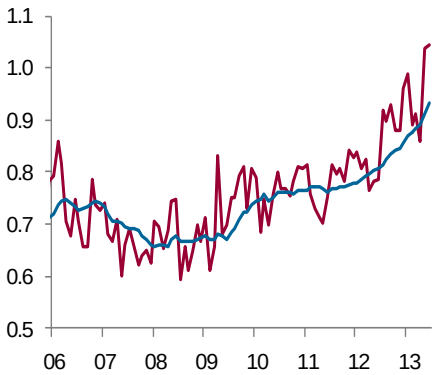
[5] IHS estimates that in the Middle East about 92 per cent of regional LPG supplies derive from natural gas processing and only 8 per cent from refineries. This contrasts with Far East Asia where natural gas processing supplies less than 1 per cent of LPG supply and refineries contribute about 99 per cent. See F. Leija and R. L. Gist (2013), 'Shale gas development altering LPG demand, trade', *Oil & Gas Journal*, 6 March 2013.

[6] Chatila, S. (2012) 'Middle East LPG growth further driving petrochemical developments in and out of the region', UOP.

[7] Argus, *Statistical Review of Global LP Gas*, 2013.

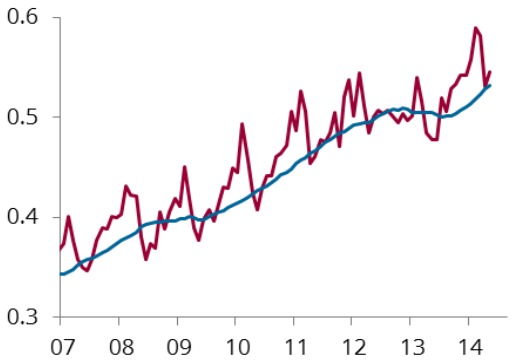
Although LPG production in Asia has been on the rise—led mainly by China and driven by the rapid expansion in refining capacity—Asian countries still rely heavily on imported LPG as demand growth continues to outpace supply growth. According to IHS, during 2002–2012, Southeast Asia experienced the highest compound demand growth of LPG of more than 15 per cent per annum.[8] Chinese LPG demand recently surged past 1 million b/d (Fig. 5) and Indian sales are over 0.5 million b/d (Fig. 6). LPG consumption has held steady in Japan at around 0.5 million b/d and declined slightly in South Korea to 0.25 million b/d. In Asia, the bulk of the demand is concentrated in the residential/commercial sector and petrochemicals, with the former being the largest component of consumption due to extensive use of propane in heating and cooking (see Fig. 7). Further, in many Asian countries, LPG used in cooking is subsidized, leading to further gains in demand in recent years. In the petrochemical sector, rising supplies of LPG has also led to the increase in the use of dehydrogenation technology to produce propylene directly from propane and to produce butadiene from butane. While Europe, Latin America, and North America are important LPG consumption centres, Asia has been responsible for most of the growth in LPG demand in recent years, a trend that is likely to continue in the next decade. In 2012, Asia Pacific already represented the largest share of demand at nearly 35 per cent (see Fig. 8).

**Fig. 5: China's LPG Demand, Million b/d**




Source: China Customs, Reuters

**Fig. 6: Indian LPG sales, Million b/d**




Source: PPAC

[8] Leija and Gist (2013).

**Fig. 7: Share of LPG Consumption by Sector Asia Pacific**

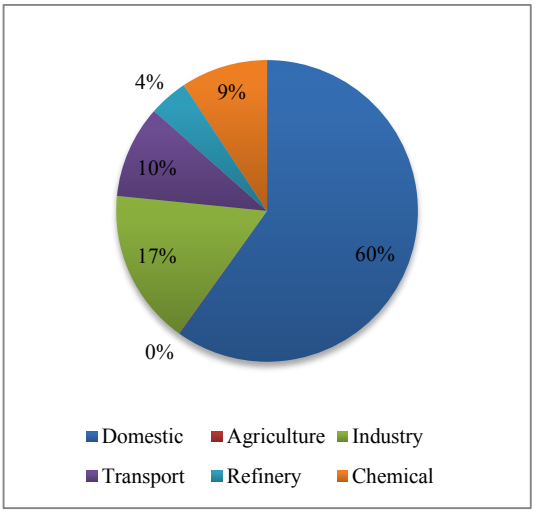
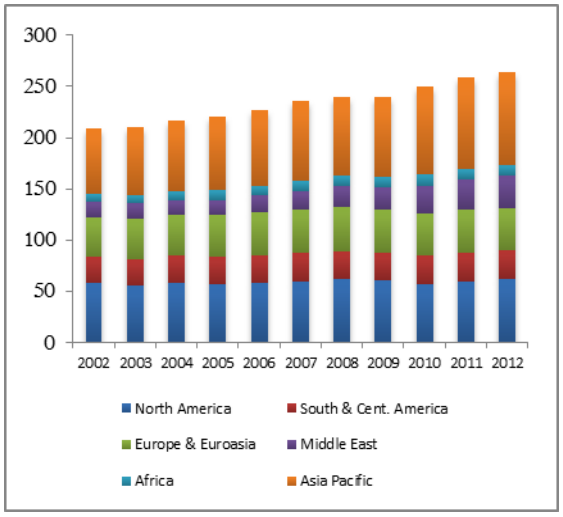



