The Allen Consulting Group

# Review of the appropriateness of the current LPG international benchmark in the setting of domestic LPG prices

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Report to Australian Competition and Consumer Commission

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# Executive summary

## Scope of the review

The Australian Competition and Consumer Commission (ACCC) commissioned a review of the appropriateness of the current international liquefied petroleum gas (LPG) benchmark price — the Saudi Aramco Contract Prices (CPs) for propane and butane — for setting wholesale and retail prices in Australia. The review sought to analyse the pricing used for automotive LPG (autogas) rather than LPG used in traditional markets such as for residential and industrial purposes. However, there is a need to discuss LPG more broadly given the variety of uses of LPG.

The review takes into account the conduct or behaviour that is expected to occur in a competitive market for the wholesale supply of LPG in Australia noting that LPG is a global commodity, that Western Australia is a net exporter of LPG and that the Eastern states of Australia import propane and export both butane and propane.

## Characteristics of LPG market

LPG is the generic name for propane and butane. At normal pressures and temperatures these gases are colourless, odourless and heavier than air. LPG is produced from oil and gas fields ("field grade") and from refineries in the processing of crude oil ("refinery grade"). LPG can be used as an alternative fuel to natural gas (methane) in residential, commercial and industrial applications, as an alternative to gasoline for automotive fuel purposes, and as a feedstock in petrochemical applications. In Australia, propane and butane are sold both separately and as a blended fuel into the automotive market (autogas).

LPG is a relatively "new" commodity. While the international use of LPG has increased substantially over the past two decades, its market continues to develop. Oil and petroleum products — like gasoline (petrol) and diesel — have more mature trading markets. The international LPG industry is less liquid and is dominated by large producers and merchants/resellers. The actions of traders and "market makers" are limited relative to the oil industry. The industry structure in most of Asia is vertically integrated from production to downstream markets. As a consequence, pricing structures in Asia are primarily "cost plus".

The LPG market is different from the oil market. Relative to oil, the infrastructure costs of LPG are considerably higher. LPG is stored and shipped in specialised refrigerated or pressure tanks, whereas tankage and shipping for oil and petroleum products is significantly less expensive. LPG producers and users therefore have close regard to capital costs in building tanks. Tankage is scaled to "just meet" parcel sizes.

In order to meet tight scheduling requirements, LPG producers seek customers who can reliably take "on-time" delivery. They therefore have a preference for buyers who have ongoing access to LPG ships. For this reason, many LPG buyers (particularly in Asia) have either company owned or time chartered LPG ships. By contrast, not many buyers of refined petroleum products have exclusive access to shipping.

Weight, dimension and cost issues restrict LPG vessel size and therefore the cost of delivery and logistics of parcel size. The largest LPG ships[1] in regular use can transport 44,000 tonnes, or approximately 500,000 barrels. Many crude oil ships transport more than 2 million barrels, with several capable of transporting over 3 million barrels. The relatively smaller size of LPG ships increases the "per unit" shipping cost of LPG relative to oil.

While this review primarily addresses LPG used for automotive fuel, LPG cannot be analysed without an understanding of the importance of security of supply to LPG used in domestic (heating and cooking, or "traditional") markets in Asia. In these markets (dominated by Japan and Korea) LPG is regarded as a utility fuel and wholesalers demand security of supply from suppliers. Many customers integrate upwards by owning or controlling their own LPG ships and tanks to afford them more control over supply and delivery scheduling.

The relatively high capital and operating cost of infrastructure, and concern by both sellers and buyers about timeliness of delivery, results in a market with fewer sellers, buyers and traders than occurs in the oil and petroleum product markets. Sales are overwhelmingly made on a term contract basis, and supported by term charter shipping arrangements. When viewed from the outside, LPG appears to be many years behind oil, refined product and pipeline gas in market maturity and sophistication.

### The international market

Saudi Arabia produces approximately 10% of world LPG, or 22% of combined Middle East and Asian production. They are the world's largest exporter. The combined LPG exports of Saudi Arabia, UAE, Kuwait, Iran and Qatar represent more than 40% of total world exports, and an even greater share of Asian LPG imports.

The contract price set by Saudi Arabia (Saudi CP) each month is the dominant price for LPG in Asia and internationally. This price is quoted "free on board" (FOB) Ras Tanura[2].

Like most oil and refined product prices, the Saudi CPs for propane and butane are effectively "spot market" related term contract prices. The methodology that Saudi Aramco applies to determine the monthly price is not published, but it regularly briefs its term customers on the factors it takes into account in setting monthly contract prices. The Saudis engage in direct discussions with customers through their marketing offices in Tokyo, Singapore, Beijing, London and Houston. The Saudi CP is set for the month and may include a "catch-up" to reflect instances if the previous month deviated significantly from spot market levels.

All Middle East sellers reflect the influence of the Saudi CP in their price determination. In Asia about 80% of LPG is priced relative to the Saudi CP, either directly or indirectly through the influence of Saudi CP on the pricing policy of other countries.

[1] The common term for these ships is "Very Large Gas Carrier" or VLGC.

[2] Ras Tanura is the primary loadport in Saudi Arabia.

In recent years, the rise in Chinese demand has increased the prominence of Far East or North Asian delivered spot prices for LPG. A market has developed for "flat price near-term"[3] LPG prices because of the Chinese buying preference for the "spot" method of purchase. In a normal week, 1-2 cargoes are transacted on a fixed price delivered into Far East or North Asian locations. Several price quotation systems now make market assessments of these prices. Argus and Platts are the most widely used of these market assessments. These prices are commonly described as "CFR FEI" (Cost and Freight, Far East Index as published by Argus) or "North Asian Zone LPG" prices (as published by Platts). Argus is the most widely accepted market quotation for LPG in the Asian market. Argus makes an assessment each business day of the market price of propane and butane delivered into Japan and southern China. The price of each location is averaged to produce the CFR FEI assessment.

Total Chinese imports (term and spot) in 2008 were approximately 12% of Asian imports. However, not all spot purchases are made on a flat price basis. Many are priced relative to the prevailing market price around the time of delivery.

The Argus CFR FEI is more widely used than the Platts LPG index in the Asian market. However, there are some concerns about its use as an accepted industry wide benchmark for the Asian market. Specifically:

- While a methodology is published and generally understood, lack of market liquidity is an issue. Normally, 1-2 market deals can be the basis for ten (one quote per day for each of propane and butane) quotes over a week.
- Argus accepts as valid any deal of 11,000 tonne or more of either propane or butane. Cargoes do not need to be "on-specification".
- There are less stringent criteria for vessel acceptability to most receiving ports when compared with Japan, Korea and Australian vessel acceptability standards. Lower standards for shipping generally mean cheaper freight.

Given the lack of liquidity in the market, there is industry scepticism at times about whether daily LPG pricing is representative of meaningful market levels. A significant market participant commented that LPG pricing was subject to occasional influence by market participants. Examples of traders executing part parcels at unrepresentative prices so as to favourably influence pricing of multiple cargoes were cited. In such an illiquid market, this type of influence is not hard to accomplish, although the distortion may only be prevalent for a few days before returning to normality.

Despite these concerns, the Argus CFR FEI prices when averaged over the month are a reasonable reflection of the LPG market. This is evidenced by the close relationship between Argus CFR FEI and the Saudi CP prices (when appropriate lagging is applied).

[3] "Flat price near-term" refers to a fixed price transaction for a cargo loading or to be delivered in the near-term (usually 2 – 6 weeks).

## The Australian market

Historically, LPG was primarily used for heating and cooking in non-reticulated gas areas. As a response to rising oil prices in the 1970s and 1980s, the Australian government encouraged the use of autogas as a petrol substitute by making LPG exempt from the fuel excise that was imposed on petrol and diesel. This policy was very successful in stimulating autogas use. Australia now has one of the highest market penetrations of autogas use in the world. It is the 5th largest user by volume, and the 2nd largest user (after South Korea) on a per capita basis. As a consequence of autogas competing directly with petrol for the transportation market, some of the pricing, market structure and distribution issues associated with petrol also pertain to autogas.

### *International trade balance*

Australia produces about 3 million tonnes of LPG per annum or approximately 1% of world production. Most production occurs in association with gas and oil production (primarily the North West Shelf (NWS), Gippsland and Cooper Basin), but over 500,000 tonnes (16% of total production) is also produced in the refining process. Australia is the largest non-Middle East exporter east of Suez with annual exports of approximately 1.5 million tonnes per annum. Despite this, Australia's ability to influence international LPG prices is minimal.

Australian exporters (ExxonMobil and BHP Billiton from Westernport, Santos and partners from Port Bonython and the NWS partners from Karratha) selling to Asian customers are able to negotiate a small premium above the price achieved by Middle-East suppliers. For East Coast producers, this premium in recent years has been $US5-15/tonne relative to the Saudi CP reflecting the freight advantage and backhaul opportunities resulting from access to VLGCs used for imported propane into the East Coast. International freight rates have been much lower since mid-2008, and as a consequence the differential would be lower if it was negotiated now. NWS producers also have a location advantage, but operational and scheduling difficulties can offset some of this premium.

Notwithstanding the fact that Australia is a large exporter, infrastructure and logistical issues mean that Australia also imports LPG (propane) into Sydney, Brisbane and occasionally Perth. The marginal supply into both the East Coast and Western Australia is therefore costed on the basis of imported supply.

### *Domestic market segmentation*

The Australian LPG market is segmented into the East Coast (Victoria, NSW, Queensland, South Australia, Tasmania and Darwin) and Western Australia. For infrastructure and logistical reasons, there is little inter-regional trade between these markets.

These infrastructure and logistical issues have a profound effect on the domestic wholesale marketing of LPG. Due to the requirement to service the "traditional" propane-only market and the high capital cost of LPG storage, the Sydney, Brisbane and Kwinana receiving facilities only import propane. No Australian production facility has sufficient propane storage to fully load a VLGC. As a consequence, it is more economically attractive for Australian importers to source foreign LPG and for Australian producers to export rather than execute sub-economic domestic delivery.

### *East coast*

Three primary price/economic "anchor points" that determine East Coast pricing parameters are:

- the export price from Westernport in Victoria:
- the import price into the Botany Cavern in Sydney: and
- the import price into Moreton Bay near Brisbane.

East Coast buyers and sellers other than Exxon and BHP Billiton (Westernport), Elgas (Botany Cavern) and Origin (Moreton Bay) do not have significant impact on the supply/demand balance, nor the power to influence domestic market prices. Buyers and sellers at other locations estimate freight and logistical variances from Westernport, the Botany Cavern and Moreton Bay, and price accordingly.

Darwin is a small propane market. Kleenheat operates a storage facility with a capacity of approximately 1000 tonnes, therefore "parcel sizes" are likely to be 700–800 tonnes. Darwin is generally supplied from Origin's Moreton Bay imports. The delivered cost of importation to Moreton Bay plus the cost of shipment to Darwin on a small pressurized ship is similar to, or lower than, the cost of importation via a small pressurized ship from Asia or by road freight from South Australia or Western Australia. As a consequence of the cost of freight, the prevailing market price is significantly higher than either the eastern states or Western Australia.

### *Western Australia*

Infrastructure and logistical factors limit the amount of NWS LPG that can be delivered into the Perth region. As a consequence, the Perth market is, at the margin, priced/costed based on propane imported in smaller semi-refrigerated or part-loaded refrigerated vessels. Perth's relative proximity to the Middle East partially offsets the sub-economic parcel sizes.

## Pricing basis

The common element for the East Coast and Western Australian markets is the price linkage to the Saudi CP. This pricing basis represents either the value of the alternative purchase (import) or sale (export).

Saudi CP is the dominant pricing basis in Australia with:

- approximately 80–85% of Australia's 1.5 million tonnes per annum (mmtpa) of LPG exports (1.0 mmtpa North-West Shelf (NWS), 0.4 mmtpa Gippsland and 0.1 mmtpa Cooper Basin) are conducted on a Saudi CP-related basis. It is probable that all Gippsland LPG exports are sold on a Saudi CP-related basis, and that while some Cooper Basin LPG exports may have been sold on "CFR FEI" basis to Asian petrochemical customers, most is sold on a Saudi CP-related basis. The remaining 15–20% are NWS shipments sold to affiliates in China on an Asian pricing basis, using the Argus CFR FEI.
- all Australian imports of LPG are purchased on a Saudi CP basis. It is unlikely that any Australian importer (Elgas, Origin, Wesfarmers) has ever purchased LPG on a CFR FEI basis.

- all Australian domestic wholesale LPG contracts are priced relative to the Saudi CP.

The use of daily Argus CFR FEI in the pricing of Australian automotive LPG (even if it was adjusted for the freight differential to Australian import locations) is not appropriate. The comparative quality, location and shipping issues that pertain to the sales that form the basis for the Argus CFR FEI are sufficiently different for Australia to render the Argus CFR FEI non-representative for the Australian market.

### Price relativities

Domestic wholesale autogas prices are currently negotiated at price levels between export parity and import parity. Prices are negotiated at each supply point (LPG plant, refinery or marine loading facility) that reflects the comparative location advantage or negotiating position of the seller. As a consequence, prices are different at each location.

When viewed relative to the cost differentials in the gasoline and diesel market, LPG cost differentials are large. Freight and storage costs for LPG imported into Sydney represent approximately 20% of the total delivered cost[4]. The "arms-length" calculated cost of delivery and storage into Brisbane since Origin commenced use of a VLGC as "floating storage" in Moreton Bay is approximately 50% or US$68/tonne higher than Elgas' Sydney storage cavern. For Perth, higher costs associated with the requirement to use smaller semi-refrigerated or part-loaded refrigerated ships, and older storage means that freight and storage costs are likely to be approximately 25% or US$35/tonne higher than Sydney despite Perth being closer to the Middle East. The calculated cost of delivery and storage for northern Queensland or Darwin is more than double (US$162/tonne higher) the cost into Sydney due to the need to use pressurized rather than refrigerated ships and smaller storage facilities.

Logic demands that sellers must be able to recoup their costs for these transactions. If market prices do not reflect costs of acquisition, there would be no incentive to operate existing import facilities or invest in supply infrastructure where shortfalls occur.

Market prices must be higher than export parity prices because the marginal supply into Sydney, Brisbane and Perth (when required) continues to be sourced from foreign suppliers. In general, imports are the lowest cost alternative for most marine receiving locations because storage limitations at domestic supply points result in uneconomic freight economics.

From a LPG producer's perspective, unless domestic prices exceed their export parity prices, they would have no incentive to supply the domestic market because of higher costs associated with supply to this market. Domestic customers invariably purchase in smaller shipments than export customers (resulting in higher per unit operating cost, credit management, administration, etc), and require them to maintain expensive storage, terminal and delivery facilities like truck loading operations.

[4] The assessed average price of propane imported into Sydney during 2005 – 2008 was $US715/tonne, comprised of the average Saudi CP of $US576/tonne and the combined cost of freight, insurance, port fees, storage and terminal fees and product premiums of $US139/tonne.

Saudi CP is likely to remain the prevailing benchmark price for most Australian exports and all of its imports until the international market evolves. Production from new sources like Qatar will increase significantly over the next few years. Depending on how this volume is marketed and priced, this may reduce the relative importance of Saudi contract prices as an international pricing basis.

*Chapter 1*

# Introduction

## 1.1 Terms of reference

The review focuses on the appropriateness of the current international benchmark and the parity pricing used in the setting of wholesale and retail prices in Australia.

- *Benchmark*
  - Analyse the appropriateness of the current Saudi benchmark prices for use in determining domestic LPG prices. In this context:
    - Assess the past and present liquidity in the Saudi benchmark prices.
    - Identify and analyse any potential alternatives for the benchmark price for use in setting domestic LPG prices, including their liquidity.
- *Parity Pricing*
  - Analyse the parity pricing approach used for the setting of automotive LPG prices and the extent to which it differs from the Import Parity Pricing (IPP) formula for unleaded petrol and diesel prices.
  - Analyse the different parity pricing approaches used in various locations across Australia and the extent to which pricing varies between IPP and Export Parity Pricing (EPP).
  - Analyse the components of the IPP and their contributions to it.
  - Report on the costs, structures and economies of LPG transportation to and from Australia.

## 1.2 What makes a good benchmark?

There are a number of attributes and characteristics that need to be considered when analysing the appropriateness of an international benchmark price in determining or influencing domestic prices.

These features may be common to different commodities. In respect to crude oil, BP has noted that characteristics such as representative quality, tradability and market acceptance, among others, are crucial in recognising a particular price for a commodity or index as a regional or global benchmark (Box 1.1).

Box 1.1

**WHAT MAKES A GOOD BENCHMARK?**

- Representative quality
- Geographic relevance
- Wide range of users and sellers
- Tradability
- Link to paper instruments
- Sufficient traded volume
- Market acceptance

Source: BP.

With respect to assessing the appropriateness of the Saudi Aramco Contract Prices for propane and butane (Saudi CPs) and other regional LPG benchmarks, the criteria listed in Table 1.1 is a general guide. For example, how objective are the price assessments by Saudi Aramco or other regional prices/indices and to what extent are the specifications or quality of the LPG traded consistent over time?

Table 1.1

**BENCHMARK CRITERIA**

| Attribute | Comment |
|---|---|
| **Unambiguous** | Is the price published and known to the market on a set schedule? |
| **Representative of commodity** | Relationship to other energy sources |
| **Responsiveness** | Does the benchmark respond to changes in the market? |
| **Methodology** | Is there a published methodology? |
| **Transparency** | Can the prices be verified? |
| **Liquidity** | How much of the trade uses the benchmark? |
| **Objective** | How objective is the price assessment? |
| **Standardized commodity** | Is it unambiguous or is it variable? |
| **Frequency of data** | Is the information published regularly? |
| **Financial instrument** | Are financial derivatives traded on the price basis? |
| **Relevance** | Is the pricing data used for contract pricing? |
| **Availability of history** | Is data available for historical comparison? |
| **Independent** | Is the price published by an independent organization? |

Source: Internal analysis.

## 1.3 Structure of the report

This report reviews the appropriateness of the current international LPG benchmark price (the Saudi CP) for setting wholesale prices in Australia. The report is structured as follows:

- *Chapter 2* provides an overview of the LPG industry focusing on quality (product specification), freight and shipping characteristics, and infrastructure issues.
- *Chapter 3* discusses international supply and demand for LPG and global trade flows. LPG price linkages with other commodities are also discussed.
- *Chapter 4* discusses pricing in the LPG market with the focus in the Asian region. The Saudi CP and other regional LPG benchmarks are analysed in detail when considering the most appropriate international benchmark for LPG.
- *Chapter 5* provides background to the Australian LPG market, including discussion on supply and demand for LPG and storage.
- *Chapter 6* examines the pricing of LPG in the Australian market. It discusses pricing for imports and exports of LPG and how domestic prices are determined in different locations in Australia.
- *Chapter 7* outlines the pertinent issues and draws conclusions.

*Chapter 2*

# Industry background

## 2.1 What is LPG?

Liquefied Petroleum Gas (LPG) is the generic name for a mixture of hydrocarbon gases, mainly propane and butane. At normal pressures and temperatures these gases are colourless, odourless and heavier than air. LPG can be used as an alternative fuel to natural gas (methane) in residential, commercial and industrial applications, as an alternative to gasoline for automotive fuel purposes, and as a feedstock in petrochemical applications.

LPG (propane and butane) is produced from oil and gas fields ("field grade") and from refineries ("refinery grade") in the processing of crude oil. Historically, LPG was seen as a waste or by–product from processing of crude oil, which presented refiners with a disposal problem. It was the harnessing of gases associated with crude oil production and the capturing of natural gas streams previously flared by oil explorers in the 1950s in the USA and 1960 and 1970s in the Middle East which provided the opportunity for development of large volumes of field grade LPG suitable for consumers in developing markets, particularly in Asia.

Both propane and butane are gaseous hydrocarbons at normal temperatures (15 degrees Celsius) and atmospheric pressure. However, they can be stored and distributed in liquid form at temperatures of under minus 45 degrees and minus 2 degrees Celsius for propane and butane respectively or contained under pressures of greater than fourteen atmospheres for propane and four atmospheres for butane. Typical properties of LPG are illustrated in Table 2.1.

Table 2.1

**TYPICAL PROPERTIES OF LPG**

| | Propane $C_3H_8$ | Butane $C_4H_{10}$ |
|---|---|---|
| Liquid density | 0.50–0.51 | 0.57–0.58 |
| Conversion: | | |
| • litres per tonne | 1968 | 1732 |
| • barrels per tonne | 12.4 | 10.8 |
| Gas density / air | 1.40–1.55 | 1.90–2.10 |
| Ratio gas / liquid (volumes) | 274 | 233 |
| Boiling point deg. C | -45 | -2 |
| Latent heat (vaporisation) | 358KJ/lkg | 372KJ/kg |
| Specific heat (as liquid) | 0.60 Btu/deg | 0.57 Btu/deg |
| Sulphur content | 0–0.02% | 0–0.02% |
| Flammability limit | 2.2–10.0% | 1.8–9.0% |
| Calorific Values | 2,500 Btu/ft3 | 3,270 Btu/ft3 |
| | 21,500 Btu/lb | 21,200 Btu/lb |
| | 11,900 Kcal/kg | 11,800 Kcal/kg |
| | 50.4 MJ/kg | 49.5 MJ/kg |
| Minimum ignition temp. | 460 deg C | 410 deg C |

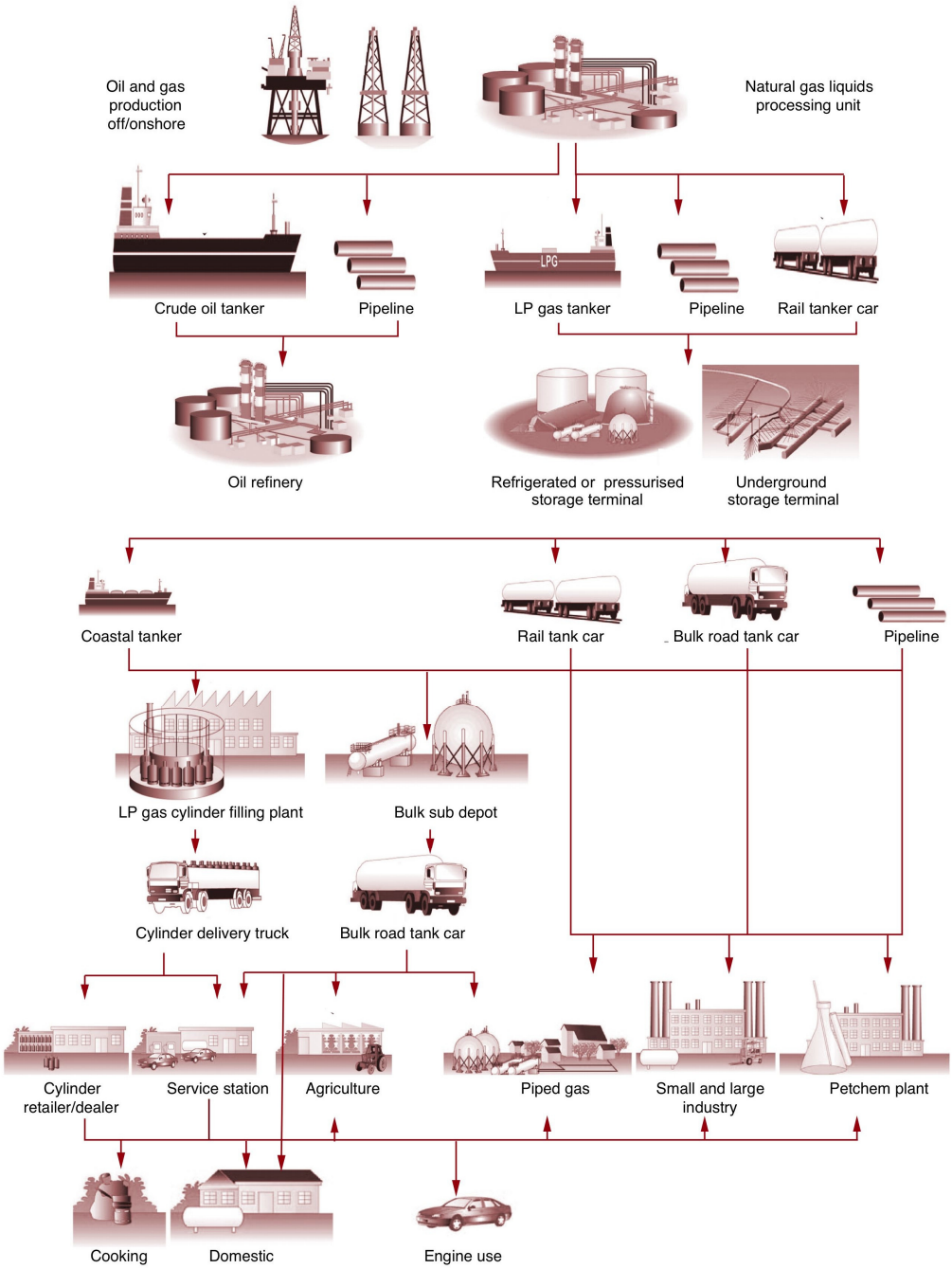
Source: Statistical Review of Global LP Gas 2008.