**Fig. 8: LPG Consumption by region 2002–1 million tonnes**




Source: Argus, *Statistical Review of Global LP Gas*

Given these supply and demand patterns, the East of Suez LPG market depends far more on seaborne imports than that in the West of Suez. In the East of Suez, the majority of LPG exports originate from the Gulf. For a long time, Saudi Arabia has been the dominant exporter and accounted for the bulk of the region's LPG exports. However, Qatar recently overtook Saudi Arabia as Middle East's largest exporter as domestic demand in Saudi Arabia continued to rise while production in Qatar has witnessed a sharp expansion from 1.5 mtpa in 2002 to 11.25 mtpa in 2012. In 2013, Qatar exported around 11 mtpa compared to Saudi Arabia's exports of around 8 mtpa.[9] Despite Qatar being the world's largest LPG exporter, Saudi Aramco is still the price setter for LPG in the East of Suez. Every month, Saudi Aramco announces its official contract price (CP), which has been the price benchmark for LPG sales to Asia (propane and butane prices are expressed in $/tonne rather than $/barrel, which is used in the US). Based on CP, Asian importers negotiate prices with their suppliers and usually prices are set as a premium to the CP to reflect factors such as freight and insurance.[10]

## 3. US LPG Exports: The New Kid in Town

The sharp rise in US LPG exports is already changing some of the existing patterns of LPG trade. These changes are likely to accelerate as the US continues to expand its LPG exports. In its Annual Energy Outlook 2013 Reference case, the EIA projects US net exports of LPG to grow by more than half a million b/d from 2011 to 2017, while in the High Oil and Gas Resource case, these are projected to be 1.4 million b/d higher than in the Reference case.[11] The scale of US future LPG exports will depend on three key factors: the increase in NGL production, the pace of domestic demand growth, and the availability of LPG export infrastructure.

### *NGL Production*

Regarding the first factor, NGL output is expected to continue on its upward trend. According to the EIA, NGL production from gas plants has risen from 1.74 million b/d in 2007 to 2.71 million b/d in Q1 14, with propane and

[9] 'Qatar's LPG exports little changed till 2018 –Tasweeq', Reuters, 6 March 2014.
[10] It is important to note that although CP prices are set once every month, spot prices change on a daily basis. Thus it is possible for buyers to purchase LPG at a discount to CP depending on the market conditions on the day.
[11] EIA (2013), 'U.S. exports of liquefied petroleum gases projected to continue through 2040', *Today in Energy*, May.

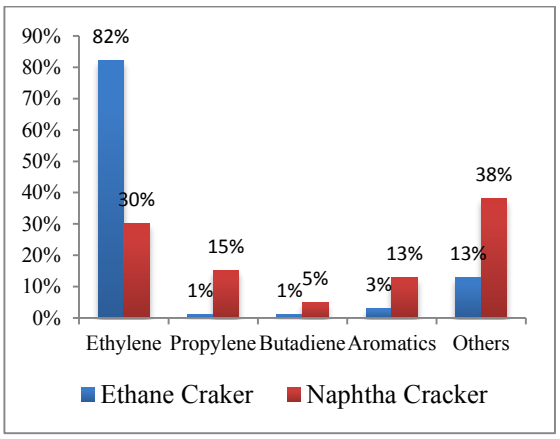
butane accounting for 33 per cent and 38 per cent of the increase respectively. US NGL production is expected to rise sharply over the coming years, with the potential for it to double between now and 2020 at over 4.5 million b/d, with the growth of tight oils supporting. The main constraint for NGL growth is infrastructure, but there is a significant push by the midstream companies to sort out bottlenecks, which should allow output to grow sharply, even if crude output starts to flat line after 2017.

### *Domestic Demand*

While traditional sources of propane demand, such as rural home heating and agriculture, are not likely to increase consumption markedly, transportation and petrochemicals demand for propane in the US is on the rise. Propane has traditionally been used to fuel forklifts and other light industrial vehicles and is being studied for use in municipal services and similar applications. But it is petrochemicals that hold the greatest promise for demand growth.

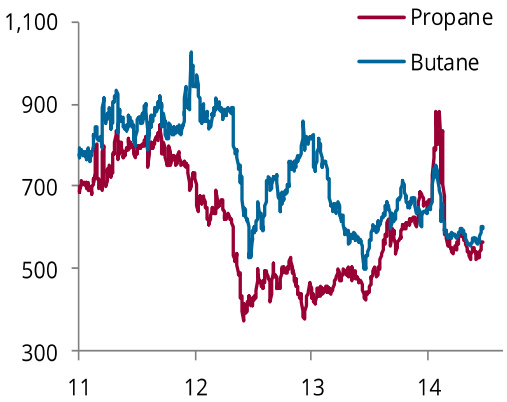
The surge in ethane output associated with the shale gas revolution has revitalized the US basic petrochemicals sector by allowing crackers to switch from expensive naphtha-based feedstocks to cheap ethane. As a result, USGC crackers are now among the most cost-competitive in the world for ethylene production.[12] But the switch to ethane feedstock has reduced production of other products, notably propylene. Whereas naphtha cracking typically yields 15 per cent propylene by weight, ethane cracking yields virtually no propylene (Fig. 9). At the same time, efforts by refineries to reduce gasoline yields have prompted changed operating practices, including reduced severity of fluid catalytic cracker operations, which has cut refinery propylene production in some cases. As such, there is increased demand for so-called on-purpose propylene manufacturing, which is typically done through propane dehydrogenation (PDH) plants.

**Fig. 9: Steam Cracker Yields by Feedstock (in Weight %)**




Source: A. T. Kearney

**Fig. 10: USGC propane/butane prices, $/tonne**




Source: Reuters

Low cost propane (Fig. 10) has prompted a number of petrochemicals firms to study the construction of PDH plants to produce polymer-grade propylene (Fig. 11). The first such facility, a 0.64 mtpa plant in Houston, Texas, came on stream in late 2010 and when at capacity processes approximately 30 thousand b/d into propylene, hydrogen, and other co-products. As a number of plants are completed in the US, 2015 will see a surge in PDH demand there. Enterprise Products Partners, a major natural gas liquids processor, is building a larger plant near its Mont Belvieu, Texas—a fractionation and storage hub that will be operated on a tolling basis. Dow Chemical is also expected to start up a similarly-sized PDH facility at its Freeport, Texas, complex. Ascend Performance Material's 1 mtpa Chocolate Bayou plant rounds out the 2015 start-ups. Assuming all three plants operate at

[12] A. Perniceni, B. H. Hartmann, W. Van Asch (2014), 'Shale Gas: Threat or Opportunity for the GCC?', A. T. Kearney, April 2014.

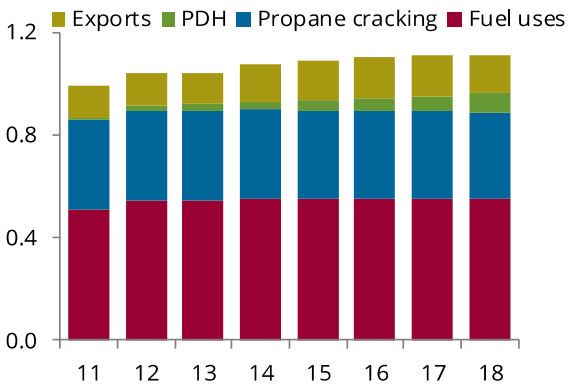
capacity, US propane demand would rise a staggering 11 per cent or 0.12 million b/d. Further plants are planned for later start up in the decade. However the economics of propylene manufacturing may not permit all these plants to be constructed. As supply increases and propane prices rise, operators will likely reduce PDH operations. Moreover, operational problems, which are not uncommon with PDH plants, mean these facilities are unlikely to operate near nameplate capacity.