LPG can be stored and transported as a liquid in purpose built pressurised containers, with a resulting reduction in volume of approximately 270 times (propane) and 230 times (butane). As a liquid, LPG is ideally suited as a transportation fuel.

A schematic of the distribution chain of LPG from upstream production, storage, and delivery to end-users is provided in Figure 2.1.

Figure 2.1

**LPG DISTRIBUTION CHAIN**




Source: WLPGA.

## 2.2 Product specifications

LPG specifications can vary significantly between countries. Propane and butane used in quality conscious Japan and Korea is of high standard compared to allowed product standards in some developing countries of the world.

Early LPG specifications such as in the USA (e.g. Gas Processors of America specification) were based around performance requirements with limits guaranteed on contaminants.

Field grade producers in the Middle East and in Australia coming on stream in the 1970s to the 1990s had access to better processing technology and were able to guarantee limits on the composition of their propane and butane.

One of the earliest benchmark standards established (and still in use today) was the Saudi Aramco specification for both propane and butane. These guaranteed minimum levels of propane in their propane stream and the same with butane (e.g. 95% pure propane and 97% pure butane). In common with the performance specifications, limits were also provided on contaminants such as sulphur and residue.

### *Propane*

The Australian producers designed their plants to produce propane to meet Japanese product specification requirements in order to compete with Saudi exports to Japan (Table 2.2). Japan's requirement initially was for propane for residential use.

Table 2.2

**PROPANE SPECIFICATION**

| Refrigerated Propane Specification | Saudi Aramco | Gippsland Export |
|---|---|---|
| Composition (vol %) | | |
| Ethane (max) | 2.0 | 2.2 |
| **Propane (min)** | **95.0** | **95.0** |
| Butane (max) | 4.0 | 3.0 |
| Pentane + (max) | 0 | 0.2 |
| Unsaturates (max) | 0.1 | 0.1 |
| Corrosive compounds, copper strip max number | 1 | 1 |
| Total sulphur, max ppm | 30 | 30 |
| Vapour Pressure, max kPa | 1380 | 1480 |
| Free Water Content | Dry | Dry |

Source: Saudi Aramco product specification A160 and BHPB website.

### *Butane*

Middle Eastern and Australian producers also produced butane, which was also exported. This led to the Japanese expanding the uses of butane into both automotive and industrial applications such as ceramics and paint drying. All require high quality butane with very low limits set for residues on evaporation and Australian field LPG exporters to Japan have to meet these standards.

As with propane, butane specifications between Saudi Aramco and Australian exporters were also very similar (Table 2.3).

Table 2.3

**BUTANE SPECIFICACTION**

| Refrigerated Butane Specification | Saudi Aramco | Gippsland Export |
|---|---|---|
| Composition (vol %) | | |
| Propane (max) | 2.0 | 3.0 |
| **Butane (min)** | **97.0** | **97.0** |
| Pentane + (max) | 1.0 | 2.0 |
| Unsaturates (max) | 0.1 | 0.1 |
| Corrosive Compounds, Copper strip max number | 1 | 1 |
| Total sulphur, max ppm | 30 | 30 |
| Vapour Pressure, max kPa | 483 | 520 |
| Free Water Content | Dry | Dry |

Source: Saudi Aramco product specification A160 and BHPB website.

### *Automotive LPG specifications*

Early automotive specifications were performance based (performance specification) and required producers to meet octane and vapour pressure limits. Since the late 1990s, European specifications particularly for automotive LPG (EN Standards) set exacting standards for performance and emission outcomes to be met by minimum and maximum proportions of propane and butane depending on region and season.

The Japanese automotive LPG specification also provides for varying amounts of propane and butane for different regions of Japan and for each season in those regions due to vapour pressure and engine startability requirements.

In general, warmer regions of the world tend to blend more butane into their automotive LPG (as well as into their residential LPG) such as in countries around the Mediterranean, South China and SE Asia. Warmer temperatures reduce concerns regarding vaporisation and engine startability as butane will vaporise at minus 5.0 deg C. Conversely, colder regions will blend more propane into their autogas where effective vaporisation at low temperature requires the influence of propane with its the lower vaporisation of propane at minus 45 deg C.

The USA and Canada do not have an extensively developed automotive LPG market.

The specifications in the developing world are far less stringent and in many cases there are no published specifications.

### *Australian automotive LPG specifications*

Automotive LPG specifications in Australia are determined by the Department of Environment, Water Heritage and the Arts. The Fuel Standard (Autogas) Determination 2003, is a performance specification and, among other things, highlights the necessary fuel parameters to improve environmental outcomes and ensures the quality of autogas in the market place.

The characteristics of the LPG fuel standard in Australia are listed in Table 2.4.

Table 2.4

**AUSTRALIAN AUTOGAS STANDARD**

| Parameter | Standard |
|---|---|
| Motor octane number | 90.5 min |
| Vapour pressure @ 40 deg C (kPa) | 800 (min)<br>1530 (max) |
| Volatile residue ($C_5$ plus)(mol %) | 2.0 max |
| Residue on evaporation (mg/kg) | 100 |
| Corrosion, copper strip | Class 1 |
| Hydrogen sulphide | Negative |
| Sulphur (after stenching) (mg/kg) | 100 |
| Dienes (mol %) | 0.3 max |
| Moisture content (@ 0 deg C) | No free water |
| Odour (LFL) | 20% |

Source: Department of Environment, Water Heritage and the Arts.

Work undertaken in 2001 by the Australian Government department of the Environment Australia (now known as the Department of Environment, Water Heritage and the Arts) examined the relative merits and considerations of propane and butane in establishing the Fuel Standard for automotive LPG. It concluded that a 50/50 blend is most suitable in meeting vehicle performance, vaporisation and emissions requirements across the nation's temperature extremes, including addressing the issue of excess supply of butane in Australia.[5]

Being a performance based standard, the Australian Autogas standard does allow for variation in the composition of autogas, provided that the test parameters (vapour pressure, motor octane number, etc) are met. Therefore, in practice, the mix of propane and butane used for automotive LPG in Australia varies. In areas supplied by marine shipment, autogas is generally propane because these facilities have either no, or limited butane storage. In areas where refinery supply or direct supply from field production is possible, the autogas may have about 50% butane in the mix.

## 2.3 Infrastructure

LPG is a gas but can be stored as a liquid if it is pressurised or refrigerated or both. As a result, the facilities involved in the production, storage, transportation, dispensing of LPG and the appliances and equipment need to be designed, built and maintained to meet special high pressure or low temperature safety considerations. The steel used in the construction of these facilities is also of a higher standard and thickness than used for the storage of other liquid fuels.

[5] Refer to "Proposed Standards for Liquefied Petroleum Gas (Autogas)" prepared by Environment Australia, October 2001.

Due to the high cost of these specialized steels, LPG storages are usually scaled by the producer to just meet offtake parcel size with little scheduling "freeboard". The tanks in LPG ships are also constructed using specialized steels and are thus more expensive to build and hire than petroleum products vessels.

Delays in arrival of LPG vessels at the load port can result in storage tanks being filled to capacity necessitating suspension of production of crude oil and/or natural gas and LPG[6]. Conversely, delay in accumulation of the parcel size to be loaded on to the vessel will result in high demurrage claims from the ship owner.

It is understandable that a symbiosis between offtake dependent LPG producers and supply dependent LPG consumers often prevails in world LPG trading.

In the residential market segment internationally, LPG can be viewed in a similar light to a utility fuel such as natural gas. Customers in this segment seek reliable and uninterrupted delivery to the LPG cylinders adjacent to their dwellings. A reliable supply chain consisting of a reliable supply source or sources, reliable transportation and reliable distribution is imperative for these LPG consumers.

Automotive use of LPG is an expanding market. In this respect, Australia has been in the forefront especially in its southern states.

The symbiosis embracing both security of supply and security of offtake leads to most of the world trade in LPG being conducted under term contract arrangements. Trade in LPG is thus not as "liquid" as trade in petrol or diesel due to fewer "spot" deals.

Due to their costs, LPG storages are not as capacious relative to offtake or delivery parcel size as those constructed for petroleum products. Storages world wide for LPG is much more limited than petroleum product storage and consequently trade in LPG is not as broad or deep as petrol or diesel. Spot sales and purchases in petrol and diesel are more extensive than they are in LPG and as a result, relatively liquid spot market price benchmarks can be derived. Examples of this include the Platts price series for petrol and diesel that are based on Singapore market prices. Attempts have been made to develop similar series for LPG based on spot LPG sales mainly into China. These are discussed later in this review.

## 2.4 Shipping

It was the development of seaborne refrigerated LPG transportation in 44,000 tonne capacity "Very Large Gas Carriers" (VLGCs) during the 1970s and 1980s that facilitated growth in world LPG seaborne trade flows. Australian producers of "wet"[7] gas and producers of crude oil were able to separate and capture the LPG. Asian customers provided a growing market if producers constructed LPG fractionation facilities and refrigerated tanks for propane and butane of a size compatible with loading of a VLGC. Producers operating the Gippsland, Cooper Basin and the North West Shelf (NWS) fields have invested in such facilities and have been able to access the quality conscious LPG markets in North Asia.

Field grade propane and butane needs to be reliably and consistently shipped to allow continuity of oil and /or gas production.

[6] This situation is described as "shut-in" of production.

[7] "Wet gas" is a gas stream that has a high content of propane, butane and condensate.

Field producers almost universally produce LPG in separate streams of propane and butane and store large volumes of these under refrigeration for subsequent transport to markets. Some, such as the Gippsland LPG producers, also provide for the storage and loading of pressurised LPG onto road tankers and smaller LPG vessels.

Typically large volumes of LPG greater than 10,000 tonnes are stored and transported using the refrigerated method whilst volumes under about 3000 tonnes are contained and transported in high-pressure tanks. Intermediate volumes are transported in semi-refrigerated vessels. Semi-refrigerated vessels transport LPG at higher temperatures than LPG in refrigerated state, and therefore require higher pressures in their tanks to maintain the LPG in a liquid state (Table 2.5).

Table 2.5

**LPG SHIPPING**

| LPG Ship Type | Typical Characteristics |
|---|---|
| Refrigerated | Large volume, long distance trade |
| Semi-refrigerated | Small/medium volume, short distance trade |
| Pressurised | Small volume, short distance trade |

Source: Purvin & Gertz.

### *Refrigerated*

With larger volumes of field grade LPG available from the 1970s especially from the Middle East, Japanese and European shipbuilders strove to build larger and more efficient refrigerated LPG tankers to allow the transport of propane and butane over long distances to energy hungry countries like Japan and Korea.

These efforts culminated in the development of the VLGC of 75–85,000 cubic metres or cargo capacity of 44–47,000 tonnes of LPG. This still remains the most efficient means of transporting LPG in bulk by sea.

It is usual in world seaborne LPG trading for both propane and butane to be both stored and shipped in separate tanks. This is because propane and butane have different uses in the importing countries. A typical VLGC of 44,000 tonnes will usually have 4 tanks each of approx 11,000 tonnes capacity. On the more modern VLGCs, each of these tanks will be capable of handling both propane and butane.

Transportation of full (44–47,000 tonnes depending on the specific gravities of the LPG) cargoes of either propane or butane is thus possible as long as both loading and discharge storages of each are compatible. There are few loading and receiving terminals that have more than 50,000 tonnes of working storage or regular ullage for one grade of LPG, so such cargoes are the exception rather than the rule.

Usually VLGCs trade with 2 tanks under propane (approx 21,000 tonnes) and 2 tanks under butane (approx 23,000 tonnes) with the lower tonnage due to propane having a lower specific gravity than butane.

Transporting LPG with separate tanks is also consistent with typical field production ratios of propane and butane. Exporters who produce LPG richer in butane (like the NWS project) may ship in 1/3 propane/butane tank segregation. Propane rich exporters may ship in a 3/1 propane/butane tank segregation.

It is possible that propane and butane could be blended for automotive use in certain importing countries. However, other uses of each of propane and butane in these countries often outweigh automotive use thus maintaining the need for separate handling.

### *Semi-refrigerated and pressurised*

Smaller volume LPG markets accessible by sea are however supplied in smaller pressure or semi-refrigerated vessels. Such markets exist in the Mediterranean, coastal China, the Pacific Islands, South East Asia and in Tasmania, the Northern Territory, Queensland and New Zealand. Pressure storages are usually less than 2000 tonnes and it is common for small coastal tankers to deliver to numerous ports (eg to Gladstone, Townsville and Cairns) on a "milk run". The LPG delivered to these low volume markets is much more expensive on a per tonne of LPG carried basis than if it was able to be delivered by larger refrigerated vessels due to the higher mass of steel required to keep the LPG as a liquid under pressure.

In addition to the higher cost per tonne, pressurised ships also take longer to load and discharge, incurring extra port, bunker and charter costs.

### *Freight rates*

A VLGC can cost more than twice the equivalent size of a petroleum products ship due to the higher quality cryogenic steels required for the VLGC. The cost of shipping LPG in both refrigerated and pressurised states is considerably higher than for petroleum products (Table 2.6).

Table 2.6

**COMPARATIVE FREIGHT RATES FOR LPG AND CRUDE OIL SHIPS**

| AVERAGE CHARTER RATES 2005–2007 (US$/MONTH) | | |
|---|---|---|
| | **LPG** | **Crude Oil** |
| 15,000 tonnes | 882,000 | |
| 30,000 tonnes | 1,058,000 | 675,000 |
| 44,000 tonnes | 955,000 | |
| 80,000 tonnes | | 903,000 |
| 130,000 tonnes | | 1,221,000 |
| 270,000 tonnes | | 1,374,000 |

**CONCLUSIONS:**

1. **Oil freight is much cheaper (per tonne shipped) than LPG**
2. **LPG ship charter rates show little variation by volume compared with oil**

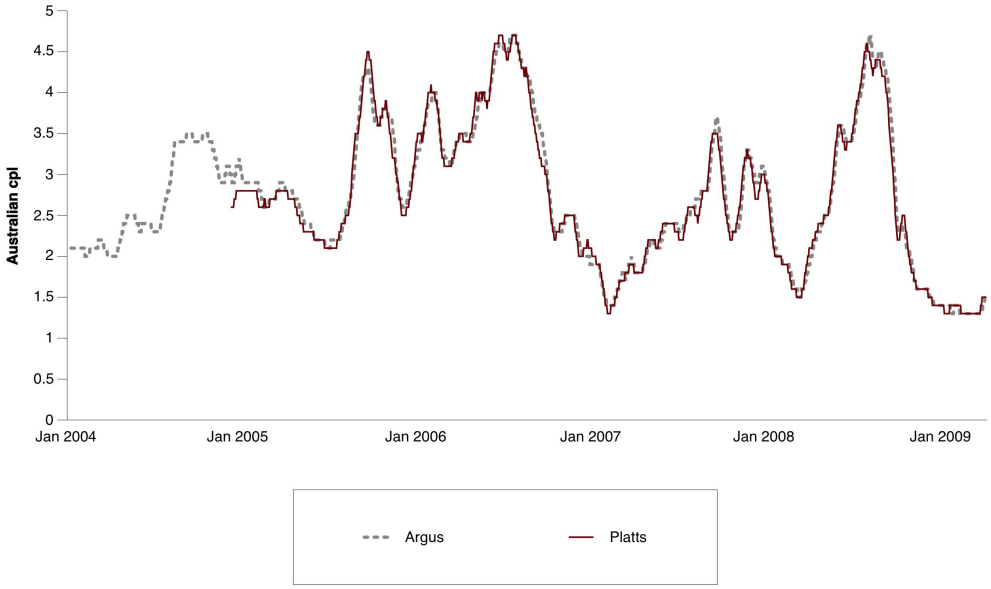
Source: WLPGA, Poten Partners.

As the majority of refrigerated LPG trade is on 44,000 tonne VLGCs from the Middle East to Japan and Korea, the main published LPG freight rates (US$/tonne) are for this route.

The Baltic Exchange is the major independent source of freight benchmarks, with over 550 members encompasses the majority of world shipping interests. Using a panel of international shipbrokers, the Baltic provides a daily assessment of the Middle East to Japan freight rate (US$/tonne). Argus and Platts also publish similar benchmarks. However the Platts benchmark is only for 20,000 tonne lots. There is a high correlation between all three freight benchmarks. Figure 2.2 illustrates freight rates in Australian cents per litre between the Middle East and Asia based on Argus and Platts assessments. In addition, Poten & Partners also publish an average monthly freight rate, which is often used in IPP calculations.

Figure 2.2

**FREIGHT ASSESSMENTS, MIDDLE EAST TO JAPAN**




Source: Argus, Platts, RBA, Internal calculations.

As a large proportion of refrigerated LPG is traded on a term basis, a time charter or TC rate is also widely published. This rate gives the monthly cost of chartering a VLGC. Unlike crude oil and refined product tankers rates, monthly charter rates of various size refrigerated LPG ships are comparatively similar. The 2005–2007 average monthly charter rate for LPG ships of 44,000, 30,000 and 15,000 tonnes[8] was US$955,000, US $1,058,000 and US $882,000 respectively (Table 2.7). Ample supply of large vessels and strong demand for smaller refrigerated ships meant that despite being able to load up to three times the volume, the total cost of the ship was virtually the same. This strongly favours the per tonne freight economics of VLGCs relative to smaller ships.

[8] Approximately 75,000, 54,000 and 24,000 cubic metres respectively.

Table 2.7

**LPG SHIPPING FREIGHT RATES**

| US$ per tonne[1] (Spot freight rates) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **From** | **To** | **1997** | **1998** | **1999** | **2000** | **2001** | **2002** | **2003** | **2004** | **2005** | **2006** | **2007** |
| **Middle East** | | | | | | | | | | | | |
| Ras Tanura | Japan | 29 | 26 | 26 | 39 | 31 | 21 | 29 | 36 | 41 | 48 | 37 |
| Yanbu | NW Europe | 31 | 30 | 27 | 37 | 30 | 24 | 30 | 34 | 34 | 45 | 38 |
| Yanbu | US Gulf Coast | 41 | 37 | 37 | 50 | 43 | 37 | 44 | 53 | 57 | 72 | 56 |
| **Mediterranean** | | | | | | | | | | | | |
| Algeria | NW Europe | 12 | 12 | 11 | 15 | 13 | 12 | 13 | 14 | 18 | 27 | 27 |
| Algeria | US Gulf Coast | 23 | 21 | 22 | 32 | 25 | 19 | 25 | 31 | 36 | 45 | 35 |
| **US$'000 per month (Monthly time charter rates)** | | | | | | | | | | | | |
| 44,000 tonnes | | 660 | 650 | 590 | 930 | 710 | 375 | 650 | 945 | 1010 | 1120 | 735 |
| 30,000 tonnes | | 610 | 540 | 585 | 710 | 730 | 540 | 750 | 720 | 970 | 1170 | 1035 |
| 15,000 tonnes | | 530 | 405 | 440 | 550 | 525 | 465 | 550 | 660 | 850 | 935 | 860 |

Basis:

[1] Approximate annual average for 44,000 tonnes vessel (VLGC)

Source: WLPGA.

Spot freight rates for VLGCs to Asia in 2008 averaged $42.30/tonne but soared to a high of over $80/tonne in mid-2008 before plummeting to $17.75/tonne by end of 2008. Spot freight rates in 2009 have remained depressed due to the world economic downturn. Freight rates have ranged between $15.25–19.50/tonne (average $16.25/tonne) for the first quarter of 2009.

As there are no spot LPG freight rates from the Middle East to Australia, it is common practice to estimate the freight to Australia by using the Middle East to Japan rate as a base and then adjusting it by the difference in sailing days between the Middle East to Japan and the Middle East to Australia routes. A similar approach can be used to estimate the freight rate for Australian LPG exported to Japan.

However, these spot rates may not reflect the freight rates embodied in term import supply arrangements. These contracts are typically concluded for one year to ensure security of supply. Spot shipping rates may however have an impact on premiums above the Saudi contract prices for propane and butane that can be earned on spot exports from Australia.

*Chapter 3*

# International LPG market

## 3.1 Supply

LPG (propane and butane) is produced from oil and gas fields ("field grade") and from refineries ("refinery grade") in the processing of crude oil. LPG production by different regions in the world for 2007 is provided in Table 3.1. Europe and Asia have a high proportion of LPG produced from refineries (around 75%). Globally, refinery and field grade LPG is evenly produced.

Table 3.1

**LPG PRODUCTION IN 2007 BY REGION ('000 TONNES)**

| | Refinery | Field | Total | % Refinery | % World |
|---|---|---|---|---|---|
| North America | 21,665 | 34,177 | 55,842 | 38.8 | 24.2 |
| South & Central America | 9,050 | 14,579 | 23,629 | 38.3 | 10.3 |
| Europe & Eurasia | 29,844 | 10,557 | 40,401 | 73.9 | 17.5 |
| Middle East | 8,227 | 36,170 | 44,397 | 18.5 | 19.3 |
| Africa | 2,645 | 14,301 | 16,946 | 15.6 | 7.4 |
| Asia | 37,646 | 11,493 | 49,139 | 76.6 | 21.3 |
| **TOTAL** | **109,077** | **121,277** | **230,354** | **47.4** | **100.0** |

Source: WLPGA.

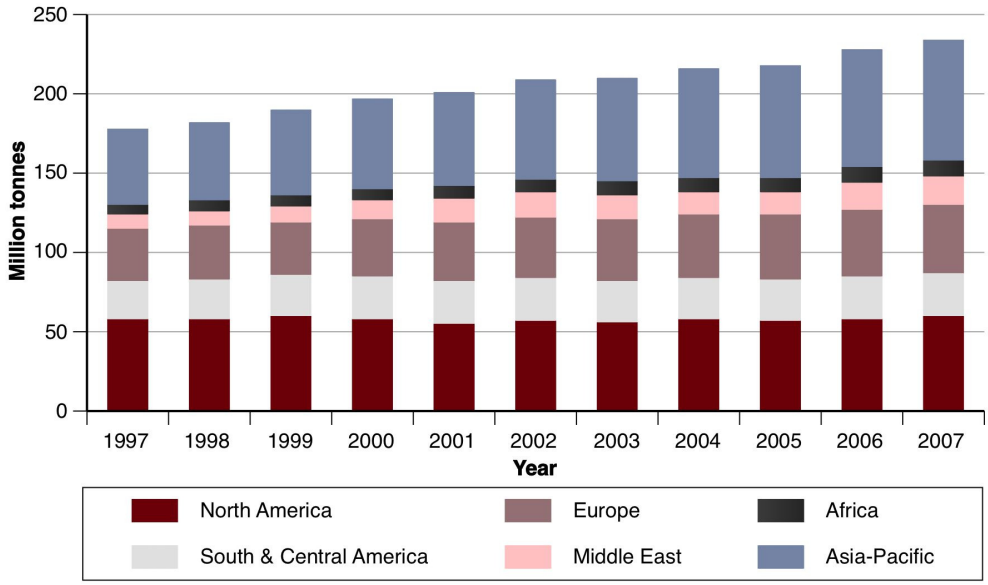
LPG produced in association with oil and gas production is more likely to be propane rather than butane. Worldwide "field production" of LPG is split approximately 60/40 in favour of propane, although this relationship varies with the oil/gas ratio (a higher oil ratio generally results in a higher butane ratio) and from field to field.

The propane/butane ratio of refinery grade LPG will vary with the type of crude processed and the type of refining hardware (processing units) that it operates. Overall, refinery grade LPG is approximately evenly split between propane and butane. In general, the higher the utilisation of reforming capacity for gasoline production, the higher the butane ratio. As a consequence, markets that have a high gasoline yield (USA and Australia) produce a higher butane ratio than diesel focussed markets like Europe and Asia.

Over recent years, LPG production has increased considerably in the Asia-Pacific, while it has been relatively steady in North America (Figure 3.1).

Figure 3.1

**LPG PRODUCTION BY REGION**




Source: WLPGA.

The USA is the largest producer of LPG in the world, with a share of about 20%. Saudi Arabia and China are also significant producers. The top 10 producers in the world make up about 62% of global production (Table 3.2).

Table 3.2

**TOP TEN LPG PRODUCERS - 2007**

| | Volume ('000MT) | Share of global total |
|---|---|---|
| USA | 45,577 | 19.8% |
| Saudi Arabia | 21,000 | 9.1% |
| China | 15,200 | 6.6% |
| Russian Federation | 10,600 | 4.6% |
| Canada | 10,265 | 4.5% |
| Algeria | 9,300 | 4.0% |
| India | 8,973 | 3.9% |
| UAE | 7,933 | 3.4% |
| Mexico | 7,081 | 3.1% |
| Brazil | 5,646 | 2.5% |
| **'Top 10'** | **141,575** | **61.5%** |

Source: WLPGA.

However, Saudi Arabia's production of LPG is about twice as much as their domestic consumption. This excess supply is exported and, as a result, Saudi Arabia is the largest net exporter of LPG in the world. Australia is the sixth largest exporter in the world and exports about 9% of the volume exported by the Saudis (Table 3.3).

Table 3.3

**LPG PRODUCTION, CONSUMPTION AND NET EXPORTS, EAST OF SUEZ — 2007, '000MT**

| Country | Production | Consumption | Imports | Exports[9] | Net Exports | Rank |
|---|---|---|---|---|---|---|
| Saudi Arabia | 21000 | 9220 | 0 | 11780 | 11780 | 1 |
| UAE | 7933 | 1037 | 21 | 6917 | 6896 | 2 |
| Kuwait | 3515 | 116 | 0 | 3399 | 3399 | 3 |
| Iran | 5450 | 2500 | 300 | 3250 | 2950 | 4 |
| Qatar | 3200 | 600 | 0 | 2800 | 2800 | 5 |
| **Australia** | **2886** | **1799** | **388** | **1454** | **1066** | **6** |
| Timor Leste | 900 | 0 | 0 | 900 | 900 | 7 |
| Indonesia | 2120 | 1245 | 30 | 880 | 850 | 8 |
| Malaysia | 3458 | 2950 | 0 | 508 | 508 | 9 |
| Thailand | 4192 | 3865 | 0 | 278 | 278 | 10 |
| Singapore | 422 | 145 | 19 | 296 | 277 | 11 |

Source: WLPGA.

## 3.2 Demand

In general, LPG markets can be segmented into primary, secondary and tertiary.

- Primary markets include its use in residential, commercial and automotive applications.
- Secondary uses include cracking to make petrochemicals in competition with naphtha. The USA uses almost 50% of its LPG in this category. The USA and Canada combined represent 43% of all petrochemical use of LPG.
- Tertiary uses include LPG used industrially for steam raising, power generation or to replace natural gas bought by refineries.

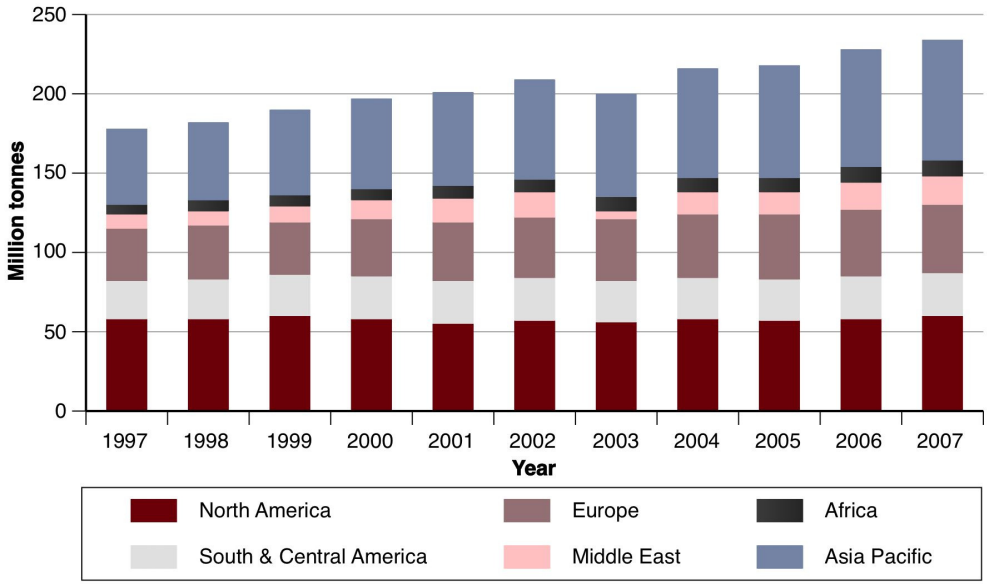
LPG is rarely flared in developed countries due to environmental concerns and standards preventing flaring.

Over recent years, LPG consumption has increased considerably in the Asia-Pacific region (Figure 3.2).

[9] Exports to all destinations, not only East of Suez.

Figure 3.2

**LPG CONSUMPTION BY REGION 1997–2007**

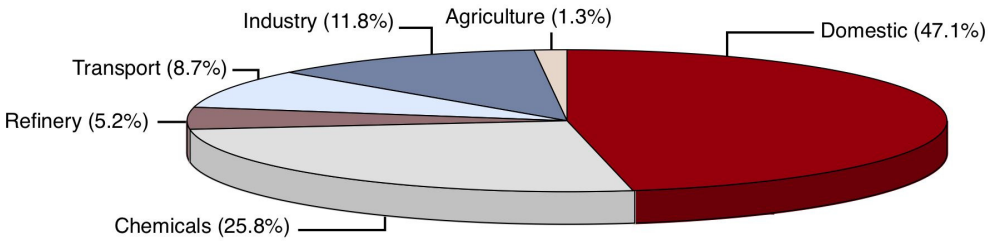



Source: WPLGA.

Worldwide, almost 50% of LPG consumed is used in residential applications such as heating and cooking. The next largest use is as a petrochemical feedstock (26%) and industrial applications (12%). Only 8.7% of LPG is used as automotive fuel (Figure 3.3).

Figure 3.3

**WORLD LPG CONSUMPTION BY SECTOR 2007**

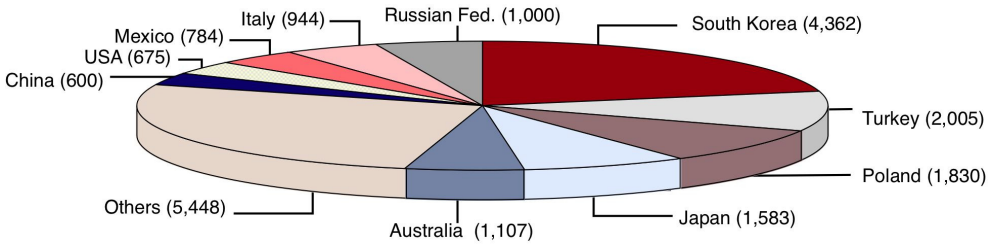



Source: WLPGA.

South Korea is the largest user of autogas worldwide (Figure 3.4). Australia is the 5th largest user. In per capita terms, Australia is the 2nd largest user in the world.

Figure 3.4

**AUTOGAS — TOP TEN WORLD USERS — 2007, MILLIONS OF LITRES**

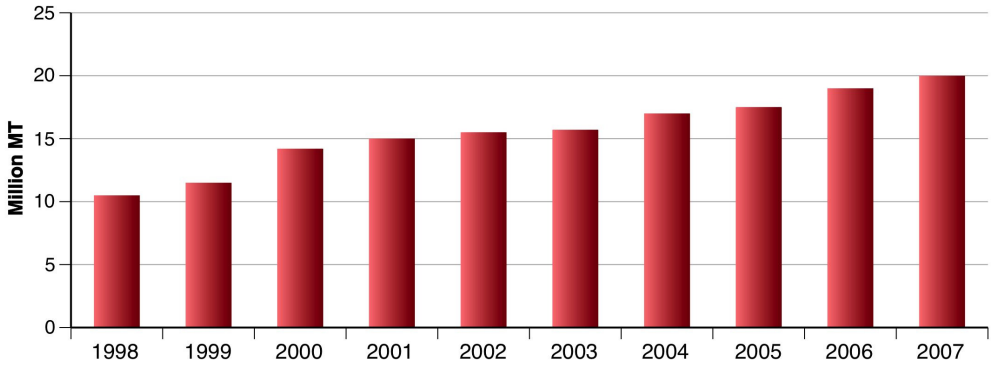



Source: WLPGA.

Autogas use is growing rapidly worldwide. It has almost doubled in the past 10 years (Figure 3.5).

Figure 3.5

**AUTOGAS — GLOBAL TREND 1998–2007**




Source: WLPGA.

## 3.3 Trade flows

Most of the world's seaborne LPG trade flows originate in the Middle East. Producing and exporting countries include Saudi Arabia, Kuwait, UAE, Iran, Bahrain and Qatar. Supply east of Suez, is now estimated by Purvin and Gertz to exceed Far Eastern demand by 4 million tonnes per annum (mmtpa).

Supply from countries bordering the Atlantic (including the Mediterranean) is less than demand. Eastern surpluses must therefore flow west. This is facilitated mainly by seaborne exports to the Mediterranean (2 mmtpa), and to the US Gulf Coast where deficits in LPG supply occurs on a seasonal basis. Northern Europe is also a seaborne importer from time to time.

American LPG production is mainly extracted from natural gas, demand for which is seasonal (heating in winter and power generation in summer for air conditioning). Windows of opportunity in spring and autumn can open for suppliers from east of Suez to access the US market through the port of Houston and the Mont Belvieu storage caverns (the largest LPG storage facility in the world).

Suppliers by sea to the Atlantic Basin include Algeria, Venezuela, Norway, Brazil and Argentina.

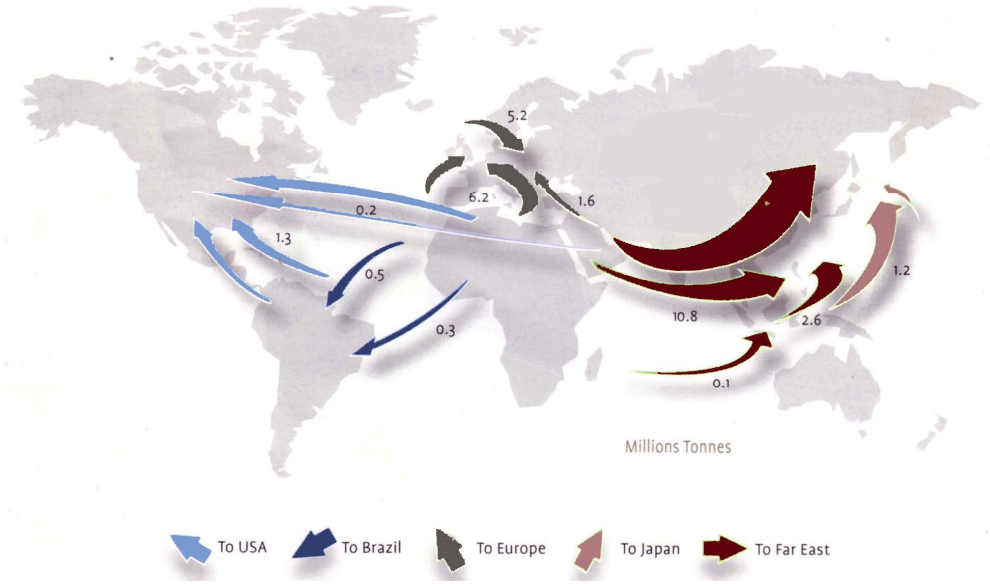
The largest exporter to the US however is Canada overland by pipe mainly to the North East of the USA. This is the largest country-to-country trade flow of LPG. Saudi Arabia to Japan is the second largest.

In 2007, the main importing nations were Japan (13.5 mmtpa), Korea (5 mmtpa), China (4 mmtpa) and India (2.5 mmtpa).

A schematic of international LPG trade flows is depicted in Figure 3.6.

Figure 3.6

**INTERNATIONAL SEABORNE LPG TRADE 2007**




Source: WLPGA.

## 3.4 Market Structure

The LPG market structure is different from the oil market.

Oil is a non-standard commodity with many producers. There are hundreds of different specifications of oil. Even the specification of oil from a specific field may vary from time to time. Producers describe the product as "of normal production quality" rather than guarantee a specific specification. Oil is a raw material that is refined into many different products. It is more easily and cheaply transported and stored than LPG.

The non-specific nature of oil means that a cargo may have many buyers. This encourages a situation where intermediaries can become involved in the market. These intermediaries can take some of the transport, time or basis risk associated with the entire chain of the activity of transferring the oil from the producer to the final customers. Intermediaries may be derivative providers, traders or speculators. Collectively they are performing the role of "market makers" by taking on some or all of the risk of specific parts of the total transaction chain.

LPG (both propane and butane) is predominantly produced and sold as a "standardized" finished product that meets a high standard of product specification. This is because LPG is often sold to the final customer (utility, autogas, petrochemical) with little additional processing. LPG requires a higher level of investment in infrastructure (shipping, storage and delivery to the final customer) than oil. Additionally, LPG's role as a utility fuel means that security of supply is a higher priority than for oil.

A consequence of these parameters is that LPG buyers are more likely to vertically integrate to ensure they have access to reliable shipping that is acceptable to their storage facility. Further, in many instances, the buyer integrates through to the retail sale because of the high cost of LPG distribution to the final customer. Even though most long-distance LPG transport is undertaken in large refrigerated ships, LPG is shipped to smaller ports in higher-cost per unit pressure ships, or by high cost road delivery.

A vertically integrated market is:

- more prone to a "cost plus" philosophy than a market with participants operating in one or few segments of the market. Where a corporation has common price exposure through the entire chain, a commodity is transferred between affiliated bodies on the same price basis but with costs added. This pricing basis is called "cost plus". This characterises the LPG industry in many locations.
- less prone to having a role for market makers. The restricted nature of the structure of LPG market (relative to oil) means that there are fewer intermediaries in the LPG market.

## 3.5 Price linkages

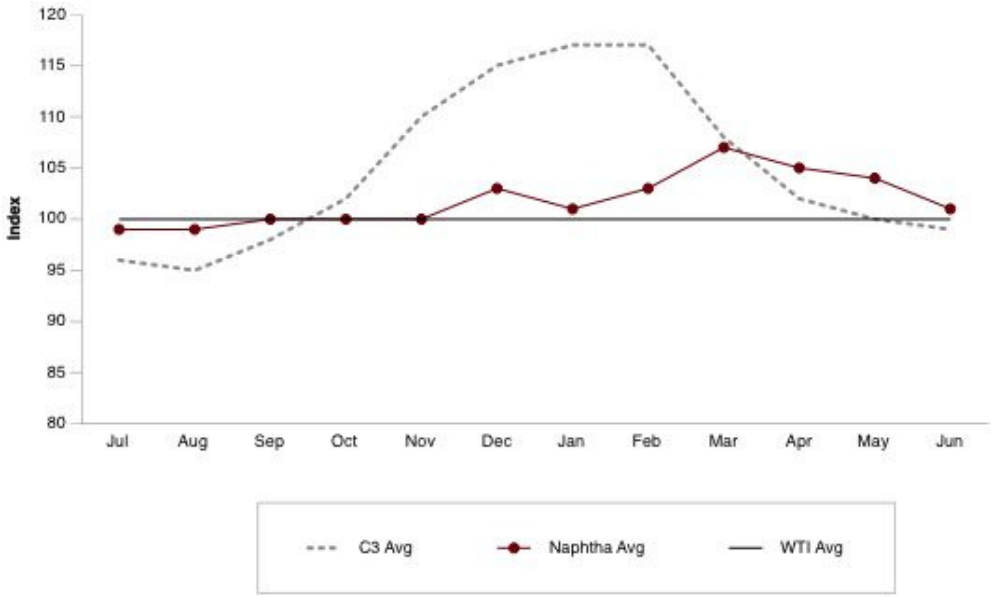
It is also important to note that LPG mainly used in the residential segment, (i.e. for heating and cooking) is akin to a utility fuel. As such LPG consumers in many parts of the world have limited alternatives for heating and cooking. The LPG distributors in these countries are very concerned with making sure that they have security of supply for their customers.

During the Northern Hemisphere winter, LPG prices are regularly bid beyond the calorific equivalent price of crude oil mainly as a result of heating demand. Prices then typically subside in the Northern Hemisphere summer towards the value of LPG when used as a petrochemical feedstock.

Figure 3.7 shows an example of the divergence in LPG prices and crude oil and naphtha during the Northern Hemisphere winter.

Figure 3.7

**PROPANE (C3) PRICES VS WTI CRUDE OIL AND NAPHTHA — 2000–2007**[10]

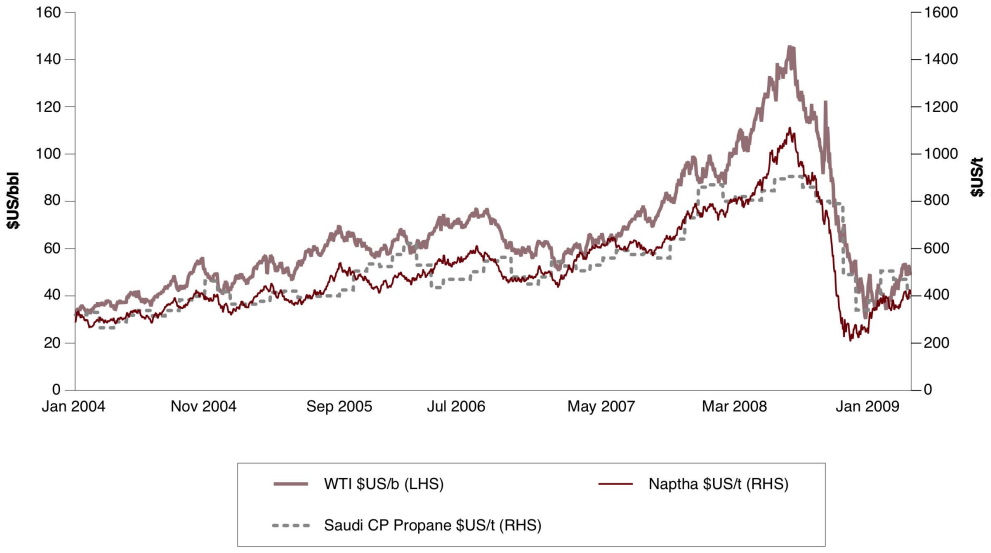



Source: Internal calculations.

Beside seasonal influences, LPG prices over time broadly track those of crude oil and other petroleum products especially naphtha (Figure 3.8). Naphtha is also an important precursor to petrol production in the refining process and thus automotive LPG prices over time broadly track petrol prices. However, by the middle of 2008, LPG prices did not increase as much as crude oil prices.

Figure 3.8

**COMPARISON — PROPANE, WTI OIL AND NAPHTHA PRICES — 2004–2009**




Source: Internal calculations.

[10] Data for 2008 was not included in the analysis because the extreme price volatility that occurred due to global economic conditions distorted results for seasonality. For instance, oil prices rose from below $100/barrel to over $140/barrel by mid-year before falling to approximately $35/barrel by end year.

The extent to which international LPG prices vary over time with crude oil price depends on supply /demand surpluses or deficits in major world LPG markets.

The oil price is influenced by refinery margins, supply conditions (factors such as production availability, arbitrage opportunities between regions, weather and industrial conditions in producer locations, etc), demand indications (US inventory information, light/heavy crude oil differentials, etc) and oil's role as the most widely traded commodity.

Oil prices display no pronounced seasonality, whereas LPG prices are strongly seasonal. LPG prices rise in the northern winter with northern hemisphere heating demand.

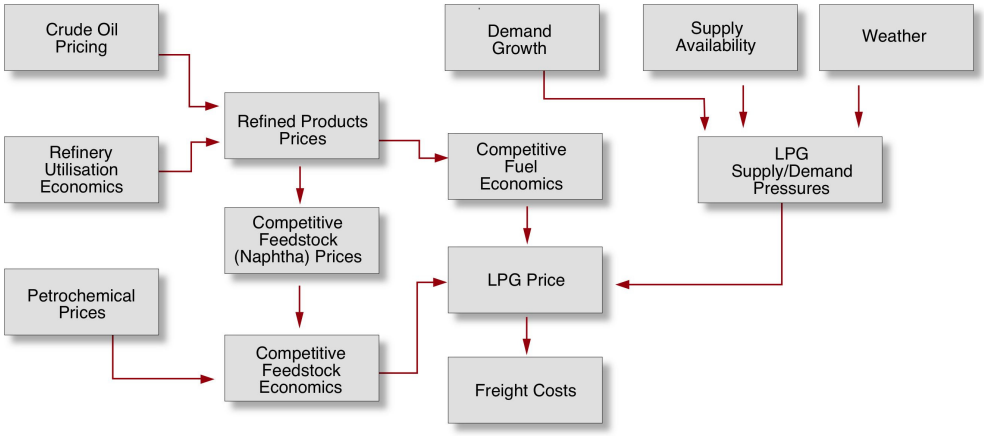
As LPG competes with naphtha as a petrochemical feedstock, issues such as naphtha cracks and petrochemical derivative (e.g. propylene) margins positively affect LPG prices. This contrasts with oil where it is often negatively correlated with naphtha cracks.