**Fig. 11: US PDH plants**

| Operator | Location | Startup | Propylene capacity (kt/y) | Propane cemand (kb/d) | Notes |
|---|---|---|---|---|---|
| Petrologistics | Houston | Oct-10 | 658 | 30 | Flint Hills to pay $2.1 billion |
| Enterprise Products | Mt Belvieu,TX | Q3 15 | 750 | 35 | Fully contracted |
| Ascend | Chocolate Bayou, TX | H2 15 | 1,000 | 47 | N/A |
| Dow Chemical | Freeport, TX | 2015 | 750 | 35 | Captive use |
| REXtac | Odessa, TX | H2 16 | 300 | 14 | N/A |
| Formosa Plastics | Point Comfort, TX | 2016 | 658 | 30 | N/A |
| Dow Chemical | USA | 2018 | n/a | n/a | Under Study |
| Enterprise Products | Texas | n/a | n/a | n/a | Under Study |
| Petrologistics | Houston | n/a | n/a | n/a | Expansion under study |

Source: Energy Aspects

**Fig. 12: US propane demand, million b/d**




Source: Envantage

### *Export Infrastructure*

Although US domestic demand from the petrochemical sector is expected to rise, the US LPG market will be structurally long throughout this decade (Fig. 12). Thus producers have little choice but to find export market for their surplus LPG. Export infrastructure is not likely to be a constraint (Fig. 13). The US already has above 0.4 million b/d of export capacity in the Gulf Coast following the expansion of Enterprise Product Partners' Houston Ship Canal terminal in March 2013. Over 0.7 million b/d of LPG export expansion projects and new-build facilities have been announced in the US for completion by end–2016. While not all of these projects will go ahead, the likelihood is that the US ends up with more propane export capacity than can realistically be used. This means the US will be in position to ramp up its exports of LPG and implies that USGC propane prices will reconnect with global markets, eroding some of the competitive advantage of US PDH plants.

**Fig. 13: Existing and proposed US LPG export terminals, thousand b/d**

| Company | Location | LPG export capacity (kb/d) | Start-up |
|---|---|---|---|
| **In operation** | | | |
| Enterprise | Houston Ship Channel, TX | 275 | |
| Targa | Galena Park, TX | 133 | |
| **Expansions** | | | |
| Targa | Galena Park, TX | 67 | Q3 14 |
| Enterprise (phase 1) | Houston Ship Channel, TX | 50 | Q1 15 |
| Enterprise (phase 2) | Houston Ship Channel, TX | 215 | Q4 15 |
| **Under development** | | | |
| Sunocol Logistics | Marcus Hook, PA | 40 | Q3 14 |
| Vitol | Beaumont, TX | 100 | Q4 14 |
| Occidental | Corpus Christi, TX | 60 | Q1 15 |
| Pembina Pipeline Co | Prince Rupert, BC | 40 | Q3 15 |
| Phillips 66 | Freeport, TX | 150 | 2016 |
| | Total operational | 408 | |
| | Expansions and new developments | 722 | |
| | **Potential capacity by 2017** | **1130** | |

Source: Energy Aspects

### *Export Markets*

One key market for US LPG exports is Asia. In China, petrochemicals firms have been investing heavily in PDH plants with a total propylene production capacity of 5.36 mtpa being built across the country and nine more PDH projects with capacity of 4.74 mtpa of propylene are being planned.[13] If all of these plants were constructed, they would require huge volumes of propane.[14] Chinese PDH plants are likely to require imported propane due to a lack of high-purity domestic propane production. For a long time, China's petrochemicals had little choice but to rely heavily on Middle East imports, but this is already changing. Many Chinese PDH plants have signed export agreements with US propane producers to secure long-term propane supplies. For instance, China Petroleum & Chemical Corp., the country's largest oil refiner, has recently signed a long-term contract to buy LPG from Phillips 66, estimated at 34 thousand b/d.[15] In fact, Chinese customs data show that the country has already started importing US propane from May 2013. Media reports indicate that China has lined up about 0.1 million b/d of long-term US LPG imports with supplies mostly starting in 2015–16.[16]

Similarly, Astomos Energy, Japan's top LPG supplier has concluded contracts with Enterprise Product Partners, which will see its annual US LPG term purchase volume increasing to 500 thousand tonnes in 2014, to 600 thousand tonnes in 2015, and 800 thousand tonnes over 2016–18.[17] Data for 2013 show that Japan imported 952 thousand tonnes of US LPG, constituting around 8 per cent of its total imports of 11.57 mtpa. In addition to the large volumes involved, of equal significance is that US export prices are linked to Mont Belvieu LPG prices rather than Saudi Aramco CP Prices. [18]