In summary, LPG prices are often driven by factors counter or irrelevant to the oil price. Further, LPG is more influenced by market developments in the Asian region whereas oil is dominated by WTI and Brent trading in the Atlantic Basin.

The broad drivers of LPG are depicted in Figure 3.9.

Figure 3.9

**BIG PICTURE PRICE DRIVERS FOR LPG**




Source: Purvin & Gertz.

*Chapter 4*

# International LPG pricing

## 4.1 Pricing fundamentals

Relative to oil and natural gas, LPG is an illiquid (some would say immature) market, dominated by several large sellers and buyers, which has not become commoditised[11]. Price discovery is poor due to limited number of spot sales. Contract prices for LPG set by National Oil Companies (NOCs) are still the prevailing price basis for most transactions, particularly in Asia.

Oil and natural gas have a larger public and political profile and are subject to greater price scrutiny. Large businesses have been founded and continue to be founded on the discovery and production of oil and/or gas. Countries have risen to prominence or been driven to financial instability based on the comparative strength of oil and gas prices. An outcome of this has been an increase in the maturity, sophistication and scrutiny of the oil and gas industry. LPG does not have the public profile or is subject to the same level of public scrutiny as the oil and gas market.

Oil and gas have become commoditised. Prices are widely quoted. Even though actual prices are infrequently set, most oil and gas price relationships are set by arms-length negotiations between the buyer and seller. Even in those countries where the NOC determines or sets a crude oil selling price, they are linked to daily spot market price variations. Where NOCs set their selling price for use in term contracts, it is often simply a basis from which to discount. Few producers (the Saudis are a notable exception) impose destination restrictions.

Oil trading activities are complex with some cargoes being bought and sold several times before being refined. Traders or third parties perform a vital role in providing liquidity and management of price and basis risk. A notable portion of the world market is transacted on spot or short-term contract basis. Most shipping movements of oil and, to a lesser but increasing extent gas, are on voyage rather than term charter or "company-owned" ship basis.

Oil and gas prices form the basis for active near-term and long-term financial markets, whereas only a fledgling derivatives market exists for LPG.

In short, oil and gas is a dynamic and rapidly evolving market with high levels of trading liquidity and price transparency (by comparison with other commodities). By contrast, the market maturity (commoditisation) of LPG is much less advanced.

[11] As trading in a product becomes more active and widespread, the product becomes more of a "commodity" or "standardised" product rather than a specific differentiated product. "Commoditisation" of LPG or oil is the situation where increasing trade has lead to the creation of a market with many buyers and sellers actively participate in the process of buying, selling and trading a "standardised" product.

### *LPG pricing*

The international market for LPG is dominated by Saudi Arabia. Not only is Saudi Arabia the largest producer (21 million tonnes of LPG produced from 230 million tonnes worldwide in 2007 compared with 9 million barrels of oil per day of about 86 million barrels of oil per day globally), but over 50% of world traded LPG is directly or indirectly priced relative to the "Saudi contract price" or Saudi CP which the Saudis set each month. By contrast, Saudi oil is priced relative to the spot market prices of Brent, WTI and the averages of the Dubai and Oman crude oils. Saudi CP related pricing is so dominant in the market that the contract or selling price of other major sellers is strongly influenced by the Saudi price. Production from Algeria (9.3 million tonnes per annum (mmtpa)), UAE (8 mmtpa), Iran (5.3 mmtpa) and Kuwait (3.5 mmtpa) is all priced to ensure sales are competitive relative to supply from Saudi Arabia. Often, the contract or selling prices simply reflect location differential (freight, timing and logistics) relative to supply from Saudi sources, although Sonatrach (the hydrocarbon arm of the Algerian energy ministry) sells its LPG on terms of 50% Official Government Selling price and 50% spot prices quoted in Mediterranean markets.

Already, Saudi Arabia consumes almost half of its 21 million tonnes of production in petrochemical operations. The extent to which they continue to invest in value-adding activities will determine the extent of Saudi LPG exports. Qatari production will increase rapidly as LNG production increases over the period to 2012-13. The marketing and pricing policies of the national marketer Tasweeq may influence future LPG pricing outcomes in the Asian market.

Chinese imports have fallen in recent years with the increase in refinery grade LPG being produced domestically. Imports have fallen by 1.5–2 million tonnes per annum to 4 million tonnes per annum in recent years. This trend is likely to continue as refinery capacity is increased.

The future shape of the market may be determined by the actions of Saudi Arabia and Qatar, and the import demand from China.

## 4.2 Asian market

In Asia, around 80% of LPG is currently priced relative to the Saudi contract price. The largest LPG buyers in Asia in 2007 were Japan (13.5 mmtpa), South Korea (5 mmtpa), China (4 mmtpa), India (2.5 mmtpa) and Taiwan (1.0 mmtpa). Of these, only China buys a significant amount relative to a price marker other than the Saudi contract prices. Most of the sales into other countries are via term contracts directly between producers (mostly the marketing arms of national oil companies) and buyers with little involvement of non-related traders. This is contrary to the situation in the oil market. Even where Japanese, Korean and Taiwanese buyers purchase spot LPG cargoes, it is mostly as an addition to an existing term supply.

Most Japanese and Korean LPG imports are purchased FOB from the originating producer with shipping sourced and managed by the buyer. The buyers or affiliated representatives engage a fleet of owned or time-chartered LPG vessels (mainly VLGCs). These ships are usually of a very high quality and have a carrying capacity of 44,000 tonnes or more of LPG. The vessels are pre-approved as suitable for the buyers' discharge ports. Time-charters are generally for a one to three year period. Significantly, the buyer therefore has a high level of cost knowledge and control. With the contract price fixed for a month, freight costs fixed for the duration of the time-charter, established trading patterns and high familiarity about the loading and discharge ports, the buyers' costs are tightly managed.

Term buyers in Asian markets are generally large and backward vertically integrated. This allows them to price to affiliated wholesale and retail customers at a margin above the Saudi Contract Price plus freight plus incidental costs. The initial buyer therefore bears little market, basis or cost risk.

### *Pricing*

In recent years, the rise of Chinese influence in the market has resulted in a greater amount of LPG being purchased on a delivered "CFR" (Cargo and Freight) or "CIF" (Cargo, Insurance and Freight) basis. This was due to a market structure that is more fragmented. Multiple traders and Chinese sellers compete for supply in this market. Customers are generally smaller and are more price/value sensitive. Chinese customers may be more likely to shift between various energy sources (LPG, fuel oil, diesel, naphtha, kerosene, electricity, coal, biomass, etc) depending on comparative energy economics. This type of market structure shortens the time period between deal consummation and delivery to the final customer. More, but not most, deals are concluded on a flat or fixed price basis. Some price discovery has become possible. The rise in volume of CFR transacted fixed and flat priced LPG transaction has resulted in several market quotation services quoting LPG prices in north/east Asian locations. The most prominent of these are Argus and Platts.

Discussions with Argus, Platts and industry players revealed a discrepancy between the perceived volumes of business transacted on a defined price. Argus and Platts noted that the number and frequency of defined priced deals upon which their market assessments were based varies over time. Generally, it was inferred that there were one or two full or part-cargoes each week. In terms of volumes, it was noted that "it is rare, but not unheard of, to see a single trade of 44,000 tonnes". In addition, the CFR Japanese assessment includes cargoes of 20,000 tonnes and above, while CFR China assessments include any cargo larger than 15,000 tonnes. When questioned about the amount of defined priced refrigerated LPG cargoes traded in the Asian market, one large market player said "very few, and only for crossover cargoes". Crossover cargoes are those cargoes that are scheduled to load at the end/start of a month. So as to avoid a situation where a customer will either delay or speed up a loading to optimise between pricing months, a price is defined so that the buyer does not influence the loading date. These cargoes only occur in the few days near month end/commencement of next month. If this was the case, actual price discovery would only occur in these periods.

Argus and Platts also noted that on those days when defined priced deals for LPG do not occur, they assess the market based on swaps market activity and general market levels.

The swaps market for LPG trades thinly, and generally on a "private and confidential" basis. This may suggest that only a fraction of swaps deals are ever reported to market reporting agencies. Additionally, LPG swap volumes are generally for small volumes (2–10k tonnes). Part of the reason for the low liquidity is the lack of transparency in the methodology of Saudi CP price determination and illiquidity in the basis upon which north/east Asian prices are based. Therefore, on those days where no actual transaction occurs, the implication is that Argus and Platts have little to base their market assessment on other than oil market direction/sentiment. This is despite the fact that, at times, a different set of price drivers may be influencing LPG prices.

## 4.3 Saudi contract price methodology

### *History*

Saudi Aramco is the national oil and gas company of Saudi Arabia.

This company initially was formed in 1933 to facilitate oil exploration concessions with Standard Oil Co of California (now Chevron). Chevron duly discovered lucrative volumes of oil and began to expand production. It formed a wider venture by bringing in Esso, Mobil and Texaco and in 1944, this company took the name Arabian American Oil Company (Aramco).

In 1950 the Saudi King threatened to nationalise Aramco. This move was deferred by the actions of western governments but by 1973, pressure had mounted again and the Americans sold 20% of Aramco to the Saudi Government. Further tranches of ownership were sold in the 1980s and by 1988, Saudi Aramco was fully owned by the Saudi Government.

Aramco shipped its first cargo of LPG in 1961 to Japan. Aramco initially priced LPG exports on a direct thermal parity link to crude oil and this prevailed up to 1990. All other Middle Eastern LPG exporters followed suit. The newly nationalised Saudi Aramco then became aware of how LPG prices were seasonally influenced and that profit margins on their product were accruing to traders and /or wholesalers. They initially addressed this in the period 1990–1994 by retaining the base thermal link formula to crude then adding 50% of the difference between spot LPG prices and the formula above US$15 per tonne. Again, the other Middle Eastern LPG exporters followed suit.

By October 1994, Saudi Aramco could see even further demand for their product emerging from China. Commercially and culturally, the Chinese were not disposed to signing term contracts and sought LPG for their newly developing coastal economic zones purely on a spot basis. This exacerbated the differential between the Saudi Aramco adjusted crude oil thermal parity formula and Far Eastern spot prices and Saudi Aramco moved to establish a monthly spot market driven contract price for propane and butane.

The process behind this was to call for three tenders for loading in the following month for a minimum parcel size, the results of which Saudi Aramco would take into account in setting the next month's propane and butane contract prices. Other factors would be market reports of other spot sales and movements in the prices of competing petroleum fuels.

The process was not transparent and initially caused consternation in consuming countries such as Japan. Saudi Aramco sought to allay these concerns by establishing customer liaison offices in major world LPG trading hubs such as Tokyo, Singapore and London to observe market trends and competitor pricing behaviour. They also sought to explain the factors taken into account in setting contract prices to their term customers.

By 2005, the LPG supply tightness had abated and Saudi Aramco was placing many spot cargoes from its increasing LPG production on to world markets. Saudi Aramco dropped the tender process in 2005 and began to use their own spot sales as well as liaison office feedback and published spot sales (such as the Argus, Platts and Rim CFR indices) as well as prices of competing petroleum products in setting CPs.

#### *Current pricing methodology*

The contract price set by Saudi Arabia (Saudi CP) for both propane and butane each month is the dominant price for LPG. The methodology that the Saudis apply to determine the monthly price is not published, nor is it apparent. Despite this, about 80% of Asian LPG is priced relative to, or influenced by, prices set by Saudi Arabia. Even though Saudi Arabia produces less than 10% of world LPG and 22% of combined Middle East and Asian production, all sellers reflect the influence of the Saudi CP in their pricing.

The Saudis engage in direct discussions with customers through their marketing offices in Tokyo, Singapore, Beijing, London and Houston. Additionally, they appear to be somewhat influenced by market assessments made by Argus and, to a lesser extent, Platts. The Saudi CP is set for the month and may include a "catch-up" to reflect instances where the previous month deviated from market levels.

### 4.4 Asian prices

In recent years, the influence of Chinese demand has increased the prominence of Far East or North Asian delivered prices for LPG. A market has developed for "flat price near-term" LPG prices because of the Chinese buying preference for this method of purchase. In a normal week, 2–3 cargoes are transacted on a fixed price delivered into Far East or North Asian locations. Several price quotation systems now make market assessments each day of these prices. Argus and Platts are the most influential of these market assessments. These prices are commonly described as "CFR FEI", "FEI" or "North Asian LPG" prices.

#### *Argus pricing methodology*

Pricing in the Asian LPG spot market as assessed by Argus is widely used by market participants, especially the Chinese. Argus publishes the Far East Index (FEI) each Singapore business day (refer to Box 4.1 for further details).

Box 4.1

**ARGUS FAR EAST INDEX**

**Propane**

Prices are in US dollars/tonne. The Argus Far East Index is the average of the CFR Japan (fixed price) and CFR South China (fixed price) assessments. The Far East Index is accumulated on a calendar month basis, rolling on the first working day of the month. Refrigerated cargoes are of field grade quality. The quotes for the Argus Far East Index will roll forward to the next month on the first day after the 15th day of each month. Time stamp is 6.30pm Singapore time.

**Butane**

Prices are in US dollars/tonne. The Argus Far East Index is the average of the CFR Japan (fixed price) and CFR South China (fixed price) assessments. The Far East Index average is accumulated on a calendar month basis, rolling on the first working day of the month. Refrigerated cargoes are of field grade quality. The quotes for the Argus Far East Index will roll forward to the next month on the first day after the 15th day of each month. Time stamp is 6.30pm Singapore time.

**Far East Index**

**– FEI = 50% CFR Japan + 50% CFR South China**

**– Assessed daily**

**– Looks forward 20-35 day**

Source: Argus.

Argus surveys 20 to 30 participants each day and forms a view about the price of the day (Table 4.1).

Table 4.1

**ARGUS FEI METHODOLOGY**

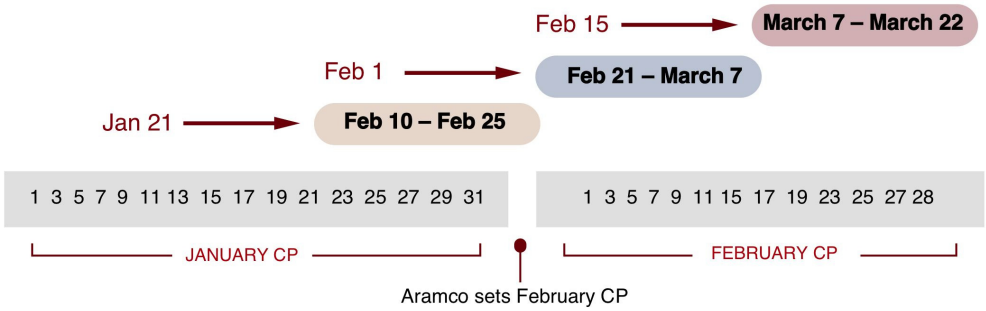
| Daily market survey | Coverage |
|---|---|
| • 20–30 participants | • Confirmed deals that meet specifications |
| • Balanced between buyers and sellers | • Any other deals |
| Includes intermediaries such as brokers and traders | • Form bids and offers |
| | • Swap values |
| | • Informed market views |

Source: Argus discussion.

The FEI looks 20–35 days forward. An example is provided in Figure 4.1.

Figure 4.1

**EXAMPLE OF PRICE DETERMINATION**

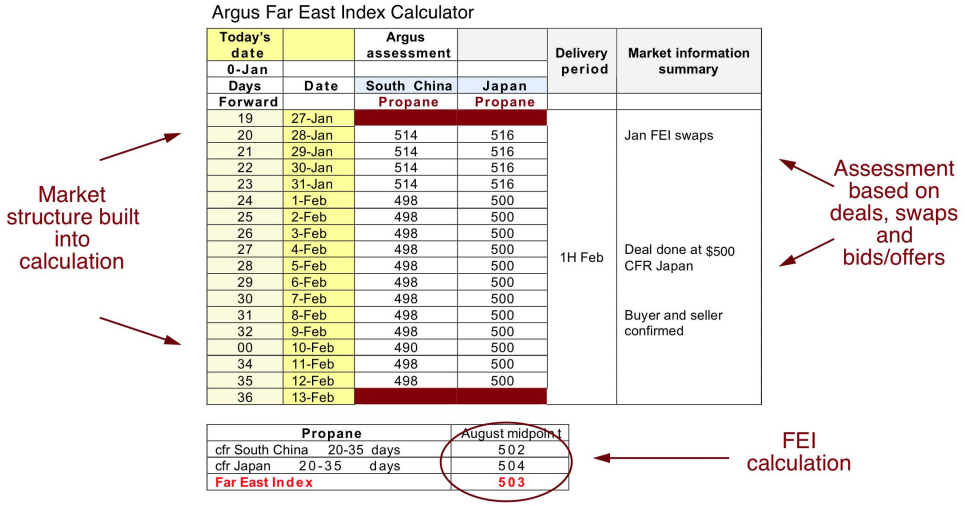



Source: Argus.

Deals reviewed and included in price determination can be flat price or swaps (Figure 4.2).

Figure 4.2

**FEI CALCULATION**



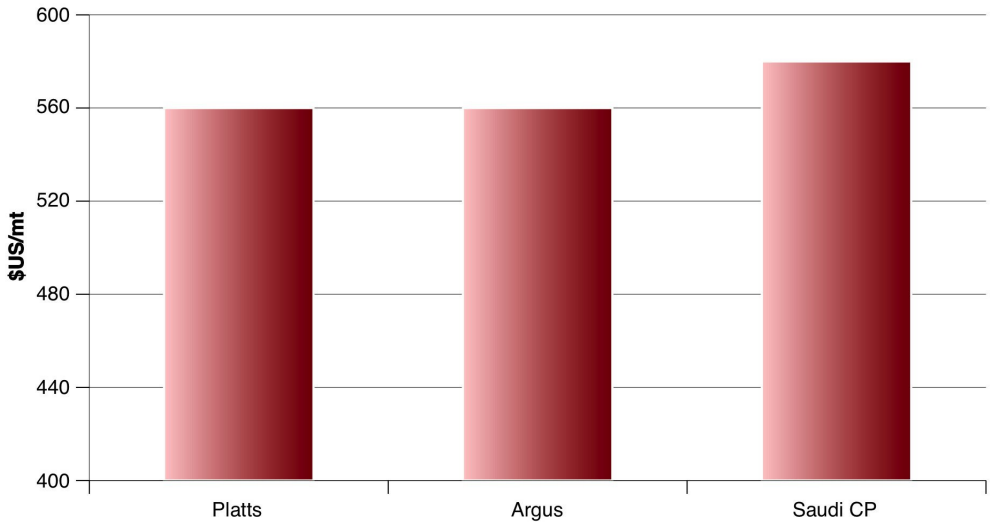

Source: Argus.

## 4.5 Comparison of LPG international benchmarks

The Saudi CP, the Argus FEI and the Platts Asia Index are compared in Figure 4.3. The figure illustrates that the average prices for propane during 2005–08 for these three price series have been broadly consistent.

Figure 4.3

**SAUDI CP, ARGUS FEI AND PLATTS AVERAGE PRICES FOR PROPANE, FOB, 2005-08**



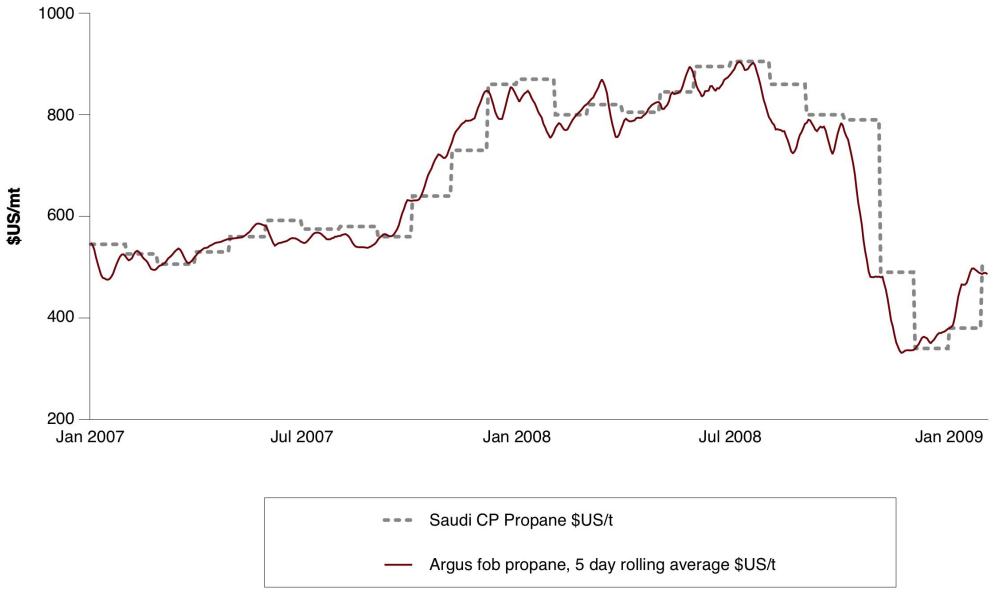

Source: ALPGA, Argus, Platts and internal analysis.

Due to the process under which Saudi Aramco establishes monthly propane CP and butane CP, it is difficult to estimate the number of its own spot sales, the extent of customer liaison office observation of spot sales, and the extent to which it uses published price indices such as Argus and Platts in setting its monthly contract price.

However, the Saudi propane and butane contract prices closely track spot markets in the Far East. This is shown in Figure 4.4, which compares the Saudi CP propane with the Argus FEI propane on a freight-adjusted basis. To demonstrate this, spot LPG freight prices between the Middle East and North Asia have been deducted from the Argus CFR (delivered) price observations.

Figure 4.4

**COMPARISON OF ARGUS FEI WITH CP PROPANE — ADJUSTED FOR FREIGHT**

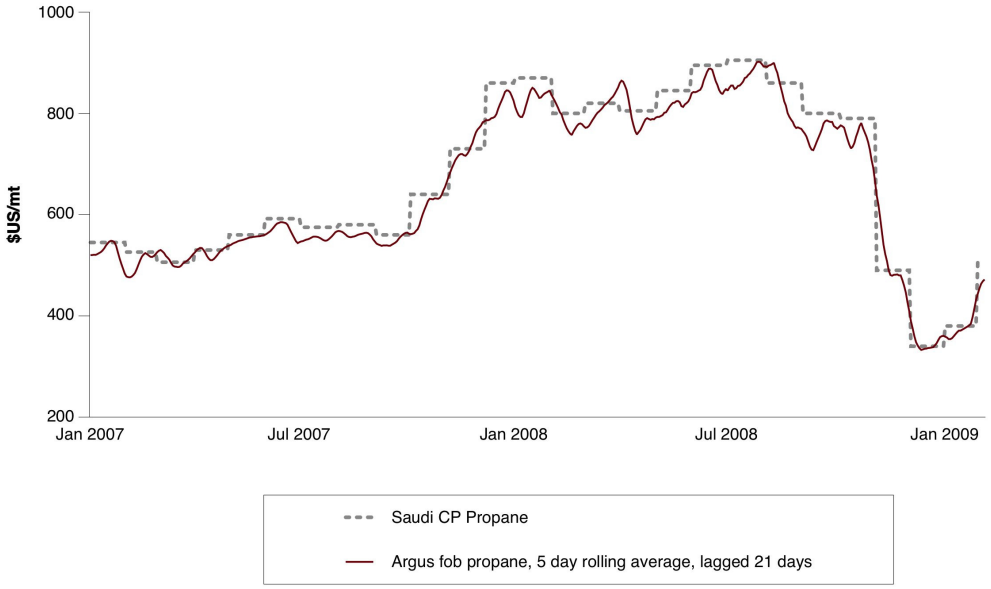



Source: Argus, LPGA and internal analysis.