In South Korea, E1 Corp, the second-biggest LPG importer, announced it plans to purchase 180 thousand tonnes per annum of US LPG, equivalent to 11.3 per cent of E1's total volume of 1.58 mtpa in 2011. This deal is part of South Korea's effort to import more than 8 mtpa of LPG produced from shale gas by 2020. SK Gas, the country's biggest LPG importer, has also plans to source US supplies.[19]

## 4. GCC Internal Dynamics and LPG Exports

Purchase of US LPG by Asian countries will continue to accelerate, driven in large part by a desire to diversify its sources of supply away from the Middle East and in part by taking advantage of low cost US propane and butane. Consequently, GCC producers will face more competition in a key market, reducing their share of LPG trade in Asia. However, it is important to note that the overall impact on prices will depend in large part on the internal dynamics within the key Middle East producers, especially the rapid growth in domestic demand for LPG driven by the petrochemical sector and the impact this may have on their LPG export volumes. In what follows we will consider the potential impact on three key producers: Saudi Arabia, Qatar, and UAE. These countries account for the bulk of GCC and Middle East LPG production (see Fig. 14).

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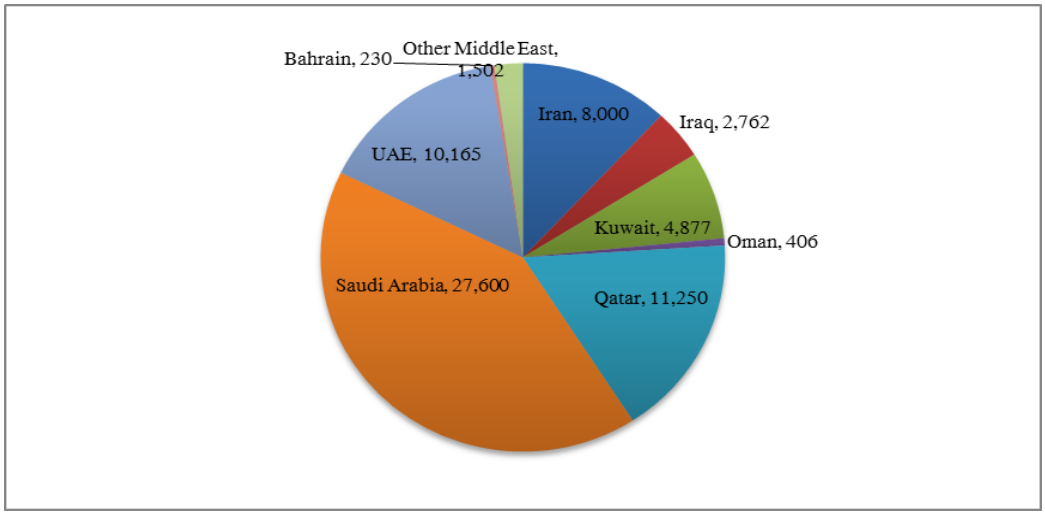
[13] Lilian Hua, 'China Propane Imports to Surge on New PDH Projects', *ICIS News*, 21 May 2013. http://www.icis.com/resources/news/2013/05/21/9670487/china-propane-imports-to-surge-on-new-pdh-projects/.
[14] Ibid. It is estimated that China will need to import 11.91 mtpa of propane to ensure feedstock supply for its 17 new PDH projects.
[15] Chen Aizhu, 'Riding shale boom, U.S to become major LPG supplier to China', Reuters April 9, 2014.
[16] Ibid.
[17] 'Japan's Astomos to buy 5 mil mt of term US LPG over 2014–21', Platts, 16 April 2014.
[18] Ibid.
[19] 'S. Korea's E1 to import U.S. shale gas LPG to diversify supplies', Reuters, 8 Nov 2012.

**Fig. 14: LPG Production in the Middle East by Country (million tonnes)**

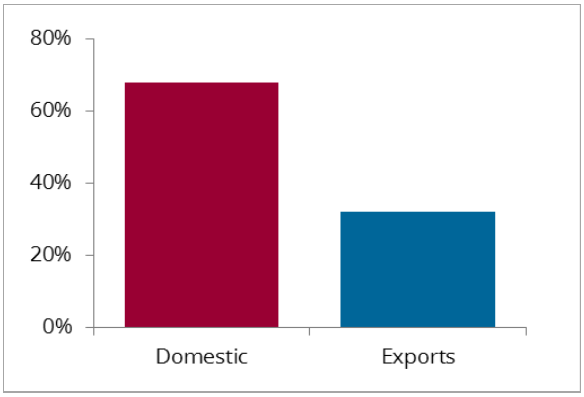



Source: Argus, *Statistical Review of Global LP Gas*

### *Saudi Arabia*

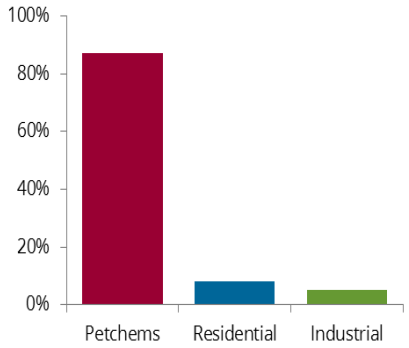
While Saudi Arabia is the Middle East's biggest LPG producer, most of this production is consumed domestically. In 2012, almost 70 per cent of LPG production was consumed in the petrochemical, industrial, and the residential sectors (Fig. 15). The petrochemical sector is by far the largest user of LPG accounting for 87 per cent of domestic consumption LPG consumption (Fig. 16).

**Fig. 15: Allocation of Saudi LPG production, %**




Source: Saudi Aramco

**Fig. 16: Saudi LPG consumption by sector, %**




Source: Saudi Aramco

The expansion of the petrochemical industry represents a major pillar in the Kingdom's development path. The aims are to promote industrialization based on locally available raw materials such as oil and natural gas, to diversify industrial production, and to generate employment. While basic chemicals production does not directly generate a large number of jobs, there is substantial potential for job creation down the product chain and in associated services. So far, however, the petrochemical industry has had limited impact on employment generation. Despite its important contribution to GDP, the petrochemical sector currently employs around 90 thousand workers who constitute only around 3.8 per cent of Saudi nationals in the workforce or 1.2 per cent of the total workforce.[20]

[20] Samba, 'Saudi Petrochemicals Sector: Current Situation and Future Prospects,' August 2009.

The main feedstock used in Saudi petrochemical plants is ethane, followed at some distance by NGLs (propane and butane). All of these are mainly derived from natural gas. Some petrochemical plants use light gasoline and naphtha as feedstock but only in modest volumes. The reliance on ethane results in an unbalanced mix of basic petrochemical products that are heavily tilted towards methanol and ethylene. To address this unbalanced mix of the petrochemical slate, there is an increasing trend towards using liquid feedstock in petrochemical plants, though for the next decade the petrochemical industry will predominately remain a gas-based industry.

The policy of providing cheap feedstock at below international prices is a key element to fostering the Saudi petrochemical position in the global market and can largely account for the phenomenal growth of petrochemicals in the last two decades and the large domestic private and foreign investment flows into this sector. Natural gas prices for domestic use in Saudi Arabia have exhibited remarkable stability. In 1984, the government set the natural gas at the price of $0.50 per mmbtu. This price was maintained until 1998 when it was revised upwards to $0.75 per mmbtu. Despite the sharp rise in gas prices in international markets during the period 1998–2008, the Saudi government did not revise the natural gas price upwards. The price stability provided an additional source of competitive advantage for the petrochemical industry in Saudi Arabia especially when compared to its Asian and European competitors who relied on naphtha feedstock whose price was linked to the volatile crude oil prices. In addition, Saudi producers have a slight advantage over neighbouring Middle East petrochemical producers who also provide cheap ethane, but at a slightly higher price range between $1.00 and $1.25.[21]

While ethane seems to be the ideal feedstock for local producers, it suffers from two major disadvantages. The first relates to the increasing scarcity of ethane over the years. At the start of the Saudi industrialization programme, ethane was in abundant supply relative to domestic demand. However, this is no longer the case which creates large uncertainty as to whether the government can maintain its policy of guaranteeing a regular flow of ethane at cheap prices in the long term.[22] The second disadvantage relates to the fact that based on ethane, petrochemical plants can only produce low value and basic petrochemical products. Encouraging the production of more sophisticated products needed to create jobs for the rapidly expanding labour force will require a more sophisticated feedstock mix involving both ethane and liquids such as naphtha, butane, and propane.

As a consequence of limited supply of ethane, the government has been encouraging the use of more liquid fuels in the petrochemical sector and thus the share of ethane in Saudi petrochemicals crackers is expected to fall while that of propane, butane, and naphtha to rise (Fig. 17). A shift from a dominant share of ethane feedstock to a more mixed feedstock will result in higher input costs for the Saudi petrochemical sector, as naphtha, propane, and butane are relatively more expensive. Furthermore, a shift towards naphtha and other heavy feedstock will expose Saudi petrochemical companies to greater volatility in feedstock prices, as the discount will directly vary with the market price of naphtha. Thus, Saudi petrochemicals companies will have their cost advantage reduced, though at current prices, Saudi Arabia will still maintain the most competitive prices of feedstock.[23] Another factor that could soften the impact of potential increase in feedstock costs is that the change in the feedstock will allow Saudi petrochemicals to produce more speciality chemicals that could be sold at higher prices.