It appears that the Argus FEI is a leading index and that the Saudi contract price lags by around three weeks. However, if the Argus FEI is lagged by 21 days as in Figure 4.5, there is no significant variation between the two price series.

Figure 4.5

**COMPARISON OF ARGUS FEI WITH CP PROPANE — ADJUSTED FOR TIMING AND FREIGHT**




Source: Argus, LPGA and internal analysis.

That is, the Saudi Aramco contract price on a FOB Arabian Gulf basis is very similar to the Argus CFR FEI price on the same basis once a time lag has been applied.

Term buyers of Middle Eastern LPG on a contract price basis will enjoy lower prices for about 3 weeks longer in a rising LPG market but conversely will pay higher prices for about 3 weeks longer in a falling LPG market.

## 4.6 Other pricing bases

LPG prices are quoted at various locations (Box 4.2), and by several different quotation services. In the Asian, and Australian context specifically, no pricing locations other than Ras Tanura in Saudi Arabia, Japan or South China have any significant relevance. The exception to this may be Mont Belvieu to the extent that Gippsland exporters have infrequently exported into this market.

Box 4.2

**MAJOR LPG TRADING POINTS**

- Mont Belvieu
- Saudi Arabia — Ras Tanura
- Japan
- South China
- North Sea
- Northwest Europe — CIF ARA
- Algeria
- Mediterranean

Source: Internal analysis.

Several market services regularly quote LPG prices (Box 4.3). The most relevant for Asian prices is "LPG International" published by Argus.

Box 4.3

**LPG PRICING PUBLICATIONS**

- Argus — *LPG International*
- Oil Price Information Service (OPIS)
- Platts — *Oilgram & LP — Gaswire*
- Purvin & Gertz — *Global LPG Market Outlook*
- Butane — Propane Newsletter
- Commercial Services — *Waterborne LPG Report*
- Bloomberg's *Oil Buyer's Guide*

Source: Purvin & Gertz.

## 4.7 The Saudi CP as a global benchmark

The acceptance in the global and Asia-Pacific markets of the Saudi CP as the most appropriate LPG international benchmark price is widely acknowledged. As depicted in Table 4.2, the CP rates highly on a number of criteria. Published prices are based on a relatively liquid market with 80% of LPG sold in the Asian market priced relative to the Saudi CP. The quality, quantity, location and timing of the CP benchmark are known and unambiguous.

On the other hand, the Argus CFR FEI is China focussed as it is widely accepted as a spot market benchmark in South East Asia. While spot sales per month are few and the product specifications and parcels vary, it is highly responsive to sentiment in the LPG market and can result in price volatility from day to day. Nevertheless, it is consistent with prices set by Saudi Aramco. In fact, in general, it is a price leader as price assessments in trading days later in each month are indicative of the price direction or prices set by the Saudis.

However, there is some industry concern about liquidity in the LPG market in general, including the Argus CFR FEI quotations. While a methodology is published by Argus and generally understood by market participants, lack of market liquidity is an important factor in the price discovery process. As normally 1–2 market deals can be the basis for ten (one quote per day for each of propane and butane) quotes over a week, such liquidity may on occasions lead to market participants executing part parcels at unrepresentative prices. Argus accepts as valid any deal of 11,000 tonne or more of either propane or butane. Parcels due do not need to be "on-specification" and there are no criteria for vessel quality or acceptability to international standard receiving ports.

Table 4.2

**BENCHMARK CRITERIA: COMPARISON OF SAUDI CONTRACT PRICE WITH ARGUS ASIAN FAR–EAST INDEX**

| Attribute | Comment | Saudi Contract Price | Argus Asian Far-East Index |
|---|---|---|---|
| **Unambiguous** | Is the price published and known to the market on a set schedule? | Price sent to term customers, however published on subscription basis & posted on ALPGA website etc. | Published daily on subscription basis. |
| **Representative of commodity** | Relationship to other energy sources. | Highly representative of market prices because it is the dominant market price. | FEI is a blend of all refrigerated cargoes reported in North and East Asia. It is not representative of any specific location, vessel conditions, Australian export or import cargo size or availability or delivery window. Approximately 2-3 deals per week are reported on this basis. |
| **Responsiveness** | Does the benchmark respond to changes in the market? | It is spot market responsive, but can be influenced by strategic and commercial factors at the discretion of Saudi Aramco. CP is generally a "lagging" indicator of the market, but also includes "leading" seasonality. | Highly, but can also reflect journalists' assessment of impact on the LPG market of oil market factors. i.e. As the "flat-price" LPG market is so thin, journalists may assess a market impact despite having no LPG market information. |
| **Methodology** | Is there a published methodology? | No. | Yes. |
| **Transparency** | Can the prices be verified? | Yes, or at least partially. Saudi Aramco briefs customers on factors it considered to setting the price. | Yes, upon request. |
| **Liquidity** | How much of the trade uses the benchmark? | ~80% of Asian LPG is priced relative to CP. | ~20% of Asian LPG is priced relative to FEI. |
| **Objective** | How objective is the price assessment? | High, price is accepted through negotiation between Saudi Aramco and buyers. | Medium to High, prices are determined by reporters asking buyers and sellers about deals done. Few deals are done per month so prices are interpolated for days when no deals take place. |
| **Standardized commodity** | Is it unambiguous or is it variable? | Quality, quantity, location, timing is known and unambiguous. | Quote is based on actual and notional cargoes of various quality specifications, on ships of various size and quality at various (unspecified) locations. |
| **Frequency of data** | Is the information published regularly? | Yes. The Saudi contract price is published just prior to the end of the month for liftings in the following month. | Yes. Prices are published on each business day. |
| **Financial instrument** | Are financial derivatives traded on the price basis? | Small amount. | Yes, but only a small quantity. Price determination methodology and procedures may not be sufficiently robust to promote investor confidence. |
| **Relevance** | Is the pricing data used for contract pricing? | Over 80% of LPG sold in the Asian market is priced relative to the Saudi CP. | Yes, but only a small amount of term LPG is priced relative to it. Only a very small percentage (Chevron NWS exports, some Shell NWS exports and part linkage of Santos exports) of Australian LPG. No domestic Australian sales are linked to FEI. |

| Attribute | Comment | Saudi Contract Price | Argus Asian Far-East Index |
|---|---|---|---|
| **Availability of history** | Is data available for historical comparison? | Yes, but the methodology of price determination changed in 2005. | Yes, since 2004. |
| **Independent** | Is the price published by an independent organisation? | No, Saudi Aramco are producers. | Yes, Argus is independent reporting agency. |

Source: Internal analysis.

## 4.8 Future changes in pricing bases

During the next 2-3 years, it is likely that major changes will occur to the prices used by exporters and importers both in Australia and in Far Eastern LPG markets.

The future shape of the market may be determined by the policies and actions of Saudi Arabia, UAE and Qatar. Already, Saudi Arabia consumes almost half of its 21 million tonnes of production in petrochemical operations. The extent to which they continue to invest in value-adding activities will determine the extent of LPG exports.

Qatari LPG production will increase rapidly as LNG production increases over the period to 2012–13 (Table 4.3). The marketing and pricing policies of the national marketer Tasweeq may determine future pricing policies in the Asian market (Box 4.4).

Table 4.3

**MIDDLE EAST LPG EXPORT FORECAST — MILLION TONNES PA**

| | 2005 | 2008 | 2010 | 2012 |
|---|---|---|---|---|
| UAE | 7 | 7 | 11.5 | 12 |
| Qatar | 1.5 | 4.5 | 7 | 9 |
| Kuwait | 3.5 | 3 | 3.5 | 3.5 |
| Iran | 1 | 3.5 | 4.5 | 4 |
| Saudi Arabia | 13 | 11.5 | 9 | 9 |

Source: Purvin & Gertz.

Box 4.4

**QATAR — THE FUTURE ENERGY HUB**

- Qatar's North Field, with over 900 trillion cubic feet of proven reserves, is the world's largest non-associated gas field — over 13% of the world's proven reserves
- By 2012 the North Field will produce over 23 billion cubic feet per day of gas
- Qatar is the world's largest producer of LNG, currently producing 31 million tonnes per year. Expansion underway will increase LNG production to 77 million tonnes per year by 2012
- Qatar has the world's largest gas-to-liquids production facility. A second, much larger GTL facility is currently under construction
- By 2012, Qatar will export almost 12 million tonnes per year of LPG
- Qatar has commissioned the 1st international gas pipeline (Dolphin) in the Middle East between Qatar and Abu Dhabi
- Qatar currently has a 100 kbd refinery in Mesaieed. A new 146 kbd condensate refinery in Ras Laffan will begin operating soon.

Note: By comparison, the NWS LNG facility has a nameplate capacity of 16.3 million tonnes per annum, and LPG exports of approximately 1.1 million tonnes per annum.

Source: Tasweeq.

Tasweeq (Qatar) is also optimistic about the future outlook for LPG exports (Table 4.4). Future industry pricing basis will depend on the marketing and pricing philosophy that Tasweeq adopt.

Table 4.4

**QATARI LPG EXPORT FORECAST - MILLION TONNES PA**

| | 2009 | 2010 | 2012 | 2014 | 2016 |
|---|---|---|---|---|---|
| Propane | 4.2 | 4.8 | 7.0 | 7.1 | 7.3 |
| Butane | 2.6 | 3.5 | 4.7 | 4.6 | 5.0 |
| **Total** | **6.8** | **8.3** | **11.7** | **11.7** | **12.3** |

Source: Tasweeq.

*Chapter 5*

# Australian LPG market

## 5.1 History

The LPG industry began in Australia in the early 1920s with propane imported in cylinders from the USA.

Australian production of LPG began at the oil refineries in the 1950s, although it was largely classified as a waste product. Seeing the potential to follow the example of the US and Japanese markets where propane was used for cooking and heating in areas without reticulated gas, Australian refineries commenced marketing to these applications.

By the 1970s, propane and butane became available in substantial quantities when Exxon Mobil (then Esso) and BHP-Billiton (then BHP) opened the Gippsland Basin oil and gas fields.

Given the market opportunities at the time for LPG in Japan, the Gippsland joint venture decided to extract LPG for export on a world scale basis. Significant investment was made in LPG fractionation and storage facilities at Westernport. The latter initially comprised some 85,000 tonnes of refrigerated storage. Adequate pressurised storage for the loading of small coastal tankers was also provided.

LPG from Westernport was distributed to inland markets by pipeline to the Gas & Fuel terminal at Dandenong and trucked to residential and commercial markets in provincial areas. The grade of LPG usually chosen for this was propane and thus storages outside of Australian capital cities are almost entirely propane.

Markets for automotive LPG grew significantly during the 1990s. Either propane or mixtures of propane and butane can meet the National Fuel Standard for automotive LPG but these must satisfy vapour pressure, octane rating and other limiting parameters.

The distribution and pricing of automotive LPG in Australia is thus interwoven with distribution and pricing of domestic heating and cooking (traditional) LPG. LPG containing a large proportion of propane meets the Australian Heating Grade Specification.

Field grade propane in Australia usually has a specific gravity (SG) of around 0.508. One tonne of this product would occupy a volume of approx 1,970 litres at normal temperatures and pressures. Field grade butane has an SG of around 0.568 and this will occupy a volume of 1,760 litres. One tonne of a 50/50 blend of propane and butane commonly found in automotive LPG will average approx 1,865 litres.

## 5.2 Domestic supply

### *Overview*

LPG is produced from both naturally occurring and refinery sources. In 2007, Australia's total LPG production was estimated to be a total of 2,886,000 tonnes, of which 82.8% came from naturally occurring sources and 17.2% from refineries (see Table 5.1).

The production of naturally occurring LPG from the major oil and gas fields located around the continent was estimated to be 2,389,000 tonnes. The main naturally occurring sources of LPG and their sellers are Gippsland (BHP-Billiton and Exxon-Mobil), Cooper Basin (Santos and joint ventures), Bass Gas (Origin, AWE and CalEnergy), Otway (Woodside, Origin, CalEnergy and Benaris International), Surat Basin (Santos and joint venturers) and the Kwinana extraction plant (Wesfarmers). A small quantity of naturally occurring LPG is also produced in Queensland.

The LPG from these facilities is sold into the domestic market, with some LPG from Gippsland and Cooper Basin exported. The LPG produced from the North West Shelf (NWS) (Woodside, BP, Chevron, BHP-Billiton, Shell, Mitsubishi and Mitsui) is all exported.

Australia also has seven major refineries that produced 497,000 tonnes of LPG in 2007. These refineries are in Melbourne (Exxon-Mobil), Geelong (Shell), Sydney (Caltex and Shell), Brisbane (BP and Caltex) and Perth (BP).

In addition, to meet the market demand for LPG, some 388,000 tonnes of LPG (propane) was also imported into Australia in Sydney (Port Botany cavern), Brisbane (into a VLGC anchored in Moreton Bay), Darwin (pressure imports from Brisbane and elsewhere) and Kwinana (small LPG ship imports). However, some 152,000 tonnes of the LPG was exported to the Pacific Islands and New Zealand from the east coast of Australia.

The naturally occurring LPG is separated and marketed as propane and butane steams, while the majority of refinery LPG is mainly produced as a propane/butane mixture. Of the total Australian LPG production approximately 52% is propane and 48% is butane.

Table 5.1

**AUSTRALIAN LPG SUPPLY - 2007, (THOUSAND TONNES)**

| | Field | Refinery | Production | Field % | National % |
|---|---|---|---|---|---|
| Victoria [1] | 1,030 | 106 | 1,136 | 90.7 | 39.4 |
| NSW | 0 | 153 | 153 | 0.0 | 5.3 |
| Queensland | 20 | 171 | 191 | 10.5 | 6.6 |
| South Australia | 296 | 0 | 296 | 100.0 | 10.2 |
| Western Australia[2] | 1,043 | 67 | 1,110 | 94.0 | 38.5 |
| Tasmania | 0 | 0 | 0 | 0.0 | 0.0 |
| Northern Territory [3] | 0 | 0 | 0 | 0.0 | 0.0 |
| **Total** | **2,389** | **497** | **2,886** | **82.8** | **100.0** |

Source: ALPGA LPG Supply Demand Study 2008.

Notes:

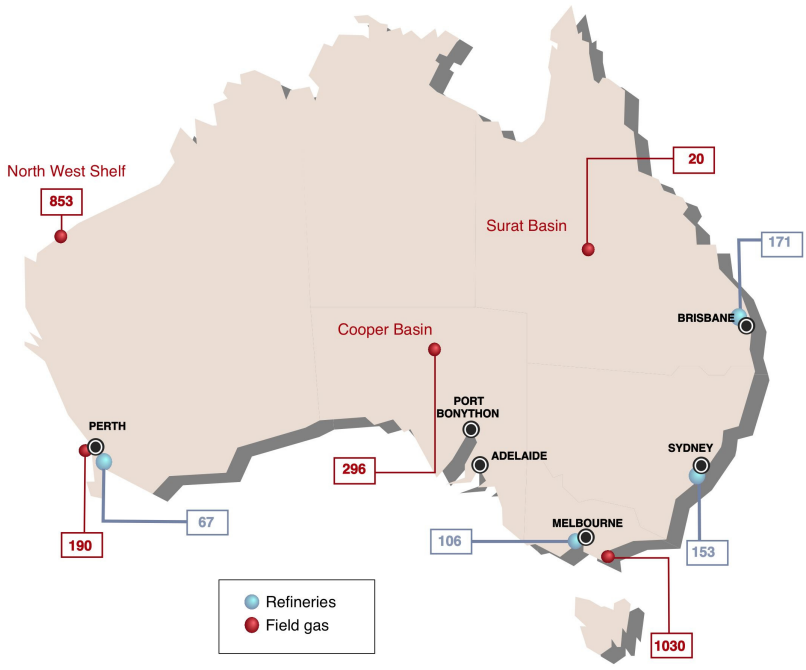
1. Altona LPG production sold to Qenos, not included in domestic supply.

2. LPG is extracted at the NWS plant and from the Wesfarmers plant at Kwinana.

3. Bayu-Undan production assumed to be produced by Timor Leste

Figure 5.1

**AUSTRALIAN LPG PRODUCTION SOURCES - 2007**




Source: ALPGA data.

### Field production

#### East Coast

In the late 1960s, Esso (now Exxon-Mobil) and BHP (now BHP-Billiton) commenced extraction of LPG from the oil and gas production from the Gippsland Basin. Both independently found separate export customers in Japan who were seeking to diversify sources of LPG supply away from the Middle East producers. A world scale LPG fractionation plant and large refrigerated and VLGC compatible storages for each of propane and butane were constructed. Exportation of LPG began in 1970. Production continues today at approximately 950,000 tonnes per annum. The propane/butane ratio is about 58/42. Gippsland refrigerated storage capacity is 61,500 tonnes butane (4 tanks) and 36,400 tonnes propane (3 tanks). Due to these tanks nearing the end of their useful life, a sequential program of tank remediation has been underway. As a result, the plant has operated with a maximum of six refrigerated tanks for several years as tanks have been repaired. The remediation program will be completed in mid 2010. During the period of this program, Gippsland has been unable to load full 44,000 tonne cargoes of butane due to lack of storage. The majority of the propane is consumed domestically. Export cargoes must therefore be either 11,000/33,000 propane/butane or equal share.

Discoveries of oil and gas in the Cooper Basin led Santos and its joint venture partners to invest in major LPG extraction facilities and VLGC compatible storage in the mid 1980s. Output from the Cooper Basin has declined in recent years, but is still approximately 300,000 tonnes per annum. The propane/butane ratio is approximately 60/40. The Cooper producers installed 42,000 tonnes of propane and 31,000 tonnes of butane storage therefore cannot fully load a VLGC for export without a propane compartment.

Both the export capable LPG producers in South Eastern Australia (Westernport and Port Bonython) are also producers of crude oil and natural gas. They have the imperative therefore to secure reliable, predictable and consistent offtake of LPG by both their export and domestic customers for assurance that neither oil nor gas production will be interrupted.

In the period from 1970–2000, the main source of field LPG was from crude oil. However, with the decline in production of crude oil from both the Cooper Basin and Gippsland, most LPG now is produced from natural gas. This fuel, widely used in residential, commercial and industrial markets, is now increasing in popularity as a fuel for peak shaving[12] power generation.

Peak shaving power generation markets are volatile and thus natural gas production can be subject to demand surges and troughs. It is thus essential for field grade LPG producers to have in place firm (but flexible) contractual arrangements that assure offtake of LPG production now subject to greater variability.

[12] Peak-shaving power is gas-fired power generation used to supplement power generated by coal fired "baseload" generators when short term peaks in power demand occur. Gas fired power generation is deemed to "shave off the peaks".

These are secured initially with major LPG distributors with deep and broad market outlets in the traditional and automotive market sectors. Additionally, domestic LPG distributors have the flexibility to manage the surplus in LPG production by shipping to other Australian markets, either by marine shipment or road transport. After domestic needs have been satisfied, they seek reliable export customers with high standard LPG shipping.

In turn, it is propane that is more subject to production variability than butane. This is because propane is more associated with natural gas production than butane that is more associated with crude oil production. Flexible propane outlet arrangements are therefore important to LPG producers. These are sought with distributors who are able to sell propane into the domestic heating and cooking markets with a winter demand profile matching the natural gas and propane seasonal production curve.

There are some small LPG extraction plants in Queensland based on the Surat Basin and recently developed LPG projects based on the BassGas and Otway projects in Victoria. Propane and butane is produced and stored separately. Storage capacity is pressurised and scaled to hold several days of production. These plants are not export capable therefore LPG must be delivered into the domestic market by road or rail delivery. At times of unexpected disruption in the lifting program (weather delays, industrial disputation, loading infrastructure limitation, etc), these producers can sometimes become very aggressive sellers.

### *West Coast*

In 1987, Wesfarmers commissioned a LPG extraction plant at Kwinana that was supplied by "LPG-rich" natural gas through the Dampier to Bunbury pipeline from the NWS. To meet domestic traditional market demand (bottled gas for heating and cooking), the propane/butane supplied through the pipeline was about 2/1 ratio despite the NWS production profile being 45/55. Kwinana has 26,000 tonnes of propane and 13,000 tonnes of butane storage.

The NWS Joint Venture Partners (NWS JVPs) began extraction of LPG from natural gas and crude oil for export from Karratha in 1995. The project installed 42,000 tonnes of butane and 32,000 tonnes of propane storage suitable for loading into a VLGC in 3/1 or 2/2 tank configurations given that NWS LPG is butane rich.

Storage for LPG on the NWS project has been constructed to closely meet the LPG offtake needs of that project. Thus space remaining in the propane tank for example between accumulation of a 21,000 tonne parcel of propane for shipment on a VLGC in 2/2 segregation (i.e. 21,000 tonnes of propane and 23,000 tonnes of butane) and workable propane storage limit of 26,000 tonnes before tank tops is only 4,000 tonnes.

In the case of butane being accumulated for a VLGC in 1/3 segregation (11,000 tonnes propane and 33,000 tonnes butane) the space remaining in the butane tank before tanktops is approximately the same, i.e. 4000 tonnes.

Production of LPG at the NWS is forecast to be over 1 million tonnes per annum after the expansion associated with the LNG Train 5. In 45/55 propane to butane ratio this is at least 450,000 and 550,000 tonnes respectively or approx 1250 and 1500 tonnes per day.

The available date range for loading of a VLGC at such rates of production is only 3-4 days. (4,000 tonnes divided by these daily rates) The NWS JVPs thus seek customers with broad VLGC fleet availability and operational flexibility to be able to meet these tight scheduling "windows." Such customers are usually Japanese although some of the NWS JVPs now have affiliates with large refrigerated or cavern storages in China with sufficient storage flexibility to accept LPG delivered from the NWS project.

The decision to extract LPG at Karratha has meant that the gas piped to Perth is now comparatively dry. Therefore, LPG extraction at Kwinana (Wesfarmers) has fallen significantly and propane imports are now required.

#### *Refinery grade production*

Refinery LPG is produced from Australia's seven refineries. Most of these can supply automotive LPG at the retail level, while some further process their LPG to meet the Australian heating grade specification for the traditional market. These sales are generally to Origin or Elgas. In recent years, Exxon-Mobil has sold its LPG into a nearby petrochemical plant (Qenos) at Altona in Victoria.

All refineries have a small amount of pressurised storage, but generally are only capable of storing several days of production. Both Brisbane refineries can export seasonal surpluses of butane in small pressure vessels. Caltex in Sydney is also export capable. Exports from the refineries are infrequent and are generally to the Pacific Islands via Origin.