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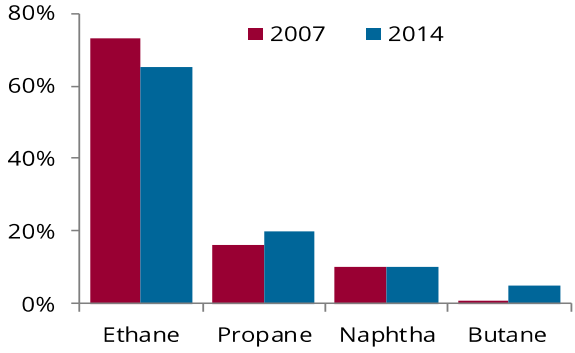
[21] As well as cheap ethane feedstock, local petrochemical plants also benefit from discounted prices of naphtha and NGLs. The pricing formula used to price the feedstock for domestic use is quite complex, with NGLs receiving 30 per cent discount to naphtha export prices and naphtha itself receiving an 11 per cent discount to its price in international prices. Thus, although naphtha prices are linked to crude oil prices and can be highly volatile, local producers still retain a substantial cost advantage.

[22] It may not have a big impact on petrochemical plants that have already secured their ethane allocation, but will certainly be the key factor in determining the viability of new investments in the sector.

[23] A. Perniceni, B. H. Hartmann, W. Van Asch (2014).

**Fig. 17: Changing feedstock in Saudi petchems, %**




Source: Rajhi Capital

The change in the feedstock mix means that less LPG would be available for exports. While crude production in Saudi Arabia has been at a high level in the last few years, LPG exports were still down as internal consumption of LPG has been on the rise. Between 2007 and 2012, Saudi LPG exports registered a negative compound annual growth rate (CAGR) of 12 per cent.[24] Looking ahead, the best possible scenario is for Saudi Arabia to maintain its LPG exports at the current level of about 8 mtpa[25], moderating the impact of higher US LPG exports on prices. Furthermore, Saudi Arabia's volume of LPG exports will become more dependent on internal dynamics and particularly on the maintenance of petrochemical plants. Therefore, the offering of unexpected spot cargoes occasionally will become a more regular feature of LPG trading. It is also worth mentioning that the Kingdom has flexibility in its LPG export policy: Saudi Arabia has large LPG storage facilities and has the option to spike some of its LPG into the crude stream.

### *Qatar*

Another key supplier in the East of Suez is Qatar. Qatar has recently overtaken Saudi Arabia as the region's biggest LPG exporter. Over the period 2007 and 2012, Qatar exports grew at an annual rate of 20 per cent.[26] Qatar's production of LPG is expected to rise by 500 thousand tonnes to 11.5 mtpa in 2014 with the commissioning of the Barzan Gas Project. More volumes are expected from the Bul Hanine oilfield development, which will add large quantities of ethane, propane, and butane.

However, as in the case of Saudi Arabia, the internal dynamics will affect the availability of Qatari export volumes. Diversification has been main a policy objective for the Qatari government as it is considered key for sustainable and stable economic growth, job creation, enhancing the role of the private sector in the economy, and protecting the economy from the wide volatility of commodity prices. The development of the petrochemical industry represents a major pillar in this diversification strategy. Unlike some of its neighbouring countries, which face gas shortages, Qatar's competitive position is quite strong given the size of the country's gas reserves, the nature of its gas reserves, which are mainly non-associated, its low cost structure, and its stable regulatory and business environment, which attracts foreign investment, skills, and technology. The Qatari petrochemical sector has made some important strides. In 2012, the value added contribution of the manufacturing sector to the economy in 2012 is estimated at $18.2 billion, out of which the chemicals sector represented 35.5 per cent or $6.7 billion. In terms of exports, chemicals accounted for 68 per cent of non-oil export in 2012. Qatar is currently

[24] A. Perniceni, B. H. Hartmann, W. Van Asch (2014).
[25] 'Qatar LPG exports will stay unchanged till 2018', Reuters, March 2014. http://www.tradearabia.com/news/OGN_253477.html
[26] A. Perniceni, B. H. Hartmann, W. Van Asch (2014).