Due to limited storage and environmental limitations on flaring, refineries will sometimes be very aggressive marketers to ensure their refining operations are not constrained due to LPG tank being at capacity. As a consequence, refinery-supplied autogas is a moderating influence on market prices, particularly in metropolitan or near metropolitan areas. While refiners attempt to maximise price, they do not have an export alternative, therefore they can sell LPG at competitive prices in order to clear their inventory.

### 5.3 Imports

Australia's major import terminal is the Port Botany cavern owned and operated by Elgas. This terminal has been constructed to allow the importation of propane only and has a capacity of approximately 65,000 tonnes. The chambers are inter-connected, therefore cannot receive butane without contaminating the propane.

Propane can thus be imported on a VLGC fully laden with refrigerated propane (approx 44,000 tonnes) that is rewarmed by the VLGC before being pumped under pressure into the cavern that in turn relies on more than 14 atmospheres of hydrostatic pressure to contain the propane in liquid form.

This terminal handles 400,000–500,000 tonnes of LPG per annum. Some of this propane is re-exported to New Zealand and the Pacific Islands.

Since 2008, Origin has had the 44,000 tonne "Summit Terra" VLGC anchored in Moreton Bay (near Brisbane) for supply of propane for the Queensland and Northern Territory market. Origin maintains a large traditional market in Queensland and rural NSW that requires propane. Propane from the anchored VLGC is transhipped into smaller (5000 cubic metre) pressurised ships for supply into Brisbane (conventional onshore storage) and marine deliveries into Cairns, Townsville, Gladstone and Darwin.

Supply arrangements are negotiated regularly. Current supply of Elgas and Origin is via a term contract with Geogas (a large international Swiss-based LPG trader). Geogas import propane via VLGC into Sydney and Brisbane. When supply is required into Brisbane, Geogas will offload one or two compartments (11,000 or 22,000 tonnes) from a VLGC import destined for Sydney.

The other import capable terminal is the Wesfarmers LPG plant at Kwinana. This terminal cannot import in fully laden VLGCs due to draught limits across the Gage Roads approach to the port. These deliveries are generally via smaller ships of 10,000–22,000 tonne size. As a consequence the delivered cost of these shipments is higher due to the inherent freight penalty relative to VLGC size delivery. Some LPG was imported in 2006. It is understood that further imports were required in 2008 as a result of shortfalls caused by the explosion at Apache's Varanus Island gas plant.

## 5.4 Demand

Australian LPG producers and importers sell the LPG as separate propane (mainly for traditional market, but can be used for autogas), butane (industrial) or propane/butane mix (autogas) in a pressurised state to their retail arms, joint venture participants or independent LPG merchants.

Australia is one of the leading worldwide users of LPG for transportation fuel, but propane for "traditional" uses remains a significant market in rural areas. There are few industrial or domestic applications for butane in Australia, (the Qenos petrochemical plant in Melbourne being the major exception). Butane can be blended with propane up to about a 60% mix for autogas use. This occurs in Melbourne and Adelaide. In most other areas, autogas is either wholly and mainly propane. As a consequence, propane comprises approximately 65–70% of the total wholesale LPG market.

Table 5.2

**AUSTRALIAN LPG DEMAND - 2007, (THOUSAND TONNES)**

| | Traditional | Autogas | Total | Autogas % | National Autogas % |
|---|---|---|---|---|---|
| Victoria | 167 | 524 | 691 | 75.8 | 47.3 |
| NSW | 182 | 263 | 445 | 59.1 | 23.8 |
| Queensland | 165 | 105 | 270 | 38.9 | 9.5 |
| South Australia | 72 | 110 | 182 | 60.4 | 9.9 |
| Western Australia | 75 | 93 | 168 | 55.4 | 8.4 |
| Tasmania | 24 | 9 | 33 | 27.3 | 0.8 |
| Northern Territory | 8 | 3 | 11 | 27.3 | 0.3 |
| **Total** | **692** | **1107** | **1799** | **61.5** | **100.0** |

Source: ALPGA LPG Supply Demand Study 2008.

Offtake of LPG is essential for continuity of production of oil and natural gas and the producers are constrained to load exportable LPG before tank tops occur. Export customers with high quality LPG shipping and offtake flexibility provide this assurance to each of the Gippsland LPG exporters.

The LPG merchants are usually mainly involved in the traditional market, however some merchants such as Elgas, through its subsidiary Unigas and Origin through Vitalgas, a joint venture with Caltex also participate in the autogas market. The refiners are also major participants in the autogas market, with Shell mainly selling through its joint venture with Coles and Caltex through Vitalgas and Woolworths. Exxon-Mobil and BP operate as direct sellers to their respective retail chains. Kleenheat is currently only involved in autogas in Western Australia and the Northern Territory after its parent company Wesfarmers bought Coles.

The merchants source their autogas from a variety of the above-mentioned producers and locations to optimise freight and logistics.

The domestic LPG market tends to operate in distinct marketing layers, with producers selling to merchants on a wholesale basis. The merchants then on sell the bulk LPG to their affiliates or retail outlets. Some merchants also act as aggregators and source autogas on behalf of a number of smaller merchants to improve their commercial position with producers.

### *Demand and supply balance*

Table 5.3 provides the demand and supply of LPG by jurisdiction.

Table 5.3

**AUSTRALIAN LPG DEMAND AND SUPPLY BALANCE - 2007, (THOUSAND TONNES)**

| | Demand | Production | Imports | Exports | Variation[13] |
|---|---|---|---|---|---|
| Victoria | 691 | 1,136 | 0 | 427 | 18 |
| NSW | 445 | 153 | 430 | 152 | -12 |
| Queensland | 270 | 191 | 99 | 9 | 11 |
| South Australia | 182 | 296 | 0 | 91 | 22 |
| Western Australia | 168 | 1,110 | 0 | 955 | -13 |
| Tasmania | 33 | 0 | 33 | 0 | 0 |
| Northern Territory | 11 | 0 | 4 | 0 | -7 |
| **Total** | **1,799** | **2,886** | **566** | **1634** | **19** |

Source: ALPGA LPG Supply Demand Study 2008.

## 5.5 Logistics

Queensland and Tasmania rely on small pressure ships to supply ports in Brisbane, Gladstone, Townsville, Cairns, Bell Bay and Hobart. These load at Moreton Bay and Port Botany (imported propane) and Westernport (propane produced from Bass Strait).

Origin Energy recently installed floating storage in the form of a VLGC in Moreton Bay to shorten the supply distances and address security of supply issues to northern Australian ports including Darwin. This facility is supplied from overseas and can handle both propane and butane.

Kleenheat's Darwin facility (1000 tonne propane storage facility) is supplied by either deliveries from Brisbane on small pressurized coastal ships (as an extension to the north Queensland supply arrangement), or international imports from Asian suppliers, or road freight from South Australia or Western Australia.

Some volumes of LPG are traded by road tanker across state borders such as Victoria to South Australia, New South Wales to Queensland (and vice versa) and Victoria to New South Wales (and vice versa).

Some LPG is understood to move west from Port Bonython (near Port Augusta in South Australia) by road or rail across the Nullarbor as far as Kalgoorlie.

A major and growing source of LPG is the product extracted from the raw gas stream of new LNG projects to meet LNG [14]specifications. Much of the expansion in Australia's LPG production is likely to occur from LNG projects scheduled for development on Australia's Northern and Western coast such that by 2018 it is forecast that refinery grade production will only account for 10% of Australia's LPG production.

[13] Stock variation or interstate transfer

[14] LNG (liquefied natural gas) is primarily methane ($CH_4$) with a very small amount (less than 4%) of hydrocarbon heavier than methane. The methane is liquefied by chilling to minus 164 degrees to reduce its volume/energy ratio about 600 times relative to atmospheric temperature to enable economic shipping. Most Australian LNG is exported to Asia, although occasional spot cargoes are sold into the Atlantic Basin.

## 5.6 Infrastructure / tankage

Infrastructure costs for LPG are much higher than those for oil and gas. The nature of LPG requires either pressure vessels or refrigeration to ensure it remains a liquid. Pressure requires heavy steel vessels, whereas refrigeration requires specialised metal to ensure it does not become brittle at prolonged very cold temperatures (propane - 45 degree C, butane -2 degree C). The high cost of infrastructure, and the changed structure of market demand since Australian LPG facilities were initially installed, has resulted in the industry being subject to logistical challenges. This has resulted in the counter intuitive situation where Eastern Australia is both an exporter and importer of propane and an exporter of butane. A similar situation exists in Western Australia, although imports of propane are relatively small and infrequent depending on any supply disruptions from BP Kwinana and Wesfarmers.

In addition to the special requirements for the production and shipping of LPG, the facilities to load, discharge and store refrigerated, semi refrigerated and pressurised LPG is also quite specialized and expensive. In Australia, refrigerated LPG is only available from

- the BHP-Billiton/Esso facility at Long Island Point (LIP) at Westernport in Victoria;
- Santos at Port Bonython in South Australia;
- BHP-Billiton/BP/Shell/Chevron/MIMI/Woodside at Karratha in Western Australia; and
- Wesfarmers at Kwinana, Western Australia.

These facilities involve significant cost to construct and maintain the storage, as they are cryogenic facilities.

LPG storage both at the production facility and at the receiving terminal is expensive due to the higher quality and volumes of steel required to contain it compared to other petroleum products. Due to these cost factors, producers and distributors usually tailor LPG storage to just meet offtake and delivery parcel size.

LPG storages are constructed in the form of large refrigerated tanks compatible with offtake and delivery by VLGC or in smaller pressurised tanks, spheres or bullets for offtake by pressure or semi-refrigerated vessels.

The refrigerated LPG is then stored in special insulated storage tanks, usually approximately 12,000 tonnes capacity, similar to that shown in Figure 5.2.

Figure 5.2

**REFRIGERATED LPG TANKS**

Source: Santos.

The LIP, Port Bonython and Kwinana facilities also have the ability to produce, store and load pressurised LPG for domestic markets. However, only LIP and Kwinana can ship pressurised LPG. To load pressurised LPG onto a ship, the refrigerated LPG must be reheated to ambient temperature. As the LPG is re-heated it expands and must be contained in special pressurised storage tanks, often called "bullets" or "cigars" of approximately 200 tonnes capacity, similar to that shown in Figure 5.3. All domestic LPG producers are capable of loading pressurised LPG into trucks for delivery to traditional and autogas markets.

Figure 5.3

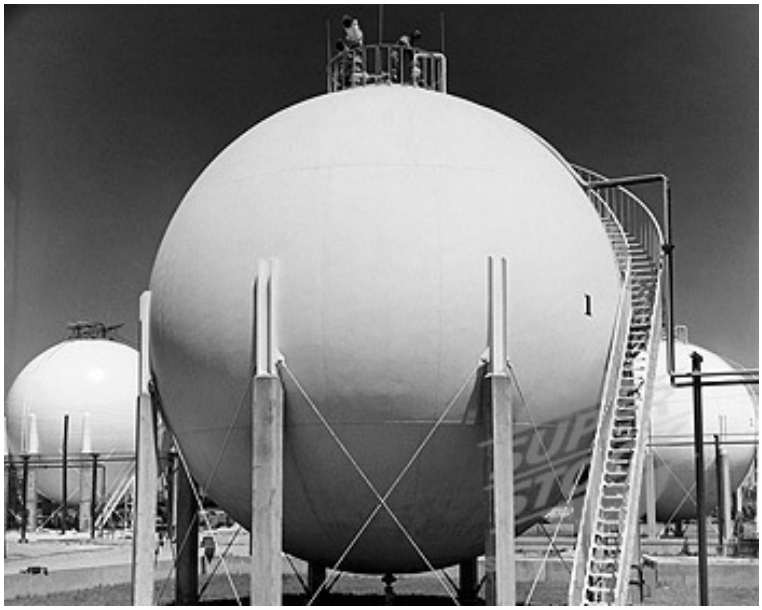
**PRESSURE LPG TANKS**


Source: G. Miles, Elgas Dandenong.

Elgas has several pressurised tanks (Horton spheres) at its Dandenong facility (Figure 5.4).

Figure 5.4

**HORTON SPHERE**

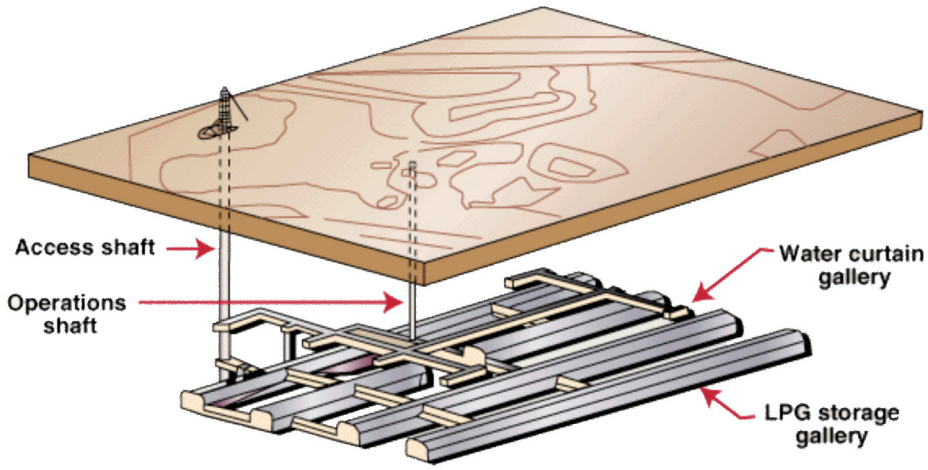


Source: Superstock.

The largest LPG receiving facility in Australia is the Elgas propane Cavern in Sydney. This facility was built at a cost of $190 million and stores 65,000 tonnes of propane in a cavern that was constructed under Port Botany in New South Wales. It keeps the propane as a liquid by combination of chilling and pressure. This facility can only export pressurised LPG. A schematic of the Elgas Cavern is shown in Figure 5.5.

Figure 5.5

**ELGAS CAVERN SCHEMATIC**




Source: Oil and Gas Journal.

LPG import facilities in Australia other than the Elgas cavern, Origin's Brisbane floating storage and Wesfarmers Kwinana facility are all small-pressurised facilities with limited capacities. Details of these facilities are included in Table 5.4.

As a consequence of storages being usually constructed close to parcel size and LPG ships being expensive, scheduling of LPG offtake is imperative. If an expensive LPG vessel is delayed waiting for production, the exporter can be subject to large demurrage claims. Conversely, if the vessel does not arrive in time, valuable LPG and potentially oil and gas production can be lost.

### *Domestic infrastructure*

The high cost of LPG infrastructure (tanks, trucks, loading facilities) and the comparatively small butane market has meant that most storage facilities post the point of production do not have butane storage.

Table 5.4

**DOMESTIC LPG INFRASTRUCTURE**

| Port | Owner / Operator | No. of Tanks | Type | Capacity (tonnes) | Product |
|---|---|---|---|---|---|
| **NEW SOUTH WALES** | | | | | |
| **Receiving** | | | | | |
| Botany | Origin Energy | 18 | Pressure | 4,500 | LPG/Propylene |
| Botany | Elgas | 1 | Cavern | 65,000 | Propane |
| Botany | Qenos | 1 | Refrigerated | 7,200 | Propane |
| Botany | Qenos | 1 | Refrigerated | 7,500 | Butane |
| Botany | Qenos | 1 | Refrigerated | 4,000 | Ethylene |
| **Total** | | | | **88,200** | |
| **Production** | | | | | |
| Clyde | Shell | | Pressure | 1,275 | Propane |
| Clyde | Shell | | Pressure | 1,900 | Butane |
| Kurnell | Caltex | | Pressure | 2,000 | Various |
| Kurnell | HCE | 2 | Pressure | 200 | Mix |
| **Total** | | | | **5,375** | |
| **NORTHERN TERRITORY** | | | | | |
| **Receiving** | | | | | |
| Darwin | Kleenheat | 4 | Pressure | 1,000 | Propane |
| **Total** | | | | **1,000** | |
| **QUEENSLAND** | | | | | |
| **Production** | | | | | |
| Pinkenba | BP | 8 | Pressure | 520 | Propane |
| Pinkenba | BP | 3 | Pressure | 1,580 | Butane |
| Lytton | Caltex | | Pressure | 900 | Various |
| **Total** | | | | **3,000** | |
| **Receiving** | | | | | |
| Lytton | Energex | 2 | Pressure | 500 | Propane |
| Pinkenba | Origin Energy | 10 | Pressure | 1,700 | LPG |
| Colmslie | Exxon Mobil | 2 | Pressure | 130 | Propane |
| Pinkenba | Shell | 4 | Pressure | 1,000 | Propane |
| Cairns | Origin Energy | 10 | Pressure | 2,500 | LPG |
| Gladstone | Origin Energy | 4 | Pressure | 1,000 | LPG |
| Townsville | Origin Energy | 5 | Pressure | 1,250 | LPG |
| **Total** | | | | **8,080** | |
| **SOUTH AUSTRALIA** | | | | | |
| Port Bonython | Santos | 2 | Refrigerated | 42,000 | Propane |
| Port Bonython | Santos | 2 | Refrigerated | 31,000 | Butane |
| Port Bonython | Santos | 2 | Pressure | 240 | Propane |

| Port | Owner / Operator | No. of Tanks | Type | Capacity (tonnes) | Product |
|---|---|---|---|---|---|
| Port Bonython | Santos | 2 | Pressure | 240 | Mix |
| **Total** | | | | **73,480** | |
| **TASMANIA** | | | | | |
| **Receiving** | | | | | |
| Bell Bay | Exxon Mobil | | Pressure | 1,000 | Propane |
| Devonport | Origin Energy | 5 | Pressure | 1,350 | Propane |
| Hobart | Origin Energy | 10 | Pressure | 1,800 | Propane |
| **Total** | | | | **4,150** | |
| **VICTORIA** | | | | | |
| **Production** | | | | | |
| Dandenong | Elgas | 2 | Horton Sphere | 2,000 | Propane |
| Dandenong | Elgas | 1 | Horton Sphere | 1,000 | Butane |
| Westernport | Exxon Mobil | 3 | Refrigerated | 36,400 | Propane |
| Westernport | Exxon Mobil | 4 | Refrigerated | 61,500 | Butane |
| Westernport | Exxon Mobil | 5 | Pressure | 600 | Propane |
| Westernport | Exxon Mobil | 5 | Pressure | 600 | Butane |
| Geelong | Shell | | Pressure | 1,100 | Propane |
| Geelong | Shell | | Pressure | 7,000 | Butane |
| Altona | Exxon Mobil | | Pressure | 1,100 | Mix |
| Lang Lang | Origin | 3 | Pressure | 900 | Propane |
| Lang Lang | Origin | | Pressure | 445 | Butane |
| Lang Lang | Origin | | Pressure | 250 | LPG |
| Otway | Woodside | | Pressure | 400 | Propane |
| Otway | Woodside | | Pressure | 400 | Butane |
| **Total** | | | | **113,695** | |
| **WESTERN AUSTRALIA** | | | | | |
| **Production** | | | | | |
| Dampier | Woodside | 1 | Refrigerated | 32,000 | Propane |
| Dampier | Woodside | 1 | Refrigerated | 42,000 | Butane |
| Kwinana | BP | | Pressure | 1,100 | LPG |
| **Total** | | | | **75,100** | |
| **Production/receiving** | | | | | |
| Kwinana | Wesfarmers | 2 | Refrigerated | 26,000 | Propane |
| Kwinana | Wesfarmers | 1 | Refrigerated | 13,000 | Butane |
| **Total** | | | | **39,000** | |
| **TOTAL AUSTRALIA** | | | | **411,080** | |

Source: ALPGA & Origin.

The combination of supply, demand and infrastructure issues result in the following broad statements about the Australian LPG market.

- Australia's LPG production of 2.9 mmtpa is approximately 50% propane (1.45 mmtpa).
- Australia's LPG demand of 1.8 mmtpa is more than 80% propane (greater than 1.45 mmtpa).
- Gippsland and NWS LPG producers do not have sufficient storage to fully load a VLGC of butane for export. As a consequence, they generally export LPG in combinations of 33,000 tonnes butane and 11,000 tonnes propane.
- The import receiving terminal in Sydney and the smaller "pressure" locations in northern Queensland and Darwin can only receive propane. The VLGC in Moreton Bay can receive butane, but does not due to lack of market demand.

The above factors have to be considered in any comparison between trade in LPG with other petroleum products such as petrol and diesel where storage is cheaper to construct and more widely available with consequent easier scheduling.

## 5.7 Future supply balance

The ALPGA Supply/Demand study released in late 2008 included forecasts of the Australian supply/demand balance to 2018 and concluded that:

- Western Australia and Victoria are to remain exporters of LPG over the forecast period.
- Queensland, Tasmania and New South Wales to remain as importers.
- South Australia to become a net importer early in the next decade as Cooper Basin LPG production reduces.
- The southwestern corner of Western Australia may become a seaborne importer of LPG as more LPG is extracted at the NWS project following the commissioning of the 5$^{th}$ LNG Train and 3$^{rd}$ LPG Fractionation plant. At present, Wesfarmers is relying upon wet gas flows from other gas fields into the Dampier to Bunbury pipeline such as Harriet, John Brookes, and Reindeer for its feed gas. It is unclear whether this will be adequate to service the Western Australian market in the future.

*Chapter 6*

# Australian LPG pricing

## 6.1 Import parity and export parity prices

Import Parity Pricing (IPP) refers to the value of a unit of product (for example, propane in $US/tonne) bought from Saudi Arabia and valued (in Australian currency) at a geographic location of interest in the importing country (for example, Sydney).

Export Parity Pricing (EPP) refers to the value of a product sold at a specific location in a foreign country (for example, butane sold in Japan), but valued from a specific location in the exporting country (for example, Port Bonython).

## 6.2 Pricing of LPG in Australia

Australian LPG pricing is based on term contracts between buyers and sellers. These contracts are usually of twelve month duration. There is very limited spot pricing or trading of LPG.

### *Term supply contracts for domestic LPG*

Contracts are usually negotiated in the fourth quarter of each calendar year for the next calendar year. The distributors approach all field producers and seek the lowest prices. For each producer, it is important for consistent offtake purposes that its customers are provided with competitively priced LPG. If they are not, they will potentially lose market share in the wholesale and retail markets and not be able to maintain their delivery obligations.

Hence producers are committed each year to match competitor supplier prices. For automotive LPG, final term contract prices have to be considered on an Australian cent per litre basis.

Due to propane use as an automotive fuel as well as the usual mixture of 50% propane and 50% butane, it is important that the price of propane mainly used in domestic applications does not move out of alignment with the price for the 50/50 automotive mixture on an Australian cent per litre (cpl) basis.

In Victoria, producer wholesale automotive prices are determined by competition between five supply sources and propane imported through the Port Botany cavern. Delivery is direct from the producers' terminal gate to the forecourt usually in economic B-Double trucks.

Victoria enjoys a surplus of LPG which it exports mainly to Japan. It is more likely that domestic wholesale prices will move towards the producers' EPP alternative when supply is "long" (excess supply in the domestic market).

It is the Australian importers' term supply price that local producers will attempt to estimate in pricing their LPG. These term contracts are re-tendered and/or re-negotiated in the fourth quarter of each calendar year for the following calendar year.

Supply to the regions in shortfall is serviced through storages owned by the importers in NSW, Tasmania, Queensland and the Northern Territory.

### *Term supply contracts for imported LPG*

Both major East Coast importers (Elgas and Origin) acquire their LPG under term supply contracts. This is because of their need to provide security of supply of the propane necessary to meet domestic heating and cooking needs in the importing regions and to ensure security of supply to service their investment in infrastructure. To this extent, they share characteristics of the Japanese and Korean importers who secure their LPG under term arrangements to assure supply security.

Elgas and Origin source propane for the Botany cavern (Elgas) and into an on-site VLGC anchored in Moreton Bay (Origin). Elgas and Origin independently negotiate supply contracts with international LPG traders. Geogas is the current supplier to both. Geogas is a large LPG trader well equipped with high standard VLGCs and awareness of LPG supplier logistics. Geogas supplied approximately 400,000 tonnes (10–12 cargoes) and 100,000 tonnes (4–6 transfers of 10–30 k tonne parcels) in 2007 into Sydney and Brisbane respectively. Up to 100,000 tonnes of propane imported into the Botany cavern was subsequently exported to New Zealand for supply of their domestic market. When the New Zealand Kupe field commenced production in 2008, this trade stopped. When supply is required into Brisbane, Geogas will offload one or two compartments (11,000 or 22,000 tonnes) from a VLGC cargo destined for Sydney.

Geogas negotiates annual contracts to supply Elgas and Origin on a fixed differential above the Saudi propane CP. Geogas manages the price exposure and price to Elgas and Origin on a "month of lifting" basis. Geogas commits to maintain adequate inventory to meet the customers' requirements. The timing and volume of the deliveries is at the discretion of Geogas. The propane is effectively priced at the time it is drawn out of the storage and sold to the wholesale customer, not when it is supplied into the Botany or Brisbane storage facility. Geogas manages the market risk associated with the timing of the price when they purchase the cargo (from Saudi Arabia or another producer) and the time when the customer (Elgas or Origin) draws the propane out of the storage at Botany or Brisbane.

To the extent possible, Geogas attempts to trade around the obligation to supply via the multiple supply (purchase) and freight (term charter and spot) agreements Geogas have in place with various producers and ship-owners. Elgas and Origin receive propane on a delivered basis therefore product title and risk transfers to them at the loadport. The customer pays the cost of insurance to protect against loss at sea and environmental exposure.

To be able to offer security of supply at a fixed premium for the duration of the annual contract, Geogas enters into term charter arrangements with ship owners. This has the effect of fixing the freight cost for the duration of the supply commitment.

It is assumed that the Geogas contract includes a margin to reflect the price exposure and costs that they incur in fulfilling this contract. This is likely to be a few dollars per tonne.

Given the unusual nature of the Australian requirement, few suppliers have sufficient storage to fully load a VLGC with propane. Saudi Arabia's Ras Tanura loadport is probably the only location that can regularly load propane cargoes of this size. It is likely that they impose a "security of supply" premium to reflect this situation. Alternately, Geogas sources the propane from separate Middle East supplies to be able to aggregate sufficient propane for a full cargo, but this involves two-port loading and consequential higher costs.

Elgas and Origin incur all additional costs post the arrival of the ship at Botany or Brisbane. These costs include port fees, costs associated with operating the terminal and a fee to recoup the cost of storage facility. In the case of Origin at Brisbane, this is the cost of annual charter of the on-station VLGC. In the case of Elgas, this supports the investment made for the construction of the cavern. The fee to recoup the cost of the storage facility is necessarily linked to the throughput of the facility (i.e. the more volume that the cost can be amortised against, the lower the cost per unit). A consequence of the loss of the New Zealand volume as Kupe production commenced was that the Botany storage fee increased significantly.

The security of supply motive also explains the term shipping arrangements supporting these contracts. The importers assure themselves that the supply contractor has access to both secure LPG supply and a fleet of tankers owned or chartered on a long-term basis. They would not accept supply arrangements based entirely on spot LPG availabilities and spot chartering of LPG tankers.

Secure term suppliers to Australian importers must also be able to meet tight delivery schedules as well as stringent operational and safety requirements. They cannot afford late delivery of the product given the key role LPG plays in both traditional and automotive markets in the importing regions.

### *Term supply contracts for exported LPG*

Australian producers of LPG with exportable surpluses more often than not cannot meet the importers' timing requirements for marine delivery. Even if economic delivery from the NWS was possible, the timing of the tight loading "windows" discussed in Chapter 5 is unlikely to match the importers' delivery date requirements.

A similar set of conditions face the exporters from the Gippsland field. Their propane production is now more subject to the vagaries of natural gas production and their export availabilities are difficult to predictably schedule within the lead times desired by the importers. Storages are also less than the 85,000 tonnes initially provided at Westernport due to a tank refurbishment programme now being undertaken after some 35 years of service. The consequence of this is that, while domestic sales should consume all propane, exports of propane will continue until at least 2010 for the following reasons:

- Limited butane tankage to load a full 44,000 tonne (44kT) vessel of butane only. This has been particularly limiting from late 2007 until at least mid 2010 due to a large butane tank being out of service for maintenance. As a result 11-22,000 tonnes of propane is required on each export vessel to avoid costly dead-freight, unless a suitable co-load opportunity can be identified.
- Export customer preference for one compartment (11,000 tonnes) of propane, primarily due to limited butane receipt tankage.

- High cost of coolant/cooling time for full 44,000 tonnes butane cargoes.

With the return of the large butane tank in 2010, and despite a smaller tank possibly being taken out for maintenance at that time, a reduction in propane exports is likely. However, the above issues will still limit ability to load 44,000 tonnes butane cargoes.

It is thus extremely difficult to align the availabilities of Australian producers' VLGC exports with the Australian importers' delivery requirements on a reliable and consistent basis. The importers thus seek supply through economic VLGC sized deliveries from overseas sources such as Saudi Arabia and to a lesser extent, the UAE, which have constructed large "tank farms" of propane storage suitable for the large volume of exports they perform to Far Eastern customers.

Flexible loading date ranges able to closely meet the Australian importers' delivery dates are available from the Middle East suppliers.

## 6.3 Regional pricing

The producer or importer pricing basis for automotive LPG throughout Australia varies between IPP to close to EPP. In general, this leads to relatively high gross indicative margins above the benchmark prices for propane and butane in regions where delivery costs are high such as North and Central Queensland to lower margins approaching EPP in Victoria.

### *New South Wales/South-East Queensland market*

For the market from South-East Queensland to northern Victoria, the determining cost is the cost of importing propane from foreign suppliers. Currently, this is the Saudi propane CP plus the costs of delivery by VLGC into the large Port Botany cavern plus terminal and handling charges and margin. Due to the economy of VLGC delivery and the economies of scale afforded by the cavern, this is lower than the imported cost of propane delivered from floating storage into small pressure storages on the Brisbane River.

Propane from the Port Botany cavern can and does compete into southeast Queensland and northern Victoria and sets a ceiling to domestic producer automotive LPG prices in those regions. Sydney and Brisbane refineries that sell LPG for automotive use into this region, would argue that, because LPG is short and has to be imported, the "market clearing" price should be the estimated import cost of propane.

Brisbane refineries manage surplus butane emanating from the requirement to reduce the vapour pressure in petrol by shipping surplus butane (particularly in summer) to the Pacific Islands. The Kurnell refinery also does this. LPG pricing in the Pacific Islands is based on butane and propane Saudi contract prices.

Other options for surplus butane from refineries in Australia include its use as a petrochemical feedstock or as a refinery fuel in place of purchased natural gas.

### *Northern Queensland market*

North and central Queensland are supplied by either pressure ship loading from Origin's floating storage at Moreton Bay (near Brisbane), or by road tankers from the Brisbane refineries or Surat Basin domestic production.

Market size and infrastructure factors explain why automotive LPG prices are higher in northern Queensland than in southeast Queensland, NSW or Victoria. The wholesale price of autogas sourced from these small marine terminals sets the import parity price against which the LPG delivered by road tanker has to compete. Both are high cost supply lines compared to those prevailing in the other East Coast automotive LPG markets.

Domestic suppliers seek to match the price of propane delivered into the marine terminals. The closest domestic producers are the small field LPG extraction plants based on the Surat Basin and the two Brisbane refineries. These suppliers produce an autogas mix that includes butane. They seek to price automotive LPG delivered by road into north and central Queensland at just below the cost of propane on a cent per litre (cpl) basis.

Refineries generally price automotive LPG at the average of butane and propane CP plus or minus a margin targeted to penetrate desired markets. Where marine delivery of propane is the competition, they would have to discount the price by the ratio of the specific gravity of the autogas mix divided by the specific gravity of propane to account for the lesser amount of litres per tonne in the autogas mix relative to propane. A tonne of propane equates to around 1970 litres whereas the autogas mix yields 1865 litres per tonne (assuming a 50/50 blend).

### *Northern Territory market*

Origin supplies the bulk of the Northern Territory demand by selling to Kleenheat by pressurised ship delivery from Brisbane into Kleenheat's Darwin storage. The Kleenheat storage has a capacity of 1000 tonnes. According to the ALPGA 2008 Supply and Demand study, Northern Territory consumption is 11,000 tonnes or approximately 30 tonnes per day, although some demand in the southern portion of Northern Territory may be supplied by road from Port Bonython. It is also possible that propane is imported from Asia on small pressure ships. Assuming a requirement to hold a minimum storage buffer at Darwin of approximately 10 days, the maximum parcel size of delivery would therefore be approximately 700–800 tonnes. Origin effectively supplies Darwin as part of their northern Queensland "milk-run", although the cost of delivery must be competitive relative to road delivery from Port Bonython or delivery from Kleenheat's Kwinana terminal or direct importation from Asia.

### *Victorian market*

In Victoria, competition between producers and importers has maintained automotive LPG prices at or below the estimated IPP level at Port Botany on a cent per litre basis and has reduced producer automotive LPG pricing levels to closer to EPP on a US dollars per tonne basis.

The refineries as well as the Otway and BassGas LPG projects in Victoria do not have export capability. They seek to assess finally settled market levels for each contract year in pricing their LPG into both heating and automotive markets. They thus discount their automotive LPG below the levels so assessed such that their product will be purchased by distributors ahead of the LPG produced by the export capable customers.

These producers are constrained by the LPG storage available to them in terms of days of production to seek flexible and reliable offtakers with wide access to the providers of LPG road tankers. At times of higher than expected LPG supply for example, due to a surge in natural gas production or at times of quiet demand, they may further discount from these levels to clear their LPG into both heating and automotive markets.

### *South Australian market*

Given such LPG supply pressures in Victoria, more LPG is now moving by road into South Australia especially from the Otway project placing more price pressure on South Australian producers. These producers are export capable with high storage to now reducing production ratios and would not discount below EPP ex Port Bonython. Thus South Australian wholesale automotive prices would be set between IPP delivered from Victoria to major automotive markets in Adelaide, less road transport costs from Port Bonython and the producers' EPP.

### *Tasmanian market*

Tasmania imports all of its LPG from Victoria and thus consumers there will face a Tasmanian wholesale IPP comprising the FOB price at Westernport plus sea freight in small pressure ships or on barges plus storage and handling costs.

### *Western Australian market*

There are four main sources of LPG supply in Western Australia. The NWS Project at Karratha, Wesfarmers LPG plant, imports into Wesfarmers marine facility at Kwinana and the BP refinery (also at Kwinana).

The NWS produces LPG from the NWS LNG and Domestic Gas (Domgas) Project. Due to the storage and operational constraints discussed in Chapter 5, this LPG is entirely exported to Japan and China. Exports in 2007 were approximately 850,000 tonnes and this is expected to increase to over 1 million tonnes per year from 2009 mainly due to expansion of LNG production and additional LPG fractionation capacity.

The NWS Domgas joint venture partners (Domgas JVP) are bound under Western Australian legislation to deliver gas into the Dampier to Bunbury Pipeline (DBPL) within a maximum and minimum heating value requirements. In the period from 1987 to the early years of this decade, they were bound by an agreement to inject more propane-rich LPG into the DBPL than was necessary to meet the minimum heating requirement so that the Wesfarmers LPG plant at Kwinana could supply domestic market demand for propane and to enable its economic operation.

Pricing of natural gas in WA is based on the delivered calorific value of the natural gas. Under this arrangement, the NWS Domgas JVP were able to obtain some incremental value for the LPG contained in the Domgas but this remained far lower than the value of LPG which could be extracted from the NWS gas streams at Karratha.

The commercial agreement for additional injection of LPG by the NWS Domgas JVP into the DBPL was not extended beyond 2005. Wesfarmers has since relied on other producers of natural gas into the DBPL for LPG feedstock for their plant. Wesfarmers' Annual Reports indicate that the production of LPG from their plant at Kwinana has reduced significantly in recent years.

The BP refinery produces relatively stable levels of LPG except in periods where extended refinery maintenance is required.

Seaborne LPG imports were required into Kwinana in 2006 due to refinery maintenance and in 2008 as a result of the fire at the Varanus Island gas plant.

The Wesfarmers facility at Kwinana is capable of both exports and imports of LPG. From total WA exports of 955,000 tonnes in 2006 as shown in ALPGA study some 850,000 was exported from the NWS. Thus Kwinana exports in 2006 are estimated at approx 100,000 tonnes however 16,000 tonnes were imported in 2006 according to ALPGA data.

From 2009, it is possible that exportable volumes from Kwinana will reduce even more given the deeper LPG fractionation available at the NWS project and further seaborne imports may be required.

These imports cannot be performed in fully laden VLGCs due to draught limitations. It is likely that an actual IPP higher than that at Port Botany (which can accept full VLGCs) may be required at Kwinana depending on demand and local supply trends.

Supply of LPG from Karratha to Kwinana is usually not attractive because:

- The southwest of WA requires propane to supply the traditional market. Due to the high cost of construction of storage, most inland locations only have propane storage. As a consequence, propane is used for both the traditional market and automotive LPG.
- NWS is butane-rich. NWS production is 45/55 with propane production of approximately 1300 tonnes per day.
- Propane storage at Karratha is 26,000 tonnes, therefore about 3-4 days between "parcel size" of 21,000 tonnes and tank-tops. This time period is too narrow to schedule/sell to customers unless they have a large fleet of vessel under their control.
- Middle East producers have more storage, and therefore can offer more flexible loading windows.

NWS producers would be exposed to offtake risks if they were to sell to Kwinana. A minor delay in shipping would result in the requirement to suspend production of all gas and oil production. The alternative of scheduling to "short-load" a ship (i.e. load only say, 18,000 tonnes) or schedule for early arrival as a buffer against potential tanktops (i.e. plan to incur demurrage) would result in the delivered price of NWS propane being unattractive relative to Middle East supply.

## 6.4 International freight cost

### *Freight from the Middle East to Australia*

The average rate for a VLGC from the Middle East to Japan in 2008 was $US42.30/tonne. This was similar to the 2005–2007 average of $US42.00/tonne. By adjusting for the number of sailing days between the Middle East and Australia relative to the Middle East to Japan, the Middle East to the East Coast of Australia average freight for 2008 was $US46.20/tonne. The comparable rate in the first quarter of 2009 was approximately $US17.75/tonne (compared with a Ras Tanura — Japan average of $US16.25/tonne).

Table 6.1

**INDICATIVE VLGC FREIGHT CALCULATION**

| | Voyage time at 13 knots (days) | Ratio to ME to Japan | Freight rate (US$/tonne) |
|---|---|---|---|
| ME to Japan | 21.5 | | 42.30 |
| ME to Sydney | 23.4 | 1.09 | 46.20 |
| Westernport to Japan | 15.6 | 0.73 | 30.90 |
| Dampier to Japan | 12.0 | 0.56 | 23.70 |

Source: WLPGA, World Distance Tables, internal analysis.

### *Freight from Australia to Japan*

The freight saving for propane and butane cargoes (1/3 product ratio) from Westernport to Japan is an average of $US11.40/tonne relative to Middle East to Japan (based on "normalised" freight for 2005–2008 average), but only a few dollars in the first quarter of 2009. The 2005–2008 average could be described as corresponding to close to the long-term average cost of modern VLGC ships. Westernport producers can charge a premium of this level on FOB sales to Japan and still be competitive relative to Saudi production. Backhaul opportunities from having VLGCs regularly coming to the East Coast with imports of propane for Sydney and Brisbane potentially offers additional support.

On this basis, the indicative EPP for Gippsland producers until recently was the Saudi CP plus a premium of $US5–15/tonne. At current international spot freight rates, this premium may have been virtually eliminated, or at least significantly reduced.

For exports of propane and butane cargoes (2/2 ratio) from Dampier to Japan, the saving in freight should be an average of $US18.60/tonne (based on "normalised" freight), however premiums of this level are usually not achieved due to the operational and scheduling constraints.

In normal periods, NWS sellers probably achieve FOB prices of Saudi CP parity or up to a premium of $US5–10/tonne. The current freight market may have reduced these prices by $US5–10/tonne.

## 6.5 Import parity pricing

Propane imported into Australia (and costed ex-storage) is priced at the Saudi Aramco contract price plus a premium.

The premium for each location is the sum of factors including a product premium, freight, insurance and loss, port fees, storage and local terminal fees. The IPP components for each location are different due to unique nature of each import facility.

On the East Coast of Australia, propane can be imported on VLGCs. Elgas has propane delivered into their purpose built 65,000 tonne cavern in Port Botany. Origin has propane delivered into a floating VLGC storage facility off Brisbane. Both companies have negotiated a supply contract so that the supplier (Geogas) delivers the propane and guarantees to keep a certain stock level in the receiver's storage. Both Elgas and Origin supply propane for both traditional and automotive uses and need to maintain sufficient stock levels to ensure no stock-outs, especially for traditional customers who use it for cooking and heating and may not have alternative sources of energy. It takes 24 days to bring a cargo of propane from the Middle East to Australia. As a result, there is also a security of supply component in the term import supply contracts.

For the LPG imported into Perth (when required) and Darwin on smaller (and more costly) pressure or semi-refrigerated ships, the supply price is much higher. Imports into Kwinana are most likely secured on a spot basis from Asia. As a consequence, import costs would be subject to large variation. Darwin is usually supplied by Kleenheat via coastal pressurised ships from Origin's floating storage off Brisbane.

Table 6.2 shows an estimate of the different components that in addition to CP make up a term import supply cost for the different import facilities in Australia.

Table 6.2

**INDICATIVE IPP CALCULATION[5]— US$/TONNE**

| | Sydney Cavern | Brisbane VLGC | Kwinana | Darwin |
|---|---|---|---|---|
| Freight — VLGC[1] | $46.00 | $51.00 | NA | $51.00 |
| Freight — Pressure | NA | $44.00 | $110.00 | $189.00[2] |
| Insurance/loss | $1.00 | $2.00 | $1.00 | $2.00 |
| Port fees | NA | $7.00 | $4.00 | $7.00 |
| Storage & terminal fee[3] | $90.00 | $101.00 | $49.00 | $50.00 |
| Supplier margin[4] | $2.00 | $2.00 | $10.00 | $2.00 |
| **Total CP plus** | **$139.00** | **$207.00** | **$174.00** | **$301.00** |

Notes:

1. The freight calculation is based on the average of the 2005-2008 spot market rates. This reflected a "normalised" market that was probably near the long-term average rate required to justify construction and operation of modern VLGC ships. Our assessment is that this rate is likely to be indicative of the freight included in the current Geogas contracts with Elgas and Origin. The spot freight rate since mid-2008 has been significantly below these levels. It is possible that this will be reflected in the contracts when they are re-negotiated in late 2009, but it is unlikely that spot market rates will remain this low indefinitely because they do not provide a sustainable revenue for ship owners.

2. Darwin freight assumes delivery via Brisbane.
3. Storage and terminal fees are difficult to separate without actual data.
4. The "supplier margin" reflects an assessment of the combined margin associated with the requirement for "propane only" imports, a requirement for security of supply to service the traditional market and a margin to reflect trading risk and service.
5. See Appendix A.2: Import Parity Calculation for explanation

Source: Market discussions and internal analysis.

Given the above information, the IPP for LPG in Australia is:

IPP = Saudi CP + freight + insurance and loss + storage and terminal fees + supplier margin

Based on average Saudi CP for propane and freight over the period 2005-08, the "landed price" of LPG in Sydney is estimated in Table 6.3. The Saudi CP is the major component of the IPP of LPG at about 80 per cent.

Table 6.3

**INDICATIVE IPP CALCULATION – SYDNEY, 2005-08 AVERAGE**

| | US$/tonne | Aust cpl | % of total |
|---|---|---|---|
| Saudi CP | 576 | 36.7 | 80.6 |
| freight | 46 | 2.9 | 6.4 |
| storage and terminal fees | 90 | 5.7 | 12.6 |
| insurance and loss | 1 | 0.1 | 0.1 |
| supplier margin | 2 | 0.1 | 0.2 |
| **Total** | **715** | **45.5** | **100.0** |

Note: Average USD/AUD exchange rate of 0.80

Source: Market discussions and internal analysis.

*Chapter 7*

# Conclusions

## 7.1 The appropriateness of the Saudi CP as a pricing basis

There are a number of important differences in the methodology and application of the Argus CFR FEI and the Saudi CP.

- Saudi CP is a spot market driven contract price for supply agreed between security of supply conscious buyers and offtake sensitive sellers.
- Japanese and, to a lesser extent, South Korean buyers have invested heavily in establishing fleets of LPG ships to transport the product in a safe and timely manner. These buyers rarely buy on a "delivered" or CFR-basis.
- In recent years, Chinese demand has become more prominent. These buyers are less security conscious. Additionally, production from Qatar and Iran has resulted in more LPG being sold on world spot markets.
- Chinese importers (unlike those in Japan and Korea) have been most active in purchasing their LPG from the spot market on a delivered basis.
- Around 80% of international LPG sales in Asia continue to be conducted under contracts that use Saudi CP as a pricing basis.
- It is unlikely that an Australian importer (Elgas, Origin, Wesfarmers) has purchased on a CFR FEI basis.
- The published price indices by Argus (and Platts) are based on a small number (approximately 4-8 cargoes/month) of observed delivered sales mainly into China and include spot market LPG freight from the Middle East.
- The Argus CFR FEI is an assessment of market values. The actual number of "deals done" is small (about 1-2 per week) and the accuracy of the reporting is dependent on the ability of the journalist to canvass and assess the market. Buyers and sellers often have a vested interest in the price being reported favourably to them. Evidence of the subjectiveness of assessments is that Argus and Platts will occasionally make significantly different price assessments of the market level.
- These journalistic quotes are sometimes prone to volatility that might be unrepresentative of the actual market. With so few actual deals being completed, "market assessments" are often done on implied market levels based on prices in other markets (either locations, or relative to movements in other hydrocarbons like naphtha or oil).
- The comparative quality, location and shipping issues that pertain to the sales that form the basis for the Argus CFR FEI and for Australia are sufficiently different to render the CFR FEI non-representative for the Australian market.

The use of daily Argus CFR FEI price indices (even if it was adjusted for the freight differential to Australian import locations) in the pricing of Australian automotive LPG would not be appropriate. The use of the Saudi CP for benchmarking purposes remains preferable.

## 7.2 LPG pricing in the Australian market

Australia exports approximately half of its production of LPG. In an apparent paradox, it also imports over 20% of domestic demand. This means that a large volume of Australian LPG is sold into, or sourced from, the international market. Domestic sellers and buyers are therefore exposed to international prices irrespective of the prevailing domestic pricing methodology.

Despite the rise of FEI/North Asia pricing, the overwhelming proportion of international LPG transactions executed by Australian sellers and buyers are conducted on a Saudi CP basis.