the second largest chemicals producer in the GCC after Saudi Arabia, accounting for 15.3 per cent of the total GCC capacity in 2012.[27]

This rapid growth in the petrochemical industry has put additional demand on Qatar's gas reserves and NGLs. Looking forward, this trend is expected to persist. Qatar is expected to export around 10–11 mtpa of LPG between 2014 and 2017. But by 2018, exports are expected to fall as domestic consumption from the petrochemical sector increases. [28] Proposed domestic petrochemical projects such as Al Sejeel, Al Karaana, and Qapco project expansion will consume Qatari LPG volumes, cutting its exports to around 8–9 mtpa in 2018.

### *Abu Dhabi*

Qatar itself is facing competition from UAE for the top Middle East exporter. Between 2007 and 2012, UAE exports grew at a healthy rate of 8 per cent annually. UAE LPG output is expected to jump to 13.76 mtpa by 2017, an increase of 3.6 mtpa from 2013, as two new gas projects come on stream (the 3.3 mtpa Integrated Gas Development and the 810 thousand tonnes per annum Shah Gas Development).[29] But as in the case of Saudi Arabia and Qatar, it remains unclear how much of this increase will find its way into the export market, as this will depend in large part on domestic demand, mainly from the UAE's fast-expanding petrochemical sector. ADNOC and Abu Dhabi Gas Liquefaction Co (ADGAS) together exported about 8 mtpa of LPG in 2013. The Abu Dhabi National Chemicals Co. is developing the Madeenat ChemaWeyaat Al Gharbia chemicals industrial city which alone could eat up to 1 mtpa of LPG. However, while domestic demand is projected to increase in the next few years, Abu Dhabi is still expected to export just below 11 mtpa of LPG in 2015.[30]

## 5. Implications on LPG Markets

The shifts in supply and demand patterns of LPG are already having wide repercussions on global trade dynamics. On the supply side, the shale revolution has introduced the US as a new and powerful player, adding a new dimension to the global LPG scene. The sharp rise in US LPG exports has allowed Asian players to have access to new source of supply, competing for market share with some of the key traditional suppliers to Asia.

In terms of impact on LPG prices, the picture is less clear. While LPG output from the GCC is expected to rise in the next few years, there is large uncertainty regarding the volume of LPG available for exports. Internal demand dynamics and the drive towards diversification imply that a large percentage of the increment in production from the GCC will be used domestically, and hence the potential impact on LPG prices will not be as severe as some are predicting.[31] Liquid cracking could also offer opportunities for GCC producers to capture a larger share of the higher value petrochemical specialty products, which fits within GCC governments' policies and, rather than competing for LPG exports, GCC producers may end up relying more on propylene exports.[32]

Shipping costs will also provide some support for LPG prices. Shipping and terminal costs alone would be in the range of $200 per tonne, which suggests that the spread between propane CFR Tokyo and spot US Gulf Coast (USGC) prices will have to remain wide in order for the arbitrage to work. The completion of the Panama Canal will reduce shipping costs substantially, but only after that will the effect of US LPG be felt on prices. It is worth

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[27] GPCA (2013), 'GCC Petrochemicals and Chemical Industry: Facts and Figures 2012'.
[28] 'Qatar LPG exports will stay unchanged till 2018', Reuters, March 2014. http://www.tradearabia.com/news/OGN_253477.html.
[29] 'Abu Dhabi set to rival Qatar as top LPG producer, exporter: ADNOC exec', Platts, 14 June 2013.
[30] Ibid.
[31] However, it is important to note that, outside Saudi Arabia, there are limits on how much LPG could be diverted domestically given the smaller size of the petrochemical sectors in these countries and given that the economics of some of the projects depend on exportation of LPG.
[32] A. Perniceni, B. H. Hartmann, W. Van Asch (2014).

noting that the cost overruns associated with the Panama Canal may result in higher transit fees, but overall should cut shipping costs by at least $50 per tonne. Nonetheless, the spread between Asia and the US prices will have to be around $150 per tonne for any long-term arbitrage to work.

The biggest uncertainty however remains as to whether access to cheaper US LPG will induce Asian petrochemicals to start seeking alternative feedstock away from Middle East naphtha, which will have dramatic effect on LPG and naphtha markets and consequently on petrochemicals trade. In other words, US LPG exports to Asia could prove to be not only a positive supply shock, but also a shock to the structure of the petrochemical industry and petrochemical trade flows.