It is understood that all Gippsland exports to Japan are sold on a Saudi CP basis. It is also understood that most NWS exports are Saudi CP related; the exceptions being some BP and Chevron exports that are sold into China. According to traders, BP corporate is taking active participation in the Chinese market and therefore uses their NWS equity to support this activity. Santos may have sold to a trader on an equal weighting of Saudi CP and Argus CFR FEI basis to facilitate a Chinese sale, but this is unlikely to be a commonplace basis.

Elgas and Origin source propane for the Botany Cavern in Sydney (Elgas) and into an on-site VLGC anchored in Moreton Bay in Brisbane (Origin). While Geogas manage the price exposure and price to Elgas and Origin on a "month of lifting" basis, the prices are linked to Saudi CP.

Since commencement of exports to Asian customers, Australian producers have been able to capitalise on their advantages over Middle Eastern suppliers. These have included security of supply from a non-Middle Eastern source, reliability of supply from a politically stable country, location advantage and high quality product.

Thus, the freight advantage or location differential for contract prices for LPG exports has usually accrued to the Australian exporter.

All sales by Australian producers (both field and refinery production) to wholesalers are transacted at a Saudi CP related price basis. The benefit of execution on this relationship is that buyers and sellers are not exposed to basis risk between international and domestic transactions.

Saudi CP is the least risky floating price position available to Australian buyers and sellers exposed to the international market because Australian market participants have little or no power to dictate the pricing basis of international sales.

## 7.3 Domestic autogas pricing

Supply, demand and infrastructure issues result in the cost of supply of LPG into different Australian marine locations being significantly different. This results in unique pricing at each location.

Key characteristics of the Australian LPG market are:

- Australia's LPG production of 2.9 mmtpa is approximately 50% propane (1.45 mmtpa).
- Australia's LPG demand of 1.8 mmtpa is more than 80% propane (greater than 1.45 mmtpa)

- Gippsland and NWS LPG producers do not have sufficient storage to fully load a VLGC of butane for export, and therefore generally export LPG in combinations of 33,000 tonnes butane and 11,000 tonnes propane to optimise freight economics.
- Most receiving terminals (the large facilities in Sydney and Brisbane that can receive refrigerated LPG and the smaller pressure locations in Queensland, Darwin and Tasmania) can only receive propane. Kwinana can accept butane, but has no need.
- Freight costs are determined by the draft and/or storage limitations at the receiving port. Both will impact on the type (refrigerated, semi-refrigerated or pressurized) and size (i.e. 700–800 tonnes in Darwin, 1000 – 2000 tonnes in northern Queensland ports, 22,000 tonnes in Kwinana or up to 44,000 tonnes in Sydney and Brisbane) of ship used to transport the LPG.

Domestic wholesale autogas prices are negotiated at each supply point (LPG plant, refinery or marine loading facility) at prices that reflects the location advantage or negotiating position of the seller. Most of the Australian autogas market has actual supply costs significantly above export parity pricing (EPP) due to varying infrastructure and distribution costs. Domestic autogas prices are currently being negotiated at price levels between EPP and IPP (import parity pricing).

At the time that the LPG market was deregulated in 1991, almost all LPG demand was sourced from domestic production. Prices were marginally below the "notional" IPP. The cost was "notional" because Australian facilities capable of receiving large LPG cargoes did not exist. Notwithstanding this, prices were sufficiently above the export parity price to attract domestic producers to supply the local market. This was particularly so during the late 1990s when strong growth was occurring in sales of automotive LPG.

### *The NSW and Queensland markets*

An element of competition emerged in 2000 when Elgas commissioned its Botany import terminal (the Cavern). This provided an "actual" rather than "notional" IPP ceiling to Australian producer prices. (Similarly, the Origin "floating storage" VLGC vessel anchored in Moreton Bay since 2008 has created an "actual" IPP.)

### *The Victoria market*

The commissioning of the Yolla (BassGas) and Otway fields off Victoria in recent years has created downward price pressure in the wholesale market. The market imperative for these projects is to maximize natural gas production. The operators are therefore loathe to shut-in the fields due to LPG tank-tops. These fields do not have a marine delivery alternative and rely totally on customers to make available sufficient trucks to ensure the plant does not become tank constrained. The most effective method of achieving this is to price the LPG at a lower price than the larger producers. As a consequence, market prices for LPG in Victoria have moved closer to EPP than IPP.

### The South Australia market

Given the LPG supply pressures in Victoria, more LPG is now moving by road into South Australia especially from the Otway project. This places more price pressure on South Australian producers. The Cooper Basin is export capable, and due to declining production, has a high storage/production ratio. Thus, South Australian wholesale automotive prices are set between:

- LPG delivered from Victoria to major automotive markets (i.e. Adelaide), less road transport costs from Port Bonython; and
- the producers' EPP.

### The Western Australia market

In Western Australia, an infrastructure-driven supply arrangement results in the NWS producers receiving EPP for their entire production and southwest buyers of WA having to pay IPP. The IPP in WA is significantly higher than the IPP prevailing in eastern Australia because LPG imported into Kwinana (when necessary) must be shipped in 10,000–20,000 tonne parcels due to draft limitations.

Supply of LPG from Karratha (the loadport for NWS production) to Kwinana is usually not attractive because:

- The southwest of WA requires propane to supply the traditional market. Due to the high cost of construction of storage, most inland locations only have propane storage. As a consequence, propane is used for both heating and automotive LPG.
- Propane production from the NWS is approximately 1300 tonnes per day. The "workable" storage limit for propane at Karratha is 26,000 tonnes, therefore about 3-4 days between "parcel size" of 21,000 tonnes and the storage being full. This time period is too narrow to schedule a sale even if the customer has a large fleet of vessels destined to southwest buyers of WA.

### Price relativities

LPG cost differentials between different locations are large.

- Freight and storage costs for LPG imported into the Elgas cavern in Sydney are calculated at approximately $US46/tonne and $US90/tonne respectively. After adding in the assumed cost of insurance, port fees and product premiums, the total estimated cost is $US139/tonne.
- The "arms-length" calculated cost of delivery and storage into Brisbane since Origin commenced use of a VLGC as "floating storage" in Moreton Bay is approximately $US68/tonne higher than Sydney or $US207/tonne because of the need to transfer the LPG to a pressure ship for delivery into on-shore storage and annual charter of the VLGC storage ship.
- Despite higher costs associated with the requirement to use smaller semi-refrigerated or part-loaded refrigerated ships, Perth's location relative to the Middle East and older storage means that freight and storage costs are likely to be only approximately $US35/tonne higher than Sydney.

- The calculated cost of delivery and storage for northern Queensland or Darwin is more than double the cost into Sydney due to the need to use pressurized rather than refrigerated ships and smaller storage facilities. The total cost of delivery and storage could be approximately $US300/tonne.

*Appendix A*

# Attachments

## A.1 Glossary of terms

Table A.1

| | |
|---|---|
| ALPGA | Australian Liquefied Petroleum Gas Association |
| APPI | Asian Petroleum Price Index |
| Argus | Argus Media is one of the largest publishers of market information and pricing data in the petroleum industry |
| Backhaul | After delivery of cargo, a ship must usually sail back to a production location like the Middle-East to load another cargo. If it is able to load a cargo from Australia to (say) North Asia, the freight will generally be lower because the ship-owner has avoided the long trip back to the Middle East. |
| Baltic Exchange | A London-based organisation that provides information on, and markets in, shipping freight and chartering. |
| BassGas | A gas basin between Victoria and Tasmania. |
| Botany cavern | An underground LPG storage facility constructed by Elgas near Botany Bay near Sydney |
| Butane | A saturated hydrocarbon gas with the chemical formula C4H10. In conjunction with propane (C3H8) is collectively known as LPG. |
| C3 | Propane |
| C4 | Butane |
| CFR | A shipping term referring to the arrangement whereby the seller pays for the "cost and freight" to have the cargo delivered to a specified port. The buyer is required to pay for insurance. |
| Commoditisation | Is the process whereby increasing trade of a product leads to the creation of a market with many buyers and sellers actively participating in the process of buying, selling and trading a "standardised" rather than "differentiated" or unique product. |
| Cooper Basin | Onshore oil and gas basin in South Australia operated by Santos on behalf of partners. |
| Cost plus | A price that is determined by the acquisition cost plus the costs associated with a specific segment of the transaction. |
| CP | Contract price |
| DBNGL | Dampier to Bunbury natural gas pipeline |
| EPP | Export parity price |
| FEI | Far-East index |
| Field grade | LPG produced in association with oil or natural gas |
| Flat price | A negotiated fixed price. |
| Geogas | A large trader specialising in the LPG industry. |
| Gippsland | An oil and gas basin offshore eastern Victoria |
| IPP | Import parity price |
| Kt | Thousand tonnes |
| Kwinana | Location of the Wesfarmers LPG terminal near Perth in Western Australia |

| | |
|---|---|
| LIP | Long Island Point. The LPG loading facility associated with the Exxon-BHPB facility on Westernport Bay near Melbourne |
| LNG | Liquefied natural gas. LNG is primarily methane (CH4) with a very small amount (less than 4%) of hydrocarbon heavier than methane. |
| Market maker | A participant in transaction who takes on risk in the expectation of making a profit. |
| MMTPA | Million tonnes per annum |
| Moreton Bay | Location of the Origin floating storage near Brisbane |
| NWS | North-West Shelf |
| Otway | An oil and gas basin offshore western Victoria. |
| Peak-shaving | The process of using short term gas fired power generation to supplement baseload coal fired power generation to supply peaks in power demand. |
| Platts | Platts is the largest provider of energy news, information and pricing in the petroleum industry. |
| Port Bonython | The loading facility for Cooper Basin production near Whyalla in South Australia. |
| Pressurised | LPG compressed to high pressure for storage and transportation |
| Propane | A saturated hydrocarbon gas with the chemical formulaC3H8. In conjunction with butane (C4H10) is collectively known as LPG |
| Purvin and Gertz | One of the leading market analysts in the petroleum industry. |
| Qenos | A petrochemical producer with plants at Altona (in Melbourne) and Botany (in Sydney). |
| Ras Tanura | The major oil and LPG load port in Saudi Arabia |
| Refinery grade | LPG produced by refineries |
| Refrigerated | LPG chilled to low temperature to reduce its volume to enable economic transportation and storage. |
| Saudi Aramco | The government-owned hydrocarbon company of Saudi Arabia. |
| Saudi CP | The contract price (CP) or official selling price for propane and butane fixed by Saudi Aramco each month. |
| Semi-refrigerated | LPG at a reduced temperature (but above its boiling point) and high pressure (but below the pressure needed to liquefy at ambient temperature). The combination of low temperature and high pressure enables better freight economics. |
| SG | Specific gravity |
| Sonatrach | The government-owned hydrocarbon company of Algeria. |
| Spot market | Individual cargoes available for sale. |
| Tank-tops | A situation when storage tanks are full. This results in field or refinery production being curtailed until the storage limitation is rectified. |
| Tasweeq | A Qatari government organisation with responsibility to market Qatar's oil and gas production into international markets |
| TC | Time charter. Refers to the periodic (generally a duration of six months to five years) charter or lease of a ship. |
| VLGC | Very large gas carrier. A large refrigerated LPG ship larger than 75,000 cubic metres capable of transporting more than 44,000 tonnes of LPG. |
| Westernport | Location of the loading facility for Exxon-BHPB LPG and oil production from the Gippsland Basin; also known as Long Island Point. |
| Wet gas | A gas stream that has a high content of propane, butane and condensate. |
| WLPGA | World LPG Association |

## A.2 Import parity price calculation — methodology

Propane can be imported into Australia at nine marine terminals. While all are capable of importing, most only receive propane which is shipped from other Australian locations. In most instances, the reason for this is that the capacity of the tankage does not enable attractive freight economics.

Table A.2

| Location | Product | Terminal Capacity |
|---|---|---|
| Sydney | Pressure Propane | 65,000 tonnes |
| Brisbane | Refrigerated Propane | 44,00 tonnes Floating Storage |
| Cairns | Pressure Propane | 2,500 tonnes |
| Gladstone | Pressure Propane | 1,000 tonnes |
| Townsville | Pressure Propane | 1,250 tonnes |
| Darwin | Pressure Propane | 1,000 tonnes |
| Kwinana | Refrigerated Propane | 26,000 tonnes |
| Hobart | Pressure Propane | 1,800 tonnes |
| Bell Bay | Pressure Propane | 1,350 tonnes |

The most efficient means of importing propane is on Very Large Gas Carriers (VLGC), which carry 44,000 tonnes. VLGCs can discharge full cargoes of propane to Sydney and Brisbane, and part cargoes at Kwinana, but are not feasible for use at other locations due to either insufficient storage or berth constraints. While Kwinana is capable of receiving VLGC vessels, its storage limitation may result in it receiving smaller semi-refrigerated or pressurised imports. For the East Coast terminals, smaller pressure ships are used, mainly of 5,000 cbm (cubic metres) or 2,000 tonnes capacity.

In addition, propane can be trucked from the receiving terminals to most service stations in Tri Axle trucks (21 tonnes) and to other City Gate terminals in B Doubles (34 tonnes), however this is very expensive means of transportation over long distances.

### *East Coast of Australia*

The main propane import terminals on the East Coast are the Elgas cavern in Sydney and the Origin floating storage off Brisbane.

Elgas runs a tender for the supply of propane every 2 years or so for the supply of 300,000–400,000 tonnes of imported propane per year. The current holder of this supply contract is Geogas.

The majority of the propane is loaded on to propane trucks through a dedicated propane truck terminal and used for the domestic and autogas markets in NSW. Until recently, approximately 100,000 tonnes of the propane has been loaded on small pressures ships for use in the Pacific islands and New Zealand. Due to new sources of New Zealand LPG coming on in 2009, this volume of propane export has been reduced.

Origin also currently sources its propane imports from Geogas. Origin has arranged for Geogas to position a VLGC off Morton Bay, near Brisbane. The propane supplied to the Origin floating terminal is approximately 100,000 tonnes per year. The propane is offloaded by ship-to-ship transfer to small pressure ships to be delivered to smaller onshore storage at Pinkenba (near Brisbane) or delivered to Origin's storage in Cairns, Townsville, and Gladstone. Additionally, Origin supplies Kleenheat in Darwin.

All purchases are made on the basis of the Saudi Aramco Contract Price. The supplier (Geogas) will have a supply contract with Saudi Aramco or some other supplier who can supply propane only parcels. This supply agreement will not necessarily be at CP flat and may include a premium.

The cost of importing propane to the East Coast has been calculated as follows:

### *Freight - VLGC*

Propane ships are mainly chartered on long term Time Charter (TC) basis. However even though the supply of propane to Australia is done on a term basis, the supplier will have more than one ship and possibly a number of supply contracts. To calculate the IPP it is therefore easier to utilise the spot index for VLGCs.

Freight indexes for LPG are published by several organisations, but they are not as comprehensive as the Worldscale system used to calculate freight for oil tankers. The most commonly used are Platts, Argus and the Baltic Exchange for Ras Tanura (the main loading port in Saudi Arabia) to Japan route. The Ras Tanura to Japan freight rate used in the following import parity calculations is a normalised rate of US$42 per tonne. This was the 2005–08 term Argus TC average rate.

To estimate the freight for other locations, it is possible use the Ras Tanura to Japan route as a base and to pro rate the freight cost by the different number of sailing days to calculate indicative freight for other routes.

Example:

Ras Tanura to Japan is 22 days, however Ras Tanura to Sydney is 24 days, therefore an indicative Ras Tanura to Sydney rate is:

Ras Tanura to Japan x 24/22 = ~$US46/tonne.

Ras Tanura to Brisbane freight can be calculated on a similar basis and is very similar to the Sydney rate.

There may be additional costs associated with supplying propane only cargoes to the east coast of Australia if it is necessary to load from an extra port to source a full VLGC of propane.

### *Freight — pressure*

For the delivery of propane from the Origin floating storage to their Queensland marine terminals, Origin has several 5,000 cubic metres (cbm) pressure ships on time charter. Due to the complex nature of supplying propane to multiple destinations it is not possible to calculate an IPP for each port. It is assumed that a 5,000 cbm pressure ship would mostly be utilised for the Cairns, Townville and Gladstone business (2 deliveries on a milk run basis per month) and another 5,000 cbm pressure ship would be utilized on the northern Queensland and Darwin deliveries other than approximately 30% of its time for the Brisbane deliveries (2 deliveries per month). On this basis, based on the 2005–08 average Argus 5000 cbm TC rates, the average cost of delivery of propane to all locations would be US$62 per tonne. That said, it is illogical that the cost of freight from Moreton Bay to Brisbane is the same as Moreton Bay to Cairns! The IPP calculation assumes a subjective cost of $US44/tonne for Brisbane deliveries.

### *Insurance & loss*

The supplier of the propane may charge for the cost of insuring the cargo while in transit. Losses of product may also occur between loading and discharge. A nominal cost of US$1 per tonne has been used in the calculations for the Botany cavern and US$2 per tonne for Brisbane and Darwin because each requires an additional transfer.

### *Port fees*

Port fees are charged at the loading and discharge ports. It is assumed that the loading port fees are included in the freight cost. The fees charged at the discharge port include items such as navigation, towage, mooring/unmooring, site occupancy, agency fee, surveying etc. The costs have been estimated based on Sydney Port's costs. The only berth in Port Botany suitable for propane ships is the Dangerous Goods berth. This berth is a "first come first served" berth, rather than a scheduled berth. As a result, if another ship is on the berth loading/unloading, the VLGC has to wait until it has finished. This delay can add an extra $2 per tonne to the cost of discharging the cargo.

For Sydney the Port fees are based on Sydney Port costs, US$4 per tonne. Brisbane port costs are assumed to be higher at about US$7/tonne because of the two stage offloading operation.

### *Storage & terminaling fee*

Elgas invested A$190 million in 2000 to build the propane Cavern at Port Botany in Sydney. This facility can store 65,000 tonnes of propane and load out propane to pressure ships and propane road tankers. It is difficult to segment the costs (fixed and variable) into costs associated with storage and cost associated with terminaling. As a consequence, a total storage and terminal fee has been assessed. This fee has been calculated at US$90 per tonne, based on a throughput of 300,000 tonne and estimated costs and margin. This fee represents an assessment of the cost of building and maintaining the cavern, operating a ship unloading and loading facility and an unmanned truck loading facility.

The Brisbane storage cost is the cost of time chartering a VLGC, operating a ship unloading and loading facility and a truck loading facility. The assessment of this cost is about US$100/tonne, based on the 2005–08 average Argus VLGC TC rates and supply of 50,000 tonnes of propane to Brisbane.

#### *Suppliers margin*

It is highly likely that there is a small margin incorporated into the supply contracts of Elgas and Origin. This margin would reflect an assessment of the combined margin associated with the requirement for "propane only" imports, a requirement for security of supply to service the traditional market and a trading risk and service margin for Geogas. The quantum of this margin is difficult to ascertain, but would be comparatively small at approximately US$2/tonne.

### *Western Australia imports*

#### *Freight — pressure*

The only terminal that can receive LPG is the Wesfarmers LPG facility in Kwinana. This facility was originally set up to extract LPG from gas from the North West Shelf, however in 2005 the obligation to supply LPG rich gas terminated. Wesfarmers imports propane on an "as required" basis. There is no facility to load 15,000 cbm propane ships from the NWS and full VLGC cannot be discharged due to Kwinana storage and port restrictions.

Wesfarmers has 26,000 tonnes of propane and 13,000 tonnes of butane storage capacity at Kwinana. Production from Wesfarmers plant and BP's refinery satisfies WA demand other than in periods of disruptions in operations at the refinery or gas production). When production does not meet demand, Wesfarmers imports propane. The maximum feasible parcel size that can be stored is 20,000 tonnes due to tankage limitation. Additionally, vessels larger than this size are probably not possible due to draft limitation into the port.

The cost of imports has been calculated at US$110 per tonne, based on importing the propane from Asia in 15,000 cbm semi refrigerated ships and using the 2005–08 average Argus 15,000 cbm rate.

#### *Insurance & loss*

The supplier of the propane may charge for the cost of insuring the cargo while in transit. Losses of product may also occur between loading and discharge. A nominal cost of US$1 per tonne has been used in the calculations.

#### *Port fees*

Port fees are charged at the loading and discharge ports. It is assumed that the loading port fees are included in the freight cost. The fees charged at the discharge port include items such as navigation, towage, mooring/unmooring, site occupancy, agency fee, surveying etc. The costs have been estimated based on Sydney Port's costs of US$4 per tonne for a 15,000CBM ship.

#### *Storage*

The Wesfarmers facility includes extraction, storage and import facilities. The import facilities were completed in 2003 at a cost of A$5 million; the cost of building the original facility is estimated at A$50 million. Based on a throughput of 170,000 tonnes (imports and LPG extraction) and estimated costs and margin, the storage cost is calculated at US$49 per tonne.

#### *Terminaling fee*

The Wesfarmers storage cost includes the terminal fee.

### *Product premium*

Wesfarmers import on an "as required" basis, therefore are spot rather than term purchases. Depending on the relative liquidity and strength in the market, Wesfarmers would be required to pay a premium for a propane-only cargo. This premium may be $10/tonne or more. All purchases are made on the basis of the Saudi Aramco CP price, even though the LPG is likely to be sourced from Asia.

Table A.3

**INDICATIVE IPP CALCULATION — US$/TONNE**

| | Sydney Cavern | Brisbane VLGC | Kwinana | Darwin |
|---|---|---|---|---|
| Freight — VLGC[1] | $46.00 | $51.00 | NA | $51.00 |
| Freight — Pressure | NA | $44.00 | $110.00 | $189.00[2] |
| Insurance/loss | $1.00 | $2.00 | $1.00 | $2.00 |
| Port fees | NA | $7.00 | $4.00 | $7.00 |
| Storage & terminal fee[3] | $90.00 | $101.00 | $49.00 | $50.00 |
| Supplier margin[4] | $2.00 | $2.00 | $10.00 | $2.00 |
| **Total CP plus** | **$139.00** | **$207.00** | **$174.00** | **$301.00** |

Notes:

1. The freight calculation is based on the average of the 2005-2008 spot market rates. This reflected a "normalised" market that was probably near the long-term average rate required to justify construction and operation of modern VLGC ships. Our assessment is that this rate is likely to be indicative of the freight included in the current Geogas contracts with Elgas and Origin. The spot freight rate since mid-2008 has been significantly below these levels. It is possible that this will be reflected in the contracts when they are re-negotiated in late 2009, but it is unlikely that spot market rates will remain this low indefinitely because they do not provide a sustainable revenue for ship owners.
2. Darwin freight assumes delivery via Brisbane.
3. Storage and terminal fees are difficult to separate without actual data.
4. The "supplier margin" reflects an assessment of the combined margin associated with the requirement for "propane only" imports, a requirement for security of supply to service the traditional market and a margin for trading risk and service.

Source: Market discussions and internal analysis.

## A.3 List of interviewees

Table A.4

| Organisation |
|---|
| Argus |
| Platts |
| RACV |
| Elgas |
| NRMA |
| Santos |
| Origin |
| Exxon-Mobil |
| BP |
| RACWA |
| Woodside |
| Wesfarmers/Kleenheat |
| Shell |
| ALPGA |
| Vitalgas |
| Geogas |
| Caltex |
| Shell Singapore |
| BHPB |

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